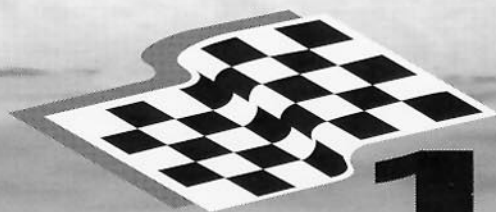


RACING

HANDBOOK

2000



1996

SEA-DOO RACING HANDBOOK

◆ **WARNING:** This information relates to the preparation and use of watercraft in competitive events. Bombardier Inc. disclaims liability for all damages and / or injuries resulting from the improper use of the contents. We strongly recommend that these modifications be carried out and / or verified by a highly-skilled professional watercraft racing mechanic. It is understood that racing or modifications of any Bombardier-made watercraft voids the watercraft warranty.

Racing of any product, including watercraft involves an assumption of risk by each competitor.

In watercraft racing these risks include, drowning, collision with other craft and falls onto the watercraft or into the water. The danger and risk is multiplied as speed is increased. Protective clothing or equipment including helmets **cannot** protect a racer in all conditions.

INTRODUCTION

Welcome to the world of SEA-DOO watercraft racing. The information in this manual contains the theory and operating principals of the SEA-DOO watercraft systems. It provides the foundation needed for setting up the watercraft for racing purposes.

All racers should obtain a copy of the model year SHOP MANUAL and necessary tools before attempting any mechanical work.

Many aspects of watercraft "Fine Tuning and Blueprinting", which are contained in this handbook are critical to insure safe and proper watercraft operation. If you are not absolutely sure how to accomplish an adjustment or procedure outlined in your service manual, please have your local authorized SEA-DOO Dealer perform the task.

The handbook also provides information on race day activities, rider presentation, general racing practices, sponsor solicitation and other useful tips to successful racing.

Some Sea-Doo watercraft may need to be altered from their stock configuration (even in the stock class) in order to meet racing guidelines established by race sanctioning bodies. It is important to refer to the racing rule book for direction.

When racing, do so within the confines of the official race meet. Do not disturb other boaters or others using the waterway. Keep your SEA-DOO watercraft legal!

Good Luck and success in your race.

Bombardier Inc.

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SAFETY

PLEASE READ AND UNDERSTAND ALL WARNINGS AND CAUTIONS IN THIS HANDBOOK.

This handbook uses the following symbols.

◆ **WARNING:** Identifies an instruction which, if not followed, could cause serious personal injuries including possibility of death.

▼ **CAUTION:** Denotes an instruction which, if not followed, could severely damage watercraft components.

○ **NOTE:** Indicates supplementary information needed to fully complete an instruction.

Prior to operating the watercraft, thoroughly read and understand the *Sea-Doo Operator Guide* and *Safety Handbook*, it will give necessary knowledge required to adequately operate your watercraft.

Check local and federal boating laws and regulations in the area where the watercraft is to be used. It is recommended to complete a boating safety course.

Never operate the watercraft after consuming alcohol and / or drugs.

At race events, always respect rules legislated by the organizer and sanctioning association.

KEEPING YOUR WATERCRAFT LEGAL AND WITHIN THE RULES
IS YOUR RESPONSIBILITY

RACE SANCTIONING ASSOCIATIONS

This handbook was written to help in the preparation of a Sea-Doo watercraft for competitive events.

Carefully study the association rule book and class of racing you intend to compete in before making any modifications to your watercraft. Your watercraft must conform to association specifications.

The IJSBA is the sanctioning association for the United States. You can contact them at the address listed below. The IJSBA will also be able to provide you with the contact information for the affiliate association in your country, as well as promoters in your region.

A membership in the association sanctioning the event is mandatory before competing in a race.

I.J.S.B.A.

INTERNATIONAL JET SPORTS BOATING
ASSOCIATION

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SECTION 01 - GENERAL RACING INFORMATION

PREPARING FOR RACE DAY ACTIVITIES

1) JOINING THE SANCTIONING BODY

All legitimate races are conducted under the guidance of a given sanctioning body. The most common being the IJSBA. The sanctioning body requires the promoter to meet safety standards and provide adequate insurance coverage for the event. You should purchase a rule book from them, or join the sanctioning body and receive a free rule book, well before you go racing. Study the rule book, learn the procedures and requirements. The rule book will give you strict guidelines as to what is allowed to be done to your vehicle for racing within a particular class. The phone numbers to the various sanctioning bodies are located on page VI of this manual. Call or write, and they will send you an entry form.

You must however, be 14 years old to join. If you are under 18 you must request a parental release form that must be signed and notarized by your parent or guardian.

2) REGISTRATION

Registration for a race should be done by mail several weeks before the event. This is the procedure preferred by the race promoter. However, most promoters, not all, will also hold late registration the night before or the morning of the race. Those who choose late registration are charged a penalty fee for that privilege.

During registration, you will have to indicate on the entry form the type of event and classes you have chosen to enter. Also at that time, your holder will need to sign a release form.

3) PIT AREA SET-UP

At the race site you will be allowed to set up your pit area the morning of the event at approximately 6:00 AM. Pit location is very important, be there early. You will have to place your watercraft close to the water line, your equipment and tent if you have one must be placed little further away. The promoter may not be on hand during your set-up. Look the site over the night before, if possible talk to the promoter to find out where to set up; by doing this, you will avoid moving all your equipment later and you will be able to get a choice spot with easy access to the water, as well as to your equipment. You are also required to keep a fire extinguisher in your pit and store your fuel in a designated area.

4) SAFETY INSPECTION

Before your watercraft is allowed on the water, the Safety Inspector, or his assistant, must perform a safety inspection.

The Inspector will check your full face helmet and your personal flotation device for compliance with sanctioning requirements. At that time your watercraft will be checked for safety requirements which are defined in your rule book, and then affix a sticker to your watercraft which signifies your compliance. After inspection you will be ready for practice, but remember, most promoters do not allow practice or free riding until after the rider's meeting. Failure to comply can mean disqualification or a fine.

During safety inspection ask the Inspector what type of fuel tests are going to be made (if any). Have your fuel tested at this time. Fuel from filling stations sometimes have alcohol added and may not test legal. Now is the time to find out and change fuel if necessary.

SECTION 01 - GENERAL RACING INFORMATION

5) RIDER'S MEETING

The rider's meeting is mandatory for racers. In many cases a roll call is held to ensure attendance. Failure to attend can be grounds for disqualification or a fine. During rider meetings the Promoter will discuss particular requirements for the day's events, including; practice order, course layout, starting procedures, number of laps, emergency rescue, technical inspections, and award presentation. If you have any questions or concerns, this is the time they should be discussed.

6) PRACTICE

Practice is for the purpose of learning the course. Red buoys signify left turns while yellow buoys are for right turns. Be on the line ready to go when your class is called. Do not race during practice. You may injure yourself or damage your boat. Many racers have been taken out during practice because of stupidity. Don't join their ranks. Remember, learn the course, don't tune your watercraft during practice. If your boat needs tuning it is due to poor preparation on your part. Go to a designated free riding area so that you can devote your thought to tuning and not negotiating the course or another rider.

7) RACE AND RESULT POSTING

The pit board will be posted before practice or shortly afterward. Now is the time to make sure you have been placed in the correct class and that your boat number is listed correctly. If you find any discrepancies see the Chief Scorer or Race Director immediately. Write down the race number that you are in, note the designated number of finishing boats that transfer to the final event. All transfer positions must report to tech inspection after the race. If you do not transfer during your heat race, then you will be placed in the LCQ (Last Chance Qualifier) race. In the LCQ only the top 1 or 2 riders will transfer. Know what the cut off point is for transfer positions and what race number the LCQ is. In some cases heat races will not be necessary due to a low rider turnout for your class. In the event that this is the case, you will normally run 2 races called "motos". You will be scored on each race and the combined totals will be your overall score. After your race, the official results for your race will be posted within 15 minutes. If there is a mistake see the Chief Scorer or Race Director at this time.

8) STAGING FOR THE RACE

When you come to the line for your race you will be lined up on the starting line. This is called staging. You will be lined up in 1 of 3 ways:

1. You will draw for your position.
2. The computer will line you up randomly as posted on the pit board.
3. You will be lined up in order of your finish position from your previous qualifier or heat race.

9) STARTING

Once in position on the line you will be allowed 1 or 2 holders to keep your boat in position safely. The holders will hold back your boat while the engine is running just before the rubber band is snapped. It is important that you practice your starts with your holders. Holders need to learn how to hold on to your boat while you increase the throttle. Holders must be in sync with you and the Starter. Many races are won or lost by your holders ability to get you off to a good start. Holders must use gloves to do a good job.

Starting procedures at your event will be discussed during the riders meeting. However, the best way to get the edge is for you and your holders to watch the Flag Man and Starter on the races prior to yours. Watching them will allow you to see the rhythm or pattern they are using for the start. This can give you the edge.

SECTION 01 - GENERAL RACING INFORMATION

It is very important to remember that if you jump the start you will be severely penalized. You will have to start with a dead engine, your throttle hand on your head and only 1 holder, or no holder to keep you in position.

10) THE RACE

Upon the start, hold your line until the first turn buoy. If you cut across in front of other riders you will be placed 1 lap down or black flagged. This does not mean you can not change lines. If you have a definite lead on another boat, and you will not endanger them, you can move in. Getting around the first turn buoy in good position is very important. If you are in back of the pack you will have a lot of trouble getting around the other boats before you finish.

In many cases a rider has been 2nd or 3rd to the first turn buoy and lost position because of water spray blinding their vision. Use race goggles at least for the first few buoys. You can duct tape the strap to the back of your helmet so you don't lose them when you pull them off.

Race smart. Stay close to your competitor and capitalize on their mistakes. Know the course.

Many times the leader has taken the wrong path with other riders following, just to have a slower rider negotiate the course correctly and win.

Be sure you race to the checkered flag. Many races have been lost because the rider thought the white flag was waved then stopped on the next lap. Flag men make mistakes. Race to the checkered flag, not 1 lap past the white. Always race past the start / finish line and between the two finish line buoys. Many Expert and Pro racers on the IJSBA National Tour have gone outside the finish line buoy during the race or at the finish, only to be penalized one lap. Racers with big leads have actually come to the finish line, slowed down and turned directly into the technical inspection area without crossing the finish line. Others have been passed because they slowed down. Race past the finish line, continue around the course as not to interfere with slower riders still finishing the race. Never turn and go against the flow of traffic after you have finished the race, even if you are going to tech. Continue around the course to get back.

11) TECHNICAL INSPECTION

After your qualifying race or moto you will be required to go to Technical Inspection if you have placed in a transfer position. On your first trip to tech, the Technical Inspector will record your hull number. The hull number is located below the bond flange on the right rear of the hull. The purpose of recording your hull number is to insure that you will be running the same boat in the final that you have qualified for or in your second moto.

On a Sea-Doo, the number is imprinted in the fiberglass or on a black tag with a series of dots forming letters and numbers. This number can be extremely hard to read, especially in the water. To make reading easier, paint over the numbers with white paint. After the paint dries lightly use a little steel wool or very fine sandpaper to take the paint off of the hull. This procedure will leave the paint in the dots which now can be easily read. At some races the inspector will place a special sticker with a serial number on the rear of the hull for easier reading.

After your hull number is recorded, the inspector may make a series of visual inspections inside and outside the hull to verify class legality or to see if safety requirements have been met. The inspector may use a paint type seal on various areas of the engine to prevent a rider from going into the engine and removing illegal parts that may have been used for qualifying. If, after the race, something goes wrong which requires you to break a seal to perform service, take your boat to the inspector before breaking the seal. You will then be able to perform repairs at tech. This will allow the inspector to check the parts coming out for legality, and he will be able to apply a new seal upon completion.

SECTION 01 - GENERAL RACING INFORMATION

After your final moto, you will then return to tech for verification of hull and seal authenticity. At this time the inspector may require the top 3 finishers to disassemble various parts of the engine for close inspection. You and one mechanic will be allowed in tech to disassemble the required items. You will not be reimbursed for any cost of gaskets, etc. If you refuse tear down you will be disqualified. In limited classes, usually the technical inspector has you remove the rotary valve housing in order to check for an illegal rotary valve. Also the head may have to be removed to check for porting in limited classes, or bore and stroke measurements for displacement limits in the modified class.

If you are using your boat in another racing class later that day, inform the inspector, he will have you come back after your last race. Don't forget to come back. The inspector keeps close notes and you will be disqualified if you do not return.

12) EMERGENCY RESCUE

During the race, several Course Marshals will be riding the course watching for missed buoys and fallen riders. In the event of an accident and you go down, wave your arm over your head if you are OK. Other riders can see you easier and the Course Marshal will pull you back to your boat.

If you are hurt, the Course Marshal will be in the water as soon as they reach you. At that time the race will be red flagged. The Course Marshals will then determine if a backboard is needed. Once they get you to shore, the EMT will take over and transport if necessary.

Always make sure that you have all your emergency information written down. Designate a member of your team to get this information to the EMT as soon as possible. The information sheet must contain your:

1. Full name
2. Address and phone number
3. Allergies
4. Blood type
5. Person to contact in an emergency and phone number
6. Insurance company
7. Social Security Number
8. Employer's name and phone number

PREPARING FOR A SAFETY INSPECTION

On race day you must have your watercraft safety inspected. The Technical Inspector will thoroughly check the watercraft for safety requirements. The requirements vary slightly from one sanctioning body to another. The IJSBA is the most stringent in their requirements. The following is a list of items the inspector will evaluate, if the race is IJSBA sanctioned.

1. Boat numbers and backgrounds must be of the correct size, color coordinated, and placed in the correct location on the watercraft. On Sea-Doo watercraft the numbers are required to be on the upper portion of the front deck, as close to the storage compartment as possible. This allows ease of visibility for the scoring staff. The background and boat number colors are determined by your experience level:

Novice - White Numbers - Medium Blue Background.

Expert - Black Numbers - Yellow Background.

Pro - Black Numbers - White Background.

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Your boat numbers must be at minimum 18 cm (7 inches) high and must be spaced 13 mm (.5 inches) apart. Backgrounds must be 20 cm (8 inches) high and 15-36 cm (6-14 inches) wide, depending on the amount of numbers you run. Boat numbers will be assigned to you by the IJSBA, or in regional events, you will be allowed to choose your own number, providing the number has not already been selected by another rider. Check with the IJSBA or your regional promoter, prior to buying or painting numbers on your boat.

2. The bow eyelet on all models excluding the 1995 and 96 XP and HX watercraft must be removed prior to inspection and racing. It is recommended that a length of nylon rope be used to replace the eyelet. The rope will facilitate easy towing off the course by the Course Marshals in the event of a breakdown and prevent water entry into the hull. When securing the rope ends inside the nose of the hull, the eyelet retaining plate must continue to be used in order to prevent the rope from pulling through.
3. The pump intake grate must have at least one bar running the length of the inlet and must not protrude down more than 12 mm (.473 inches) below the flat plane of the intake portion of the pump housing.
4. The ride shoe (pump plate) must not contain any fin or rudder type protrusions, and aftermarket plates must stay within required dimensions.
5. The rubber bumpers must be in place and securely attached.
6. The hull and deck must not have any sharp edges (torn or improperly repaired fiberglass).
7. Steering must turn from lock to lock without binding.
8. The handle bar grips must be secure.
9. After market handle bars that have a cross bar must have padding on the cross bar.
10. The fuel cap must fit tightly.
11. The throttle lever must work freely.
12. The Safety Lanyard (tether cord) will be checked for proper operation.
13. The engine idle will be checked to determine that the engine will not idle in the event of lanyard failure.
14. Inside the hull the fuel tank, oil tank, and battery box will be checked for secure mounting.
15. All fuel lines must be secured to the carburetor and fuel tank with clamps or zip ties. Fuel injected engines must have approved high pressure fuel lines. There can be no fuel leaks of any type.
16. Flame arresters must be USCG approved and not modified.
17. Electrical components must be properly wired, insulated, and routed away from high temperature components.
18. Decals that are required to be placed on the boat by the sanctioning body, promoter, or sponsor will also be checked.
19. You will be required to show your USCG approved floatation device and approved full face helmet, without face shields, at this time.
20. The sponsons on the Stock Sea Doo XP and GT models protrude beyond the width of the hull bond flange. Because of this it is necessary that the sponsons be filed or ground down to fit within the bond flange in order to be race legal.

NOTE: The inspector will place a small decal on your boat upon satisfactory completion of the inspection. If you are competing in a multi-day event, the inspection will be valid for the entire event.

SECTION 01 - GENERAL RACING INFORMATION

PRE RACE MAINTENANCE LIST

The following items should always be checked when preparing for an upcoming race:

1. Check the engine compression. If the compression is low or the variance between cylinders is greater than 10 psi, determine the cause and remedy the problem. Check the torque on the cylinder head bolts. Put in new spark plugs.
2. Check the ignition timing and ignition flywheel nut torque.
3. Lubricate the electric starter gear and shaft. Check the starter mounting bolts for tightness and the starter electrical cable for a clean, corrosion free, connection, both on the starter and solenoid.
4. Check all rotary valve housing, intake manifold, and carburetor mounting bolts for tightness.
5. Check for correct oil injection pump adjustment, if an injection pump is being used.
6. Check the fuel filter for debris or water, if any abnormality is noticed, remove and clean the fuel tank, fuel filter, fuel lines, and carburetors.
7. Carburetor diaphragm screws should be checked and pop off pressure verified. Now is a good time to check your low and high speed fuel mixture screws to make sure they have not backed out and are still set to the required setting. Throttle cable operation should be checked to insure maximum throttle opening is being attained. Lubricate the throttle cable at this time.
8. Clean or replace the flame arrester as necessary.
9. Engine bed plate bolts should be checked for tightness.
10. Check all exhaust system components for cracks or signs of fatigue. Pay close attention to rubber couplers, exhaust pipe, and exhaust manifold mounting bolts.
11. Service the battery and check for clean, corrosion free, battery cable connections.
12. Grease the PTO flywheel and the drive shaft seal carrier at their grease fittings. If the seal is damaged replace it.
13. Check the hull and deck for signs of cracking, or damage. If the bottom of the hull has been damaged or scraped, repair should be made to restore the configuration to it's original shape.
14. The impeller housing should be removed to allow for a close inspection of the jet pump and related parts. Impeller clearance, stator vane, and general pump condition should also be checked. Remove the drive shaft and inspect the splines. Check for correct engine to pump alignment. Grease all necessary components during reassembly. Lubricate the steering stem, steering support and cables. Upon completion, check for proper steering cable and trim cable adjustments.

NOTE: Poor engine to jet pump alignment will cause excessive vibration and loss of horsepower!

15. Check the pump intake grate for damage and tightness.
16. Verify that all gauges are functioning correctly.
17. Test ride the watercraft and perform any adjustments before leaving for the race site.
18. Flush the cooling system to insure cleanliness and maximum cooling system efficiency.

The following items should be checked between races :

1. Remove the spark plugs and check their condition, change if necessary.
2. Check the exhaust system for leaks and tightness.
3. Check throttle operation, make sure full throttle is being attained.
4. Visually inspect all inner hull components for secure mounting and proper operation.

SECTION 01 - GENERAL RACING INFORMATION

5. Adjust fuel and oil levels as needed.
6. Visually inspect the hull for external damage or punctures, repair as necessary.

NOTE: Irreparable hull damage, which occurs during a race, is the only reason a racer is allowed to run a different boat in a race than that which they have already qualified for. The Technical inspector must make the determination.

7. Check the intake grate for damage and secure mounting.
8. Inspect the pump for rocks or debris that may have been lodged inside.
9. Check the operation of the steering components and adjust or tighten as necessary.

EQUIPMENT AND SPARE PARTS TO BRING TO THE RACE

Racers must be prepared for any situations that may arise on race day. However, most racers do not have the resources required to attain, or to transport all the equipment necessary to cover all possible situations. You will have to determine what your capabilities are for the level of racing you are at (Pro, Expert, Novice) and just how important winning a race is to you.

Serious racers normally have two boats of equal capabilities. If a problem is encountered on one boat, before it is qualified for an event, the backup boat is used. If the boat has already been qualified for a race, the parts are taken from the backup boat, then used to repair the qualified boat. These racers normally bring extra parts as well.

All racers should be equipped with the *Service Manual* for their watercraft. They should have at minimum the necessary tools to accomplish the service procedures that they are capable of performing themselves.

The following is a list of parts and equipment that are recommended for you to have on hand for quick repair when needed :

1. Spark plugs.
2. A complete gasket and o-ring set.
3. Two sets of piston rings.
4. Two flywheel keys.
5. Extra exhaust couplers.
6. A roll of fuel and water line.
7. A throttle and steering cable.
8. A fuel filter.
9. A carburetor rebuild kit.
10. A starter motor.
11. An ignition coil and multi-purpose electronic module.
12. A fully charged battery and jumper cables.
13. Quick drying epoxy or fiberglass repair kit.
14. Various size hose clamps.
15. Zip ties of assorted sizes.
16. Safety wire.
17. Duct tape and electrical tape.
18. Waterproof silicone sealer.
19. Assorted nuts and bolts.
20. A grease gun with grease.

SECTION 01 - GENERAL RACING INFORMATION

PIT AREA PRESENTATION

Your pit area is of major importance in many ways. Race teams that are well financed actually pay the promoters to place large tents, with sponsor names on them, at the most advantageous locations on the beach. This allows them greater media exposure by film crews, and easy access to the water for their racers.

For these same reasons, and more, your pit location is just as important.

Your choice for pit location should be based on the following factors. Weigh these factors in your mind and make the best possible choice given the circumstances.

1. You need to set up where you will receive the greatest amount of exposure to the spectators, media, and well financed race teams. You need to be recognized for your professional appearance, your attention to small details, and your finishing position by all of these people. Setting up next to large race teams will allow you to watch them and learn from them. When people come to see these teams, they will also see you.
2. You must be able to get your boat to and from the pit area between races. This will allow you to service the boat with easy access to your tools. In some cases this is not possible because the race site will not allow for it.
3. Set up where other racers do not have to go through your pit to get to their boat or the water.

Your pit area is a reflection on your sponsors as well as yourself. You should invest in a tent for your pit as soon as you can afford one. Always anchor your tent, and do not leave it up over night, unless it is very secure. The tent should be attractive and of a light color to be cooler. A section of indoor / outdoor carpet to set your watercraft stand and tool box on can help add a professional appearance.

Many racers hang banners of sponsors on their tents to advertise their sponsors. This can add appeal to your area, assuming you don't clutter the tent with too many banners. Some racers have designed a small billboard and placed it next to their tent. The sponsors names have been placed on the billboard with custom paint or decals. The billboard can also be arranged to prevent easy access to, or through, your pit. Some sponsors may be providing you with very generous support. You might want to design something special for them. Again, sponsors are always looking for new and innovative ways to advertise, if you can provide that "something different" it will not only help you keep a sponsor, but other sponsors will recognize your work and may throw support your way.

Keep your pit area clean, bring a small waste can for your pit, (it's another place to put decals) it adds to the professional look. You are required to have a fire extinguisher in your pit. Do not set it on the ground, it will be hard to locate in the event of an emergency. Attach a hanger to one tent post and place the extinguisher on it. Your fuel container should be of high quality, red in color, (a requirement, not normally enforced by the promoter), and stored away from smoking areas.

There should be no horse play in your pit area, again, your conduct, and that of others with you, is a direct reflection on your professionalism. Do not loose your temper, act like a child, or allow yourself and those with you to use profane language, under any circumstance.

INTERACTION WITH RACE OFFICIALS

There are many officials that you will come in contact with during race day. These officials have specific duties required of them, all of which play a part in how efficiently the race is conducted. Always treat the officials with respect. Never raise your voice, use profane language, or make rude gestures to officials. You can always discuss your differences without losing your cool. Being loud and obnoxious will not change the officials mind on a decision, but it can sway his opinion on future matters, normally against you! Treat all officials courteously, it will pay off in the long run.

SECTION 01 - GENERAL RACING INFORMATION

The person in charge of the officials is the Race Director. The Race Director orchestrates all activities on race day. If you have a problem with a judgement made by an official, and you cannot come to an equitable solution, see the Race Director. The Race Director is in charge of settling disputes. The Race Director's calls are final at the race site. If you feel the wrong decision was made, you can file a written protest to the Race Committee of the sanctioning body, under which the race was conducted. Normally, the protest must be accompanied with a protest fee. If it becomes necessary, follow the procedures outlined in your rule book for filing an official protest. There has been documented cases where the Race Committee has reversed the decision of the Race Director, however, it is rare.

The most common problems which arise between racers and officials occur at the start of the race. Racers jump the start, and then the race is red flagged, or the rider and their holders are unhappy because they feel a red flag should have been thrown, but was not. Because of these problems being most common, it is recommended that you watch the start of the races preceding yours whenever possible. Determine the type of calls the Starter is making and use the information to your advantage. When problems arise, and the call is made against you, respond professionally. If you believe that the call made by the Starting Official was incorrect, talk to the Race Director. The Race Director's decision is final in these matters.

The second most common problem occurs during a race because a racer misses a buoy and no officials witnessed the incident, or the racer was called for a missed buoy and the racer believes they did not miss the buoy. When missed buoys are not seen by a race official, then the call against the racer in question cannot be made, even when the error was captured on video tape. Video tape evidence is not permissible by any sanctioning body. If you feel that the call made against you was invalid, consult the Race Director. The Director will consult with the official making the call against you. If that official wishes to retract the call on the buoy in question, the decision will be reversed. The Director will not reverse an officials call, unless the Director witnessed the situation personally.

While there are many examples of differences between officials and racers, most can be solved without bringing the Race Director into the conversation. An example of this would be a scoring error. When a discrepancy arises in scoring that places you further back in the race than you thought was correct, see the Chief Scorer. The Chief Scorer will recheck the lap charts to determine if an error was made. If no error is found, the Scorer can explain to you how they arrived at the decision.

If your complaint concerns the legality of a given watercraft's modification, go to the Technical Inspector. The Inspector knows the modification rules better than any other official, it's their job. If you believe that a boat is illegal, tell the inspector. If the item can be visually inspected without any tear down, the Inspector will normally keep an eye open for the infraction. If the infraction requires engine or pump tear down, it would then be your responsibility to lodge a formal protest. The protest must be in writing to the Race Director. The protest must be specific, not general in scope. For example; you may protest the fuel induction system, ignition system, or crankshaft, but, you could not protest the entire engine as a whole unit. Each item protested must be accompanied with a protest, and an additional fee to cover tear down. The fee is determined by the Technical Director and Race Director. You are allowed only a short time period to file the protest after the race concludes. Check your rule book for specific details.

Remember, officials can make mistakes, but so can racers.

When problems arise, conduct yourself in a professional manner. Attempt to locate and deal with the official that handles that aspect of the race. If you don't get satisfaction, then it's time to take your problem to the Race Director. The outcome may not always be to your liking, but if you handle yourself professionally the Race Director will be more open to your comments, and in the future will place more validity on your side of the argument.

SECTION 01 - GENERAL RACING INFORMATION

SPONSORSHIP AND SOLICITATION

There are many levels of sponsorship available to racers. The amount of sponsorship you receive is primarily dependent on your national ranking and experience level (novice-expert-pro). There are many novice and expert racers with much greater sponsorship support than some pro racers. The reason is, that they made a commitment to their racing program. They practiced hard, stayed in shape, and made sure their machines were always race ready. Because of this, they won races, received media coverage, and gained recognition.

Recognition is what sponsorship is all about. Racers seek sponsorship to help offset the cost of racing, while sponsors support you for one purpose, recognition of their product. Your winning races promotes their products and exposes them to a large target population group. The sponsor hopes this will enhance their image and sales.

As a novice, expert, or first year pro, the type of sponsorship support you can expect will normally be very limited unless you're the best in your class. When you're national number one sponsors will be at your door step, however, in the mean time you must actively seek support in every possible way. Many large companies have solicited marketing specialists to research and determine the feasibility of racer sponsorship, while most smaller or local businesses have not. On a regional level these smaller businesses may not even realize the potential for product recognition that watercraft racing can bring them. Go after these sponsors, invite them to a regional race so that they can experience first hand the advertising opportunities available to them.

When making initial contact with a potential sponsor, attempt to set up an appointment to meet with them. Try to avoid discussing your proposal over the phone or by mail. Face to face meetings normally accomplish much more. Major sponsors will have representatives at the national events in your area. Call these people several weeks prior to the event and arrange a meeting with them during race weekend. In many instances personal meetings are impossible. When this is the case, contact the sponsor by phone and inform them that you will be sending your resume and sponsorship proposal to them for review. Close your conversation by setting a date to call again to discuss your proposal.

Your resume should begin with your personal information such as; name, age, address, marital status, schooling completed, occupation, etc. Next, you should list your future goals as a watercraft racer. This section should be concise and to the point. It should outline your short term and long term goals.

After your statement of goals, list all the races you have competed in, complete with your finishing positions and overall titles. Conclude your resume with a listing of your previous sponsors, their product line, and any major media coverage that you have received that would be advantageous for a sponsor to know.

The complexity of your sponsorship proposal will vary, quite noticeably, depending upon the level of racing at which you are competing. Racers who are competing in regional events, or are well back in the standings on the National Tour, are not able to get the "high dollar" support that requires an exhaustive detailed proposal. Most proposals should list the various levels of support that are available for the sponsor within your racing program. Each level of support should be followed by a statement of the service you will provide for that support.

There are many ways a sponsor can support your racing program and there are many services you can provide for that support.

Types of support can include:

1. Products such as; racing equipment for your boat, racing apparel, safety equipment, or transport equipment (trailers-totes).
2. Services including; repair work or modifications to your engine, hull, jet pump, or paint jobs for your boat and trailer.
3. Cash for entry fees, and other types of expenses.

SECTION 01 - GENERAL RACING INFORMATION

The services you can provide for this support is only limited to your imagination. Innovative, new ideas are what businesses are looking for. The better job you do for the sponsor the more support you can count on in the future.

Types of services can include:

1. Placing the product name on various racing equipment, such as your boat, truck, trailer, helmet, wet suit, or tent. Different decal size or location can be dependent upon the amount of support received by the sponsor.
2. News releases can be sent out to the magazines and newspapers detailing your wins and sponsor support.
3. You can provide your sponsor with your trophy to be displayed in their place of business or office.
4. You can make personal appearances at their business, or fund raisers to sign autographs or to talk about the effectiveness of their products.

Your proposal must include a list of the races you will compete in for that season. The listing of races should include the date of each event, and detail the estimated rider and spectator turnout.

Racers competing on the National Tour, that are ranked in the top five in the world in their respective classes, seek an entirely different level of support than most racers. These racers normally receive support from the manufacturer of the watercraft they race. Some riders receive support directly from manufacturers race team directors, while others receive support from the manufacturer through factory race centers. These individuals have achieved the highest goals in racing through hard work and commitment to their racing program. They started out just like you, with the ambition to be the very best racer they could be. With hard work, preparation, and a little luck, you can do the same.

THE PROFESSIONALS POINT OF VIEW

Westcoast Performance Products' Racing Team Manager, Ken Clark was asked, what does a Team Manager look for in the "Ideal Racer". This was his response:

The ideal racer has a fierce desire to win, and will work as hard as necessary to accomplish that goal. Regardless of that old saying, "it's not whether you win or lose, it's how you play the game", the ideal racer will only understand the winning part of this. For the ideal racer, anything other than victory is only second best. The ideal racer has a commitment to the sport they have chosen to compete in. These racers are always searching for ways to improve their performance, either by superior physical conditioning, superior personal skills and coordination, or a better understanding of the dynamics of the vehicle involved. This takes a dedication that is foreign to most competitors, which, combined with superior motor skills, is what distinguishes champions from other competitors. There is a single-mindedness evident in the racers that I have seen become champions. In nearly every case, this factor was evident from the very first.

In conclusion, the riders that I am looking for have demonstrated a level of intensity and dedication that makes them noticeably different from the majority of other competitors. These traits coupled with physical condition, coordination, and courage are the qualities that will take them to the top in whatever sport they chose to compete in.

Ken Clark,
Pro Racing Team Manager,
Westcoast Performance Products

SECTION 01 - GENERAL RACING INFORMATION

Jeff Prieur and Kelly Kurpil are two of the top Professional Sea Doo racers in the world. Each were asked to give their point of view concerning their racing careers.

Most people that race Personal Watercraft seem to share the same goal. That goal is, to be the fastest on the track and to someday become a "Professional". What does it take to be a Pro racer? Is just being a fast racer enough to make you a candidate to be a Pro? The answer, "No".

There are a lot of different aspects of being a Pro, which include training, diet and mind control. To be at one with your craft, to have a certain confidence (not to be confused as cockiness) and to be able to make everything you do look easy.

In my years of racing I've seen many talented riders come and go. The racers that prevailed had one thing in common, "PERSEVERANCE". They were able to conquer their goals after major set backs, such as equipment failure, personal injuries, or being knocked off your watercraft at the start of the race and battling your way back to the lead.

Being a Pro is a big responsibility. You have a responsibility to your sponsors and to your sport. As a professional racer you are a representative of your sponsors and all personal watercraft racers. Everything you do on or off the track is reflected on those you represent.

If you are a budding Pro racer and wonder sometimes if it is all worth it, I personally know the feeling. I've been through the ups and downs of a Pro racing career (more downs than ups) and wondered myself sometimes. I also know the feeling of winning and winning World Championships. There is nothing that can compare to the feeling of being number one.

I feel the challenge is worth the effort. Good luck.

Jeff "Poison" Prieur
Pro Watercraft Racer

As a Pro Runabout racer each day of training, testing and racing has taught me more. Conditioning has become a big part of my daily routine. I learned early on while racing in the Modified Division against the men, that physical strength plays a major role in being competitive. Each day I include a weight training program with my personal trainer for strength and stamina. Weight training has given me the strenght I need to compete on a professional level. I use this training to my advantage to improve my endurance and cornering skills. This type of conditioning has taught me dedication, motivation, responsibility and self control. The lessons I have learned have helped me sharpen the skills I need to be a competitive racer.

Racing may not be for everyone because of the commitment involved. But for me, I feel racing brings out the best in me and builds physical endurance. I knew at my first race as a novice when the rubberband snapped, that my life would never be the same again. It takes a special individual to pursue an avenue of contrast excitement and disappointment. However, that's what racings all about.

Being a Pro Runabout racer is a big responsibility. Racing impacts every part of your life. I feel (as does Sea-Doo) that the image I project to others must be positive. This includes safety, responsibility, and attitude both on and off the race course. You must always be a positive role model.

While racing, fear can not be in your vocabulary and challenge you accept on a one to one basis. Your striving each day to improve upon the talents that people may think comes naturally.

My commitment and conditioning to be a Pro Runabout racer has put me up front in my class. A class that many people dare not adventure, for fear of where it may or may not lead them. Take the challenge, it may bring out the best in you.

Kelly Kurpil
Pro Woman Runabout Racer

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PREPARING THE HULL FOR INSPECTION

The production hulls produced by Sea-Doo are manufactured to fine tolerances. All riders can benefit from truing the hulls. Hull truing becomes most beneficial on watercraft equipped with highly tuned modified engines. Exacting tolerances are necessary to attain proper high speed stability.

The section of the hull where truing is most important is from the rear of the hull to a point approximately 1.5 meters (60 inches) forward. This is due to the fact that at high speeds only the rear section of the hull is in contact with the water. You can not alter the hull configuration more than 2 mm (0.079") in any direction if you are racing in Limited Class, otherwise your modification will be illegal.

NOTE: The hull bond flange can not be altered in length or width even in the modified classes. Doing so is considered an illegal modification by all sanctioning bodies.

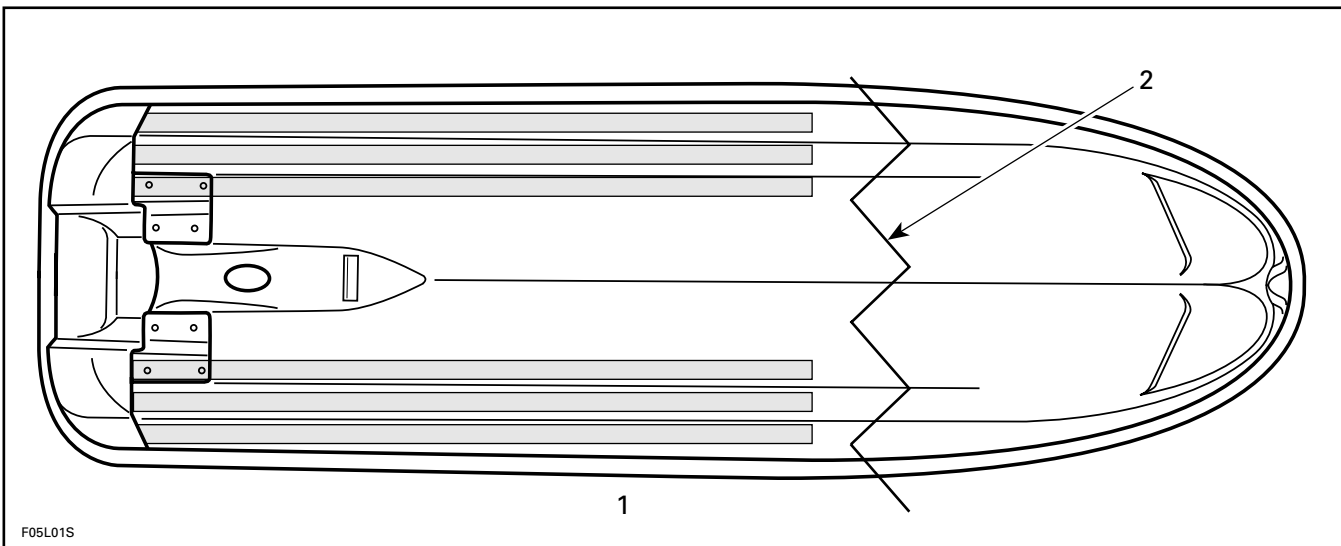
The following steps must be observed before turning the watercraft upside down.

- remove seat
- remove battery
- remove engine and jet pump
- siphon fuel and oil from tanks

NOTE: Refer to appropriate model year *Shop Manual* for proper removal and installation procedures.

MEASURING THE HULL

A straight edge should be used to measure the condition of the hull bottom surface. Place straight edge on its most rigid side along the bottom of the hull. Identify the low and high spots on the surface as shown below.



1. Place straight edge at difference locations as shown by shadow areas
2. Not necessary to true beyond this point

TRUING THE HULL

Truing the hull means to make the hull as straight as possible. This will help you gain maximum performance and top speed. Follow these steps and you will attain a good racing hull. Special tools and materials may be required to perform this work.

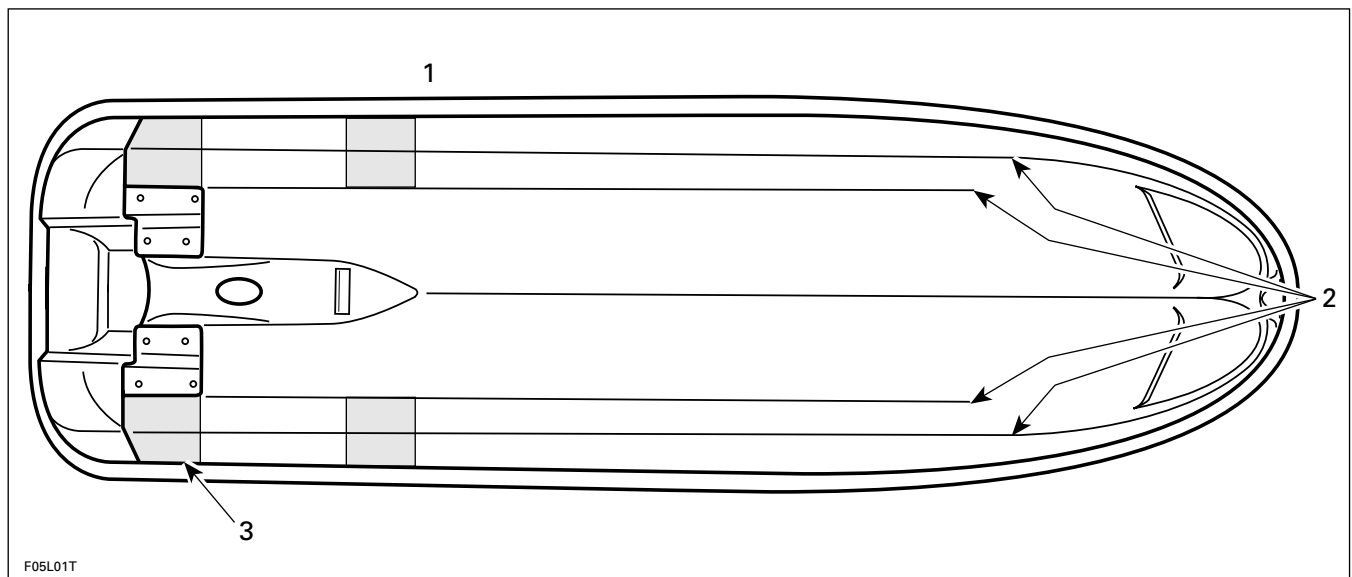
REQUIRED TOOLS AND MATERIALS

- pneumatic long sander
- long flat sander (long board)
- dual action sander
- sandpaper
- epoxy fairing compound (found at marine supply store)

NOTE: It is not recommended to use bondo or auto body filler as it is less durable and can absorb water. A compound with fiberglass particles in it will be very hard to sand flat and true if proper techniques are not observed.

PROCEDURE

- a) Remove intake grate.
- b) Mask off body and ride shoe. Accurately place masking tape down in seam where aluminum ride shoe meets relief in hull.
- c) **Carefully** sand each section by hand using the long board sander. This will help to indicate the low / high spots along the hull surface. Be careful not to remove excess material.



TYPICAL

1. Shadow areas indicate possible high spots
2. Strakes
3. Corner to be reinforced

- d) Using the dual action sander, sand the low spots just enough to rough up the gelcoat. These low spots are indicated where gelcoat hasn't been sanded with the long board. This is done so that fairing compound will adhere.

SECTION 02 - HULL PREPARATION

- e) Measure the low area and mix up enough filler material to fill the area in. Follow the manufacturers mixing instructions. Fill low area and blend in evenly with bondo spreader. Try to leave your filler a little high so you have material to sand. Allow proper curing time.
- f) Using the pneumatic long sander, sand the area until you accomplish a flat surface. Remember to finish edges, radius and flat sections of strakes as well. Using the straight edge, check the area which was just finished. Verify flatness and if the area still has a low spot, start your filling steps again.
- g) At the rear of the watercraft, where the transom meets the hull, there is a radiused edge (approx. 4 mm radius) this radius should be covered with epoxy fairing compound and sanded to a square edge.
- h) For refinish, we recommend using PPG products. PPG high build K-36 primer can be used for fine finishing small hull irregularities after application of fairing compound.

PAINTING

GENERAL

The following was prepared in conjunction with PPG Industries Inc. It contains 2 painting procedures, CONCEPT™ the most commonly used, and DELTA™ (with low VOC) mainly used in California.

If more information is needed, contact a PPG dealer or a Sea-Doo watercraft authorized dealer.

CONCEPT™ PAINTING PROCEDURE

For additional information refer to *PPG P-Bulletin* no.168.

SURFACE PREPARATION

Prepare and clean surface consistent with good painting practices.

PRIMER

DP Epoxy Primer / DP 401 Catalyst; DX 1791 / 1792 (Prime before topcoating).

PRIMER SURFACER

K36 / K201, K200 / K201 or DZ KONDAR® Primer Surfacers.

 **NOTE:** KONDAR® must be sealed before applying CONCEPT color.

SEALER

KTS30 2K Sealer, DP Epoxy Primer reduced as a sealer or DAS 1980 or DAS 1987.

DIRECT GLOSS COLOR

HOW TO MIX

Standard Air Dry: Mix CONCEPT Color 2:1:1 - 2 parts color with 1 part DT Reducer best suited to shop temperatures and 1 part DU 4 below 29°C (85°F) or DU 5 above 29°C (85°F) Hardener.

Standard Force Dry: Mix CONCEPT Color 2:1:1 - Application temperatures below 29°C (85°F) use DU 5 Hardener, above 29°C (85°F) use DU 6.

Medium Solids (MS) Application: For faster film build, when using solid colors, mix 2 parts CONCEPT color with half part DT Reducer and 1 part DU 5 or DU 6 Hardener. Select the DT Reducer appropriate for shop temperature.

POT LIFE

Pot Life of ready-to-spray CONCEPT color is 6 to 8 hours at 21°C (70°F). Medium solids option is 2 to 4 hours at 21°C (70°F).

FULL PANEL AND OVERALL REPAIRS

APPLICATION

Apply 1 medium wet coat and give 5-10 minutes flash, followed by 2 wet coats with 15 minutes flash time between each coat. Adjust metallic on the last full wet coat. If necessary, apply a mist coat. For medium solids option apply 2 full wet coats.

AIR PRESSURE

275-345 kPa (40-50 PSI) at the gun.

SECTION 02 - HULL PREPARATION

DRY TIME

- dust free: 30 minutes
- tack free: 2 to 3 hours
- tape print free: 6 hours
- dry to handle: 6 to 8 hours at 21°C (70°F)
- force dry: 40 minutes at 60°C (140°F)

Faster dry times may be obtained by using 15 mL (1/2 oz) of DXR 81 Accelerator per sprayable 1.2 L (quart), however, the pot life is reduced to 2 hours.

SPOT / PANEL REPAIRS

APPLICATION

Spray medium wet coat of color on the repair area and allow 5-10 minutes flash time. Apply 2 additional full coats until hiding is achieved, extending each coat beyond the previous coat. Flash 15 minutes between each coat. For medium solids option apply 2 full wet coats.

BLENDING

Add DT 95 Reducer to a second gun cup. Reduce the fluid feed of the gun and lower the air pressure to 207 kPa (30 PSI). Dust the dry edge until a slight wet look appears, then stop. Or mix reduced and catalyzed color with equal parts of reduced and catalyzed CONCEPT DCU 2020 Clear.

SECTION 02 - HULL PREPARATION

DELTA™ PAINTING PROCEDURE

(with low VOC, mainly in California)

For additional information refer to *PPG P-Bulletin* no. 157.

SURFACE PREPARATION

Primer : DELTA™ PRIME PPU 166.

DELTA™ 2800, COLOR

HOW TO MIX

Mix DELTA™ 2800 2:1, 2 parts colors to 1 DU 6 Catalyst.

APPLICATION

Apply 2 coats of DELTA™ Polyurethane Color. Apply the first coat at 1.5 - 1.8 wet mils. Allow a minimum of 15 minutes flash time prior to application of the second coat. Apply a second coat of DELTA™ using the same technique as the first application, paying strict attention to gun set up and proper equipment choices.

RECOMMENDED SPRAY EQUIPMENT

Gun Manufacturer	DeVilbiss	Binks	Graco	HVLP
Gun Model	JGA	62	800N	Can Am Model 900
Fluid Tip Size	FF 1.4 mm (.055 in)	63D 1.5 mm (.059 in)	02N 1.2 mm (.047 in)	HT #9072 2.5 mm (.098 in)
Air Cap	797 / 264	63PW	02 / 03	C9062
Gun Distance	26-30 cm (10-12 in)	26-30 cm (10-12 in)	26-30 cm (10-12 in)	26-30 cm (10-12 in)
Fluid Delivery	227-340 mL / min. (8-12 oz / min.)	227-340 mL / min. (8-12 oz / min.)	227-340 mL / min. (8-12 oz / min.)	227-340 mL / min. (8-12 oz / min.)
Air Pressure (At-the-Gun)	42-51 kPa (60-75 PSI)	42-51 kPa (60-75 PSI)	42-51 kPa (60-75 PSI)	62 kPa (9 PSI)

DRY TIME (AT 21°C (70°F))

- dust free: 25-35 minutes
- tack free: 2-1/2 - 3 hours
- tape / sand: Overnight

FORCE DRY

Allow 20 minutes purge time at 27-32°C (80-90°F) before bake. Bake 75 minutes at 65°C (150°F) or 40 minutes at 82°C (180°F). Allow to cool after force dry, before sanding or taping.

SECTION 02 - HULL PREPARATION

SEALING OF BODY COMPONENTS

Important areas to check: hull, storage compartment cover, water trap tank, drain hoses, seat seal and rear baffle. Reseal all leaks (Refer to appropriate *Shop Manual*).

HULL AND BODY MAINTENANCE TIPS

To obtain a smooth hull after every use, wash watercraft with soap and water. This will remove residues which will slow your watercraft. Wax the hull periodically. When storing outdoors, keep your watercraft covered.

LIGHT WEIGHT PARTS

There are several aftermarket MFG which produce lighter weight and / or stronger parts for racing purposes such as seats and storage covers. These are worth considering. Be sure the parts you are installing are within the rules.

SPONSON KITS

Advantages of the sponson

- improved handling
- reduces spin out. Holds better in corners
- more stability

NOTE: The sponsons on the Stock Sea Doo XP and GT models protrude beyond the width of the hull bond flange. Because of this it is necessary that the sponsons be filed or ground down to fit within the bond flange in order to be race legal.

There are long type sponsons and short type sponsons available in kits. They do work well when interchanged within the same type. It is only a matter of preference.

AVAILABLE KITS:

Short Sponsons

295 500 168 GREY (XP 93)

295 500 194 / 195 (GREEN / MAGENTA respectively)

Long Sponsons

295 500 092 GREY

INSTALLATION GUIDELINES

The following pertain to all types of sponsons. The sponson holes location are given for short type. For long type, it is recommended to experiment to obtain what you require.

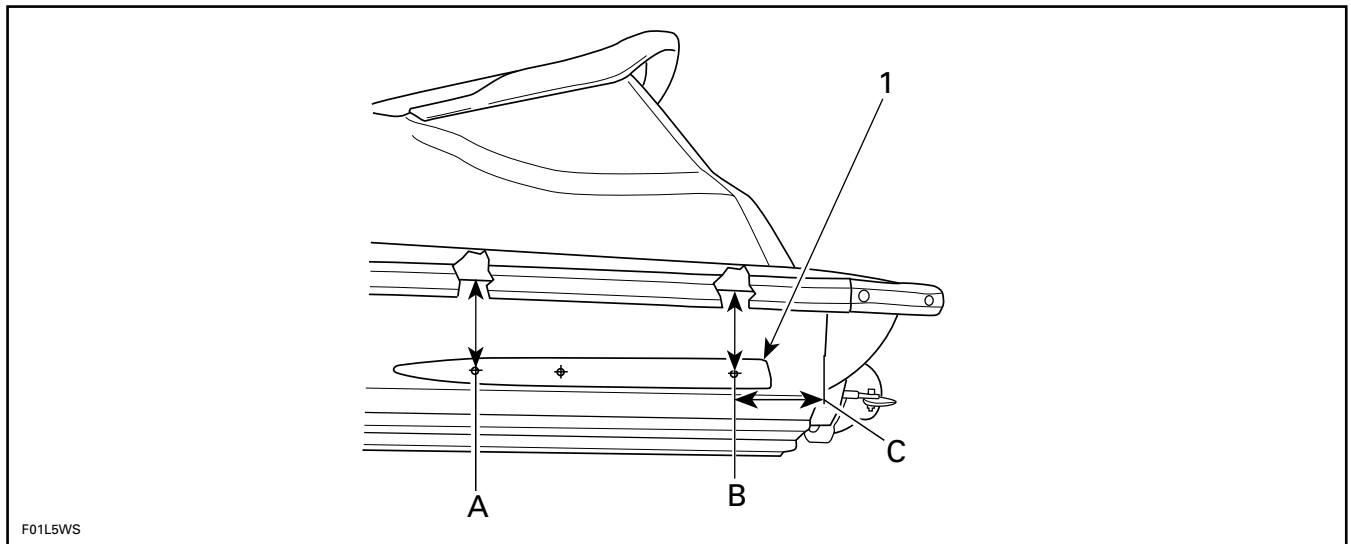
Minor adjustments in angle or height location of the sponson can have a tremendous effect on handling and speed. The position illustrated is a good starting point. Pro riders experiment with sponson design and location many times before they choose a position or design which is best suited for their riding style.

Experimenting with location of sponsons is time consuming but necessary. Sponsons that are angled with the front too far down will cause the rear of the watercraft to drag in the water. Sponsons angled with the front too far up will cause the nose of the watercraft to plow. You must find the position that works best for you. The one sponson position that keeps the pump in the water in corners without sliding out, while not creating excessive down force.

Sponsons, when attached must not exceed the width or length of the bond flange. The bond flange is considered the fiberglass joint under the rubber bumper, not the bumper. Most add-on long sponsons will require sanding on the base before attachment to prevent this from occurring.

HOLE LOCATION IN HULL (SHORT SPONSONS)

The vertical measurement must start from under the top edge of the hull. This will avoid mounting the sponson too low.



- 1. Template on hull
- A. 100 mm (3-15/16 in) from hull flat surface
- B. 89 mm (3-1/2 in) from hull flat surface
- C. 115 mm (4-17/32 in) from center of radius

Be sure to verify stud location on your particular sponsons and compare to dimensions on diagram. Some minor adjustments may be necessary. Mark center of holes in gelcoat with an awl or center punch. When drilling holes in fiberglass start slowly with a light pressure on drill motor, as it is easy to drift off your locating point.

SECTION 02 - HULL PREPARATION

URETHANE FOAM CUTTING

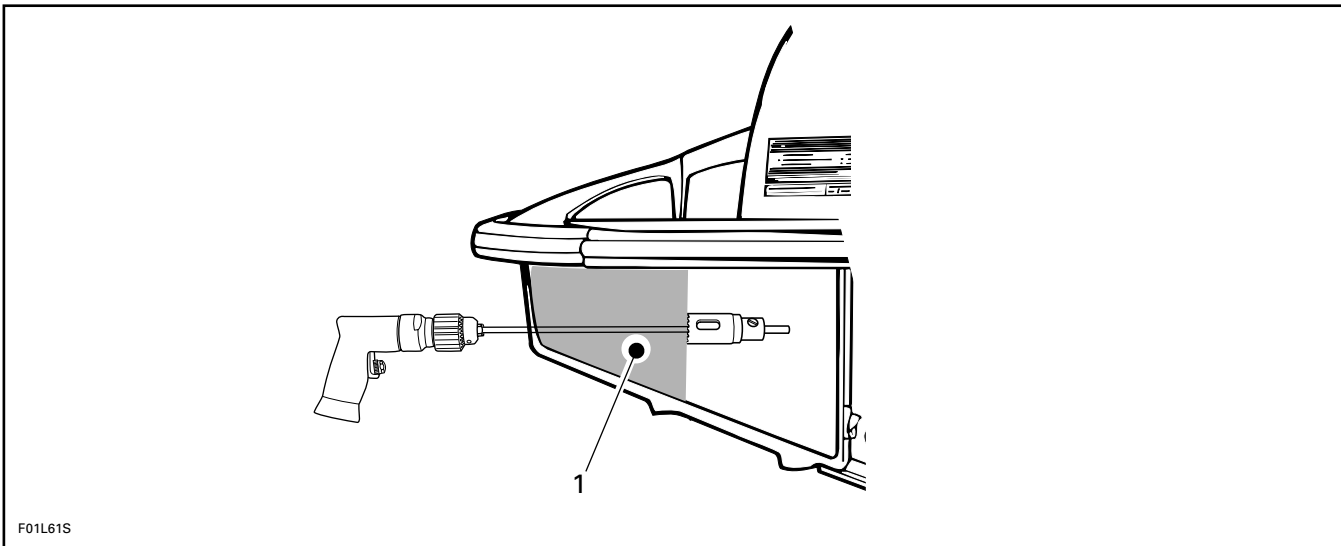
Cutting of the urethane foam can be accomplished by using a 35 mm (1-1/2 in) hole saw.

NOTE: The center drill bit must be removed from the hole saw.

Insert a pilot wire through the urethane foam.

Then, insert a 6 mm (1/4 in) steel rod through the urethane foam by hand.

From inside bilge, attach the hole saw to the steel rod. Refer to the following illustration.



1. Urethane foam

Start cutting the urethane foam by carefully pulling hole saw into the foam and operating the drill in reverse position.

NOTE: Depending on hole saw depth, approximately 3 passes will be required to cut the urethane foam. Keep the first foam core. It will be reinstalled once the job is completed.

CAUTION: When cutting the last portion of urethane foam, carefully listen to the sound of the hole saw making contact with the side of the hull. Stop sawing immediately and remove the remaining foam by hand.

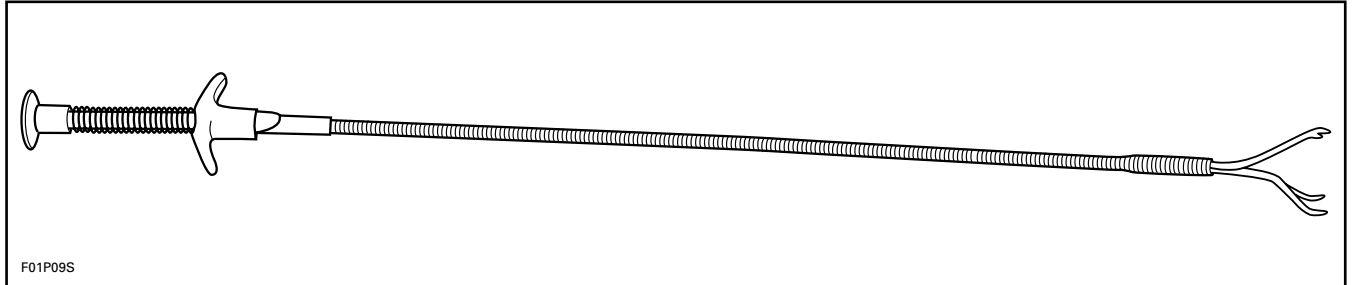
SECTION 02 - HULL PREPARATION

SPONSON INSTALLATION

Place a generous bead of silicone sealant along mating surface of sponson and around studs. This will help keep water from entering through attachment holes.

Insert sponson locating studs into corresponding holes inside of hull.

Install flat washers onto sponson studs using a flexible 4-claw pick-up tool (Snap-on YA837). Apply Loctite 242 to nuts prior to installation.



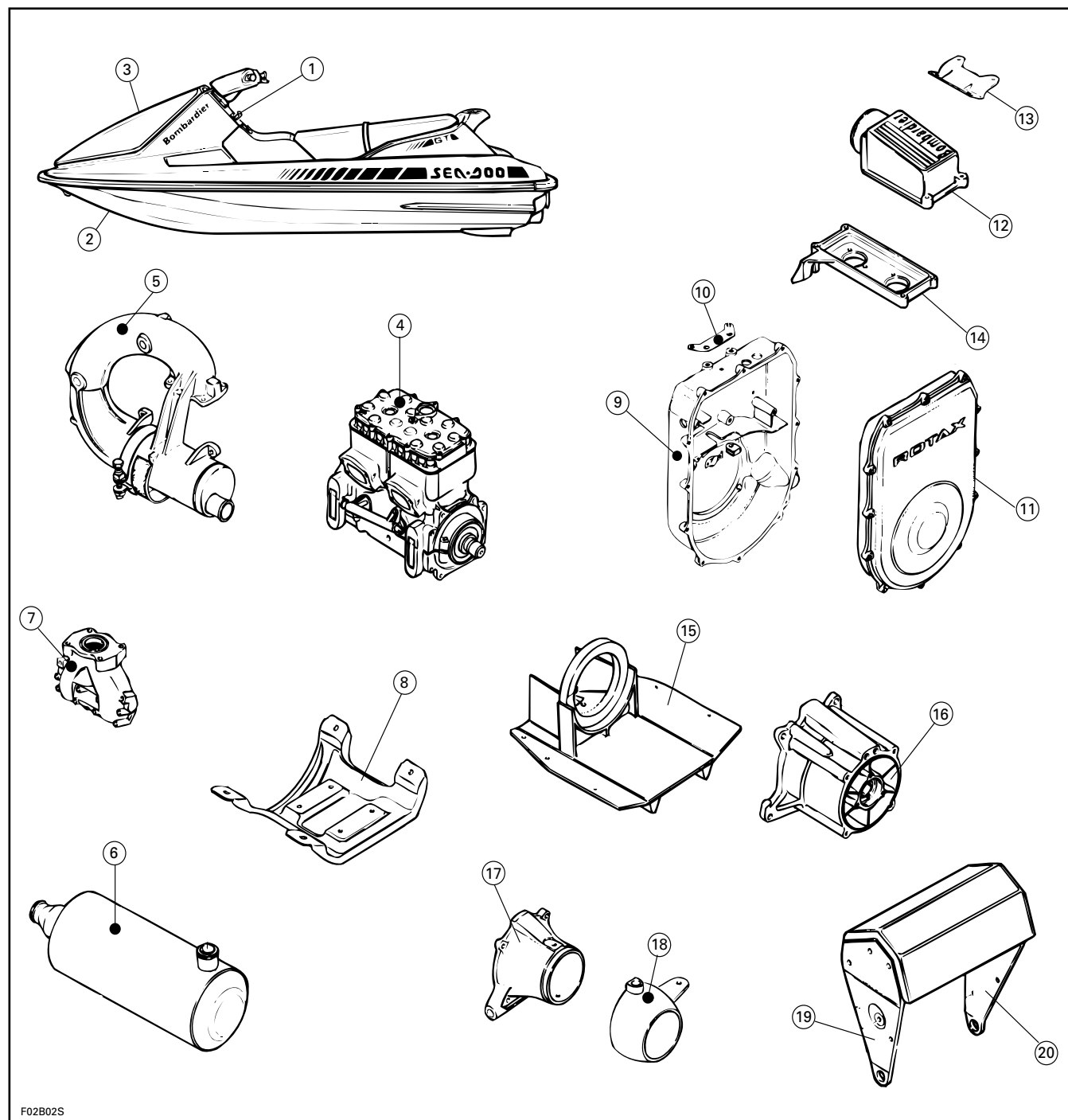
Install lock nuts by using the 4-claw pick-up tool or a 10 mm deep socket. Torque nuts to 10 lbf•ft).

URETHANE FOAM REINSTALLATION

When sponsons installation is completed, you can reinstall the first removed urethane foam core into each hole. Glue with RTV 128 sealant (P / N 293 800 027).

SECTION 02 - HULL PREPARATION

PARTS THAT CAN BE PAINTED (1988-1991 WATERCRAFT MODELS)



F02B02S

- | | | | |
|------------------|------------------------------|----------------------------|------------------------------|
| 1. Body | 6. Muffler | 11. Ignition Housing Cover | 16. Impeller Housing |
| 2. Hull | 7. Exhaust Manifold | 12. Flame Arrester Cover | 17. Venturi |
| 3. Storage Cover | 8. Engine Support | 13. Flame Arrester Support | 18. Steering Nozzle |
| 4. Engine | 9. Ignition Housing | 14. Flame Arrester Base | 19. Reverse Gate Left Plate |
| 5. Tuned Pipe | 10. Ignition Housing Support | 15. Ride Shoe | 20. Reverse Gate Right Plate |

SECTION 02 - HULL PREPARATION

PPG COLOR CHART

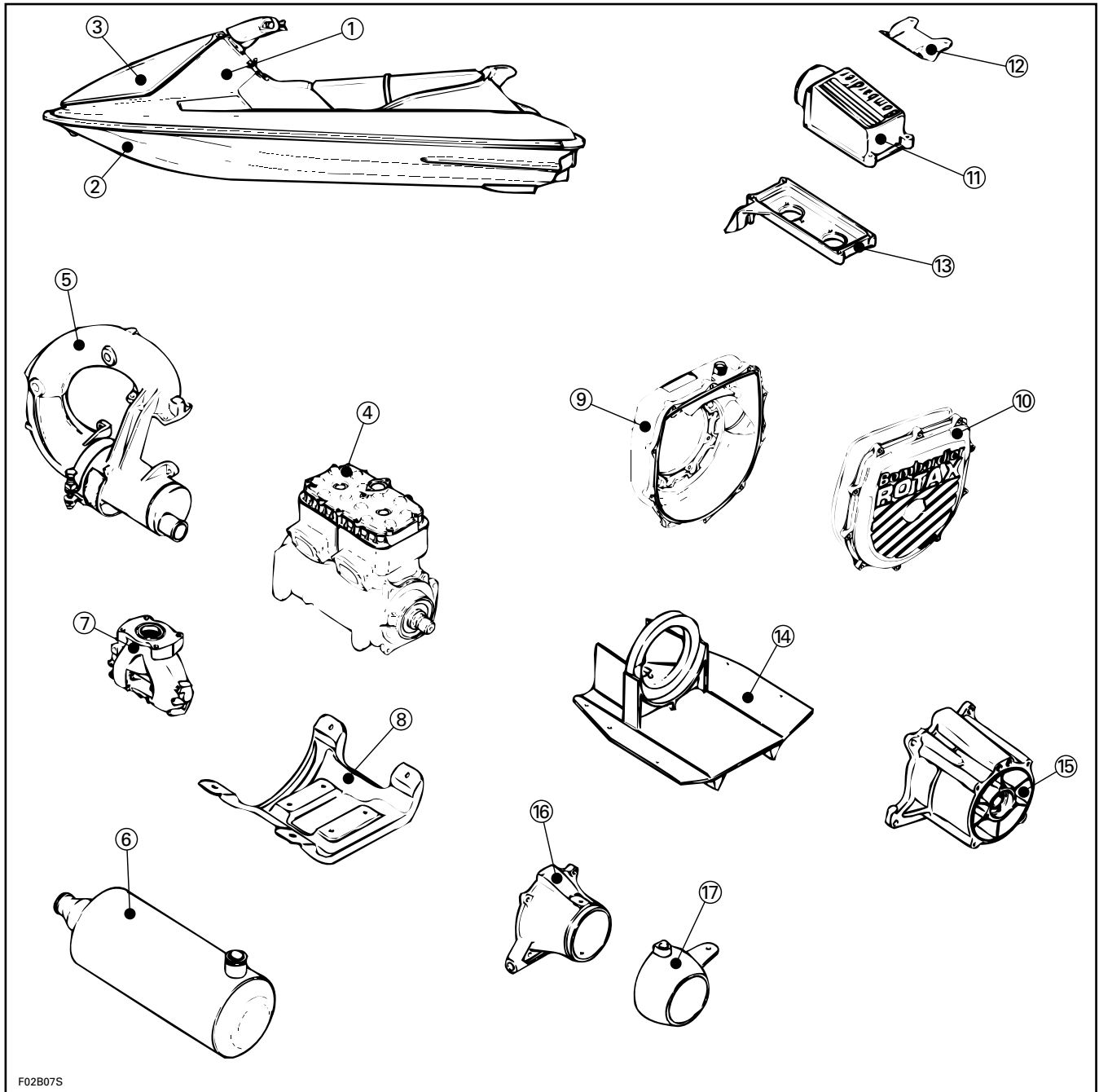
COMPONENTS	1988-1991 SEA-DOO MODELS			
	SP (5801 / 5802)	SP (5803 / 5804)	GT (5810 / 5811)	XP (5850)
1. Body	White 98192	White 98192	White 98192	White 98192
2. Hull	Medium Dark Gray 38248	Medium Gray 38247	Medium Gray 38247	Purple 59962
3. Storage Cover	Not Applicable	Not Applicable	Medium Blue 17861	Not Applicable
4. Engine	Yellow 88207	Yellow 88207	Yellow 88207	Yellow 88207
5. Tuned Pipe	Black 9551	Blue 17862	Blue 17862	Purple 59963
6. Muffler	Black 9551	Blue 17862	Blue 17862	Purple 59963
7. Exhaust Manifold	Yellow 88207	Yellow 88207	Yellow 88207	Yellow 88207
8. Engine Support	Black 9551	Black 9551	Black 9551	Purple 59963
9. Ignition Housing	Yellow 88207	Yellow 88207	Yellow 88207	Yellow 88207
10. Ignition Housing Support	Yellow 88207	Yellow 88207	Yellow 88207	Yellow 88207
11. Ignition Housing Cover	Yellow 88207	Yellow 88207	Yellow 88207	Yellow 88207
12. Flame Arrester Cover	Black 9551	Blue 17862	Blue 17862	Purple 59963
13. Flame Arrester Support	Yellow 88207	Yellow 88207	Yellow 88207	Yellow 88207
14. Flame Arrester Base	Black 9551	Blue 17862	Blue 17862	Purple 59963
15. Ride Shoe	Medium Dark Gray 38248	Black 9551	Black 9551	Purple 59963
16. Impeller Housing	Medium Dark Gray 38248	Black 9551	Black 9551	Purple 59963
17. Venturi	Medium Dark Gray 38248	Black 9551	Black 9551	Purple 59963

SECTION 02 - HULL PREPARATION

COMPONENTS	1988-1991 SEA-DOO MODELS			
	SP (5801 / 5802)	SP (5803 / 5804)	GT (5810 / 5811)	XP (5850)
18. Steering Nozzle	Medium Dark Gray 38248	Black 9551	Black 9551	Purple 59963
19. Reverse Gate Left Plate	Not Applicable	Not Applicable	Black 9551	Not Applicable
20. Reverse Gate Right Plate	Not Applicable	Not Applicable	Black 9551	Not Applicable

SECTION 02 - HULL PREPARATION

PARTS THAT CAN BE PAINTED (1992-1993 WATERCRAFT MODELS)



1. Body
2. Hull
3. Storage Cover (GTS and GTX Models Only)
4. Engine
5. Tuned Pipe
6. Muffler
7. Exhaust Manifold
8. Engine Support
9. Ignition Housing

10. Ignition Housing Cover
11. Flame Arrester Cover (Except XP Model)
12. Flame Arrester Support
13. Flame Arrester Base
14. Ride Shoe
15. Impeller Housing
16. Venturi
17. Steering Nozzle

SECTION 02 - HULL PREPARATION

PPG COLOR CHART

COMPONENTS	1992 SEA-DOO MODELS			
	SP (5805)	GTS (5812)	XP (5851)	GTX (5860)
1. Body	White 98208	White 98208	White 98208	White 98208
2. Hull	Medium Gray 38247	White 98208	Purple 59962	White 98208
3. Storage Cover	Not Applicable	Lavender 59974	Not Applicable	Magenta 59973
4. Engine	White 98209	White 98209	White 98209	White 98209
5. Tuned Pipe	Gray 38269	Gray 38269	Purple 59962	Purple 59962
6. Muffler	Gray 38269	Gray 38269	Purple 59962	Purple 59962
7. Exhaust Manifold	White 98209	White 98209	White 98209	White 98209
8. Engine Support	Black 9551	Black 9551	Purple 59962	Purple 59962
9. Ignition Housing	White 98209	White 98209	White 98209	White 98209
10. Ignition Housing Cover	White 98209	White 98209	White 98209	White 98209
11. Flame Arrester Cover	Gray 38269	Gray 38269	Purple 59962	Purple 59962
12. Flame Arrester Support	Gray 38269	Gray 38269	Purple 59962	Purple 59962
13. Flame Arrester Base	Gray 38269	Gray 38269	Purple 59962	Purple 59962
14. Ride Shoe	Black 9551	Black 9551	Purple 59962	Purple 59962
15. Impeller Housing	Black 9551	Black 9551	Purple 59962	Purple 59962
16. Venturi	Black 9551	Black 9551	Purple 59962	Purple 59962
17. Steering Nozzle	Black 9551	Black 9551	Purple 59962	Purple 59962



NOTE: Due to natural discoloration, it may be necessary to completely repaint the part.

SECTION 02 - HULL PREPARATION

PPG COLOR CHART

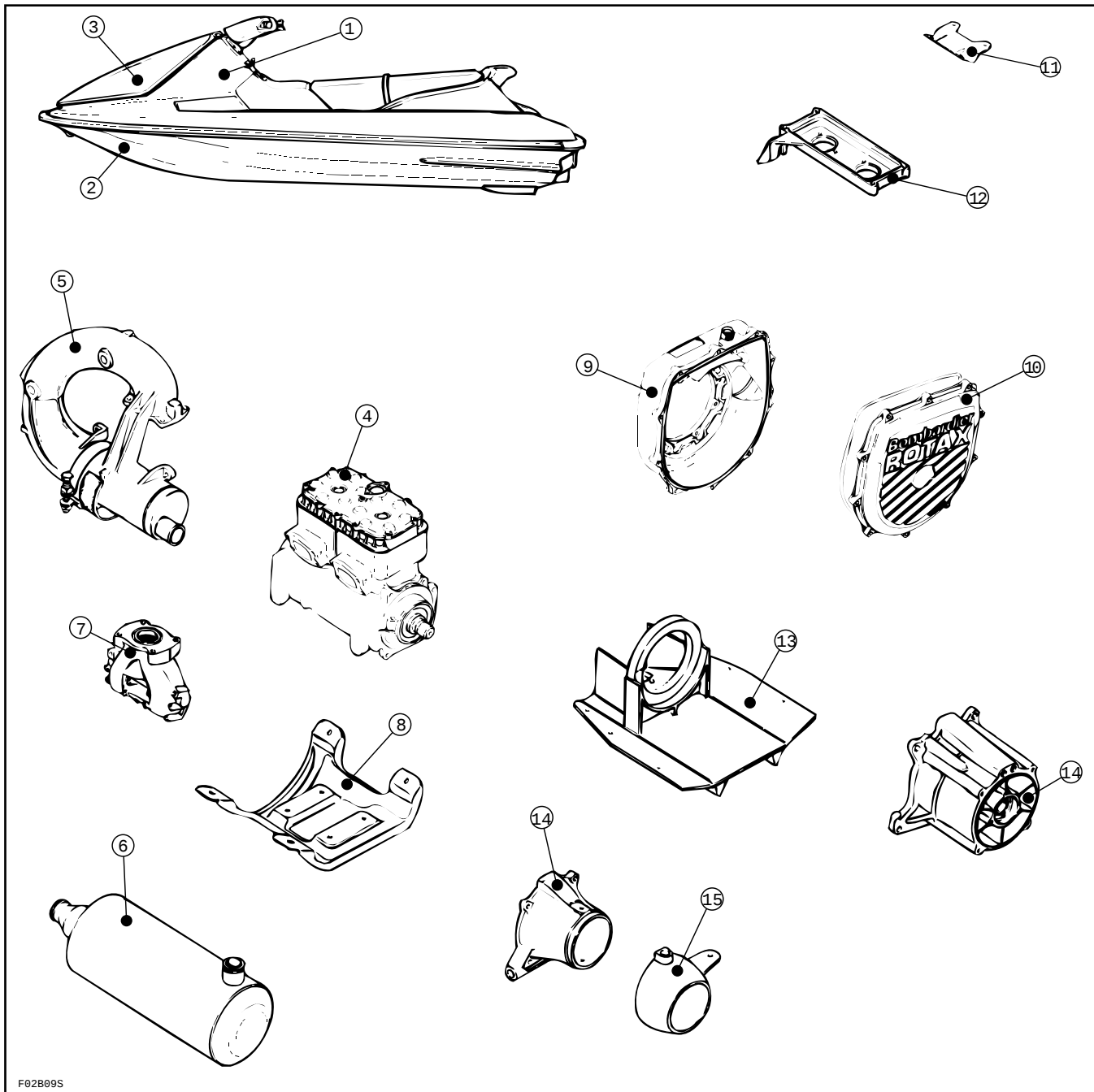
COMPONENTS	1993 SEA-DOO MODELS					
	SP (5806) SPI (5808)	SPX (5807)	XP (5852)	GTS (5813)	GTX (5861)	EXPLORER (5820)
1. Body	White 98223	White 98223	White 98223	White 98223	White 98223	White 98223
2. Hull	Light Gray 38287	Medium Blue 19518	Light Green 49580	White 98223	White 98223	White 98223
3. Storage Cover	Not Applicable	Not Applicable	Not Applicable	Lavender 59974	Magenta 59973	White 98223
4. Engine	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
5. Tuned Pipe	Gray 38269	Gray 38269	Purple 59962	Gray 38269	Purple 59962	Gray 38269
6. Muffler	Gray 38269	Gray 38269	Purple 59962	Gray 38269	Purple 59962	Gray 38269
7. Exhaust Manifold	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
8. Engine Support	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
9. Ignition Housing	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
10. Ignition Housing Cover	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
11. Flame Arrestor Cover	Gray 38269	Gray 38269	Not Applicable	Gray 38269	Purple 59962	Gray 38269
12. Flame Arrestor Support	Gray 38269	Gray 38269	White 98209	Gray 38269	Purple 59962	Gray 38269
13. Flame Arrestor Base	Gray 38269	Gray 38269	Purple 59962	Gray 38269	Purple 59962	Gray 38269
14. Ride Shoe	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
15. Impeller Housing	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
16. Venturi	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
17. Steering Nozzle	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
18. Console	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	White 98223



NOTE: Due to natural discoloration, it may be necessary to completely repaint the part.

SECTION 02 - HULL PREPARATION

PARTS THAT CAN BE PAINTED (1994 WATERCRAFT MODELS)



- F92B09S
1. Body
 2. Hull
 3. Storage Cover (GTS and GTX Models Only)
 4. Engine
 5. Tuned Pipe
 6. Muffler
 7. Exhaust Manifold
 8. Engine Support

9. Ignition Housing
10. Ignition Housing Cover
11. Flame Arrester Base
12. Ride Shoe
13. Impeller Housing
14. Venturi
15. Steering Nozzle

SECTION 02 - HULL PREPARATION

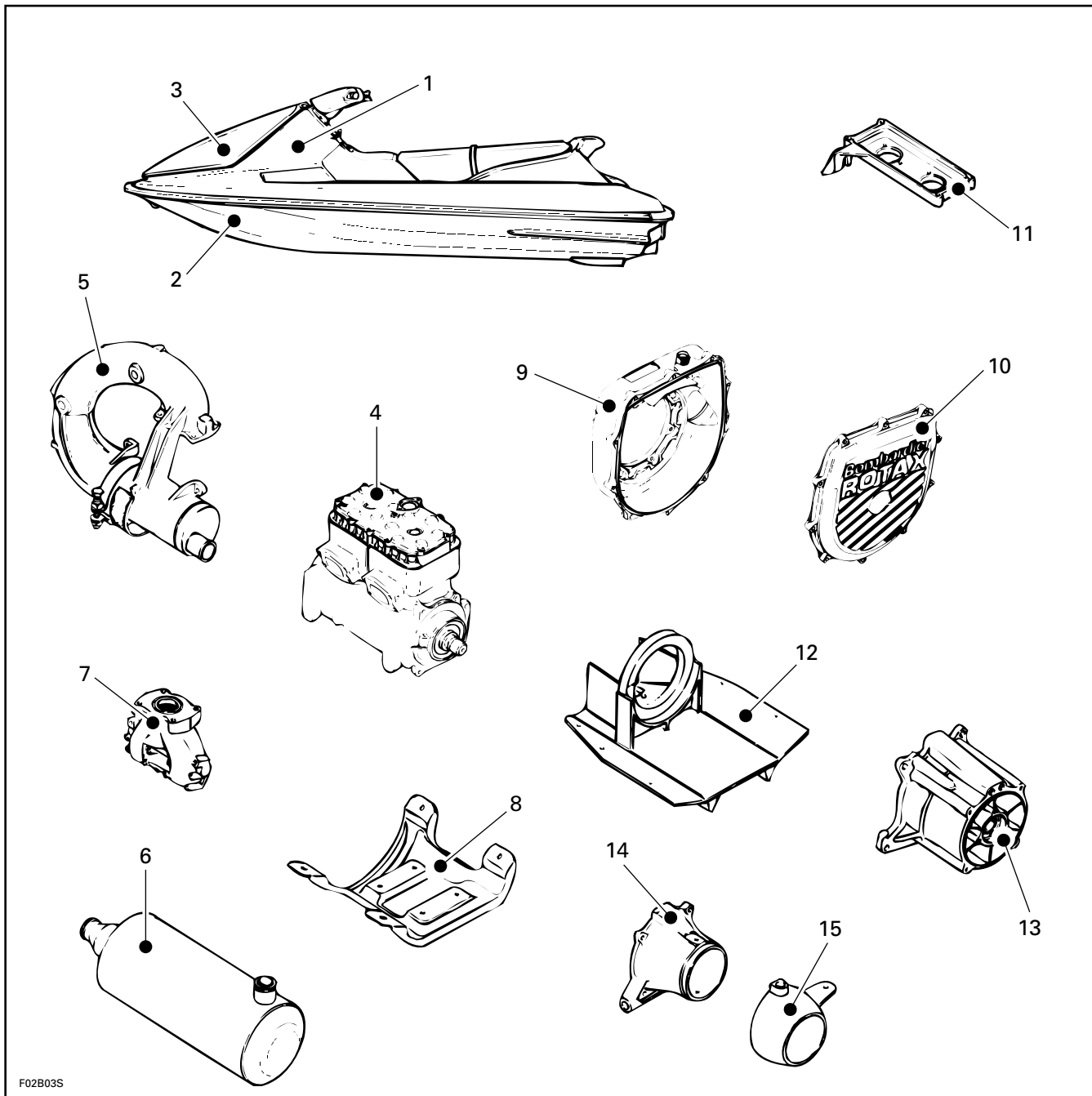
PPG COLOR CHART

COMPONENTS	1994 SEA-DOO MODELS					
	SP (5870) SPI (5872)	SPX (5871)	XP (5854) XPI (5855)	GTS (5814)	GTX (5862)	EXPLORER (5821)
1. Body	White 98223	White 98223	White 98223	White 98223	White 98223	White 98223
2. Hull	White 98223	Teal 18923	Green 49580	White 98223	White 98223	White 98223
3. Storage Cover	Not Applicable	Not Applicable	Not Applicable	Teal 18923	Green 49580	White 98223
4. Engine	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
5. Tuned Pipe	Gray 38269	Gray 38269	Purple 59962	Gray 38269	Purple 59962	Gray 38269
6. Muffler	Gray 38269	Gray 38269	Purple 59962	Gray 38269	Purple 59962	Gray 38269
7. Exhaust Manifold	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
8. Engine Support	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
9. Ignition Housing	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
10. Ignition Housing Cover	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
11. Console	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	White 98223
12. Flame Arrestor Support	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
13. Flame Arrestor Base	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
14. Ride Shoe	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
15. Impeller Housing	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
16. Venturi	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
17. Steering Nozzle	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551

 **NOTE:** Due to natural discoloration, it may be necessary to completely repaint the part.

SECTION 02 - HULL PREPARATION

PARTS THAT CAN BE PAINTED (1995 WATERCRAFT MODELS)



F02B03S

1. Body
2. Hull
3. Storage Cover (Hood for the HX Model)
4. Engine
5. Tuned Pipe
6. Muffler
7. Exhaust Manifold
8. Engine Support

9. Ignition Housing
10. Ignition Housing Cover
11. Flame Arrester Base
12. Ride Shoe
13. Impeller Housing*
14. Venturi*
15. Nozzle*

*Except for parts made of plastic

SECTION 02 - HULL PREPARATION

PPG COLOR CHART

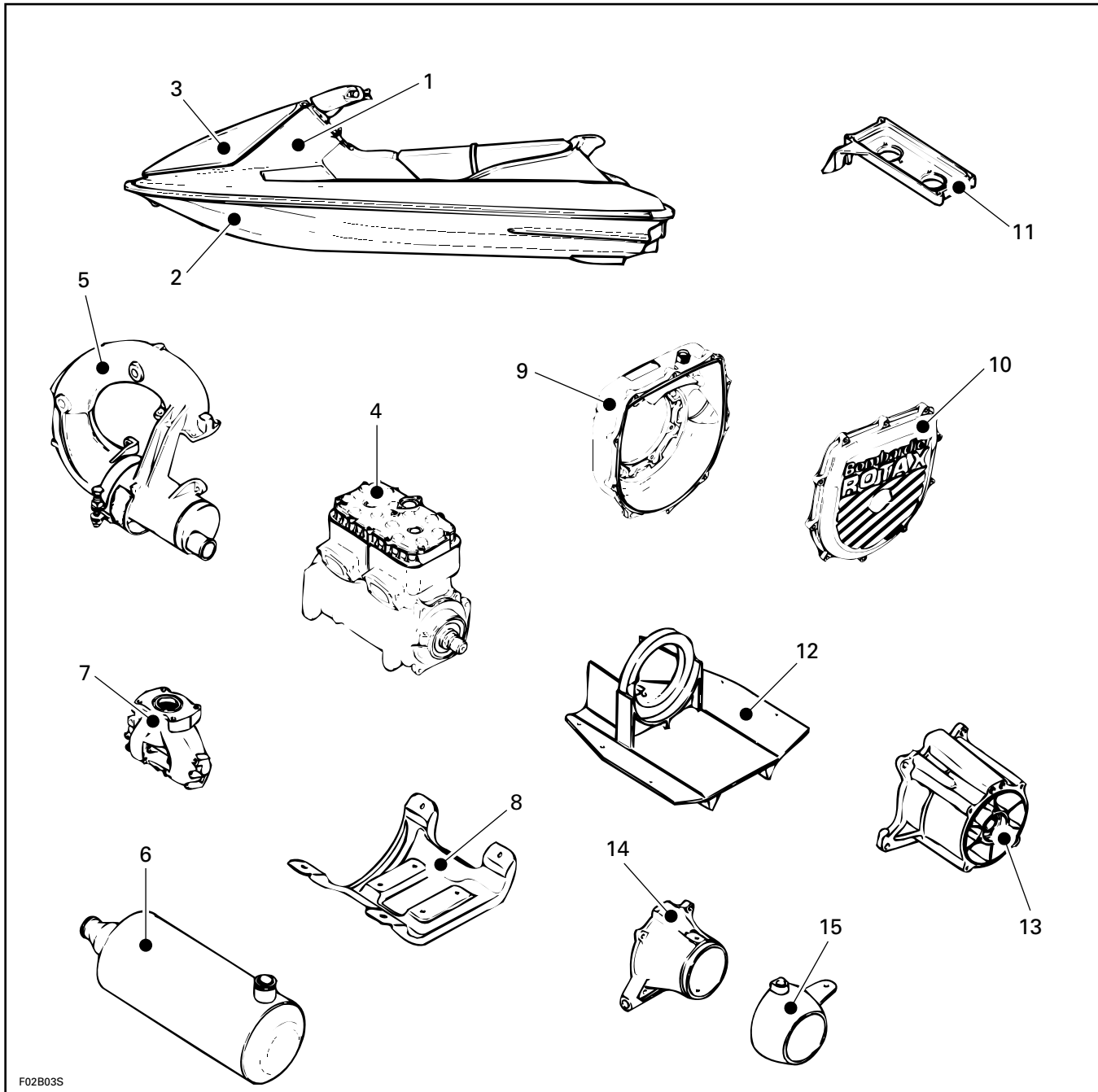
COMPONENTS		SEA-DOO MODELS				
		SP (5873) SPI (5875)	SPX (5874)	XP (5857)	GTS (5815) Standard (5816) Touring	GTX (5863) Standard (5864) Touring
1. Body	COLOR PPG no.	White 98260	White 98260	White 98260	White 98260	White 98260
2. Hull	COLOR PPG no.	White 98260	Teal 18923	Yellow 88243	White 98260	White 98260
3. Storage Cover	COLOR PPG no.	Not Applicable	Not Applicable	Not Applicable	Teal 18923	Green 49521
4. Engine	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209
5. Tuned Pipe	COLOR PPG no.	Purple 59962	Purple 59962	Purple 59962	Purple 59962	Purple 59962
6. Muffler	COLOR PPG no.	Purple 59962	Purple 59962	Purple 59962	Purple 59962	Purple 59962
7. Exhaust Manifold	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209
8. Engine Support	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
9. Ignition Housing	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209
10. Ignition Housing Cover	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209
11. Flame Arrester Base	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
12. Ride Shoe	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
13. Impeller Housing*	COLOR PPG no.	Black 9551	Black 9551	Not applicable	Black 9551	Black 9551
14. Venturi*	COLOR PPG no.	Black 9551	Black 9551	Not applicable	Black 9551	Black 9551
15. Steering Nozzle*	COLOR PPG no.	Black 9551	Black 9551	Not applicable	Black 9551	Black 9551

 **NOTE:** Due to natural discoloration, it may be necessary to completely repaint the part.

*Except for plastic parts.

SECTION 02 - HULL PREPARATION

PARTS THAT CAN BE PAINTED (1996 WATERCRAFT MODELS)



F02B03S

1. Body
2. Hull
3. Storage Cover (if applicable)
4. Engine
5. Tuned Pipe
6. Muffler
7. Exhaust Manifold
8. Engine Support

9. Magneto Housing
10. Magneto Housing Cover
11. Flame Arrester Base
12. Ride Shoe
13. Impeller Housing*
14. Venturi*
15. Steering Nozzle*

*Except for parts made of plastic.

SECTION 02 - HULL PREPARATION

PPG COLOR CHART

COMPONENTS		SEA-DOO MODELS					
		SP SPI	SPX	XP	HX	GTS	GTI
1. Body	COLOR PPG no.	White 98260	White 98260	Yellow M506	White 98260	White 98260	White 98260
2. Hull	COLOR PPG no.	White 98260	Marine green M511	Yellow M506	Yellow 88243	White 98260	White 98260
3. Storage Cover (hood for the HX model)	COLOR PPG no.	Not applicable	Not applicable	Not applicable	Yellow 88243	Marine green M511	Yellow M506
4. Engine	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
5. Tuned Pipe	COLOR PPG no.	Purple 59962	Purple 59962	Purple 59962	Purple 59962	Purple 59962	Purple 59962
6. Muffler	COLOR PPG no.	Purple 59962	Purple 59962	Purple 59962	Purple 59962	Purple 59962	Purple 59962
7. Exhaust Manifold	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
8. Engine Support	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
9. Magneto Housing	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
10. Magneto Housing Cover	COLOR PPG no.	White 98209	White 98209	White 98209	White 98209	White 98209	White 98209
11. Flame Arrester Base	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
12. Ride Shoe	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
13. Impeller Housing*	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
14. Venturi*	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551
15. Nozzle*	COLOR PPG no.	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551	Black 9551

 **NOTE:** Due to natural discoloration, it may be necessary to completely repaint the part.

*Except for plastic parts.

SECTION 03 - ENGINE PREPARATION

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SECTION 03 - ENGINE PREPARATION

ENGINE TUNING CAUTIONS

A few items to keep in mind when preparing your engine:

- There are specific set of rules for racing, know what those rules are!
- If your engine is operating at higher than stock RPM, the rev limiter must be changed accordingly. Never operate the engine without a rev limiter.
- Sloppy engine building will usually result in less power output.
- Follow the assembly and disassembly procedures outlined in the appropriate model year *Shop Manual*.
 - 1989 *Shop Manual* - 295 000 060
 - 1990 *Shop Manual* - 219 100 002
 - 1991 *Shop Manual* - 219 100 004
 - 1992 *Shop Manual* - 219 100 006
 - 1993 *Shop Manual* - 219 100 008
 - 1994 *Shop Manual* - 219 100 010
 - 1995 *Shop Manual* - 219 100 013
 - 1996 *Shop Manual* - 219 100 031
- Always use a laboratory blended fuel. Do not add your own octane booster. Doing so will result in unknown burning rates of the fuel. Select a fuel with a given octane rating and tune your engine to maximum efficiency for that fuel. (REFER TO OCTANE REQUIREMENTS FOR ROTAX ENGINES).
- Correct your carburetor(s) jetting to compensate for engine modifications. Reconfirm correct jetting at the race site. Atmospheric conditions (ALTITUDE, TEMPERATURE, BAROMETRIC PRESSURE, HUMIDITY) may be quite different at the race site or during different times of the year.

Ignition timing may need to be altered from standard timing specifications to achieve maximum power output if modifications are made to the engine.

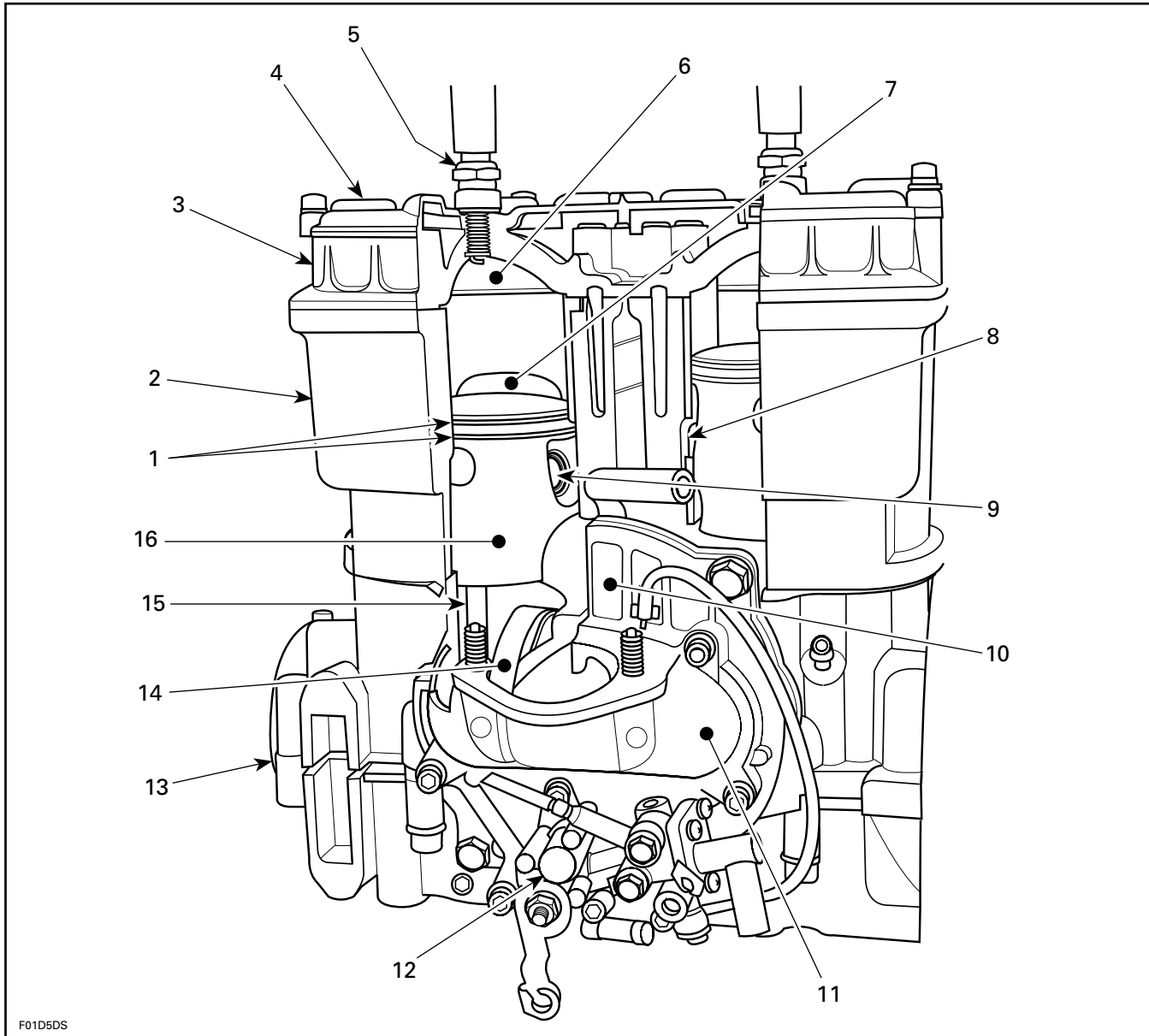
BASIC ENGINE THEORY

TERMINOLOGY

CYCLE:	In a combustion engine, a cycle is accomplished when the 4 phases are completed; intake, compression, ignition and exhaust.
TDC:	Top Dead Center: The position of the piston when it reaches the upper limit of its travel inside the cylinder.
BTDC:	Before Top Dead Center.
ATDC:	After Top Dead Center.
BDC:	Bottom Dead Center: The position of the piston when it reaches the lower limit of its travel inside the cylinder.
BBDC:	Before Bottom Dead Center.
ABDC:	After Bottom Dead Center.
BORE:	Diameter of the cylinder.
STROKE:	The maximum movement of the piston from BDC to TDC. It is characterized by a 180° crankshaft rotation.
COMBUSTION	
CHAMBER:	Space between cylinder head and piston dome at TDC.
DISPLACEMENT:	The space within the cylinder swept by the piston as it travels from TDC to BDC.
COMPRESSION:	Reduction in volume or squeezing of a gas.

SECTION 03 - ENGINE PREPARATION

BASIC ENGINE COMPONENTS



1. Rings
2. Cylinder
3. Cylinder head
4. Cylinder head cover

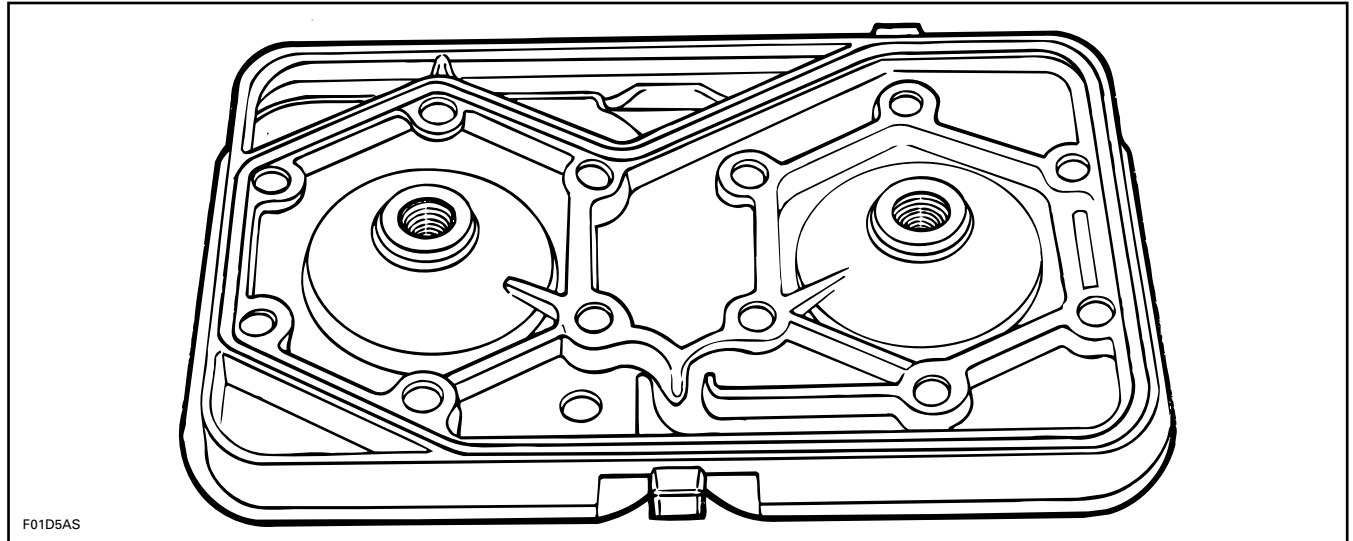
5. Spark plug
6. Combustion chamber
7. Exhaust port
8. Transfer port

9. Wrist pin
10. Rotary valve
11. Intake port
12. Oil injection pump

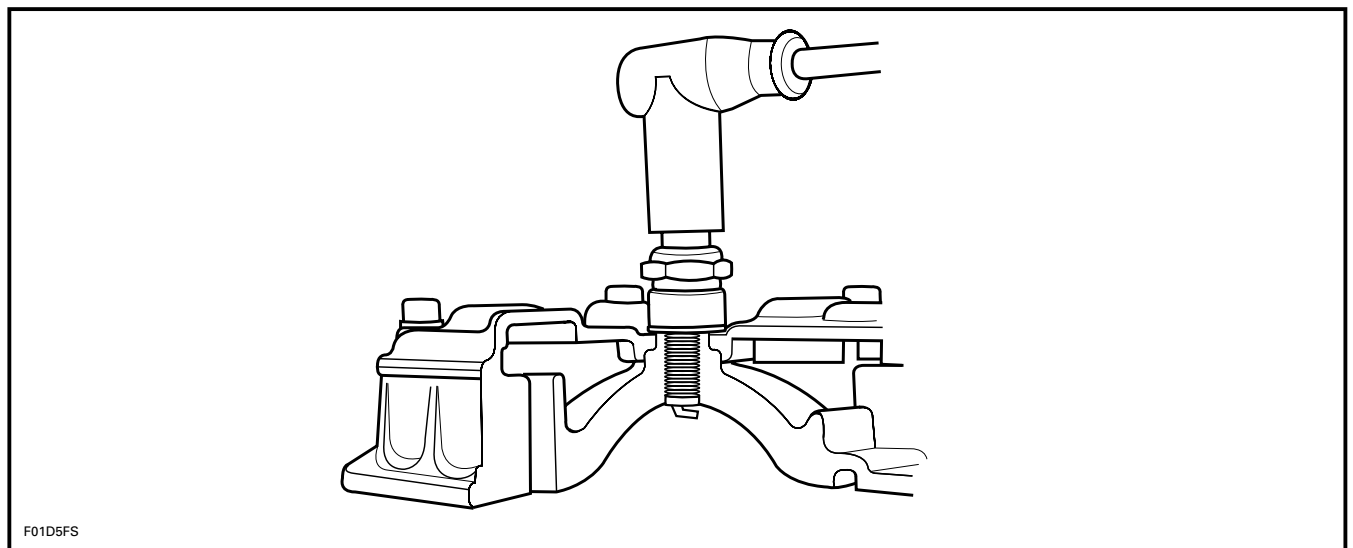
13. Crankcase
14. Crankshaft
15. Connecting rod
16. Piston

CYLINDER HEAD

A shaped aluminum alloy casting bolted to the top of cylinder. It contains the combustion chamber and is designed with a threaded hole to accommodate a spark plug.



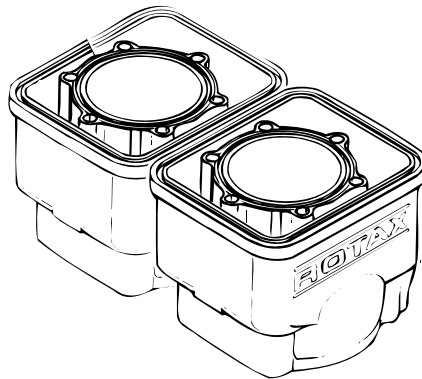
High-performance engines use hemispherical heads with squish areas allowing a better dispersion when combustion occurs.



CYLINDER

Characterized by the presence of intake, exhaust and transfer ports. It directs the passage of the air/fuel mixture from the crankcase to the combustion chamber. A large hole bored through it accepts a piston. Through the years, Rotax engineers have designed many types of cylinder blocks to attain better engine efficiency.

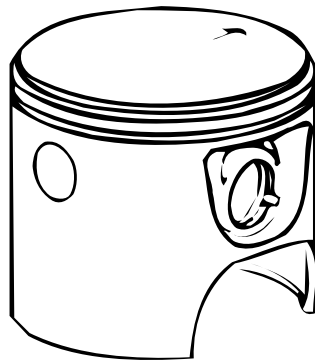
SECTION 03 - ENGINE PREPARATION



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PISTON

A shaped cast aluminium alloy “plug” made to fit inside the cylinder bore. It is attached to the crankshaft by a connecting rod and wrist pin.

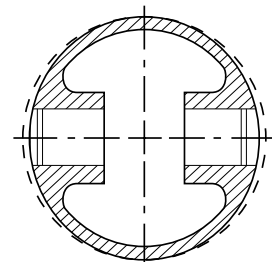
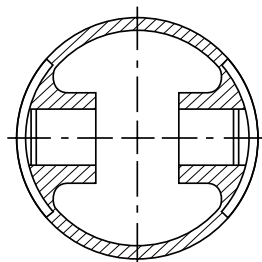
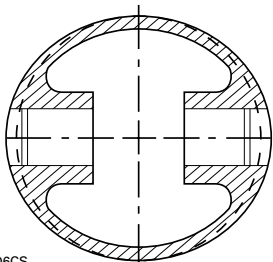


F01D5RS

The piston serves 3 purposes:

- 1) Transmits combustion expansion forces to the crankshaft.
- 2) Acts as a valve for the opening and closing of exhaust and transfer ports.
- 3) Retains piston rings which seal the bore.

Heat flows into piston bosses on normal circular piston (center) causes distortion to oval (left). If oval turned (right), distortion converts to circular shape.



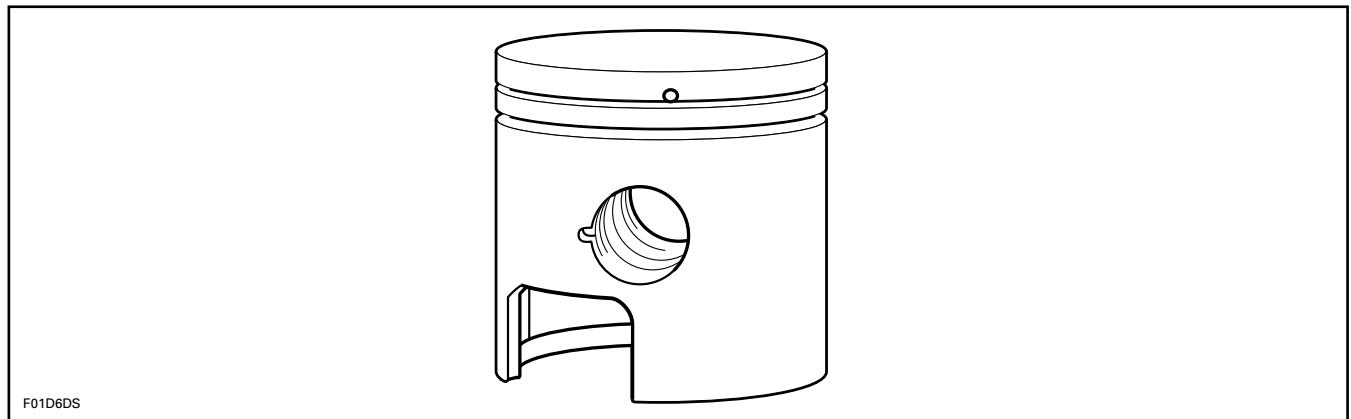
F01D6CS

SECTION 03 - ENGINE PREPARATION

The piston is manufactured out-of-round, the reason being that wrist pin bosses have a greater volume of metal than the other sections of the piston, and consequently, will absorb more heat. The greater the absorption, the greater the area will expand. Under normal operating temperatures, the piston expands and assumes a more rounded shape.

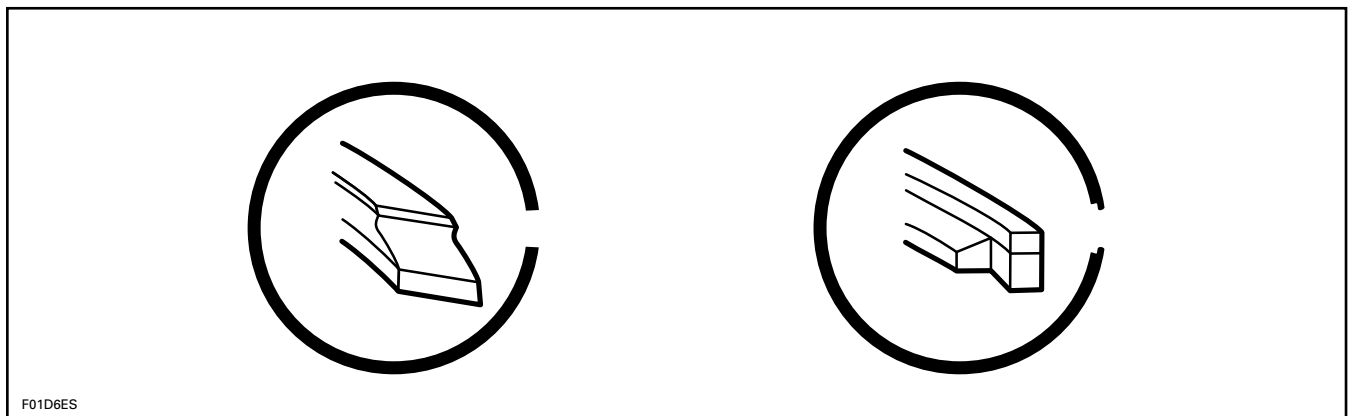
PISTON RINGS

Expanding rings are placed in the grooves immediately below the piston dome. They seal the piston and cylinder wall. Within each ring groove is a small pin that provides a locating point for the ring ends. This pin prevents the ring from rotating around the ring land. Without it, rings would catch on the port edges and piston ring breakage would occur. When installing a new piston and/or piston rings, it is critically important that piston ring locating pin is matched or indexed with gap in piston ring. This should be checked as the cylinders are being installed.



2 types of compression rings are used with Rotax pistons:

- 1) Rectangular, cast iron
- 2) L-type, trapezoid, molybdenum

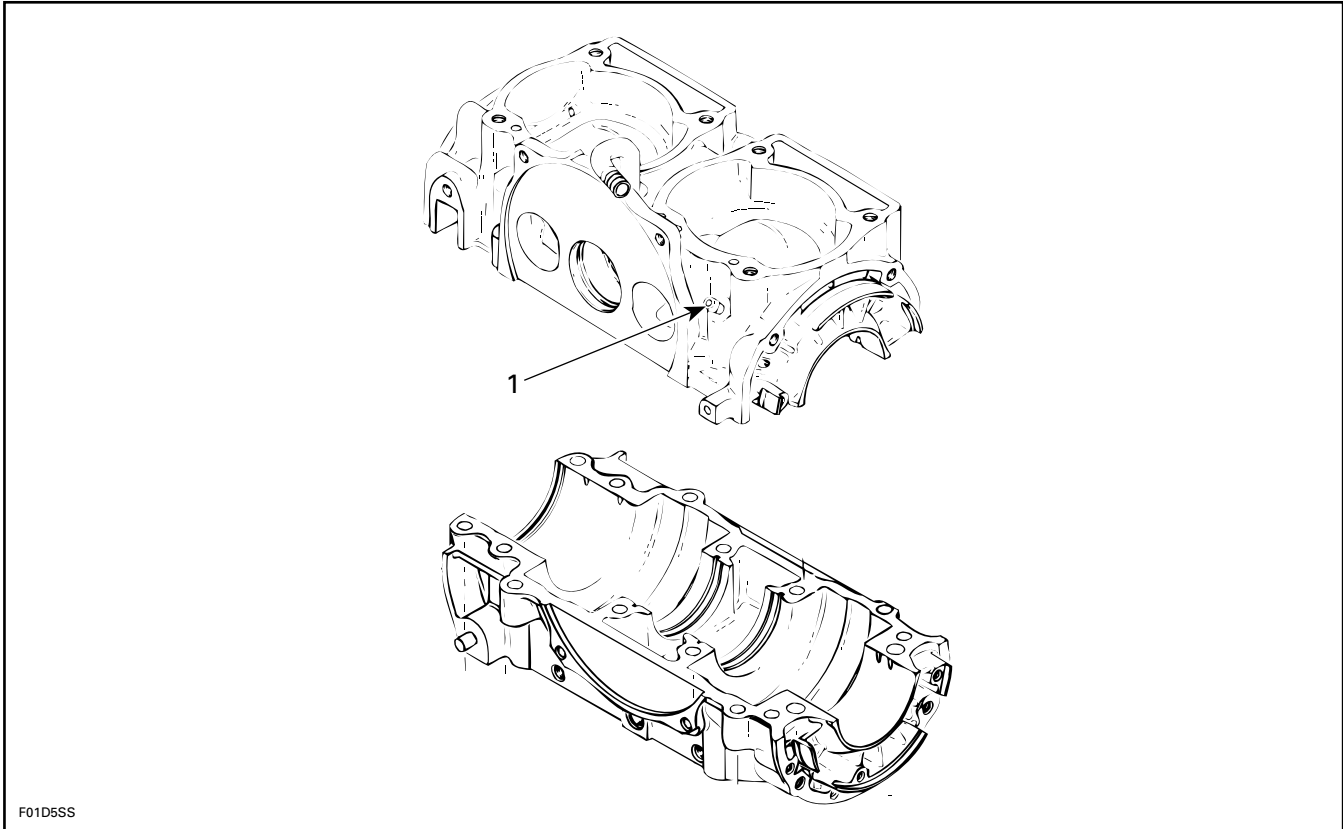


Selection of the appropriate type of piston ring is relative to the use of a particular engine. For example, rectangular rings provide adequate piston sealing for a normal medium revolution engine. While performance engines with a higher revolution capacity require better than average sealing with L-type trapezoid rings.

SECTION 03 - ENGINE PREPARATION

CRANKCASE

Crankcases are fabricated as matched halves and are split horizontally.

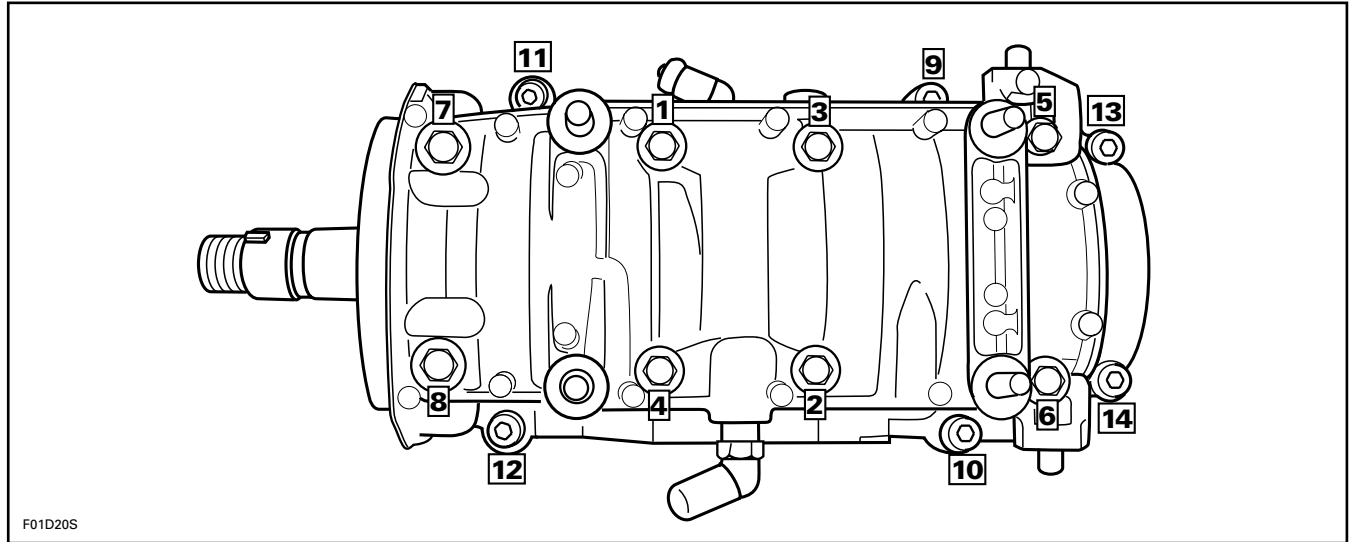


1. *Pulse nipple*

Material is of light-weight alloy to reduce overall engine weight. Incorporated into crankcase designs is a pulsation nipple (a tube connects the pulsation nipple to the carburetor fuel pump to assist with the fuel pumping cycle).

SECTION 03 - ENGINE PREPARATION

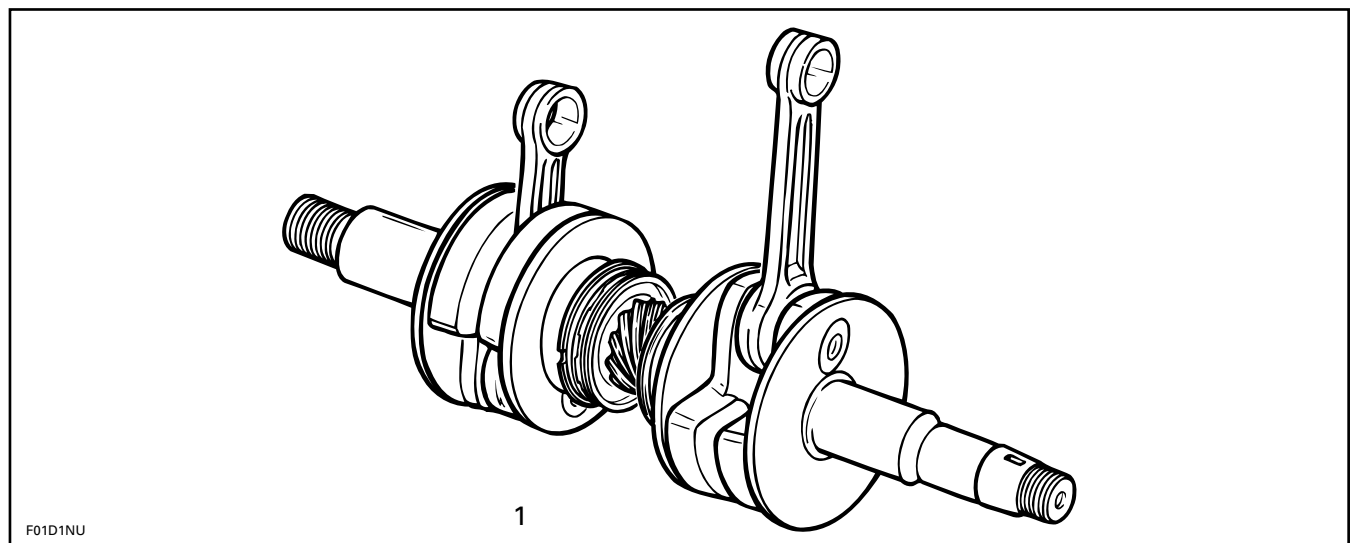
Torque crankcase screws to 24 N•m (17 lbf•ft) as per following illustrated sequence.



The engine crankcase serves 3 main functions:

1. Supports the crankshaft in perfect line bore.
2. Serves as a primary compression chamber for incoming air / fuel mixture.
3. Supporting structure for the cylinders, armature plate, coils, etc.

CRANKSHAFT



1. Crankshaft shown with connecting rods

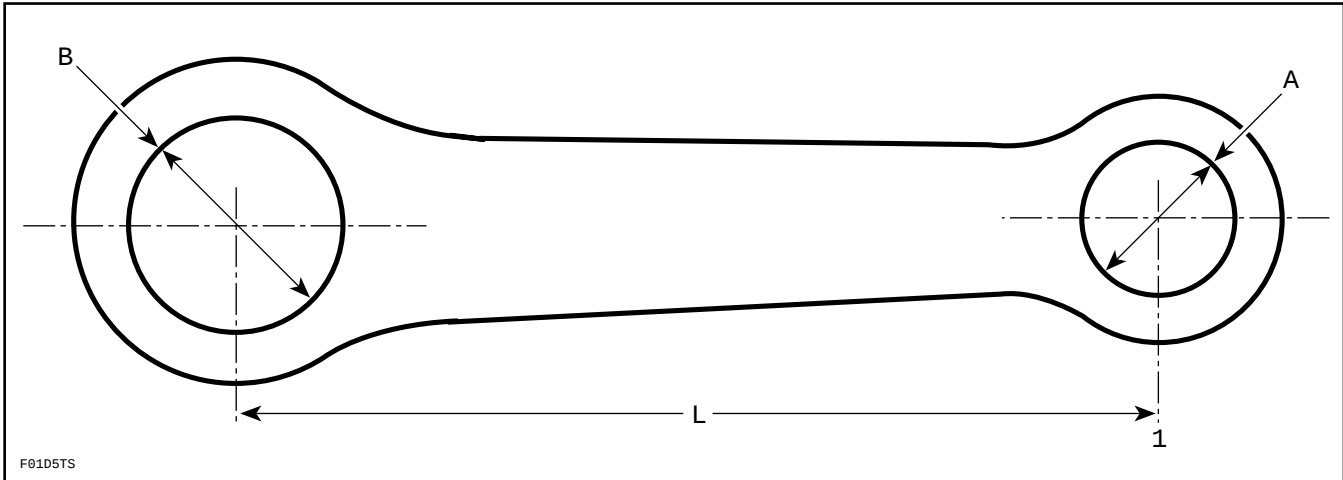
The engine crankshaft is the backbone of the engine. It converts the reciprocating movement of the piston into rotary movement.

The crankshaft is supported by ball bearings mounted inside the crankcase. It is finely machined to obtain precision journals and perfect alignment. Distortion or out-of round will impair the necessary free and smooth rotation.

SECTION 03 - ENGINE PREPARATION

CONNECTING ROD

The connecting rod links the piston to the crankshaft. Within each bored end of the rod is a needle bearing. Rotax connecting rods are integral parts of the crankshaft assembly and therefore, are not removable unless crankshaft is disassembled with special tooling. If you are unsure about the condition of your crankshaft or if you know your crankshaft needs to be worked on, it is highly suggested that you send the crankshaft to a machine shop specializing in this type of work.



Less expensive engines have the crankshaft and connecting rods mounted on sleeve bearings rather than roller or needle bearings. The advantage of roller or needle bearings is less friction and longer life.

WRIST PIN

Provides support for the piston. It also links the piston to the connecting rod. This machined pin is inserted through a needle bearing resting within the upper end of connecting rod. It is supported by bosses and is locked in position with circlips.

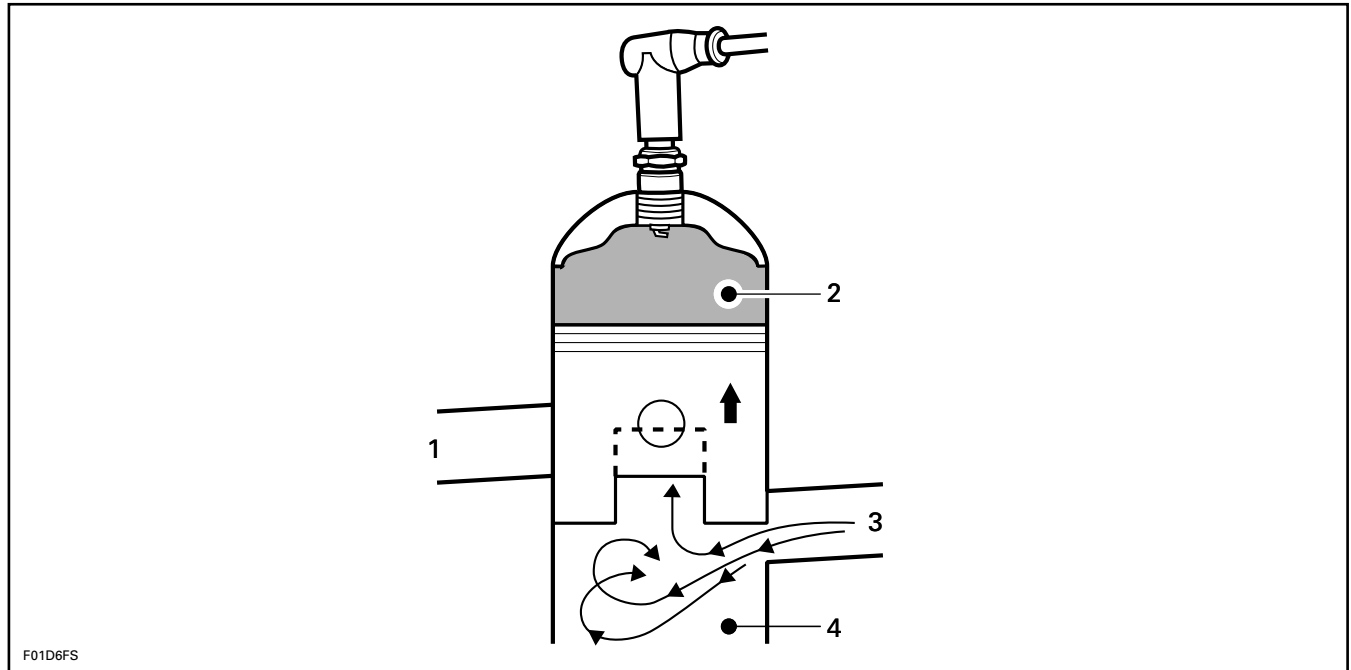
ENGINE OPERATION

Basically, the 2-stroke engine performs the same operation as a 4-stroke. However, instead of completing the cycle in 4-strokes or 720 degrees crankshaft rotation, the 2-stroke engine completes the cycle in only 360 degrees (2 strokes). In other words, the 2-stroke engine piston travels to Top Dead Center and back to Bottom Dead Center once, to complete the intake, compression, combustion and exhaust phases.

NOTE: On all Sea-Doo engine types, the intake is controlled by a rotary valve, and not by the piston skirt as shown in the following illustrations. The illustrations are provided just to demonstrate the principles of operation which are very similar whether the intake is controlled by piston movement or a rotary valve.

1) INTAKE AND SECONDARY COMPRESSION

Intake port:	Partially open
Exhaust port:	Closed
Transfer port:	Closed
Boost port:	Closed



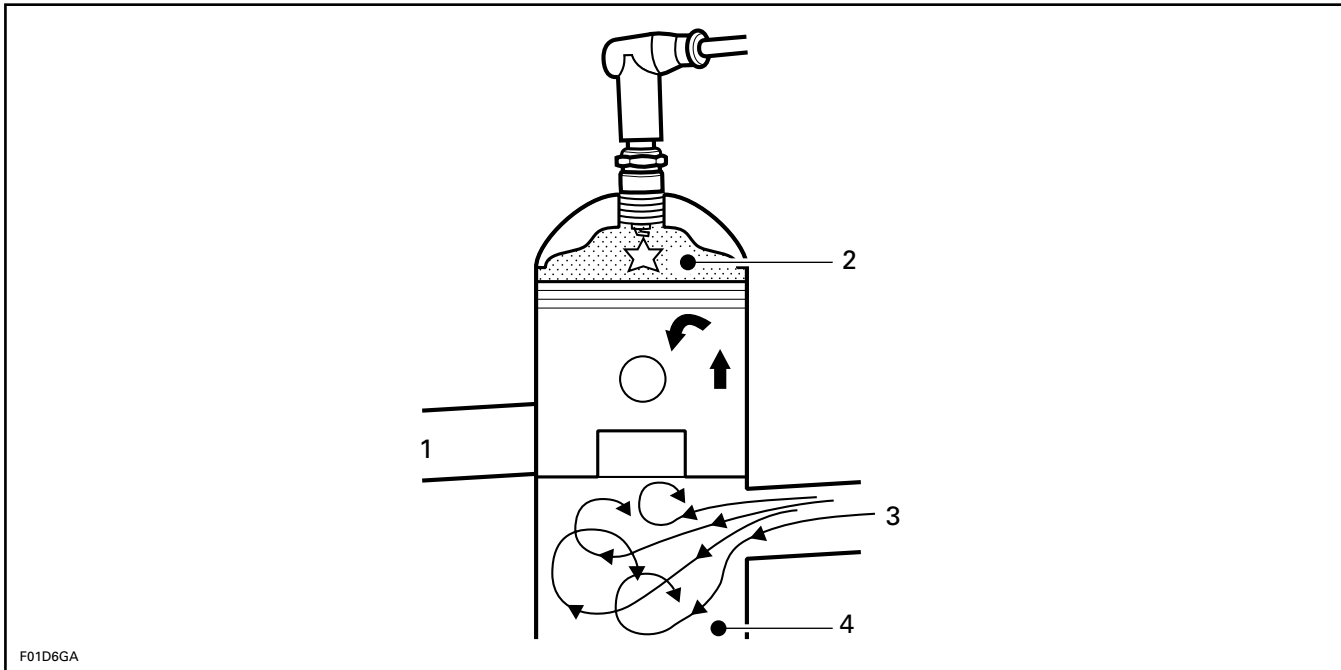
1. Exhaust
2. Compressed charge
3. Intake
4. Fresh charge

When the piston starts its upward stroke, a vacuum is created inside the crankcase and an air / fuel mixture is sucked in from the carburetor via the intake port. At the same time, the piston blocks the exhaust and transfer ports, and compresses the fuel charge in the combustion chamber (secondary compression).

SECTION 03 - ENGINE PREPARATION

2) IGNITION AND COMBUSTION

Intake port:	Open
Exhaust port:	Closed
Transfer port:	Closed
Boost port:	Closed

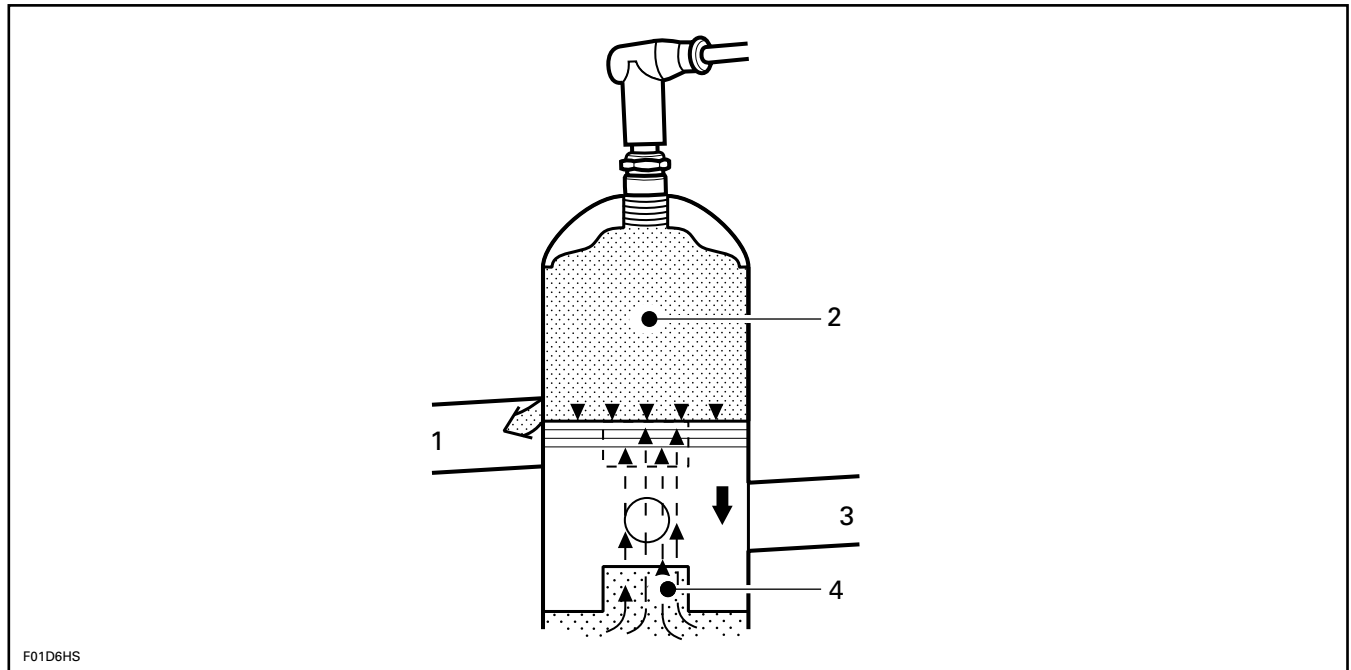


1. Exhaust
2. Combustion
3. Intake
4. Fresh charge

As the piston nears the top of the cylinder (TDC), the compressed air/fuel mixture inside the combustion chamber is ignited by the spark plug. The burning gases expand and push the piston downward, thus causing a power stroke.

3) EXHAUST AND PRIMARY COMPRESSION

Intake port:	Closed
Exhaust port:	Partially open
Transfer port:	Closed
Boost port:	Closed



1. Exhaust
2. Burnt gases
3. Intake
4. Fresh charge

As the piston descends, the intake port is blocked and pressure begins to build inside the crankcase (primary compression). As the piston continues its course downward, the exhaust port is uncovered and burnt gases are allowed to escape.

SECTION 03 - ENGINE PREPARATION

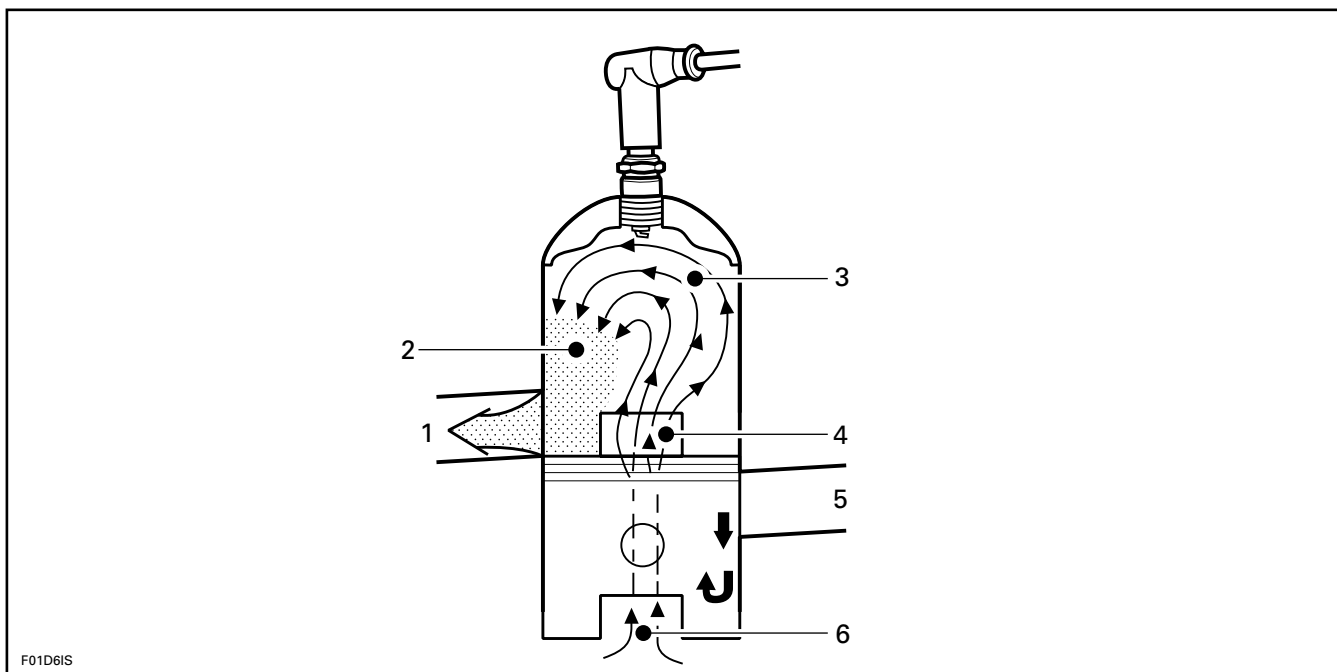
4) TRANSFER

Intake port: Closed

Exhaust port: Open

Transfer port: Open

Boost port: Open



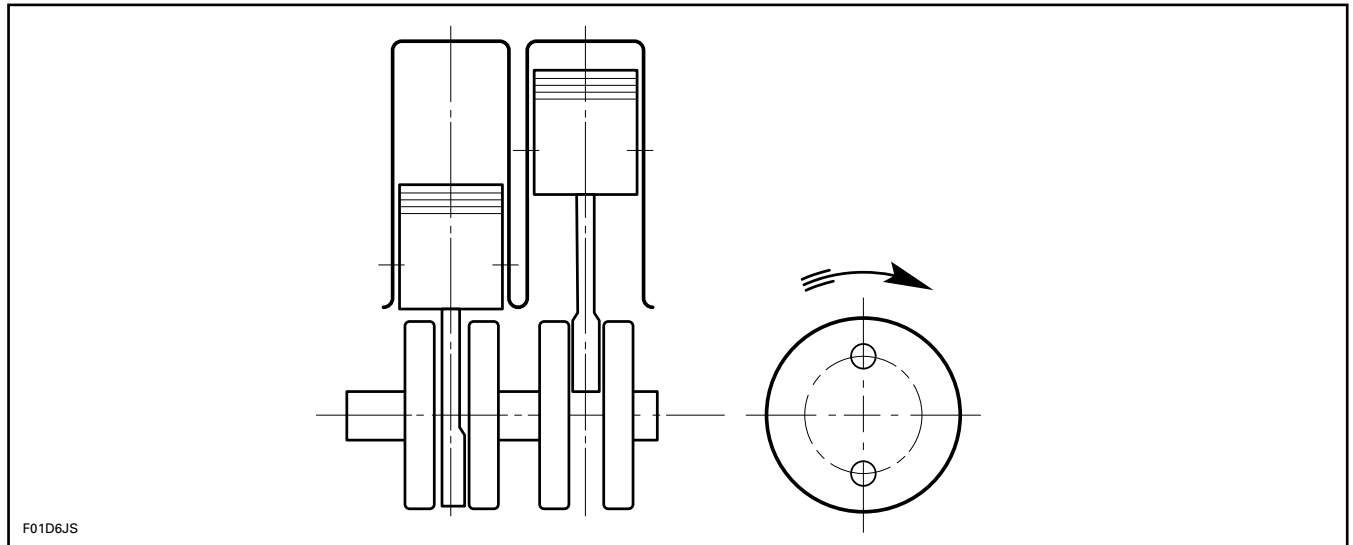
1. Exhaust
2. Burnt gases
3. Fresh charge
4. Transfer port
5. Intake
6. Fresh charge

Near the bottom of the downward stroke, the transfer port is uncovered and the compressed air / fuel mixture inside the crankcase rushes into the cylinder and combustion chamber. Just after the opening of the transfer port, the boost port opens and this allows the remaining air / fuel mixture (mixture trapped under piston crown) to flow into the combustion chamber. This assists in clearing the combustion chamber and cylinder of all burnt gases. The boost port also aids in cooling the piston dome, lubricating and cooling wrist pin bearing.

The cylinder head, transfer port and exhaust pipe design limit the escape of the fresh incoming charge to a minimum.

ENGINE CONFIGURATION

Two pistons are connected to a single crankshaft mounted in a horizontally-split crankcase with 2 cylinders and a 1 piece head.



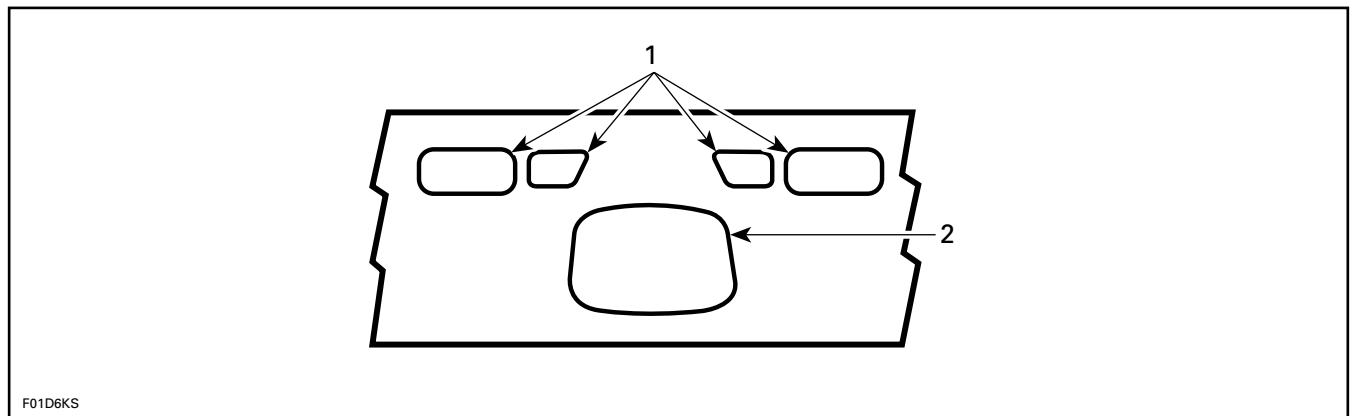
In operation, while 1 piston is at TDC, the other is at BDC, therefore producing a simultaneous ignition and transfer.

Since there is both transfer and ignition occurring, rubber center seals isolate the primary compression areas of the crankcase and thereby, retains the equilibrium of crankcase and cylinder areas.

TRANSFER PORTS

To achieve greater efficiency, Rotax engineers have designed the engines with 2 extra transfer ports.

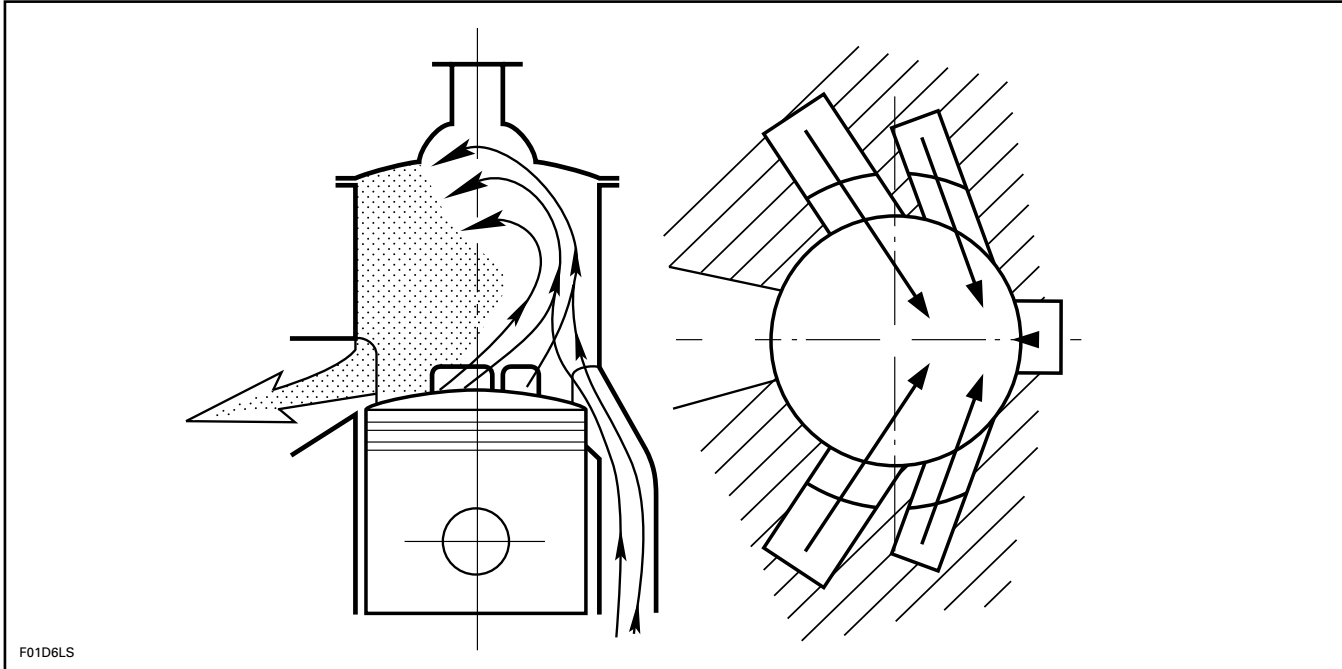
An engine with 4 transfer ports enhances the rapid escape of the air/fuel mixture from the crankcase into the combustion chamber.



- 1. Transfer ports
- 2. Intake port

SECTION 03 - ENGINE PREPARATION

The configuration of the transfer ports is termed as being “tangential type flow”. In other words, the indirect positioning of the transfer port openings in the cylinder creates an upward swirling movement of the air /fuel mixture. This swirling action is, in general, limited to the sides of the cylinder wall.



Flushing action of transfer flow: the fresh mixture staying close to the walls of the cylinder expels the burnt gases without mixing with them and /or causing turbulence.

When this upward swirl reaches the cylinder head dome, it attempts a downward inward movement. However, since the piston is also ascending at the same time, a vortex type of effect occurs. This vortex retains the air /fuel mixture in the upper part of the combustion area therefore, burnt exhaust gases are completely expelled by the vortex pressure and upward movement of the piston.

By doing this, the large volume of air /fuel mixture taken into the engine during intake is wholly retained inside the engine, and not partially expelled with the exhaust. Combustion therefore, is with a completely fresh charge.

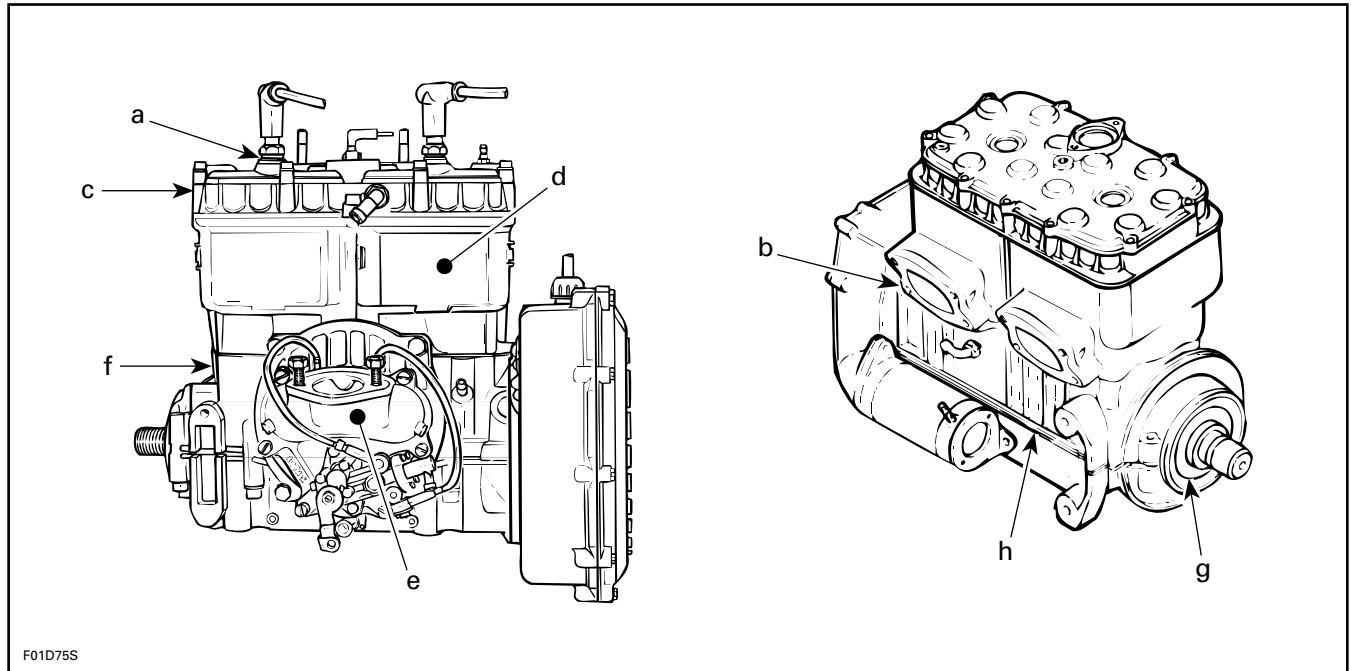
BOOST PORT

The boost port or finger port as occasionally referred to, is a cavity in the wall of a cylinder. The prime purpose of this port is to assist the clearing of burnt gases from the combustion chamber. In doing so, it allows a fresher charge for the next combustion phase and at the same time, cools the piston dome. This port comes into function after the third phase of engine operation, or during the transfer stroke of the piston.

Unlike the transfer port, the boost port does not connect to the crankcase via a passage in the cylinder wall. On the 587 engine type, the boost port communicates with the crankcase via a hole in the piston skirt. On all 1994 and later Sea-Doo engine types (587-657-717-787) the boost port is connected with the crankcase and functions much as a transfer port.

AIR TIGHTNESS

Areas to verify for leakage are illustrated below:



a) SPARK PLUGS

The results of thread stripping, crossing, or installing a spark plug without a gasket could result in loss of compression or serious spark plug and cylinder head damage.

b) EXHAUST SYSTEM

If the gaskets, O-rings, or hoses are damaged, omitted, or incorrectly installed, engine damage or a drastic reduction in engine output will occur.

c) CYLINDER HEAD SEALING

If there is damage to either the cylinder head mating surface or the cylinder top mating surface, engine compression will be forced into the cooling jackets and damage the cylinder head o-ring; if the cylinder head o-ring is omitted or damaged, water may enter the combustion chamber from the cooling jackets, causing engine damage.

d) PISTONS AND RINGS

If the pistons, rings or cylinders are worn, damaged, or incorrectly installed, engine damage or poor performance will occur.

e) INTAKE SYSTEM

If there is damage to any of the mating surfaces on the carburetors, intake manifold, rotary valve cover or damage to any of the gaskets or o-rings, a lean mixture condition will occur causing poor engine performance and serious engine damage.

SECTION 03 - ENGINE PREPARATION

f) CYLINDER BASE GASKET

If omitted or incorrectly installed, could lean the air/fuel mixture and result in poor engine performance and serious engine damage.

g) CRANKSHAFT OIL SEALS

If omitted, cut or incorrectly installed, could lean the air/fuel mixture and result in poor engine performance and serious engine damage.

h) CRANKCASE HALVES

If sealed/joined incorrectly, could lean the air/fuel mixture and result in poor engine performance and serious engine damage.

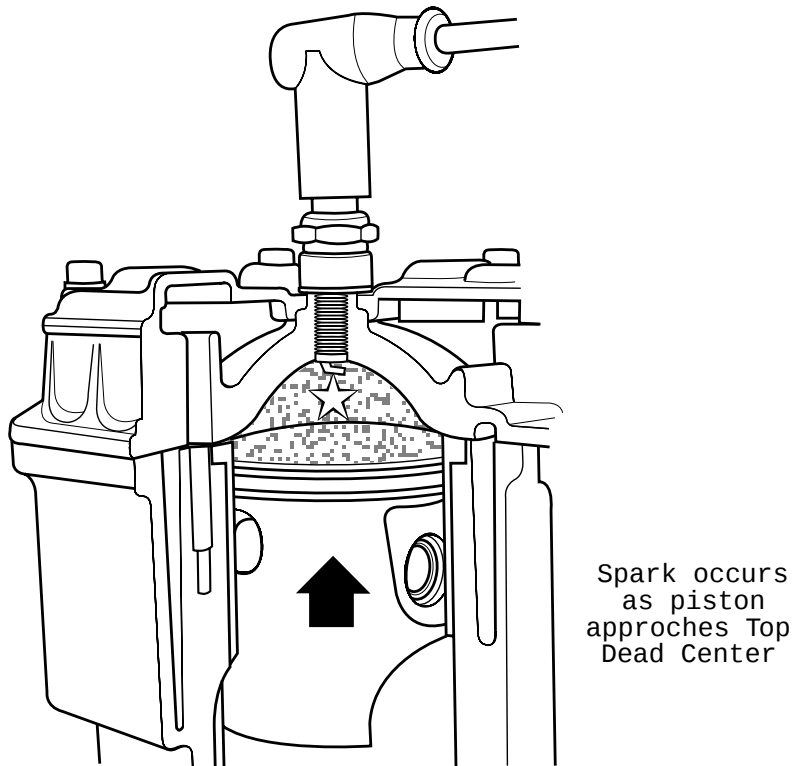
COMBUSTION PROCESS

NORMAL COMBUSTION

Since the beginning of this study we have spoken of air/fuel mixture combustion rather than explosion. This combustion is a slow then accelerated burning of the mixture within the combustion chamber. It is not an explosion. Ignition occurs with the firing of the spark plug.

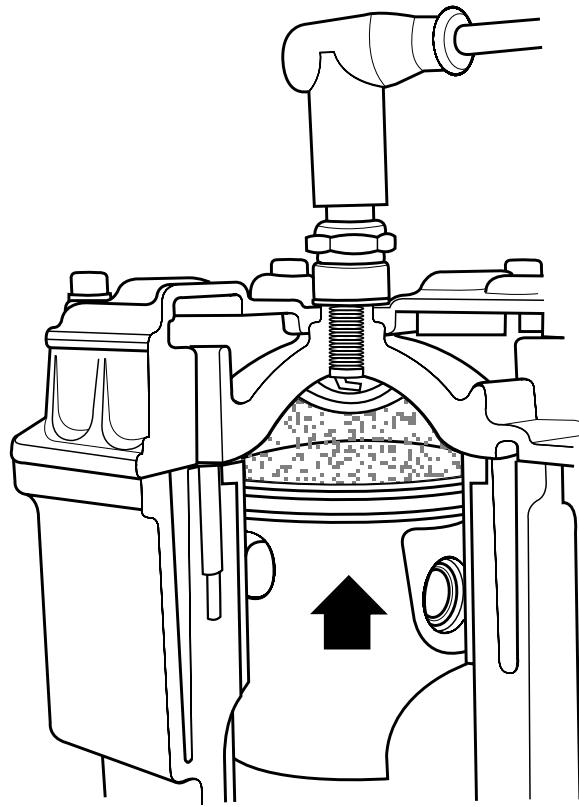
This initial process generates heat and pressure which in turn, is transmitted by conduction to the contiguous portion of the unburned mixture. When this portion has reached the point of self-ignition, it starts to burn releasing more pressure and heat.

This burning action, called a flame front, travels at a speed of approximately 30 m (100 feet) per second until all mixture is burned, thus providing maximum piston thrust.



F01D5GS

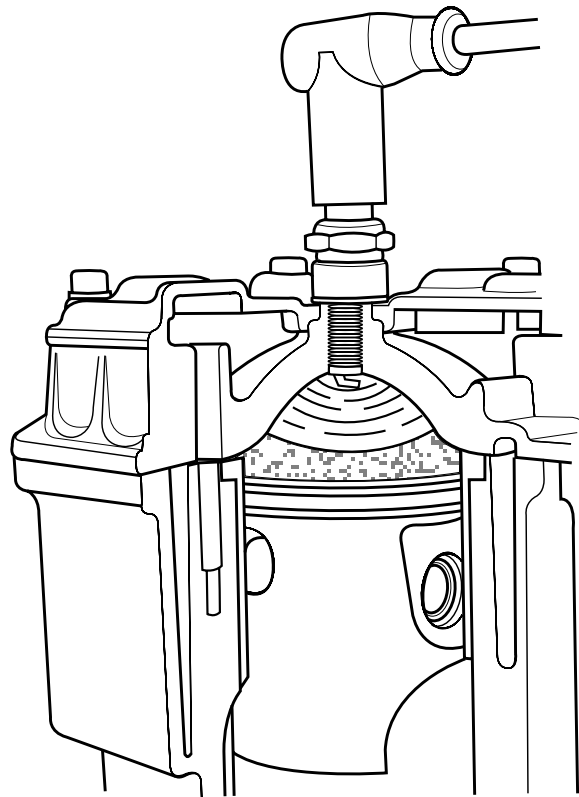
SECTION 03 - ENGINE PREPARATION



Flame front begins...

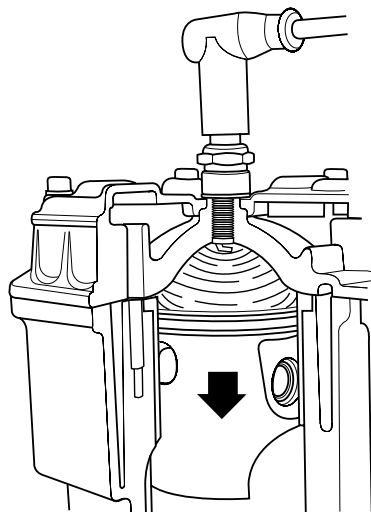
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SECTION 03 - ENGINE PREPARATION



...Traverses
combustion
chamber rapidly...

F01D51S



...until mixture is
completely burnt

F01D53S

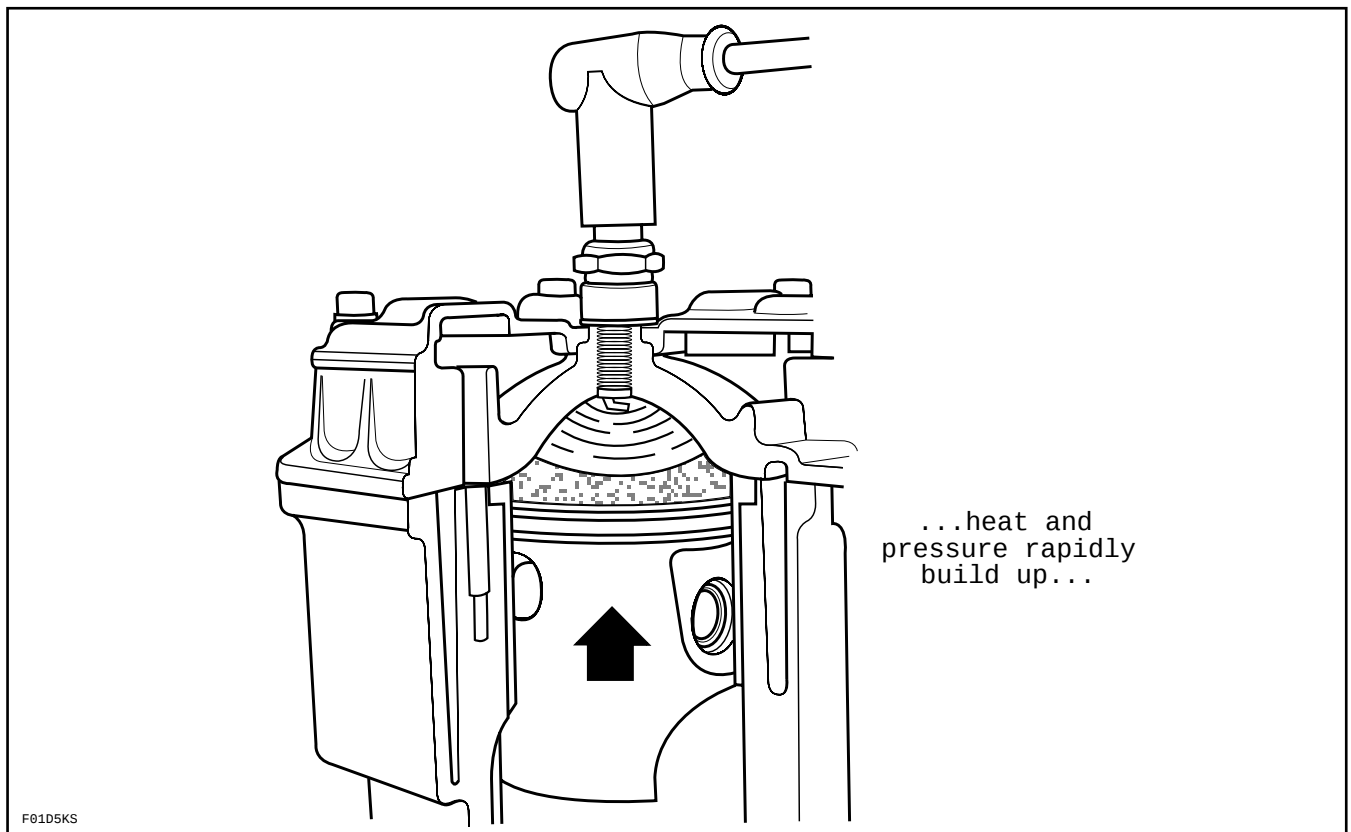
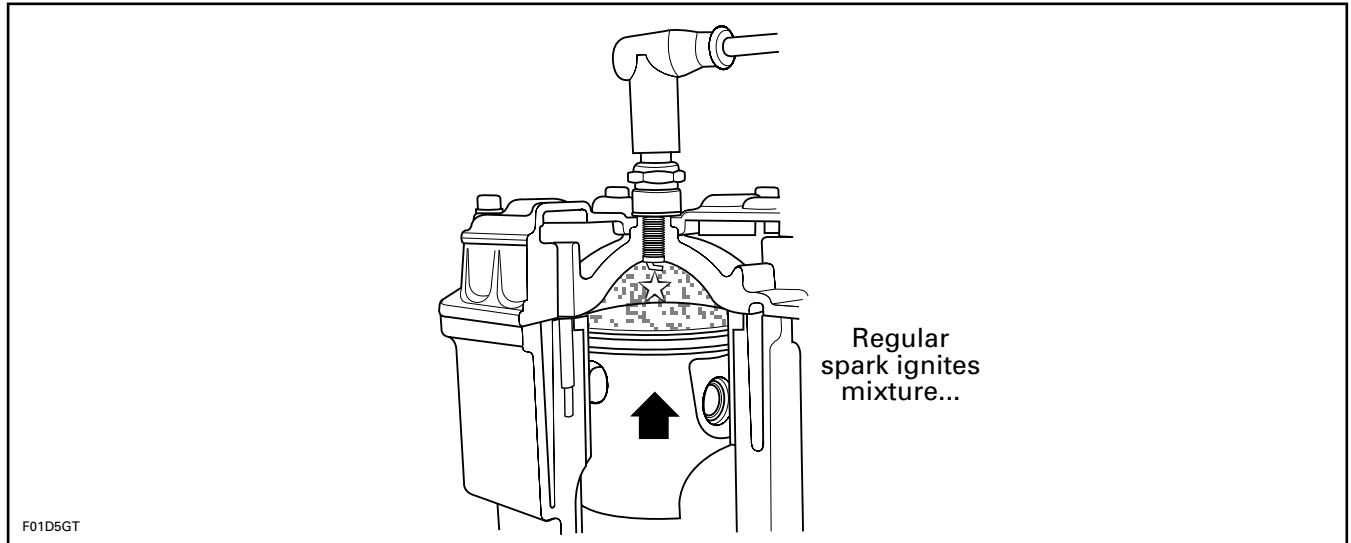
With all operating parameters correct, normal combustion will take place. However, if for some reason the temperature inside the cylinder is increased during combustion, abnormal combustion will occur and lead to serious engine damage.

SECTION 03 - ENGINE PREPARATION

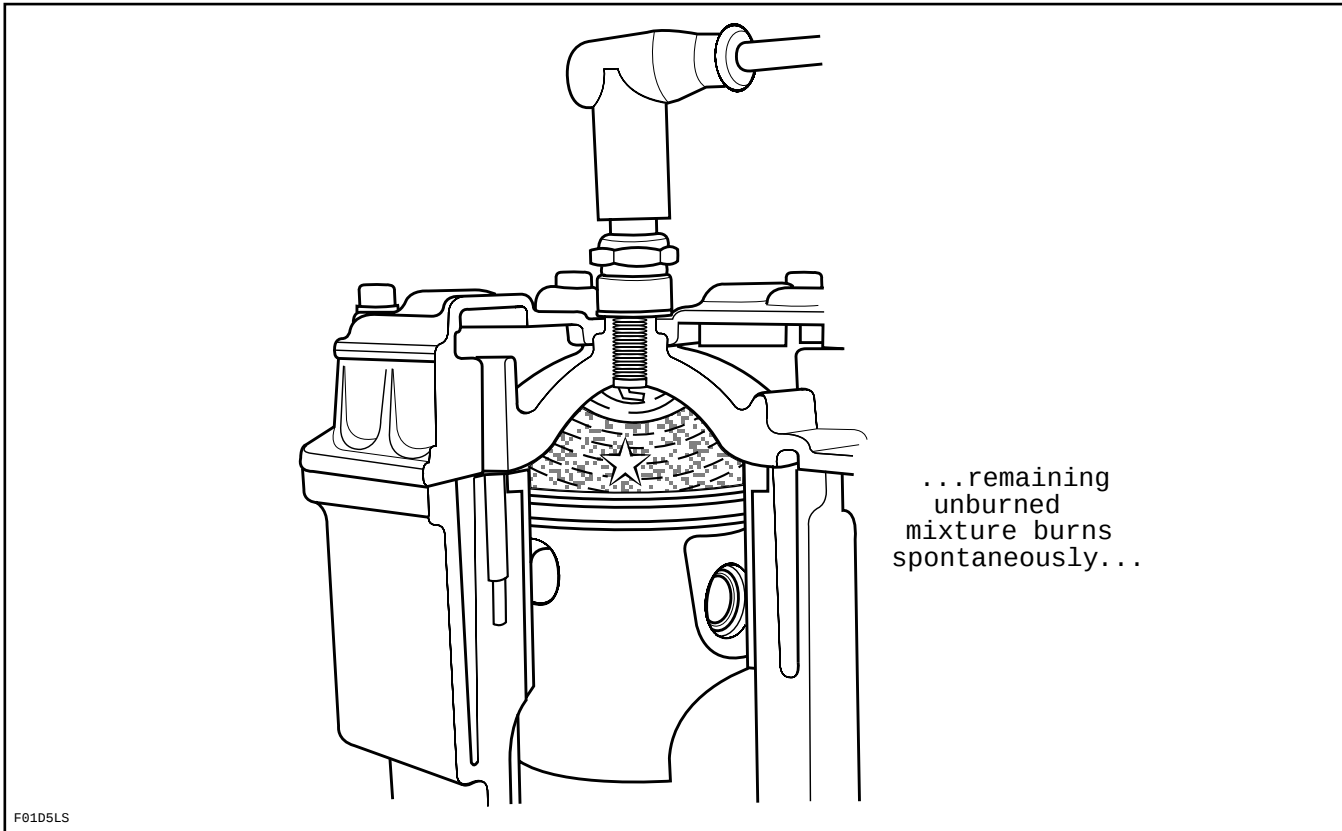
DETONATION

In detonation, the spark plug initiates burning and the air/fuel mixture starts to burn in the usual manner but as combustion continues, the heat generated affects the large portion of the yet unburnt air/fuel mixture.

This unburnt mixture temperature becomes so high that it burns spontaneously creating high-velocity pressure waves within the combustion chamber.



SECTION 03 - ENGINE PREPARATION

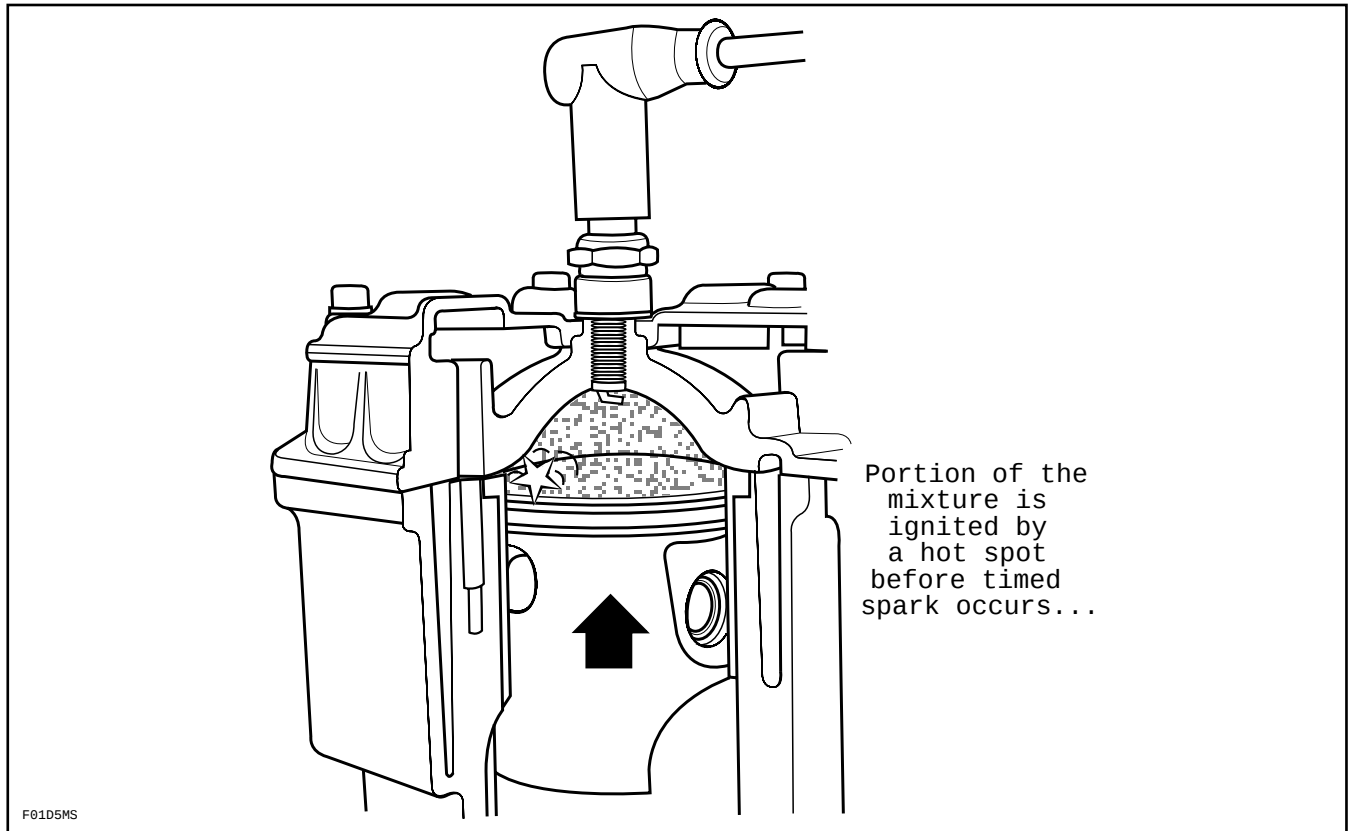


These shock waves can sometimes be heard as “pinging” (This pinging is especially detrimental to engines with raised compression ratios). While these shock waves can be detrimental to the mechanical integrity of the engine, it is the generation of excessive heat that causes most problems in 2-strokes. For many various reasons the piston may expand excessively causing a seizure or the piston dome may in fact melt. The melting will occur at the hottest points, which will be right below the spark plug and around the edge of the piston, often at a ring locating pin. If allowed to continue, a hole may melt completely through the top of the piston.

PRE-IGNITION

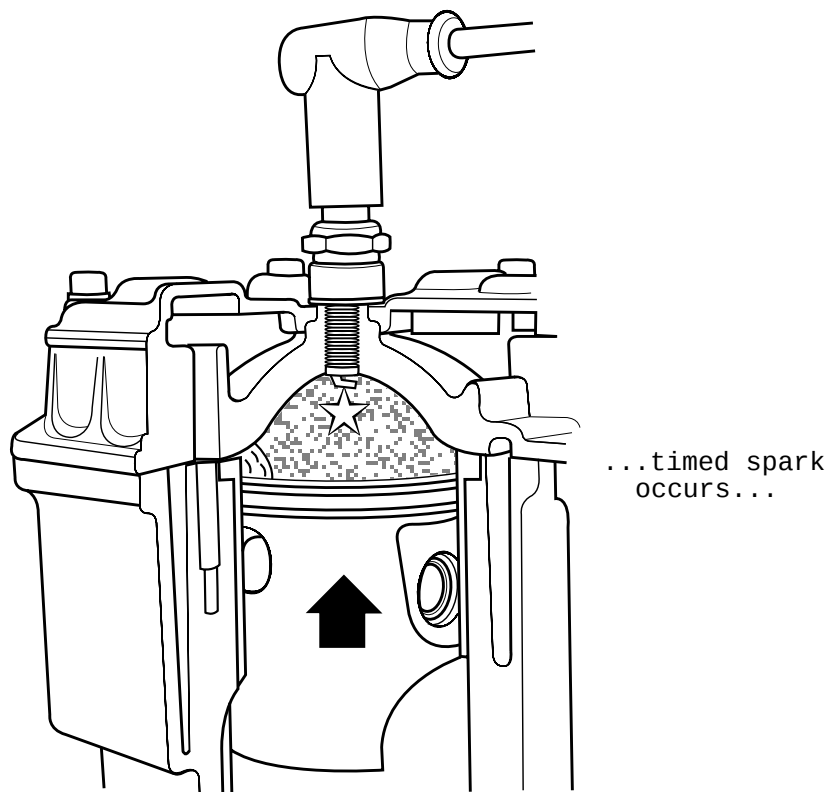
Pre-ignition is the ignition of the mixture inside the combustion chamber before the timed spark. Pre-ignition sources are generally an overheated spark plug tip or a glowing carbon deposit on the piston head. Since ignition occurs earlier than the timed spark, the hot gases stay longer in the combustion chamber, thus increasing cylinder head and piston temperatures to a dangerous level.

SECTION 03 - ENGINE PREPARATION



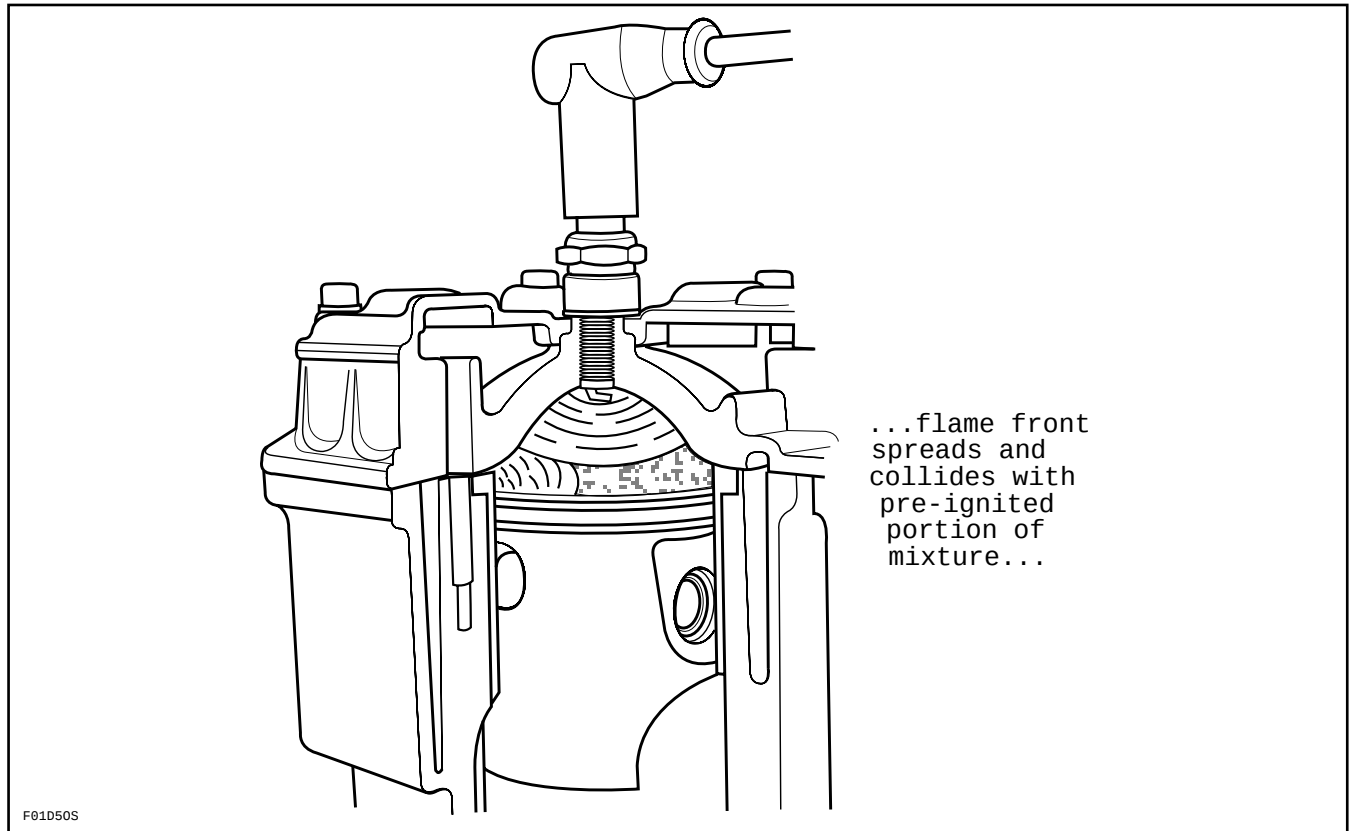
NOTE: Detonation and pre-ignition are conditions you need to be listening for as serious engine damage or complete failure may occur if this condition is allowed to continue. These 2 conditions can be heard if you are listening carefully. The engine will produce a sound similar to glass bottles rattling together or a noise which sounds like transmission gears growling. These sounds will usually be more audible at specific throttle positions. Do not hold the throttle at these positions for any longer than absolutely necessary i.e. just the amount of time required to identify/verify that there is a problem.

SECTION 03 - ENGINE PREPARATION



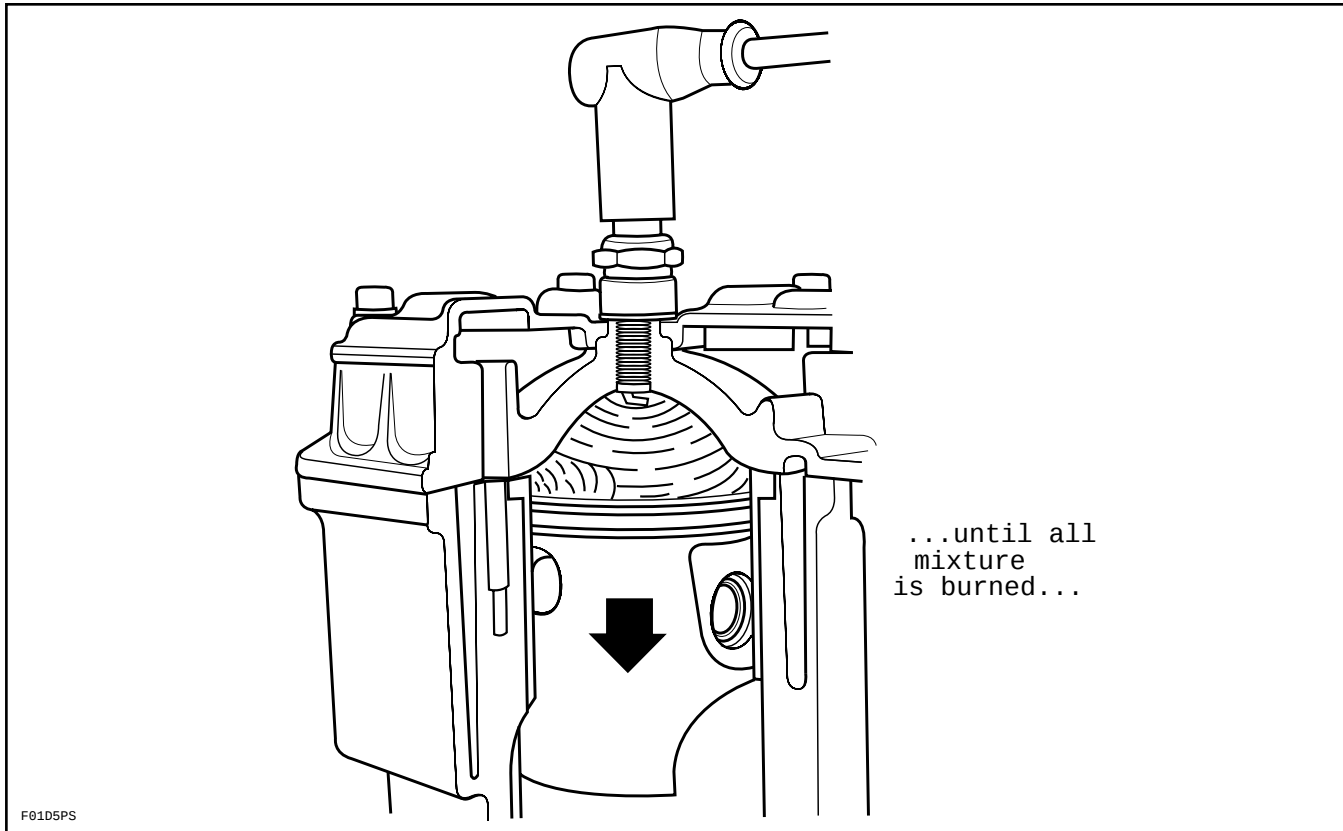
F01D5NS

SECTION 03 - ENGINE PREPARATION



Please consult section "Causes of detonation" on the next page for possible causes and begin diagnostic process to correct this condition before serious damage occurs to your engine.

SECTION 03 - ENGINE PREPARATION



Usually the piston is subject to damage. It may seize or the aluminum on the exhaust side of the piston dome may melt. Pre-ignition is always preceded by detonation.

CAUSES OF DETONATION

1. Octane of the fuel is too low for compression ratio
2. Air/fuel mixture is too lean
 - incorrect jetting
 - air leaks
 - varnish deposits in carburetor
 - malfunction anywhere in fuel system
3. Spark plug heat range too hot
4. Ignition timing too far advanced
 - initial timing off
 - ignition component failure
5. Compression ratio too high for fuel being used
 - improperly modified engine
 - deposit accumulation on piston dome or head

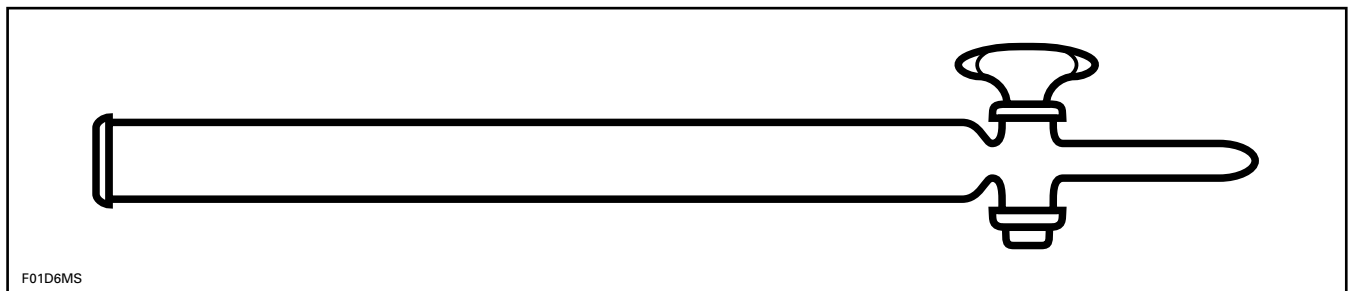
6. Exhaust system restrictions
 - muffler plugged / restricted
 - tail pipe diameter too small
 - incorrect design of expansion chamber
7. General overheating
 - restriction in cooling system
 - debris in water pick-up
8. Water entering combustion chamber

MEASURING COMPRESSION RATIO

The minimum combustion chamber volume is the region in the head above the piston at Top Dead Center. It is measured with the head installed on the engine.

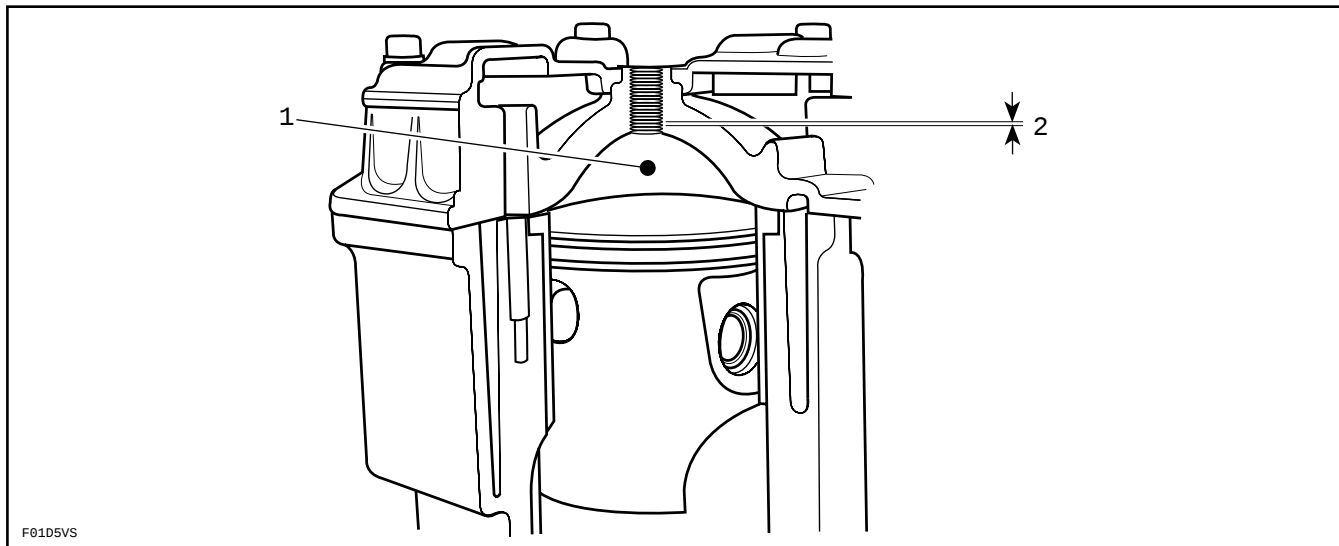
1. Remove spark plug and place piston at Top Dead Center.
2. Obtain a cc graduated burette (0-50 cc) and fill with 50% gasoline and 50% oil.

○ **NOTE:** Suggested burette; Canlab no. 8-000 / T or equivalent.



3. Inject the burette content through the spark plug hole until mixture touches the 2 bottom threads of the spark plug hole.
4. Read the burette scale and obtain the number of cc injected into the cylinder (example: 21.5 cc).
5. Record the volume which we will note as V_2 .

SECTION 03 - ENGINE PREPARATION



1. Combustion chamber (V_2)
2. Liquid mixture 2 threads

NOTE: When the combustion chamber is full, the level of fluid should not decrease. If it does there may be leakage between the piston and cylinder.

Removing the head and measuring the head volume by laying a flat plate across the head will not give an accurate measurement of combustion chamber volume because the dome of the piston protrudes into the head on an assembled engine.

The uncorrected compression ratio of an engine is the volume of a cylinder plus the minimum volume of the combustion chamber divided by the minimum volume of the combustion chamber.

$$\text{C.R.} = \frac{V_1 + V_2}{V_2}$$

WHERE:

C.R. = compression ratio: 1

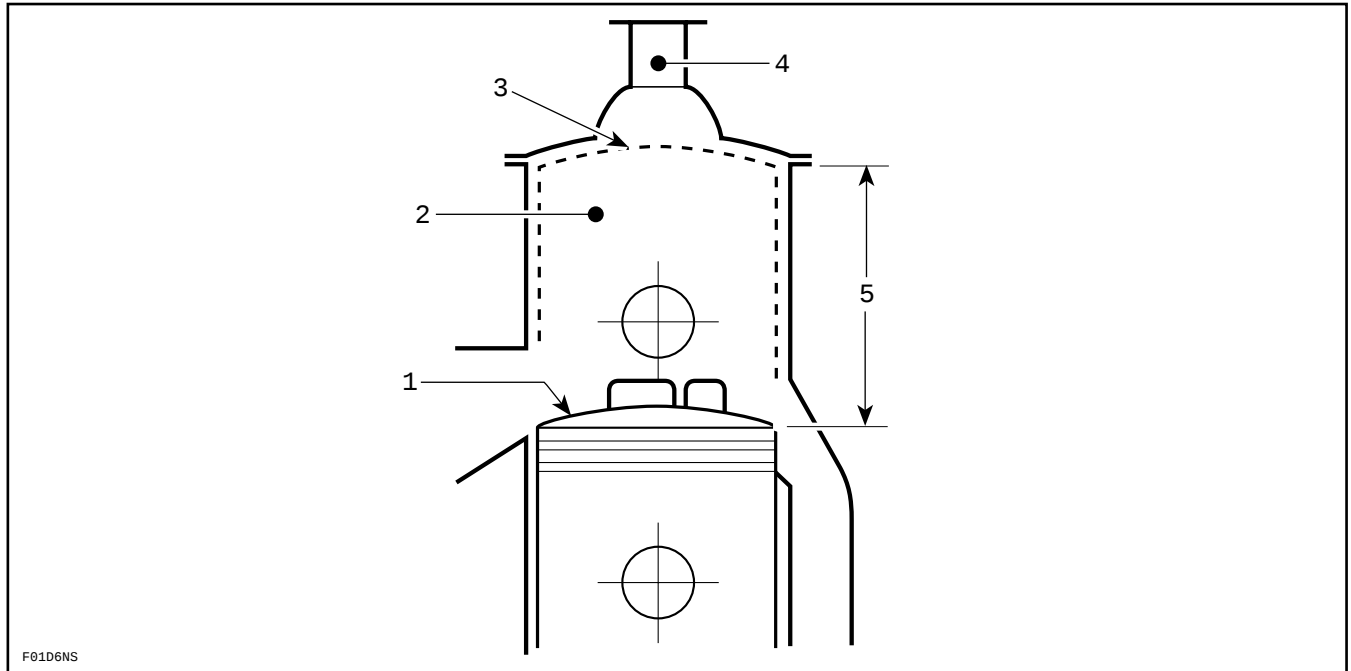
$$V_1 = \text{volume of a cylinder} \quad \frac{B^2 \times S \times \pi}{4}$$

V_2 = minimum combustion chamber volume

π = 3.14

B = bore diameter (cm)

S = stroke (cm)



1. B.D.C.
2. V_1
3. T.D.C.
4. V_2
5. Effective stroke

EXAMPLE:

$$B = 76 \text{ mm} \quad \underline{V_1 = 7.6^2 \text{ cm} \times 6.4 \text{ cm} \times \pi = 290.3 \text{ cc}}$$

$$S = 64 \text{ mm} \quad 4$$

$$V_2 = 27.6 \text{ cc}$$

$$\text{C.R.} = \frac{290.3 \text{ cc} + 27.6 \text{ cc}}{27.6 \text{ cc}}$$

$$\text{C.R.} = 11.5 : 1 \text{ UNCORRECTED}$$

In a 2-stroke engine, this is referred to as the “uncorrected compression ratio.” Because of the exhaust port midway up the cylinder, some designers believe that actual compression does not begin until termed “corrected compression ratio”, and is measured with the piston just as it closes the exhaust port.

MEASURING CORRECTED COMPRESSION RATIO

$$\text{C.C.R.} = \frac{V_3 + V_2}{V_2}$$

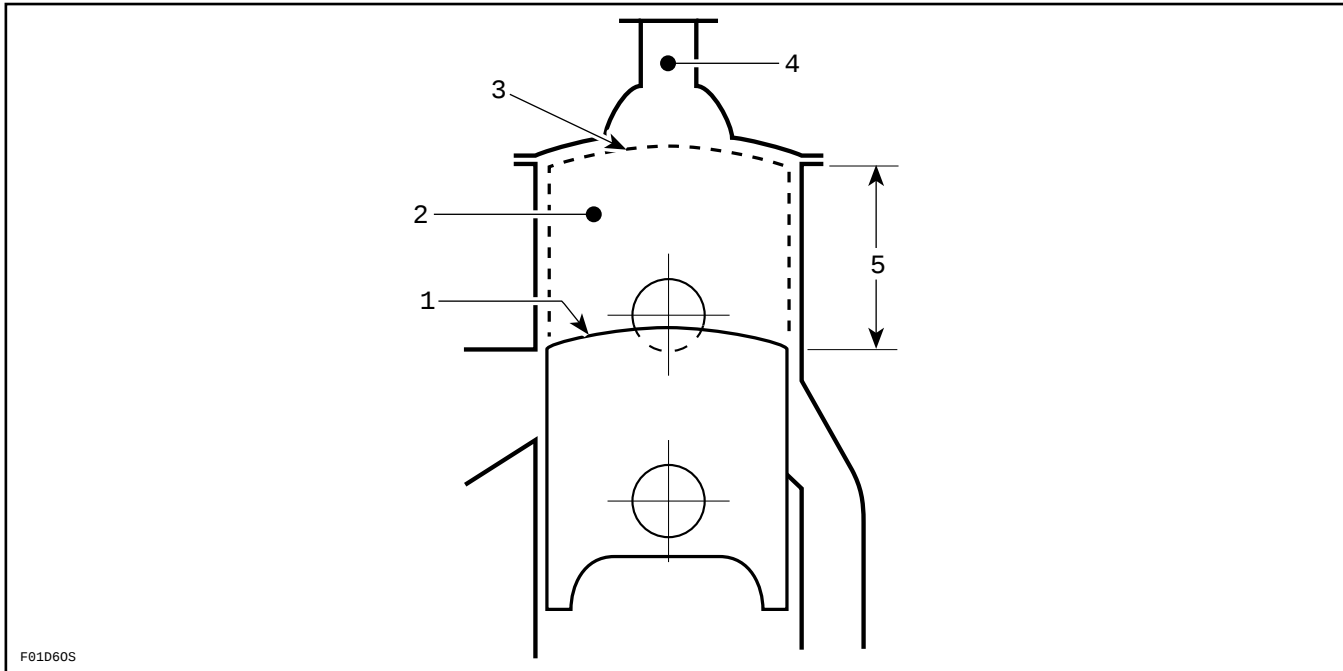
WHERE:

C.C.R. = corrected compression ratio

V_3 = volume of a cylinder with piston just closing the exhaust port

V_2 = minimum combustion chamber volume

SECTION 03 - ENGINE PREPARATION



1. Exhaust port just closed
2. V_3
3. T.D.C.
4. V_2
5. Efficient stroke

Following is a guideline for compression ratio and how it should relate to combustion chamber squish band clearance. It is very important that the compression ratio and squish band clearance should be the same for both cylinders of any given engine.

PRODUCTION ENGINES :

- Uncorrected compression ratio: 11.5 : 1 engine type 587
12.2 : 1 engine type 657
12.25 : 1 engine type 717
11.75 : 1 engine type 787
- Squish clearance: 1.30 mm - 1.70 mm (.051 in - .067 in) engine type 587
1.00 mm - 1.40 mm (.039 in - .055 in) engine type 657
1.30 mm - 1.70 mm (.051 in - .067 in) engine type 717
1.30 mm - 1.70 mm (.051 in - .067 in) engine type 787

PREPARED ENGINES:

- Uncorrected compression ratio: up to 14.5 : 1
- Squish clearance: 1.00 mm - 1.60 mm (.039 in - .063 in) engine type 587
0.80 mm - 1.40 mm (.031 in - .055 in) engine type 657
1.00 mm - 1.60 mm (.039 in - .063 in) engine type 717
1.00 mm - 1.60 mm (.039 in - .063 in) engine type 787

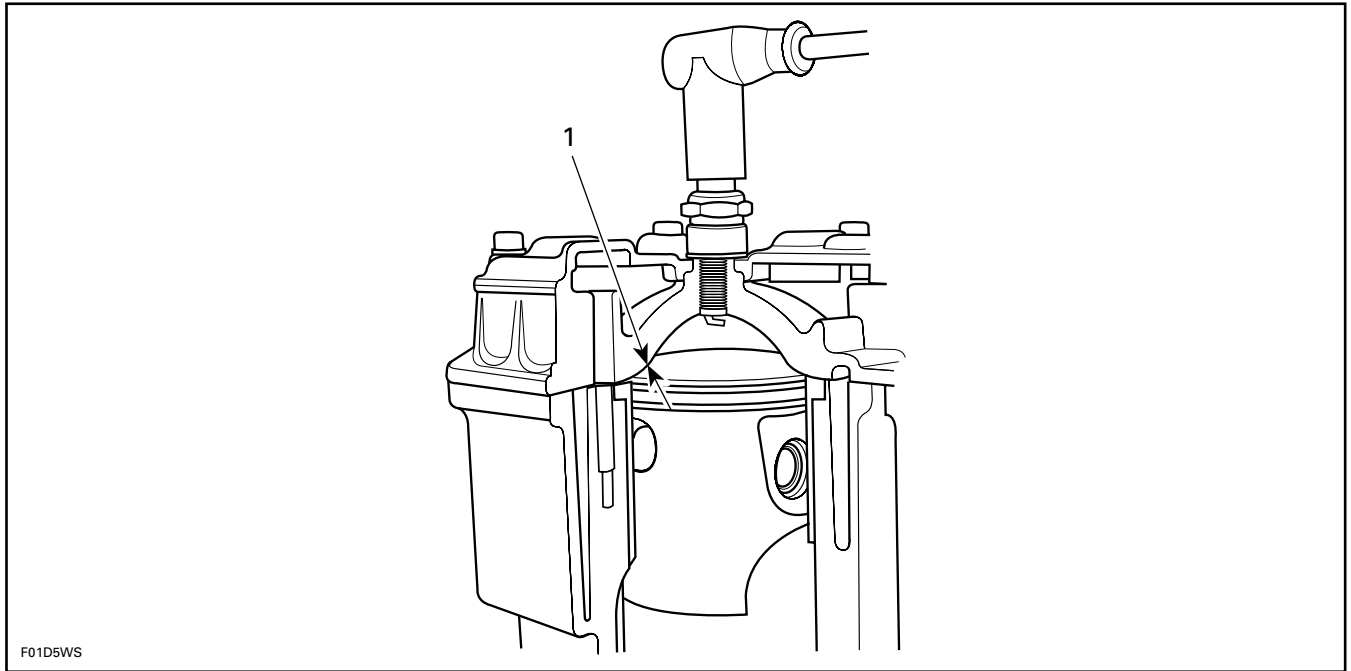


CAUTION: Reducing squish area may require using higher octane fuel as well as retarding ignition timing.

SECTION 03 - ENGINE PREPARATION

SQUISH AREA

Rotax rotary valve cylinder heads incorporate a squish area. This area is basically a “ledge” projecting beyond combustion chamber area. In operation, as the piston ascends and approaches the ledge, a rapid squeezing action is applied to the air/fuel mixture contained in the area immediately between the piston dome and the ledge. This squishing action forces the entrapped mixture rapidly into the combustion chamber area, creating a greater mixture turbulence. Additionally, the small volume and large surface area of the squish band allow a better cooling of the end gases to help prevent detonation.



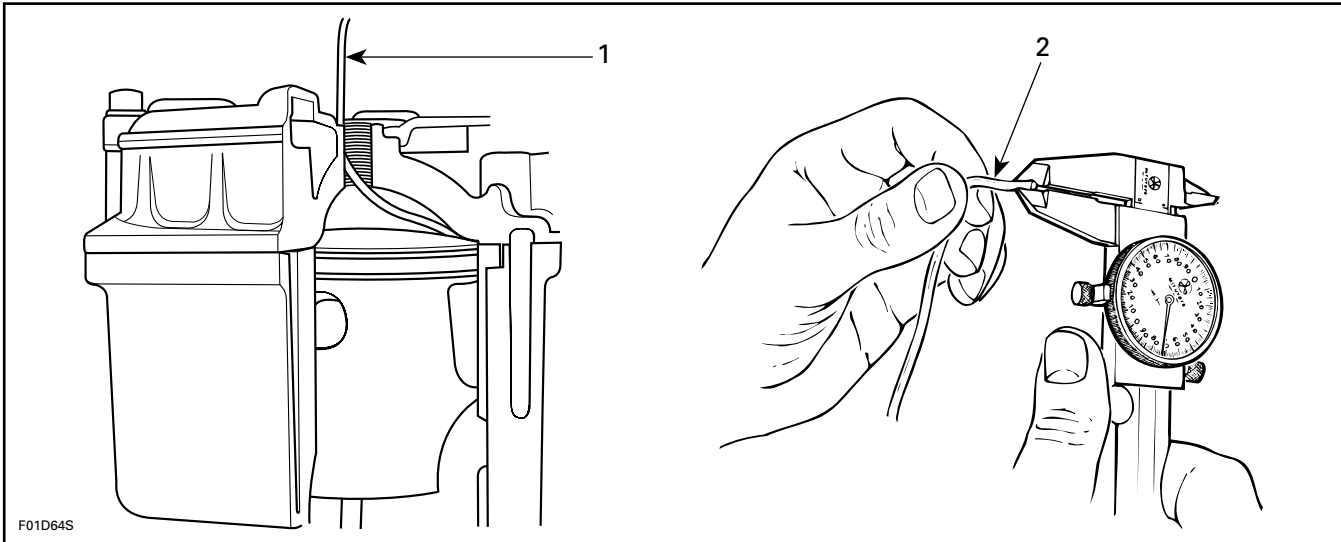
1. Squish area

If the squish clearance is increased, a loss in power will occur while too small a squish clearance will lead to detonation.

The squish clearance can be measured by inserting a piece of resin core solder into the combustion chamber, rotating the engine through Top Dead Center, removing the solder and measuring the thickness of the compressed solder.

The solder should be inserted above and in line with the wrist pin.

SECTION 03 - ENGINE PREPARATION



1. Solder
2. Measure here

CAUTION: Do not use acid core solder; the acid can damage the piston and cylinder.

NOTE: If you are machining your cylinder head to increase compression ratio, be sure to respect proper squish band tolerances in the machining process.

OCTANE REQUIREMENTS FOR ROTAX ENGINES

Following is a set of guidelines for a suggested relationship between uncorrected (full stroke) compression ratio, combustion chamber squish band clearance, and octane requirements for an engine built to compete in racing. These are only suggested guidelines and are not the only factors involved in the complete building of a reliable race ready engine. All Rotax engines will perform best on unleaded regular gasoline of the proper octane. There is no advantage of using a higher octane fuel if the compression ratio is not higher than production. However, if the compression ratio is higher, it may become necessary to use a higher octane fuel or engine damage will result. Do not use a compression gauge to determine compression ratio. A compression gauge is useful in checking general condition of any engine, but is useless when checking compression ratio.

Minimum octane requirement for production engines: 87 RM (Regular unleaded).

R = Research octane number = 90

M = Motor octane number = 84

$R + M = 87$ octane

2

Minimum octane requirement for engines with higher compression ratio: (Premium unleaded):

Up to 14: 1 = 108-112 motor octane

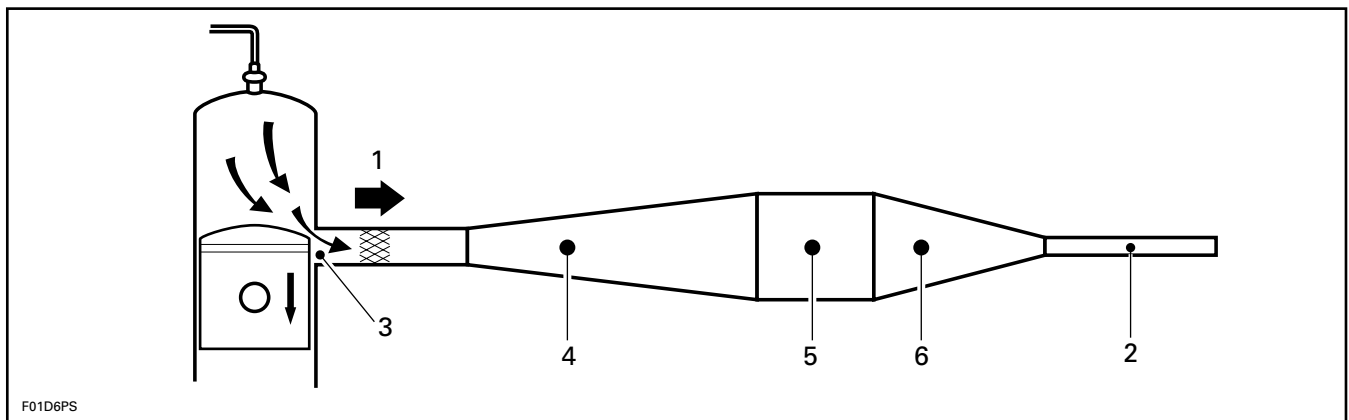
Over 14: 1 = 114 motor octane

FUNCTION OF AN EXHAUST SYSTEM

Volumetric efficiency (V.E.) of an engine is the ratio of the actual amount of air drawn into an engine versus the capacity of the engine. The natural V.E. of a 2-stroke is about 65%. This means a 250 cc cylinder only draws in about 160 cc of air. The HP output of an engine can be raised by increasing the V.E. of the engine.

The most notable method of raising V.E. is the use of a correctly tuned expansion chamber (or tuned pipe). If the exhaust port is emptied into the open atmosphere, much of the fresh air/fuel charge rushing up the transfer ports is expelled out of the exhaust port and lost. To prevent this charge from being lost, a tuned chamber is attached to the exhaust port. The tuned chamber uses sonic wave motion, which is separate from the exhaust particles and fresh charge particles, to move the particles around (this is like waves in water moving a cork).

When the exhaust port is opened, a sonic or sound wave is generated by the high pressure exhaust gases expanding into the header pipe. The speed of sound at exhaust temperature is 518 meters (1700 ft) per second.

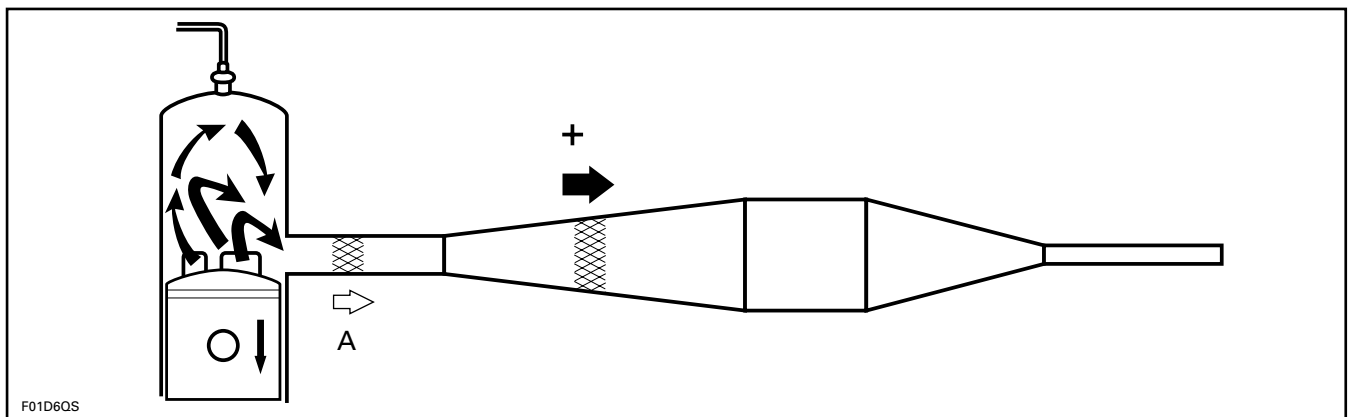


1. Sonic wave initiated as exhaust port opens
2. Tailpipe or stinger
3. Head pipe

4. Diverging cone/s
5. Mid section
6. Converging cone/s

This wave travels down the header pipe and expands into the diverging cone causing a negative pressure of about 48 kPa (7 PSI).

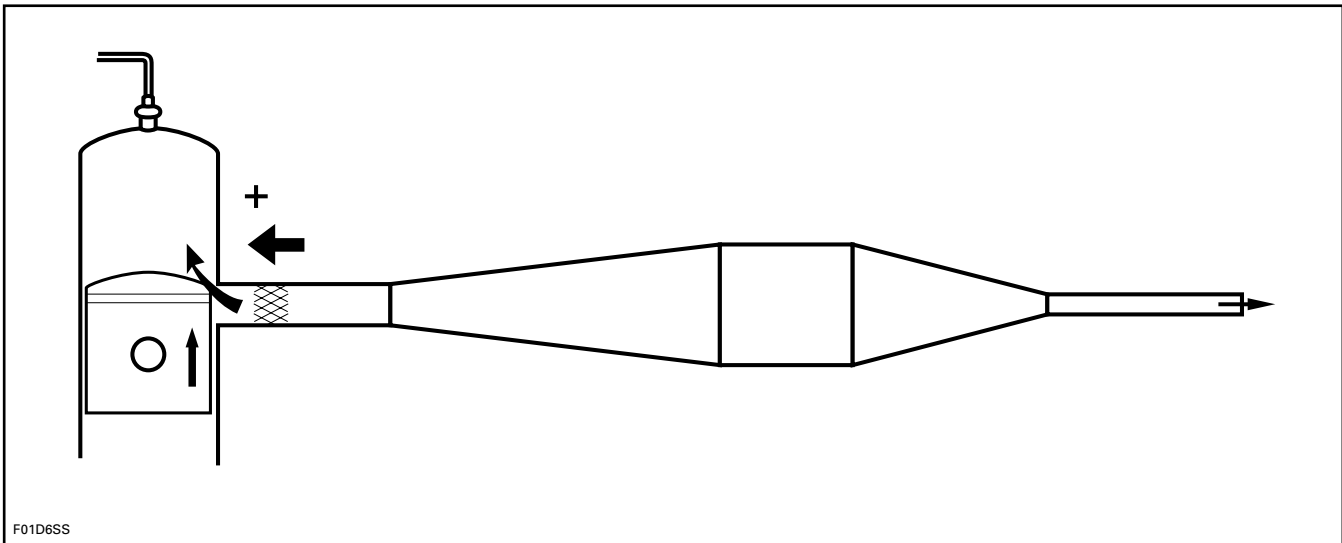
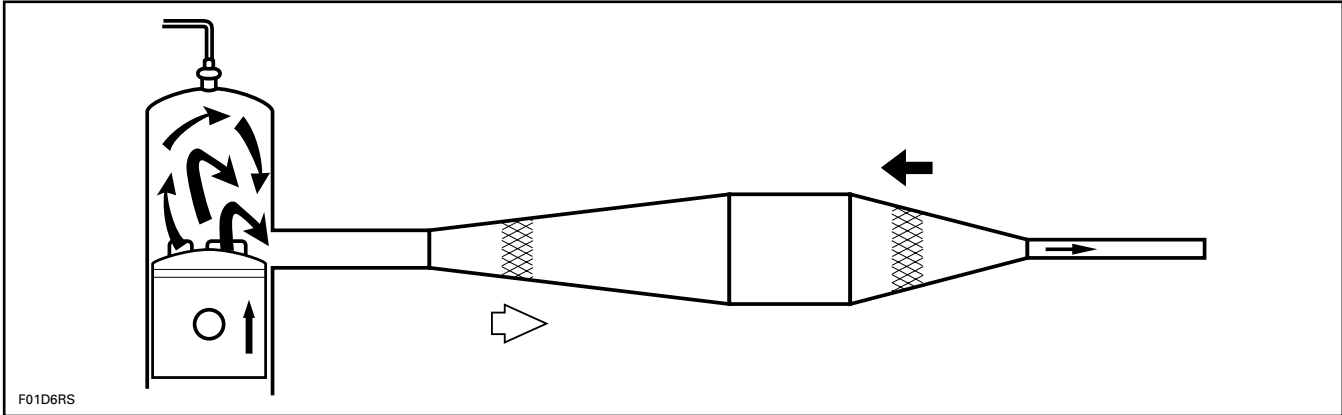
This negative pressure helps pull the remaining exhaust particles out of the cylinder. It also helps pull the fresh charge up the transfer ports and into the cylinder.



A. 48 KPa (7 PSI)

SECTION 03 - ENGINE PREPARATION

As the sonic wave hits the converging end of the pipe, a positive pressure wave is reflected back towards the exhaust port. If the length of the pipe is tuned correctly, this positive pressure returns to the header pipe just before the exhaust port closes and pushes the fresh charge that has escaped into the header pipe into the cylinder.



The pipe then bleeds down to approximately atmospheric pressure and the cycle is repeated. The design of the pipe depends upon many factors, including bore, stroke, and desired effective operating RPM.

Because the sonic wave speed is fairly constant, the length of the pipe is a large factor in controlling the engine RPM at which the pipe will be efficient. A shorter pipe will result in higher RPM's but not necessarily more horsepower (the pipe must be compatible with the other flow characteristics of the engine, carburetor size, intake timing, etc.)

Maximum efficiency is generally obtained by having 1 pipe for each cylinder. But, this maximum point may be across a narrow and / or high RPM range, causing difficulties in driveability.

The 2 into 1 tuned pipes used on Sea-Doo watercraft are very accurately tuned for the overall design of these particular engines.

NOTE: Changing the tuned pipe for an aftermarket unit will usually change RPM and torque of the engine. An impeller change to compliment your new tuned pipe will probably be necessary.

WATER INJECTED EXHAUST SYSTEM

Several factors necessitate the use of a water cooled, water injected, tuned exhaust system. One major concern is overall bilge temperature, which is kept low by keeping the part of the tuned pipe closest to the engine jacketed with water and the remainder of the exhaust system cool by injecting water directly into the exhaust stream. Injecting water into the exhaust system not only helps keep the exhaust system cool, but also changes the characteristics of the sonic wave in the tuned pipe. The water injected exhaust system reduces exhaust gas temperature, therefore increasing exhaust gas density in the tuned pipe. The sonic wave moves slower in this cooled, denser air so it takes longer to reflect back to the exhaust port. The net effect is that the tuned pipe can be shorter yet achieving the same results as a longer "dry" tuned pipe.

By changing the amount of water injected into the exhaust stream, the characteristics of the engine power band can be altered. It is important that enough water is injected into the exhaust stream to keep the rubber hoses and muffler from damage due to excessive heat.

In Limited Class racing an aftermarket exhaust pipe and manifold are allowed. The water box or muffler however must remain stock with no modifications. When purchasing an aftermarket pipe consult the manufacturer of the pipe to determine if the pipe is race legal by your race sanctioning body (IJSBA). Some pipes will fit your craft, but may not be race legal because of inadequate head pipe cooling or mounting of the pipe requires relocation of the waterbox. Waterbox relocation is illegal by several sanctioning bodies for Limited Class racing.

XP 800 EXHAUST WATER REGULATOR OPERATION AND REMOVAL

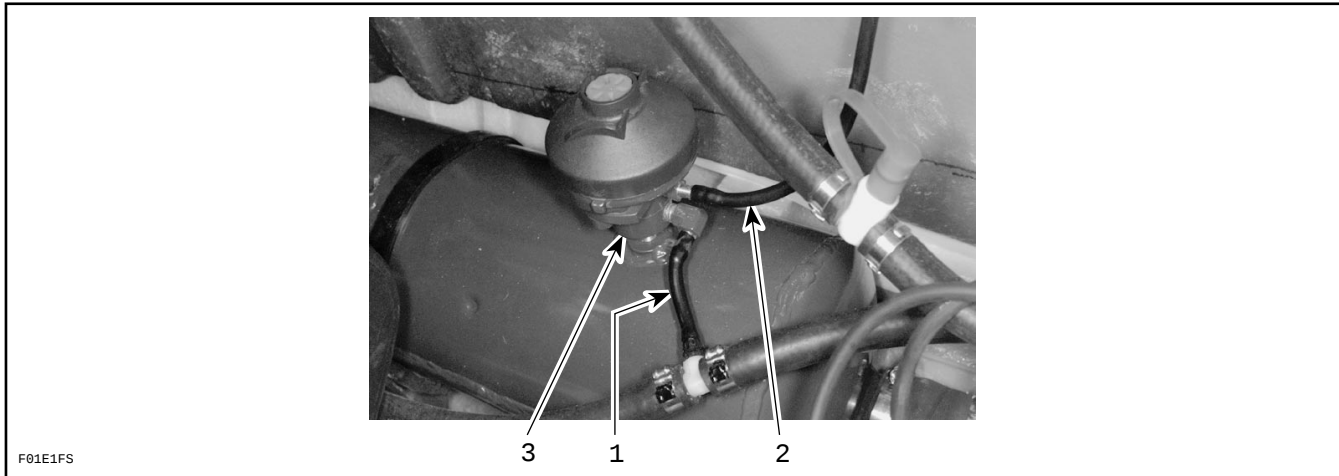
The XP 800 models utilize a water regulator located on top of the muffler to control the amount of water injected into the exhaust system at the tuned pipe head and the muffler box. The purpose of this is two fold:

1. It effectively controls the exhaust wave speed thereby creating a more usefull or broader power curve.
2. It cools the exhaust system and hoses which prevents heat damage.

The water regulator is calibrated for use on XP 800's which have no engine modifications. The regulators works quite well on the stock watercraft and provides a noticeable increase in performance over models not so equipped. If the watercraft is **not being raced** but modifications are made to the engine such as increased compression, changes in port timing, etc. the water regulator will not deliver the correct amount of water for optimum performance. Recalibrating the regulator water flow will require most users to experiment with different size holes being drilled into the regulator then threading and fitting the holes with jets. Various size jets will then be tried until the best performance is found.

The water regulator has been disallowed for competition usage by the IJSBA. Furthermore any valves used within the entire engine cooling system must be of the fixed type. This rule was placed into affect during the mid 1995 racing season. Due to this ruling the water regulator must be removed and the exhaust system must be "Hard Jetted" (fitted with jets of the fixed type).

SECTION 03 - ENGINE PREPARATION



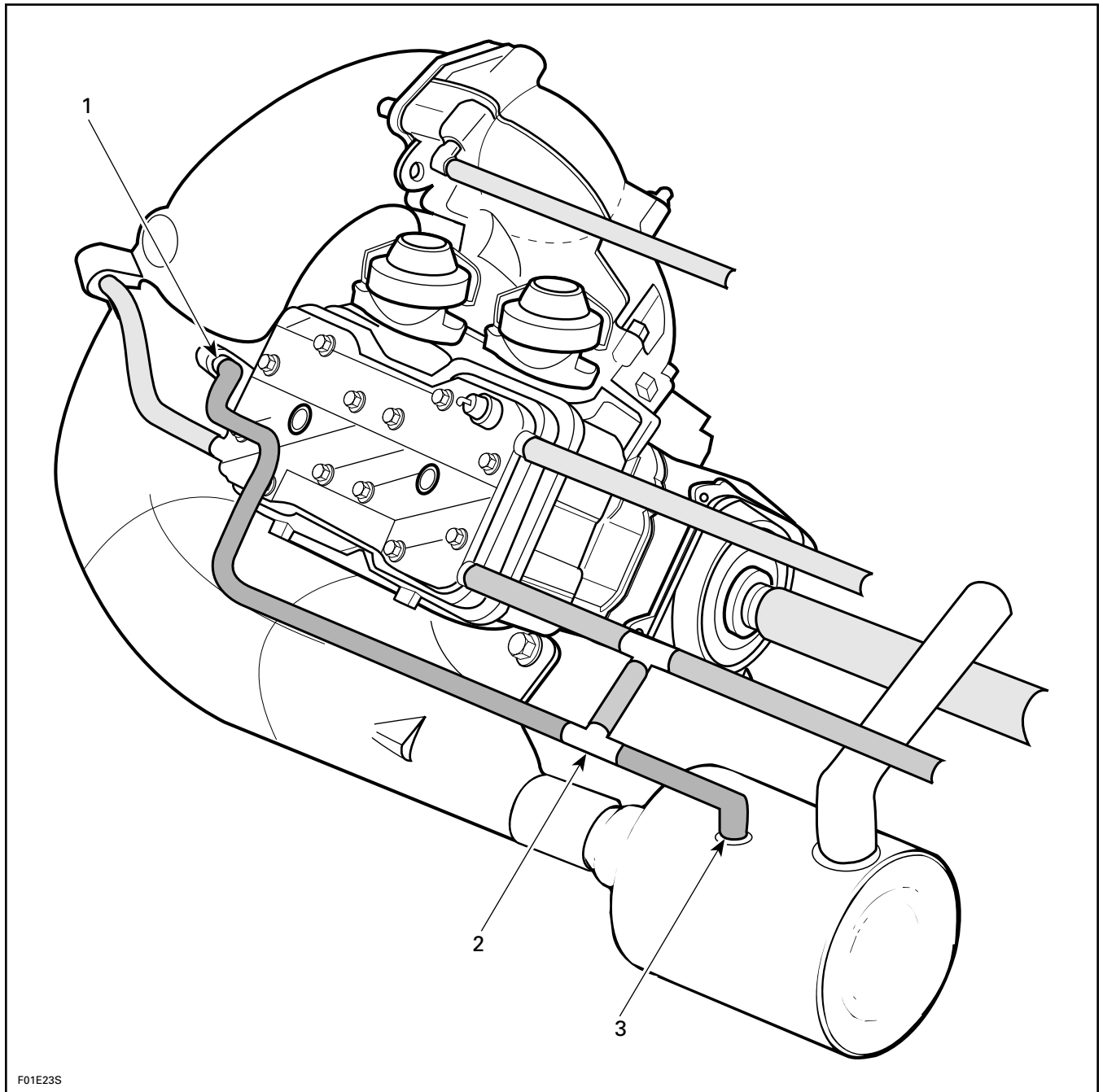
1. Water supply hose of regulator valve
2. Regulated water to injection fitting at tuned pipe head
3. Water injected into the muffler

▼ **CAUTION:** When “Hard Jetting” an exhaust system small jets are used to regulate water flow. These jets are very prone to clogging by sand or debris. The jets must be continually checked for blockage or system damage will occur.

THE PROCEDURE FOR HARD JETTING THE EXHAUST SYSTEM IS AS FOLLOWS :

1. Remove the water regulator and replace the unit with a fitting that will thread into the waterbox in its place. The fitting must have at least a three millimeter orifice through it and be threaded to accept a Mikuni main jet. The fitting must also accept a one quarter inch I.D. hose.
2. At the exhaust tuned head pipe there is a one quarter inch fitting already in use that was used to accept the regulated water supply from the now discarded water regulator. Remove the hose from the fitting at the head pipe and thread the fitting to accept a Mikuni main jet.
3. The engine is equipped with a one half inch water inlet hose coming from the jet jump. Between the jet pump and the engine there is a one quarter inch O.D. T-fitting and hose currently installed. The fitting and hose was used to supply water to the now discarded water regulator. Attach a one quarter inch T-fitting to the hose in place of the water regulator. Attach two quarter inch hoses to the T-fitting, run one hose to the new fitting on the muffler which replaces the water regulator and one hose to the fitting on the tuned head pipe.
4. Start the hard jetting procedure by installing a #200 Mikuni main jet in the fitting on the muffler and a #150 Mikuni main jet in the fitting on the exhaust tuned head pipe. After an initial test ride of no more than three minutes, stop and check the exhaust hoses for excessive temperature. If you believe the temperatures to be too high install a larger jet in both areas. This is highly unlikely because the initial jet sizes stated should be more than sufficient.
5. After verifying that the exhaust hose temperature is not excessive you can start testing the watercraft with smaller or larger jets in order to attain the performance desired.

SECTION 03 - ENGINE PREPARATION



1. Original fitting threaded to accept a Mikuni main jet size 150
2. New 1/4" T-Fitting
3. New fitting threaded to accept a Mikuni main jet size 200

IMPORTANT: It is necessary to readjust the exhaust hard jetting for maximum performance when racing in different water temperatures. Because of this it is recommended that you keep a record of the jet sizes chosen at given water temperatures.

SECTION 03 - ENGINE PREPARATION

FUNCTION OF THE COOLING SYSTEM

All Sea-Doo watercraft are equipped with a total loss cooling system. The water supply is taken from a pressurized area in the pump between the impeller and venturi. The water passes through a tee, where a small amount is diverted into the exhaust stream (refer to WATER INJECTED EXHAUST SYSTEM in this section), and the majority continues into the exhaust system cooling jacket to be warmed before entering the engine. On the 1988-91 engines, water enters at the bottom of the exhaust manifold and tuned pipe cooling jackets; then to the engine. On the 1992-96 engines, (excluding the 717 and 787 X engines) the water enters the cooling jacket on the tuned pipe, and travels into the cooling jacket around the exhaust manifold, after which it enters the cooling jackets of the cylinders through small passages under the exhaust ports.

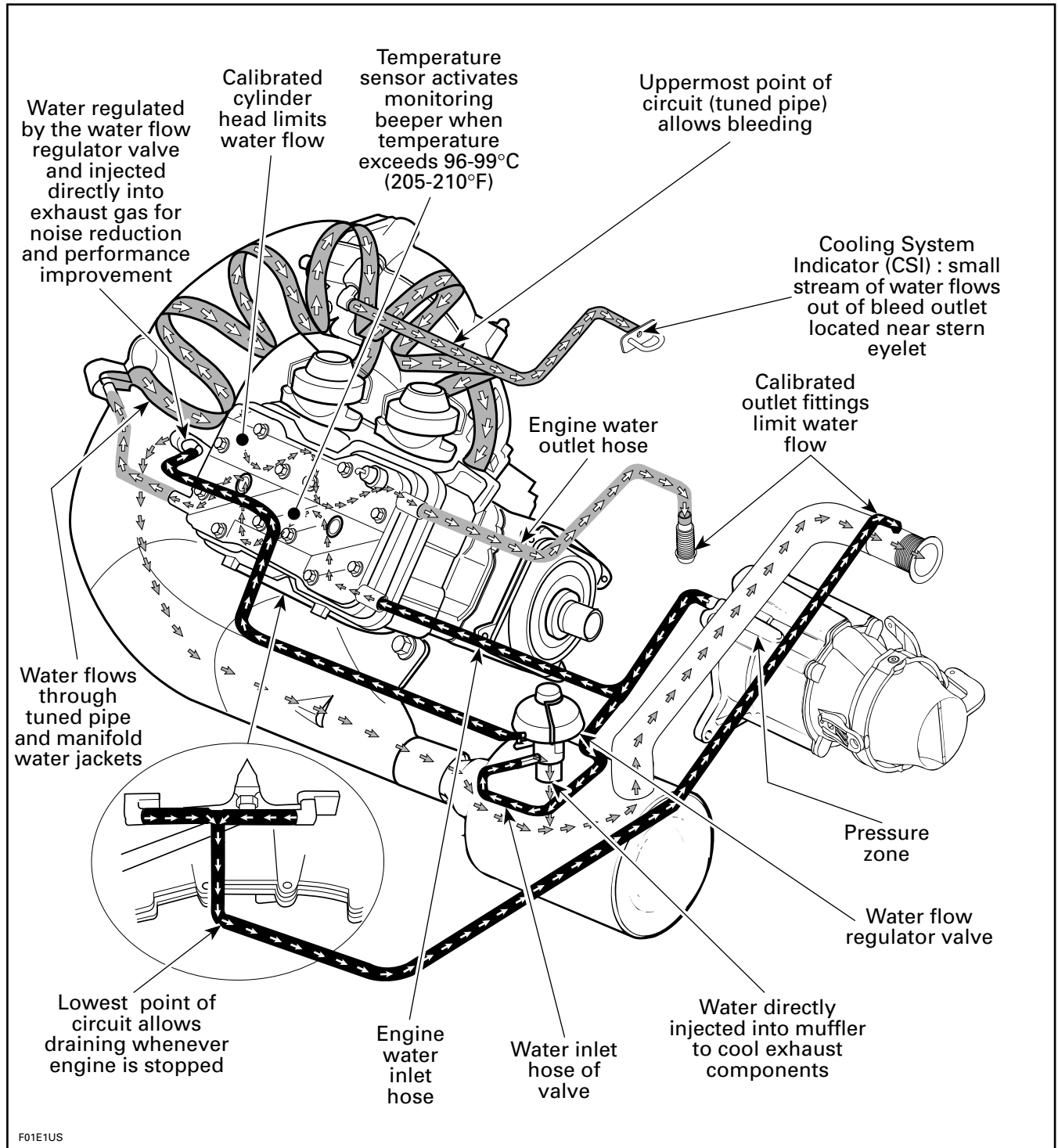
The flow of water through the exhaust system has changed slightly from the 1988-91 yellow engines to the 1992-96 white engines; however, the most important point is that on either type of engine, the water is still pre-heated by the exhaust system before entering the engine cooling jackets.

On the 1995-96 717 and 787 X engines the water first enters the cylinder head, unlike previous models. The cylinder head cooling jacket has been divided into 2 sections. One side of the head's water jacket (exhaust side) has cool incoming water circulate around the combustion chambers, then into the tuned pipe and exhaust manifold cooling jacket. The preheated water then enters the cooling jackets of the cylinders. From the cylinders the water flows upward through calculated holes to the outlet side of the cylinder head. The outlet side of the cylinder head's cooling jacket also houses the engine temperature sensor, where the now hot water escapes through the engine water outlet hose.

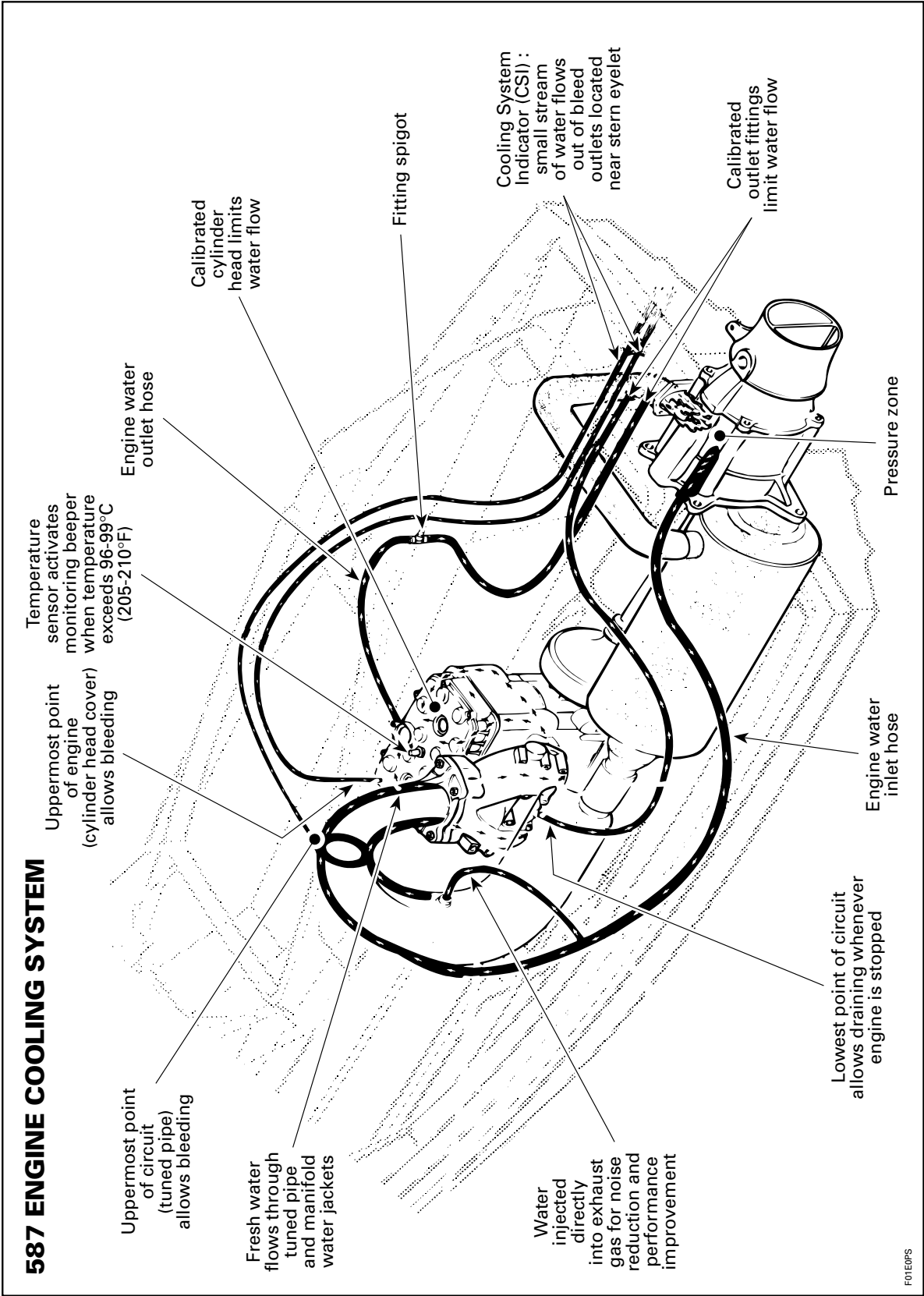
Some aftermarket companies may suggest that the cooling system be re-routed to feed cold water directly to the engine instead of allowing the exhaust system to warm it first. This change should be approached with caution as random changes without adequate testing and development could be detrimental to the engine. Changing the routing of the cooling system could result in less power output and engine reliability.

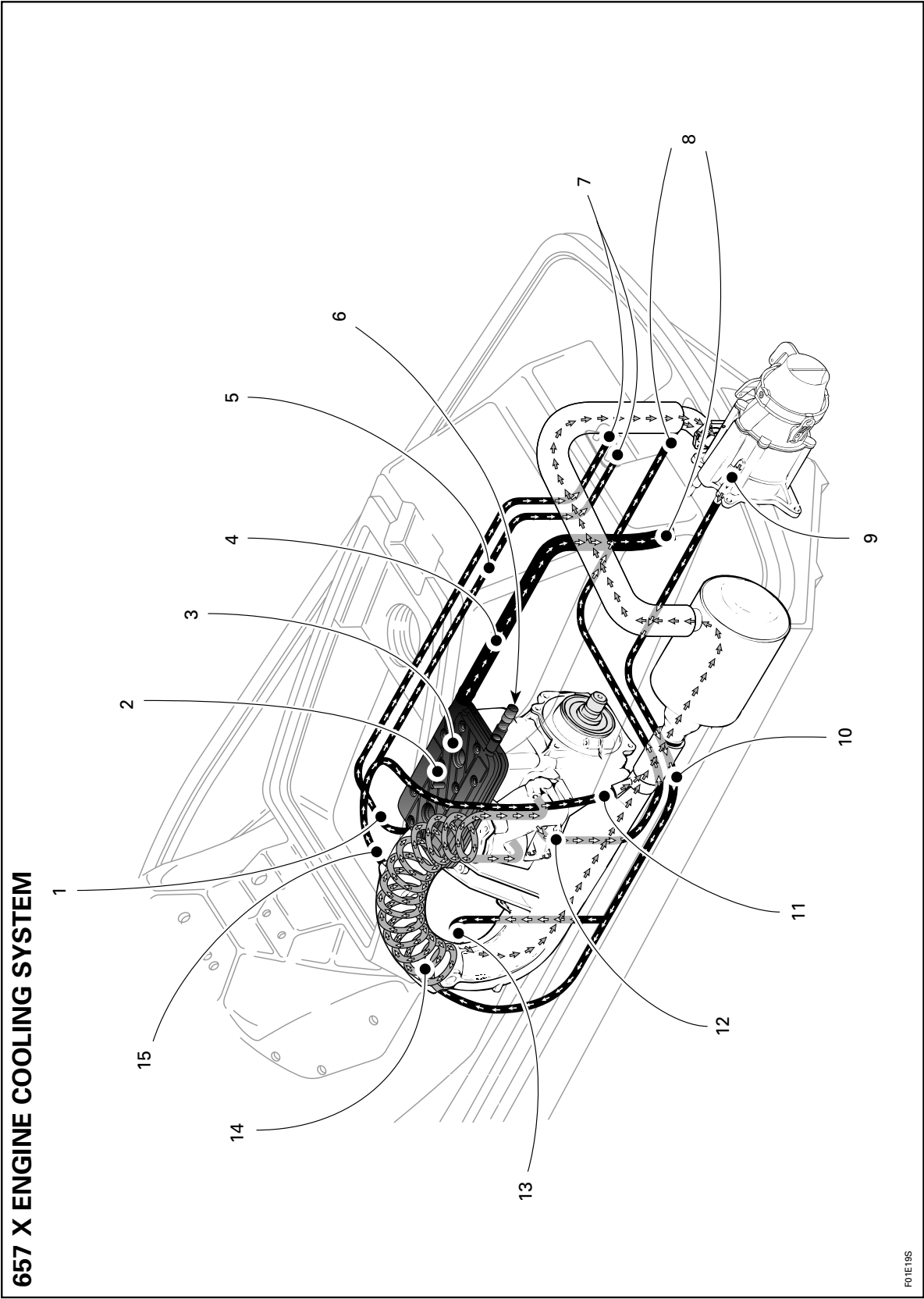
On the 1988-91 engines, the cooling water proceeds into the engine via a water distributor into the crankcase, then up to the cylinders. On the 1992-96 engines, the cooling water proceeds from the exhaust manifold cooling jacket into the cylinder cooling jacket via the passages below the exhaust ports. On all engines, the water surrounds the cylinders and moves upward through calculated holes in the cylinder head exiting the engine at the intake side of the cylinder head.

SECTION 03 - ENGINE PREPARATION



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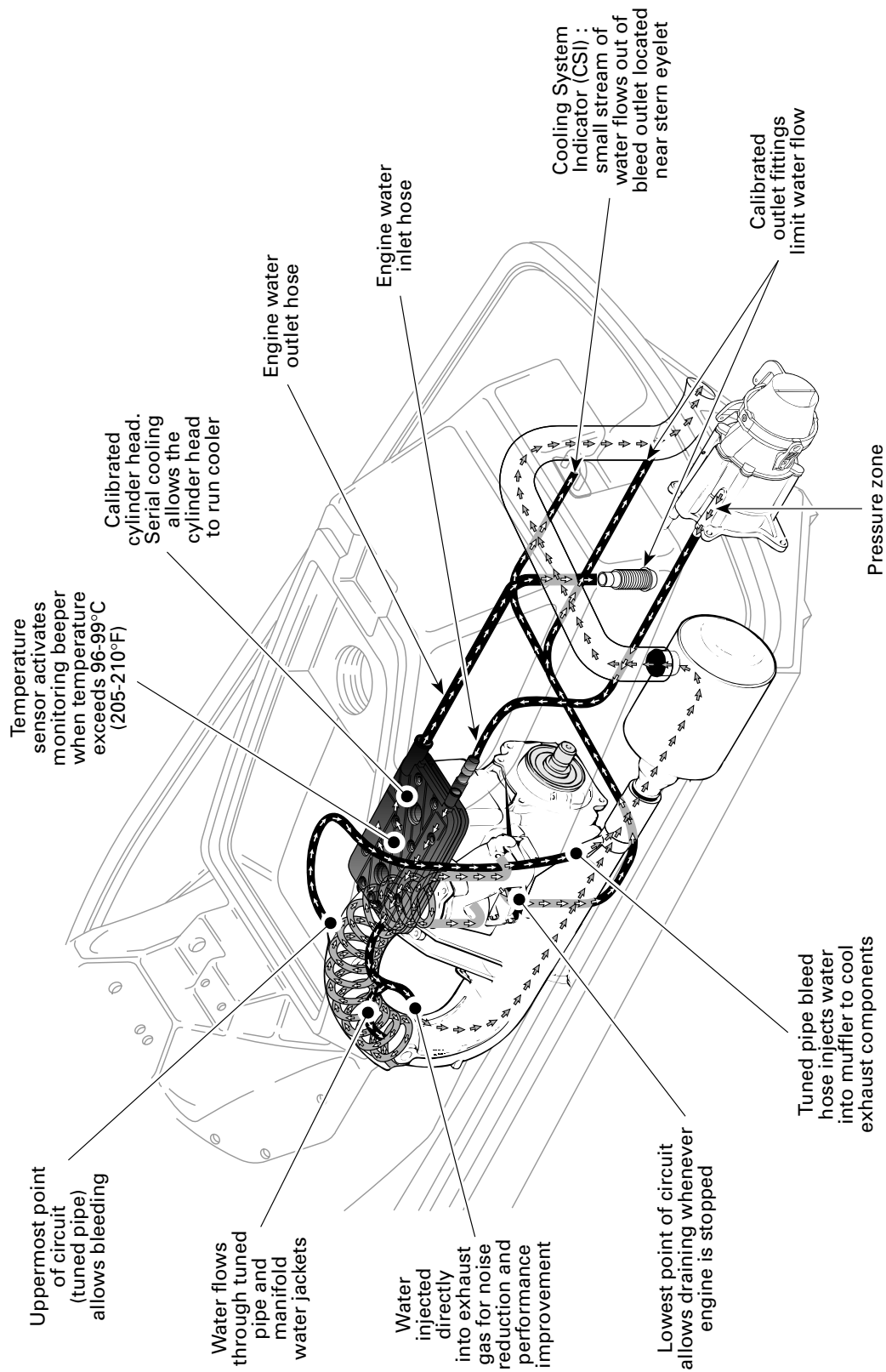




SECTION 03 - ENGINE PREPARATION

1. *Uppermost point of engine (cylinder head) allows bleeding*
2. *Temperature sensor activates monitoring beeper when temperature exceeds 96-99°C (205-210°F)*
3. *Calibrated cylinder head limits water flow*
4. *Engine water outlet hose*
5. *SPX model*
6. *Fitting spigot*
7. *Cooling System Indicator(s) (CSI): Small stream of water flows out of bleed outlet(s) located near stern eyelet*
8. *Calibrated outlet fittings limit water flow*
9. *Pressure zone*
10. *Engine water inlet hose*
11. *Tuned pipe bleed hose injects water into muffler to cool exhaust components (GTX model)*
12. *Lowest point of circuit allows draining whenever engine is stopped*
13. *Water injected directly into exhaust gas for noise reduction and performance improvement*
14. *Fresh water flows through tuned pipe and manifold water jackets*
15. *Uppermost point of circuit (tuned pipe) allows bleeding*

717 ENGINE COOLING SYSTEM



F01E0US

SECTION 03 - ENGINE PREPARATION

RAVE SYSTEM OPERATION

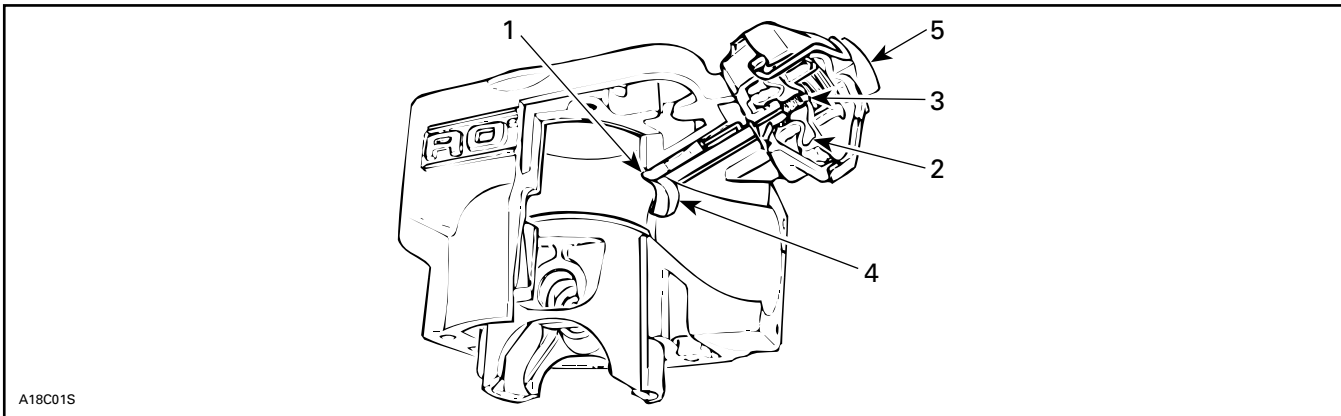
For a 2-stroke-cycle engine to have high power capacity at high crankshaft speeds, a high volumetric or breathing efficiency is required and the fresh charge losses must be minimized. The result is achieved by opening the exhaust port early and utilizing the resonant effects of the tuned exhaust system to control fresh charge losses.

When an engine of this design is run at a high speed, efficiency falls off quickly. The relatively high exhaust port effectively shortens the useful power stroke and because the exhaust system is tuned for maximum power, there is a large increase of fresh charge losses at lower speeds. As a result, the torque decreases along with a dramatic increase of the specific fuel consumption. Higher torque along with lower fuel consumption can be obtained at lower engine speeds if the time the exhaust port is open is shortened.

Bombardier-Rotax has patented a remarkably simple system to automatically change the exhaust port height based on pressure in the exhaust system.

Located above the exhaust port is a guillotine-type slide valve. This rectangular valve is connected by a shaft to a diaphragm which is working against a return spring. Two small passages in the cylinder just outside the exhaust port allow exhaust gas pressure to reach the diaphragm.

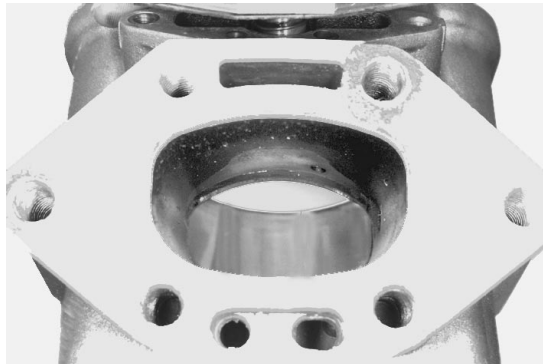
To the outside of the return spring is a red plastic adjustment knob. Turning the adjustment in or out changes the preload on the return spring which, in turn, will change the RPM at which the RAVE valve opens and closes.



1. Sliding Valve
2. Diaphragm
3. Spring
4. Exhaust Port
5. Adjustment Knob

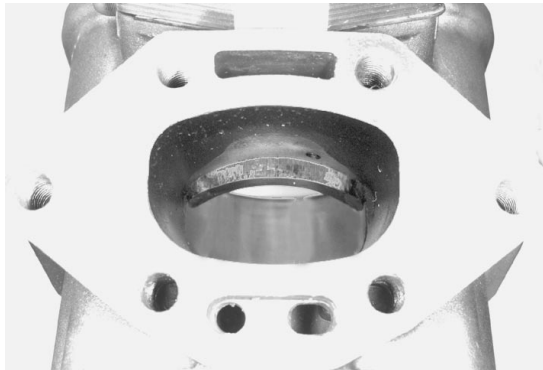
As the throttle is opened and the engine begins producing more power, the pressure against the diaphragm will overcome the pressure of the return spring and the RAVE valve will open.

SECTION 03 - ENGINE PREPARATION



F01D7GS

Valve Fully Open

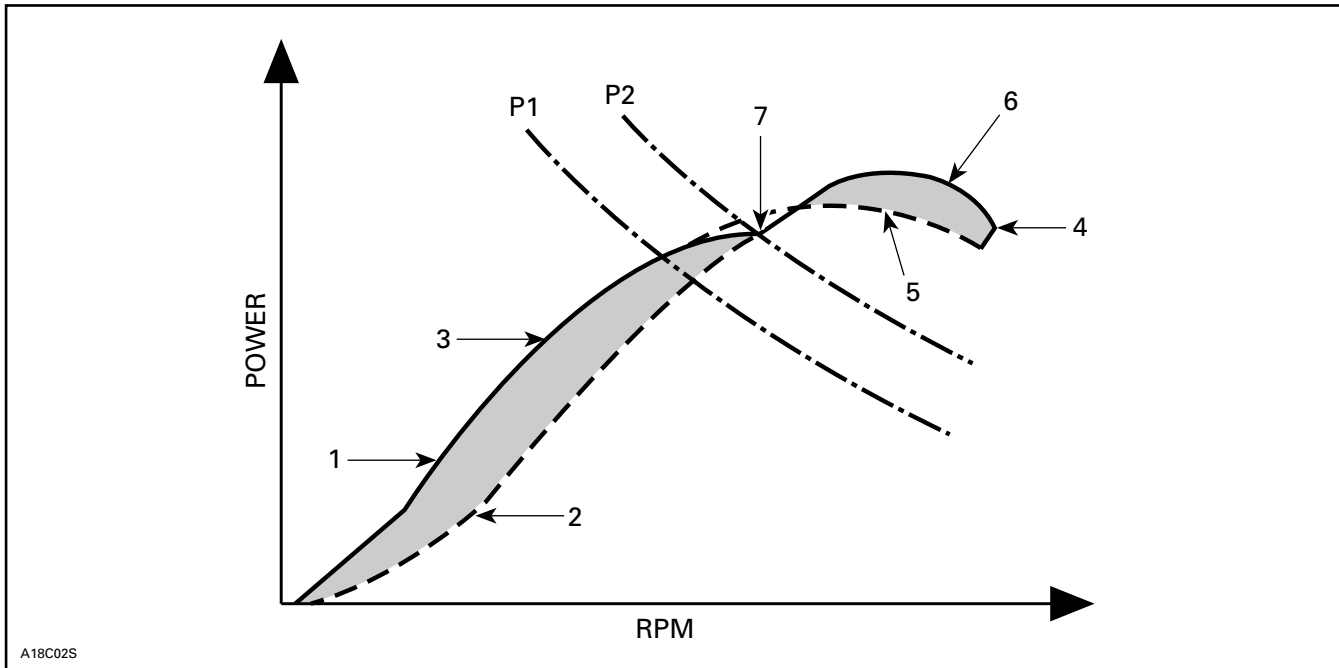


F01D7HS

Valve Fully Closed

The RAVE valve does not allow an engine to make higher peak horsepower than an engine not so equipped, it can however make moving the peak horsepower higher practical, because of its effect on the rest of the power curve. Item 2 in the following figure is the power curve of an engine with the RAVE valve held fully open through its entire RPM range. Item 6 notes the peak power produced. That peak will not change if the exhaust port time of a similar engine without a RAVE valve was the same (with all other features equal).

SECTION 03 - ENGINE PREPARATION



Item 1 is the power curve of the engine with the RAVE valve closed through its entire RPM range. The shaded area (item 3) is the improvement in power at lower engine speeds that is gained because of the lower exhaust port. If the port remains at this height however, the power would peak as noted in item 5. Raising the exhaust port at the proper RPM (item 7) will allow the engine peak power to continue to rise (item 6).

Item P1 in the figure is the pressure of the return spring against the diaphragm. The exhaust pressure must be high enough to overcome this pressure before the valve begins opening. Item P2 is the pressure required to completely open the RAVE valve. Between P1 and P2, the usable power curve of the engine is moving from curve 1 to power curve 2. This transition takes place very rapidly at full throttle and from a practical standpoint can be considered to be instantaneous at item 7. Gradual application of the throttle, however, will result in the RAVE valve opening much later.

If the RAVE valve opens too late, the engine will bog or hesitate momentarily as the RPM increases. Full peak performance (item 6) is still available. From a functional point of view, it is better to have the valve open a bit early than a bit late.

RAVE VALVE ADJUSTMENT

To adjust the RAVE valve turn the red adjustment knob all the way in (clockwise). Open the red knob 1 turn out (counter clockwise) and perform an acceleration run on the craft starting from zero and accelerating to full speed. Repeat the procedure until you attain the best performance. The use of a radar gun with acceleration recording capabilities is advised in order to obtain accurate data, however rider observation will surface.

SECTION 03 - ENGINE PREPARATION

MAINTENANCE

The RAVE components should be periodically checked. The RAVE valve requires cleaning of carbon deposits. Cleaning intervals would depend upon the user's riding style and the quality of the oil used. Using FORMULA XP-S synthetic injection oil, clean the valve periodically. Check for clean passages between the exhaust port and diaphragm chamber. If cleaning is necessary, use solvent to remove the deposits. Also check the diaphragm for punctures, replace if damaged.

No special solvents or cleaners are required when cleaning the valve.

CYLINDER BORING PRECAUTION

In its stock configuration the RAVE valve guillotine has a minimum of 0.5 mm (.020 in) clearance to the cylinder bore measured at the center line of the cylinder. This is the minimum production clearance.

There is only a first oversize piston available. It is 0.25 mm (.010 in) larger in diameter than the stock piston. When the oversize is installed, the guillotine will have a minimum clearance of 0.375 mm (.015 in) with the cylinder bore. This is the minimum operating clearance the guillotine should be used with. Clearance less than 0.375 mm (.015 in) will require reworking of the guillotine to achieve the proper clearance and radius.

NOTE: When boring the cylinder on the XP 800 watercraft with the 787 model engine, the engine displacement will be 785.76 cc's after boring and honing. The engine will **no longer be race legal** for 785 cc class racing. In order to maintain legality, have your Sea Doo dealer re-sleeve the cylinders and install stock diameter pistons.

FUNCTION OF THE ROTARY VALVE INTAKE SYSTEM

Controlling the opening and closing of the intake port is also a critical factor in the volumetric efficiency of an engine. Best V.E.'s are obtained by asymmetrical intake timing (opening and closing of intake port operates independently with regard to piston position. Example: 130° BTDC opening, 65° ATDC closing). While also allowing for an unobstructed intake tract to provide maximum airflow into the engine. This is best accomplished by using a rotary valve type inlet.

The rotary valve engine is 1 of the most innovative concepts to be applied to 2-stroke watercraft engines.

Simply stated, the design produces more horsepower out of the same size engine displacement at the same RPM. Because the aperture size and degree of opening exceed that of a piston port engine, a greater air/fuel mixture supply can enter the engine and remain in the engine without spitback.

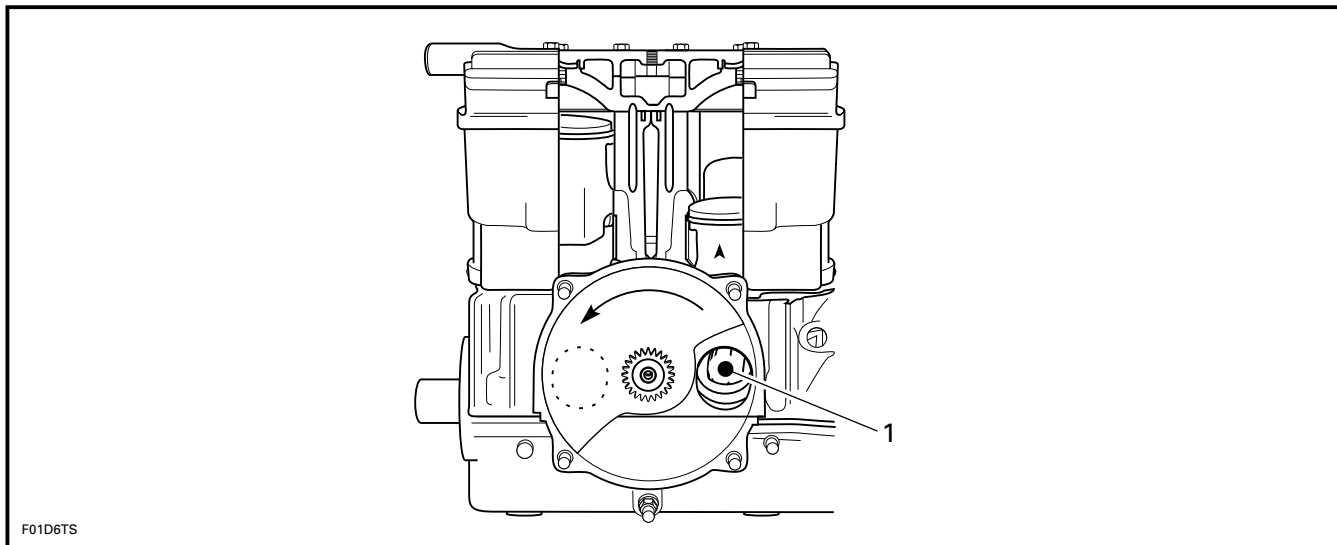
ENGINE OPERATION

Basically, the rotary valve engine performs the same operation as the piston port 2-stroke engine. The only difference being the location and operation of intake.

- 1) The intake port is positioned directly in the crankcase.
- 2) The opening and closing of the intake port is controlled by a rotary valve instead of the piston.
- 3) The rotary valve is driven by the crankshaft in a counterclockwise direction.

SECTION 03 - ENGINE PREPARATION

INTAKE AND SECONDARY COMPRESSION

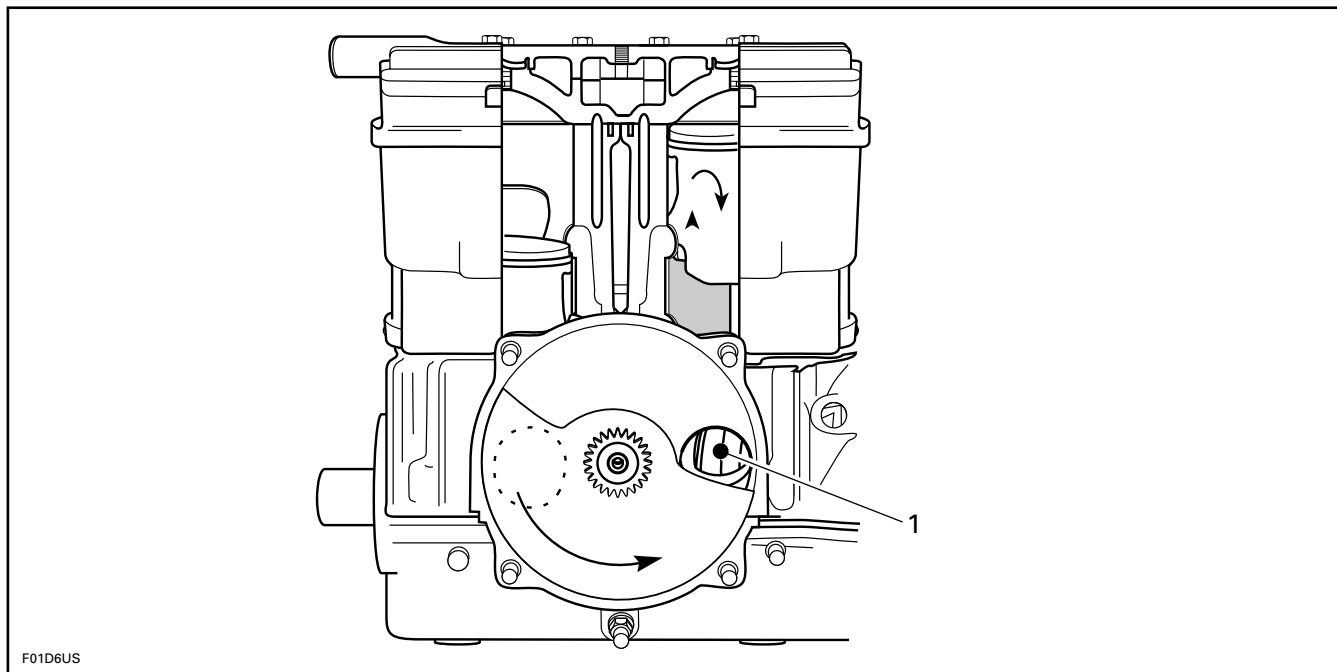


1. Fresh charge from carburetor

As the piston starts its upward stroke, the air /fuel mixture is drawn into the crankcase from the carburetor via the intake port (the rotary valve uncovers the intake port).

At the same time, the piston blocks the exhaust and transfer ports, and compresses the air /fuel mixture in the combustion chamber (secondary compression).

IGNITION AND COMBUSTION

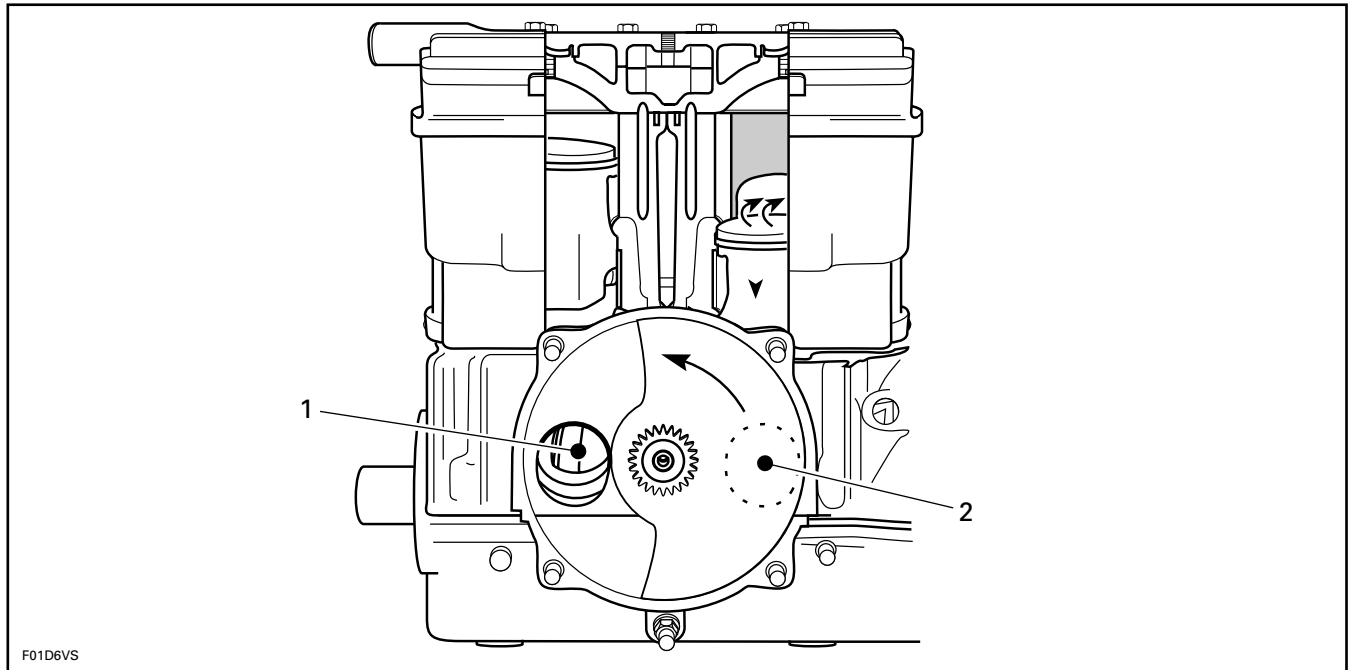


1. Fresh charge

As the piston nears the top of the cylinder (TDC), the compressed air/fuel mixture in the combustion chamber is ignited by the spark plug. The burning gases expand and push the piston downward, thus causing a power stroke.

SECTION 03 - ENGINE PREPARATION

EXHAUST AND PRIMARY COMPRESSION

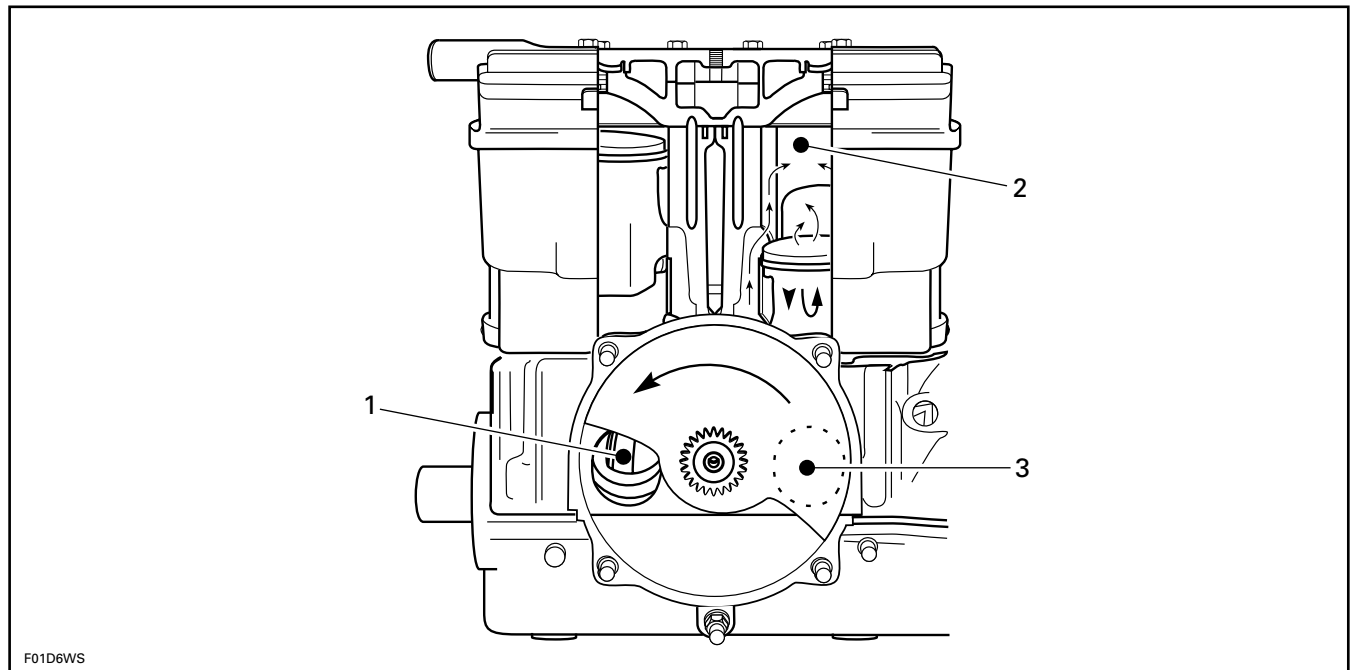


1. Fresh charge for the other cylinder

2. Intake port covered

As the piston descends, the intake port is blocked by the rotary valve and pressure begins to build inside the crankcase (primary compression). The exhaust port is uncovered as the piston continues its course downward, and burnt gases are allowed to escape.

TRANSFER



1. Fresh charge for the other cylinder

2. Fresh charge

3. Intake port covered

SECTION 03 - ENGINE PREPARATION

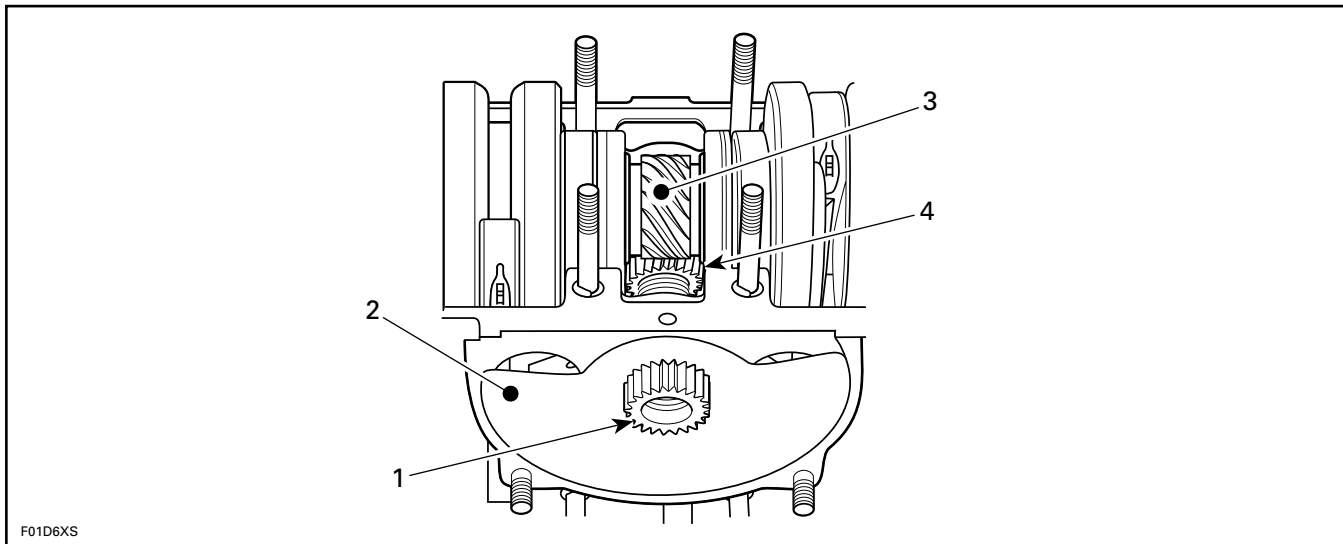
Near the bottom of the downward stroke, the transfer ports are uncovered by the piston, and the compressed air / fuel mixture in the crankcase rushes into the combustion chamber via the transfer ports. Piston dome and combustion chamber configuration and exhaust back pressures prevent fresh charge (air/fuel mixture) from escaping through the exhaust port. This also assists in clearing the combustion chamber of all burnt gases.

ROTARY VALVE DRIVE GEARS

Located in crankcase halves between the 2 cylinder bases. These gears transmit crankshaft rotation to the 90° angled rotary valve shaft.

The helical gear mounted on the rotary valve shaft uses the crankshaft as a power source. To prevent overheating and provide lubrication, the gears operate in an oil bath.

To prevent pressurization of the system, a vent tube from the top of the gear chamber returns to the oil reservoir which is vented to the atmosphere.



1. Pinion (on rotary valve shaft)
2. Rotary valve

3. Gear (crankshaft)
4. Gear (on rotary valve shaft)

ADVANTAGES OF THE ROTARY VALVE ENGINE

The major differences between a piston port engine and a rotary valve engine are:

- 1) Intake port directly positioned in the crankcase
- 2) The opening and closing of the intake port is controlled by a rotary valve instead of the piston, allowing asymmetrical timing.

The use of a rotary valve enables a very short inlet track. The design introduces the mixture in a very suitable position without obstruction to the gas flow that would impair the volumetric efficiency. This intake position also enhances the lubrication of the lower connecting rod bearings. With rotary valves, the opening duration of the intake port is specifically controlled by the valve. Therefore, it is possible to determine the maximum possible intake with benefit to crankcase filling.

SECTION 03 - ENGINE PREPARATION

The following chart indicates the intake phase differences between a piston port engine and a rotary valve engine.

INTAKE	PISTON PORT ENGINE	ROTARY VALVE ENGINE
Total Duration	150°	195°
Opening (BTDC)	75°	130°
Closing (ATDC)	75°	65°

As shown for the rotary valve engine, the total duration of the intake is greater and the opening starts earlier. This results in a better volumetric efficiency.

In the rotary valve engine, the intake closes earlier to avoid fresh charge spitback.

Some watercraft manufacturers have adopted reed valve engines to increase overall performance. However, reed valve engines do have some disadvantages over the rotary valve engine. These disadvantages are:

- 1) The intake port is restricted by the reeds and cage.
- 2) The reeds tend to separate air from fuel.
- 3) Since the crankcase "vacuum" must first open the reed to permit intake, this initial force is not fully applied to the intake operation. Consequently, there is a partial loss of intake potential.
- 4) At high speeds, the delay in closing the reed affects the reopening of the reed. Again potential volumetric efficiency is affected.
- 5) The continual "rebounding" of the reed causes further intake restrictions.

CONCLUSION

With the central rotary valve, duration of the intake is asymmetrical. In piston port engines, intake duration is symmetrical. With the central rotary valve, complete control of intake timing means greater torque at lower RPM's, more peak power and easier starting.

INSPECTION

Inspect rotary valve cover for warpage. Small deformation can be corrected by surfacing with a fine sandpaper on a surface plate. Surface part against oiled sandpaper.

Inspect bearings. Check for scoring, pitting, chipping or other evidence of wear. Make sure plastic cage (on bigger bearing) is not melted. Rotate them and make sure they turn smoothly.

Check for presence of brass filings in gear housing.

Visually check gear wear pattern on gears. It should be even on each tooth for the complete rotation of the gears. Uneven wear could indicate a bent shaft; check for deflection. Replace gear if damaged.

There should be no deflection in the rotary valve shaft. If there is, the shaft must be replaced.

SECTION 03 - ENGINE PREPARATION

ROTARY VALVE / COVER CLEARANCE

There is a choice of 2 measuring methods.

1 with solder, the other 1 with a depth micrometer.

The clearance between the rotary valve and the cover must be 0.18 - 0.30 mm (0.007 - 0.012 in).

SOLDER METHOD

Remove rotary valve cover and its O-ring.

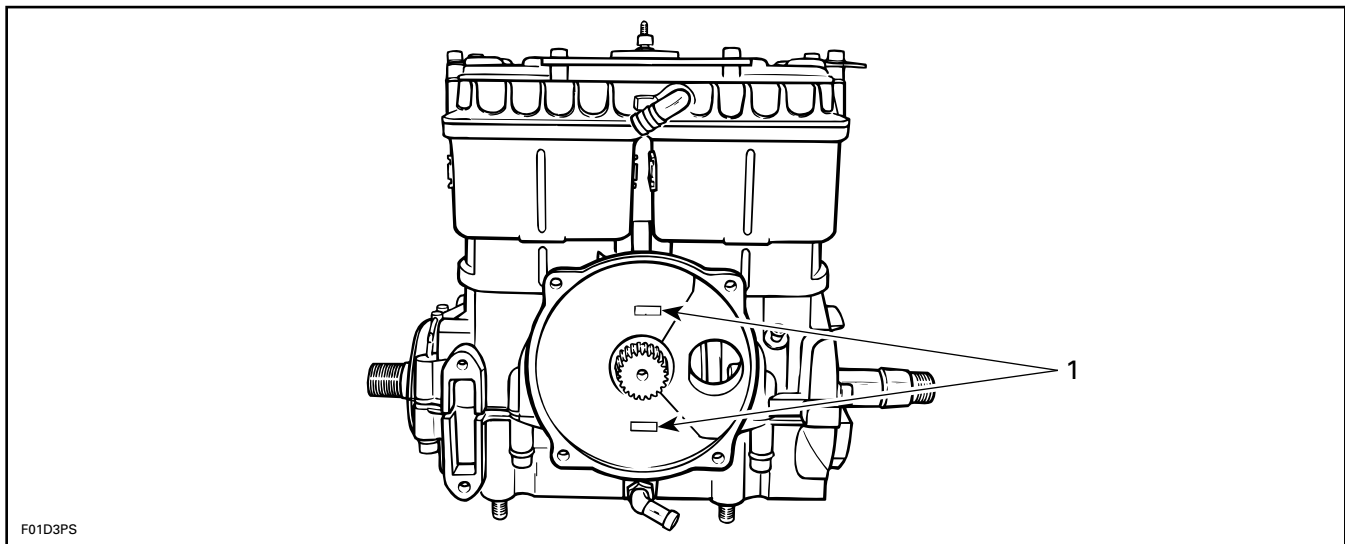
Use the following type of solder :

- rosin core
- diameter : 0.8 mm (0.032 in)
- electronic application (available at electronic stores)

Install 2 short pieces (13 mm (1/2 in) long) of solder directly on rotary valve, 1 above and 1 below rotary valve shaft. Apply grease to hold solder in position.

Reinstall cover in place WITHOUT its o-ring and torque screws to 20 N•m (15 lbf•ft).

Remove cover then clean and measure compressed solder thickness, it must be within the specified tolerance.



1. Solder

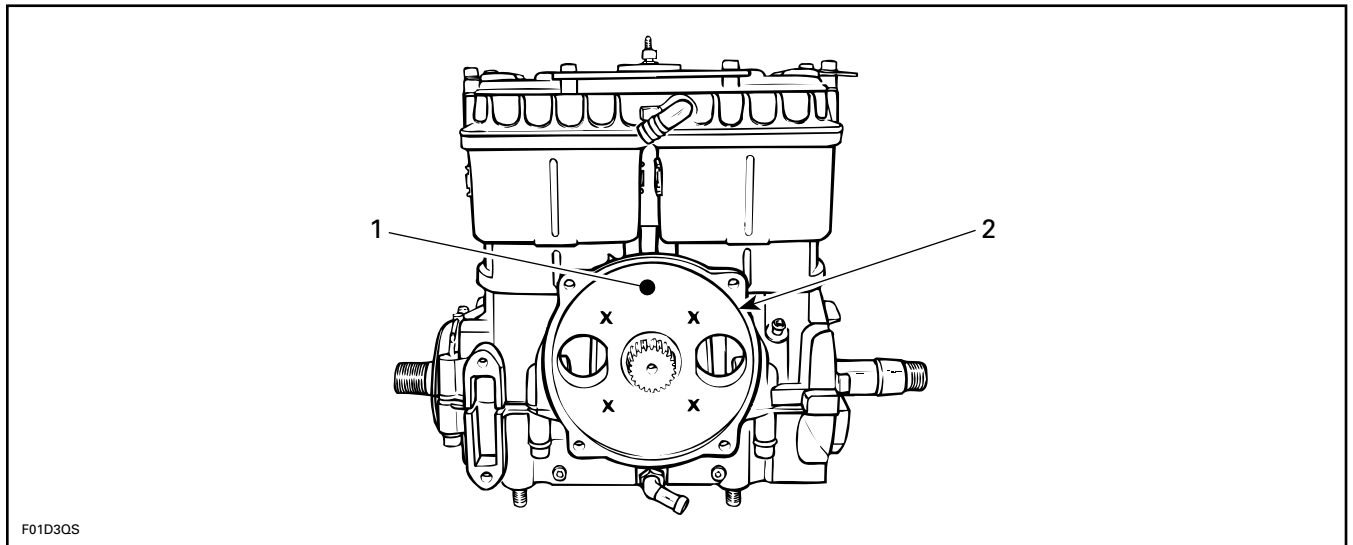
SECTION 03 - ENGINE PREPARATION

DEPTH MICROMETER METHOD

Remove rotary valve cover.

Using a depth micrometer, measure the distance from the crankcase rib to the valve surface of the crankcase.

Measure at 4 different places.

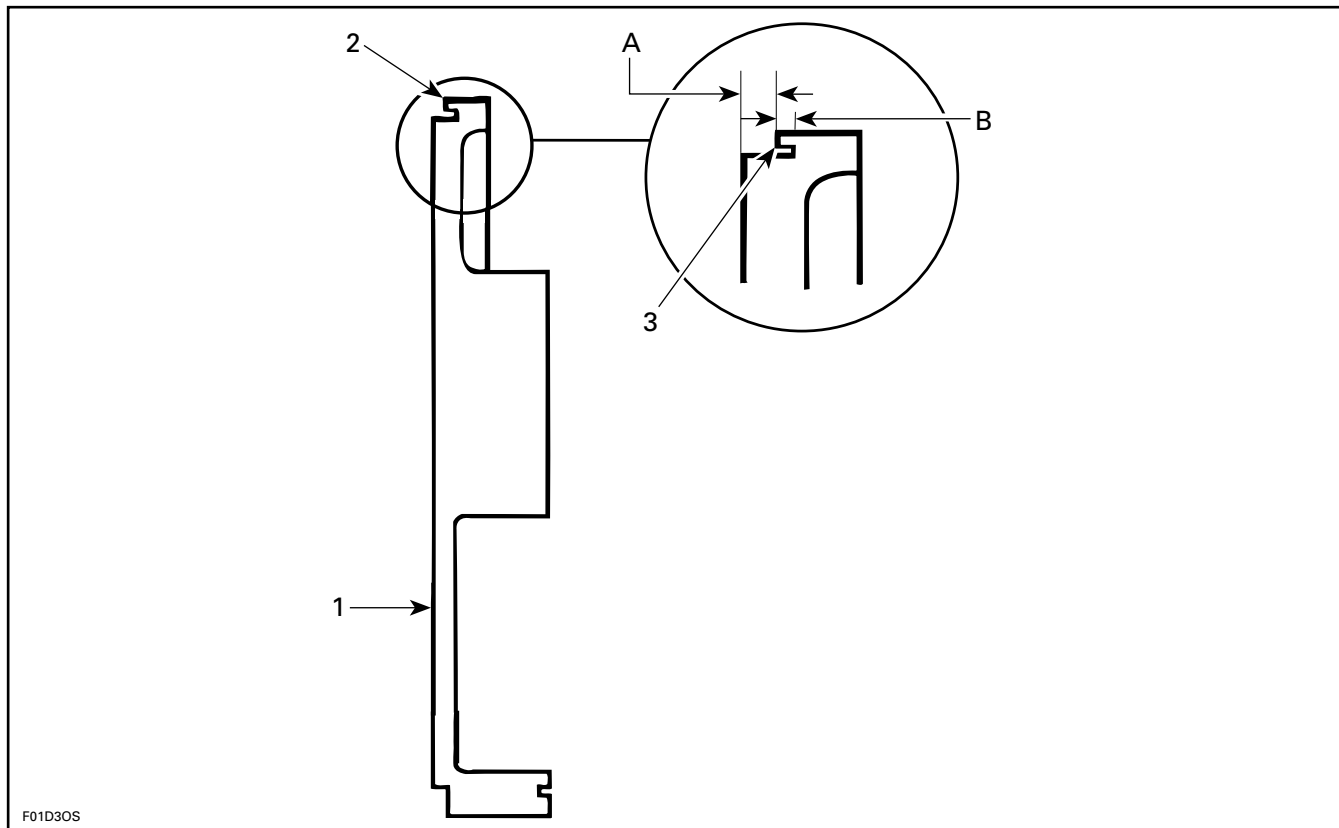


- 1. Valve surface
- 2. Rib

Add the 4 measurements and divide by 4 to obtain an average. A typical reading should be around 3.5 mm (0.138 in).

SECTION 03 - ENGINE PREPARATION

Using the depth micrometer again, measure the distance between the rotary valve cover seating surface and the valve surface of the cover.



- F01D30S
- 1. Valve surface
 - 2. Cover seating surface
 - 3. No burrs
 - A. $2.67 \pm 0.25 \text{ mm}$ (.105 $\pm$.001 in)
 - B. $1.0 \pm .03 \text{ mm}$ (.039 $\pm$.001 in)

Measure at 4 different places around the cover.

Add the 4 measurements and divide by 4 to obtain an average. A typical reading should be around 2.67 mm (.105 in). Knowing that the tickness of the rotary valve is .58 mm (.023 in), the clearance between rotary valve and rotary valve cover can be found using the following formula.

EXAMPLE :

Crankcase rib depth	3.50 mm
Depth of cover seating surface	<u>- 2.64 mm</u>
	0.86 mm
Rotary valve tickness	<u>- .58 mm</u>
Clearance between rotary valve and cover	0.28 mm

Your result must be within the specified tolerance; 0.18 - 0.30 mm (0.007 - 0.012 in).

If rotary valve, rotary valve cover clearance is out of specification, machine rotary /valve cover seating surface and O-ring groove.

SECTION 03 - ENGINE PREPARATION

MACHINING INFORMATION

The amount of mm (in) over tolerance must be removed from the rotary valve cover seating surface.

Also cut the o-ring groove an equal amount to obtain $1.0 \pm .03$ mm ($.039 \pm .001$ in) between the bottom of the groove and the seating surface.

Remove burrs on the edges of the seating surface and O-ring groove.

Reverify the clearance.

At assembly, the rotary valve timing must remain as per original setting.

CRANKSHAFT AND ROTARY VALVE SHAFT DRIVE GEARS BACKLASH

Remove PTO flywheel guard.

Remove spark plugs, rotary valve cover and valve.

Manually feel backlash at one position, then turn crankshaft about 1/8 turn and recheck. Continue this way to complete one revolution.

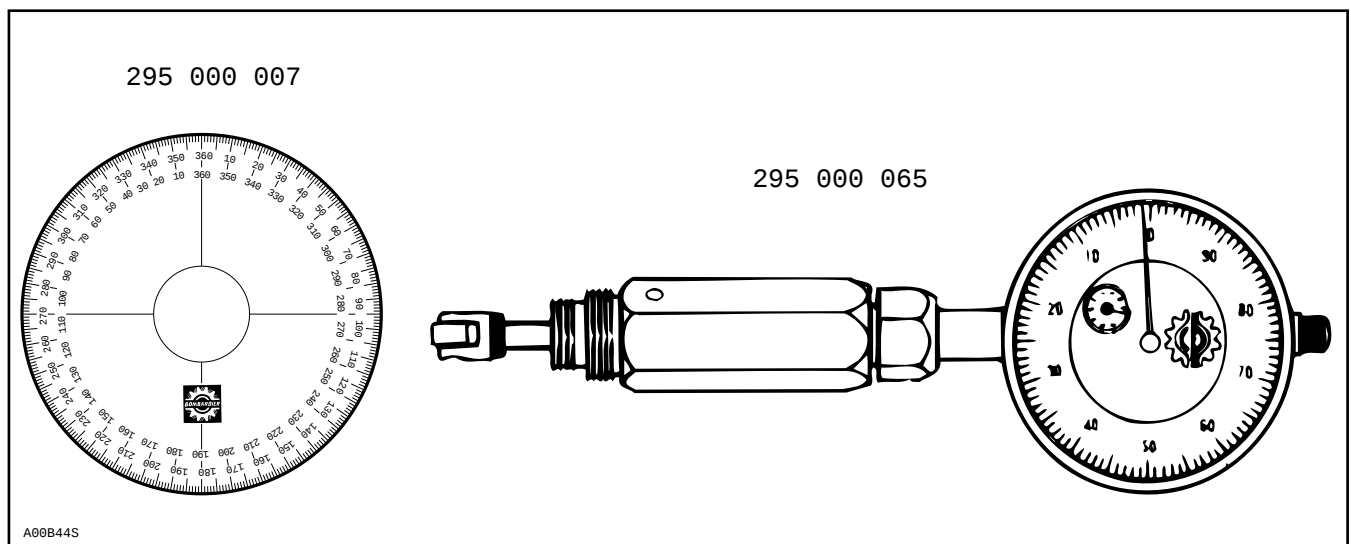
Backlash must be even at all positions. Otherwise, disassemble engine to find which part is faulty (drive gears or rotary valve shaft with excessive deflection).

ROTARY VALVE TIMING



CAUTION: Never use the ridge molded in crankcase as a timing mark.

The following tools are required to measure rotary valve opening and closing angles in relation with magneto side piston.



SECTION 03 - ENGINE PREPARATION

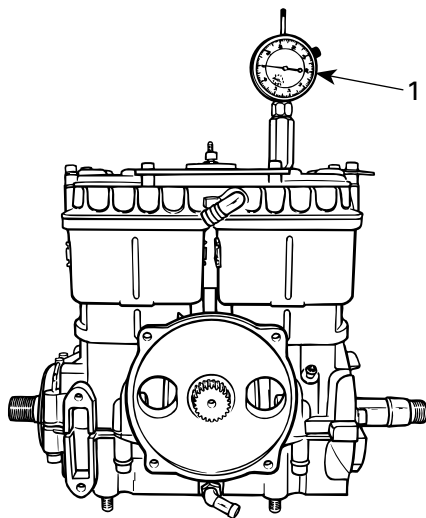
For the following instructions, let's use these specifications as **example**:

OPENING: 130° BTDC

CLOSING: 65° ATDC

Proceed as follows:

— Turning crankshaft, bring MAG side piston to Top Dead Center using a TDC gauge.

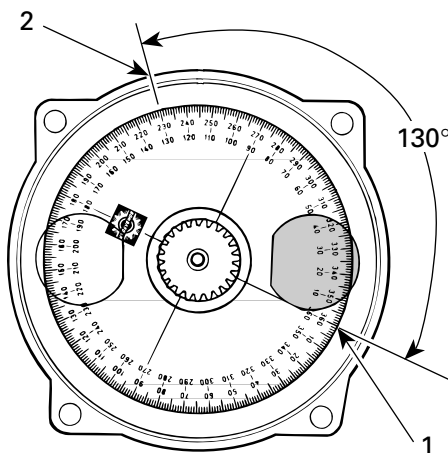


F01D2IS

1. TDC gauge on MAG side

For opening mark, first align 360° line of degree wheel with BOTTOM of MAG side inlet port. Then, find line 130° on degree wheel and mark crankcase at this point.

OPENING MARK



F01D3DS

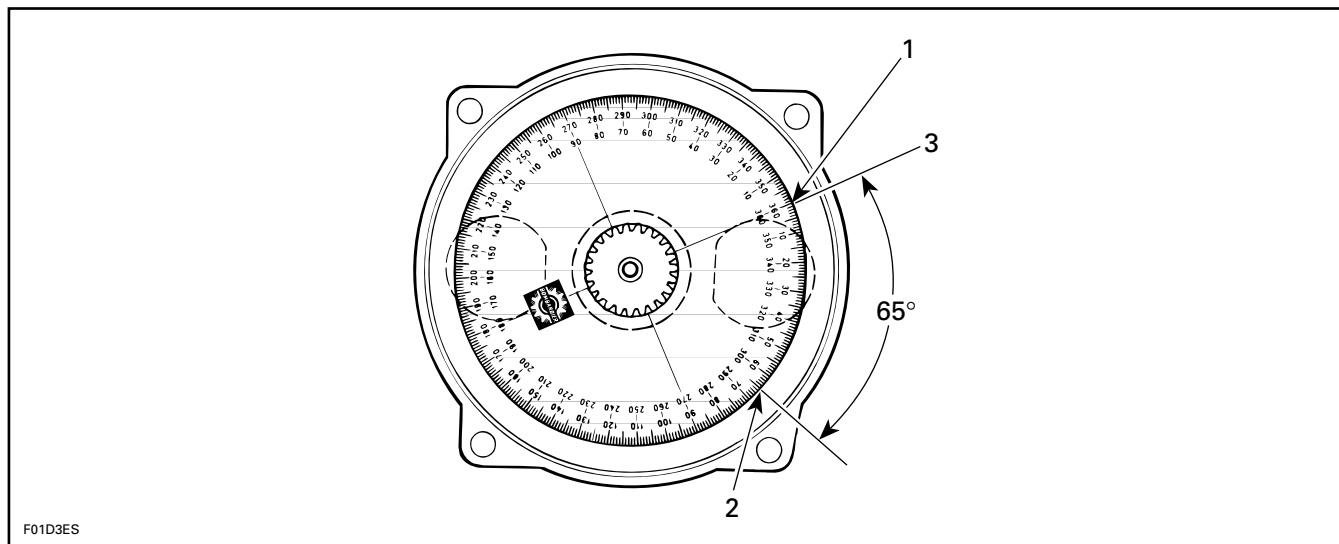
- 1st Bottom of MAG inlet port align 360° line of degree wheel here
- 2nd Find 130° on degree wheel and mark here

NOTE: Do not rotate the crankshaft.

SECTION 03 - ENGINE PREPARATION

For closing mark, first align 360° line of degree wheel with TOP of MAG side inlet port. Then, find 65° line on degree wheel and mark crankcase at this point.

CLOSING MARK



1. 1st Top of MAG inlet port
2. 2nd Find 65° on degree wheel and mark here
3. Align 360° line of degree wheel here

Remove degree wheel.

Position rotary valve on shaft splines to have edges as close as possible to these marks with the MAG piston at TDC.

NOTE: When checking the timing with the MAG side piston at Top Dead Center, the rotary valve shaft should be lightly held in a clockwise position to take up any gear lash that may be present. The valve is asymmetrical and can be flipped over to obtain a better timing position. There is a possibility that exact timing cannot be reached by this method. When this occurs, the rotary valve shaft may have to be removed and the gear repositioned. Refer to appropriate model year *Shop Manual*. By removing the rotary valve shaft and re-installing it with the drive gear in a different position with respect to the crankshaft gear and /or valve shaft splines, a different valve position may be established. When a crankshaft rotary valve shaft, or drive gear is removed or replaced, it will be necessary to re-verify the timing.

Apply Sea-Doo injection oil on rotary valve surfaces before reassembling rotary valve cover.

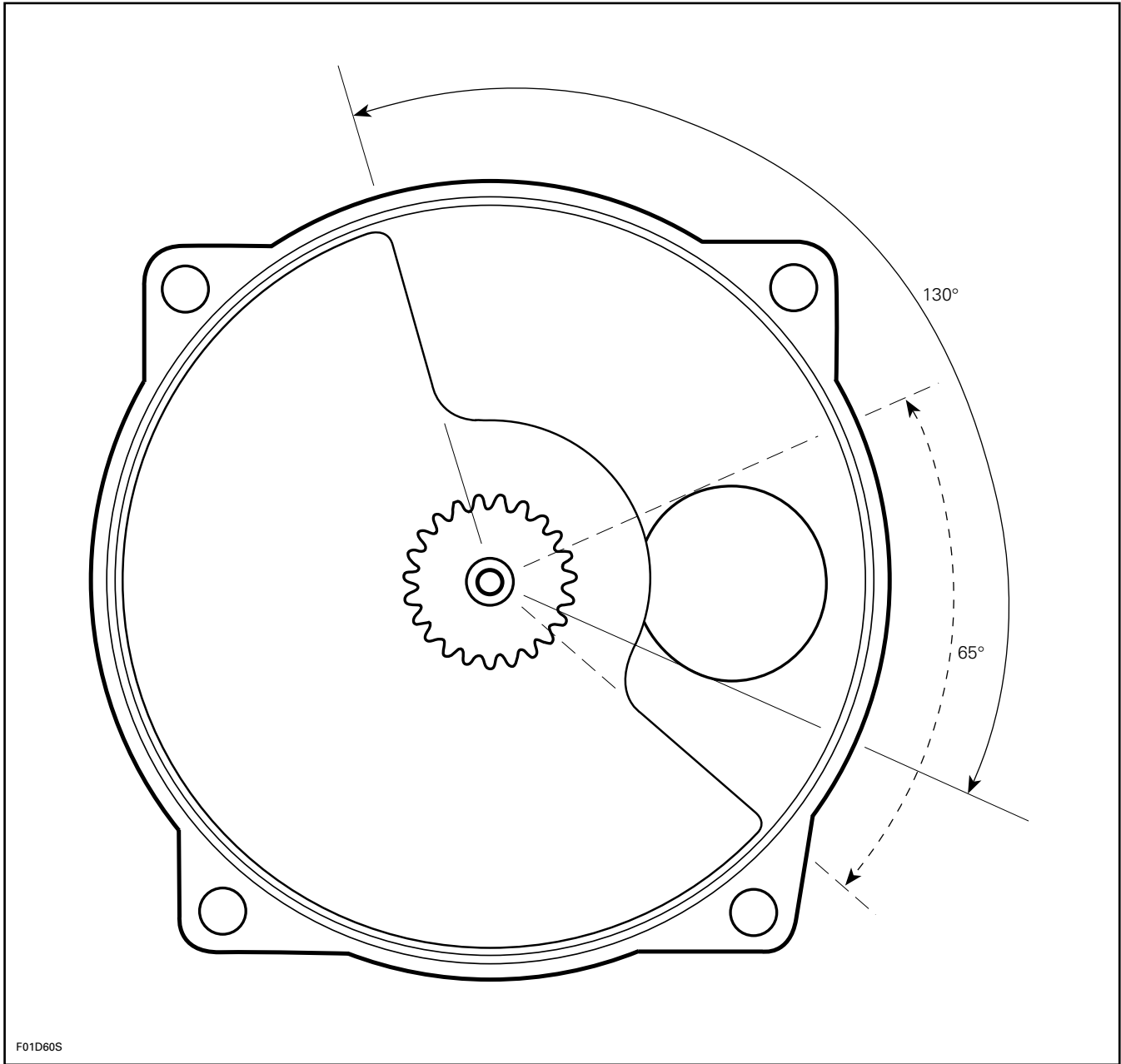
— Remove TDC gauge.

ROTARY VALVE COVER INSTALLATION

Install O-ring and cover. When installing O-ring, do not roll O-ring into groove. Instead, place O-ring in groove until it becomes necessary to stretch it to fit (about half way around diameter). Now pull O-ring beyond cover and lay it into groove without twisting or rolling O-ring; then, torque screws to 20 N•m (15 lbf•ft) in a criss-cross sequence.

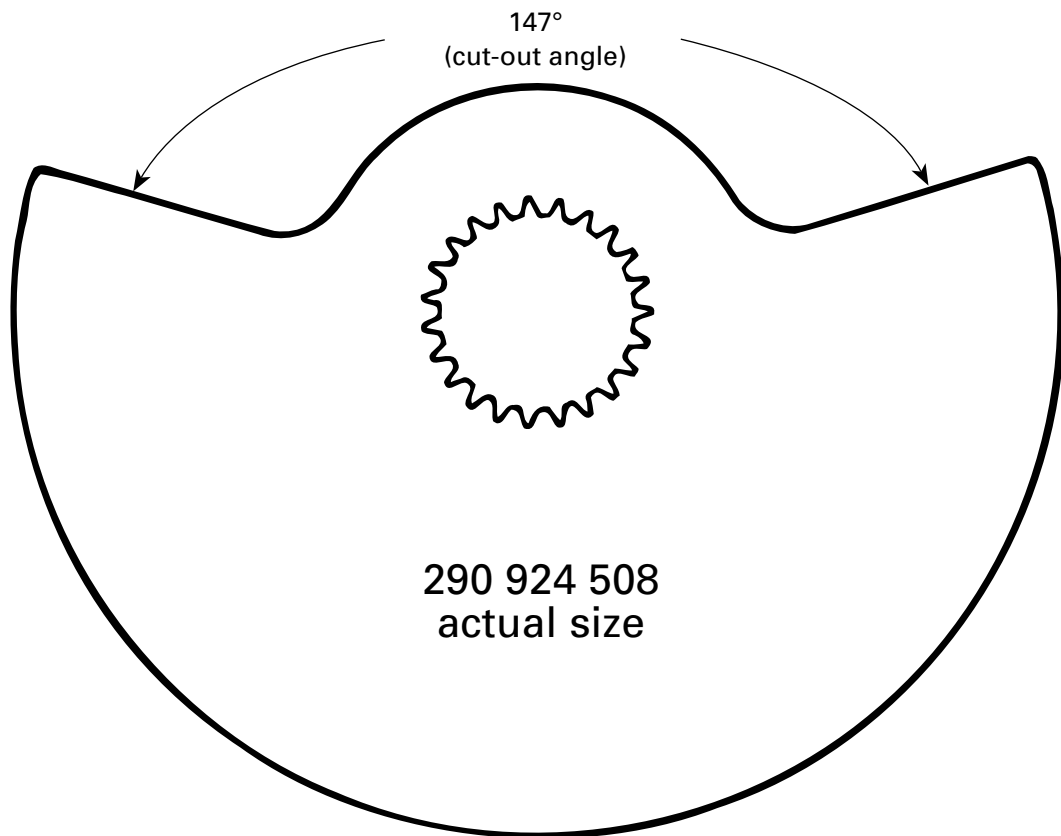
CAUTION: Crankcase halves must be separated and crankshaft must not be present to install rotary valve shaft assembly in crankcase.

SECTION 03 - ENGINE PREPARATION



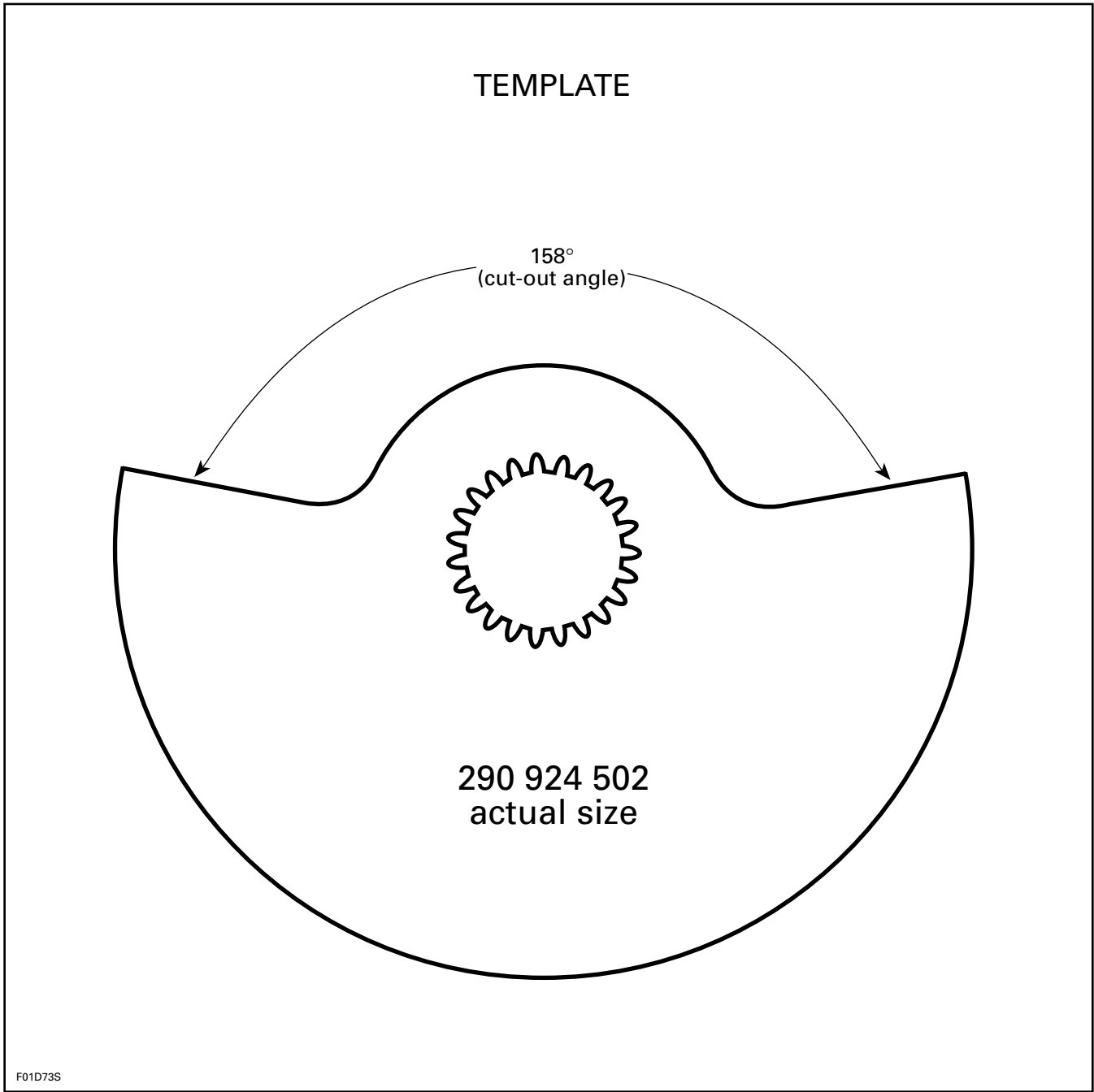
TYPICAL

TEMPLATE



A00A0YS

SECTION 03 - ENGINE PREPARATION



CRANKSHAFT INSPECTION



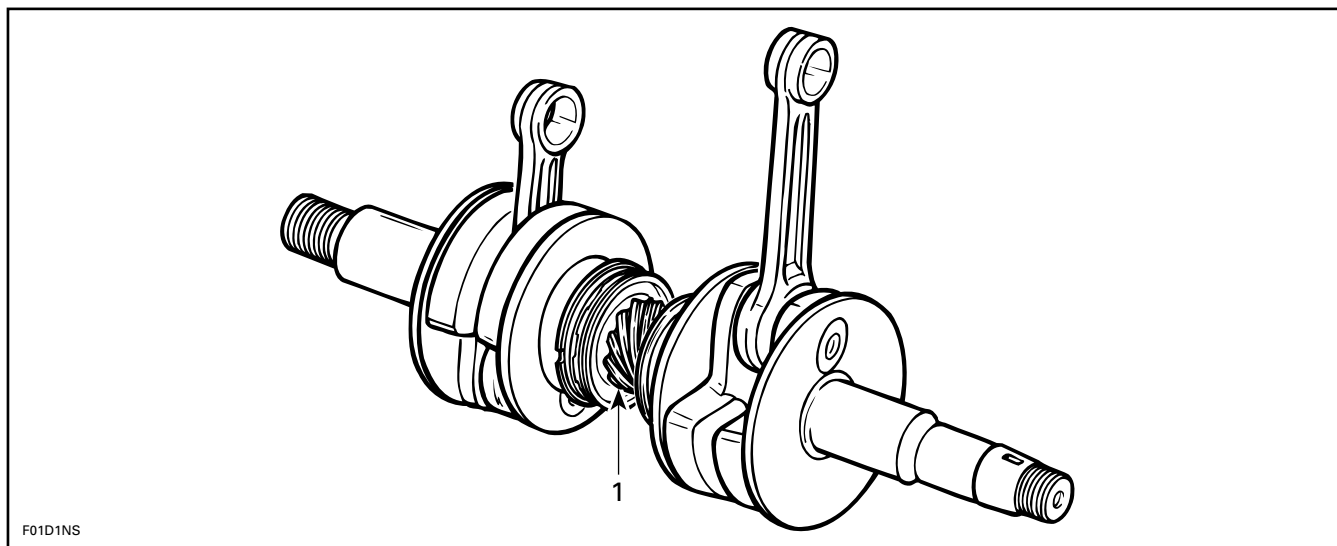
SECTION 03 - ENGINE PREPARATION

COMPONENTS

1. Oil Seal
2. Crankcase Assembly
3. Ball Bearing
4. Retaining Shim
5. Retaining Ring
6. Retaining pin
7. Hexagonal Head Screw M8 x 70
8. Hexagonal Head Screw M10 x 75
9. Allen Screw M8 x 45
10. Stud M10 x 25/ 18
11. Oil Fitting
12. Distance Ring
13. O-Ring
14. Crankshaft
15. Shim

CRANKSHAFT MISALIGNMENT AND DEFLECTION

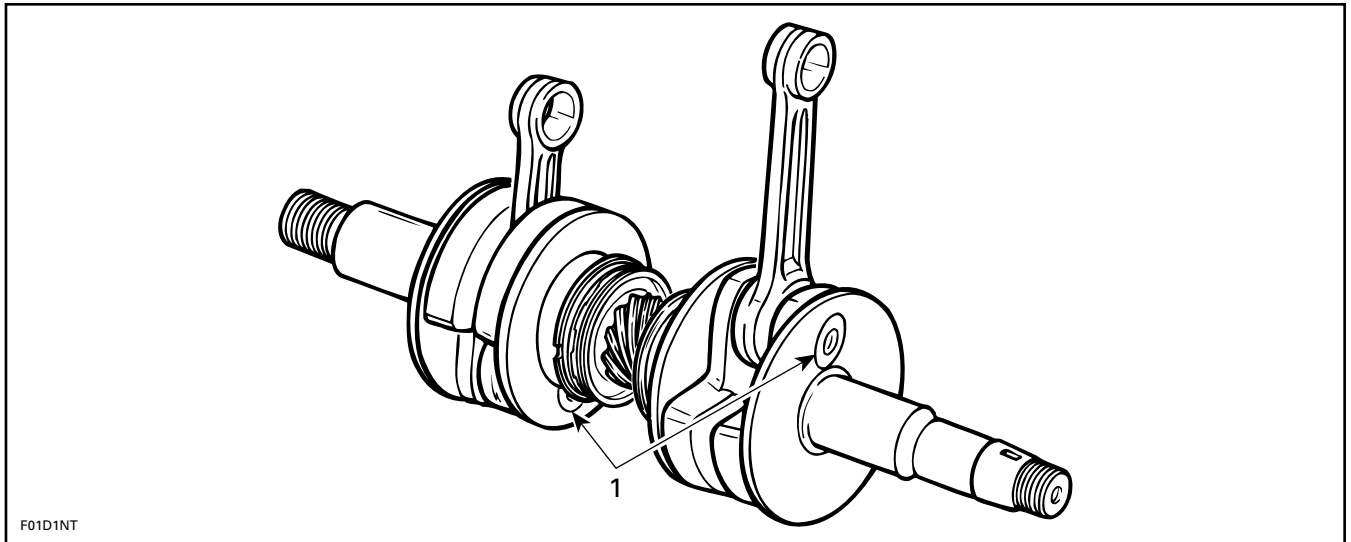
Since it is an assembled crankshaft, it can become misaligned or deflected. Crankshaft can be twisted on center main journal, changing timing of 1 cylinder in relation with the other, also changing the ignition timing for the PTO cylinder, and the rotary valve timing for the MAG cylinder.



1. Main journal alignment here

Counterweights can also be twisted on connecting rod journal on any or both cylinders.

SECTION 03 - ENGINE PREPARATION



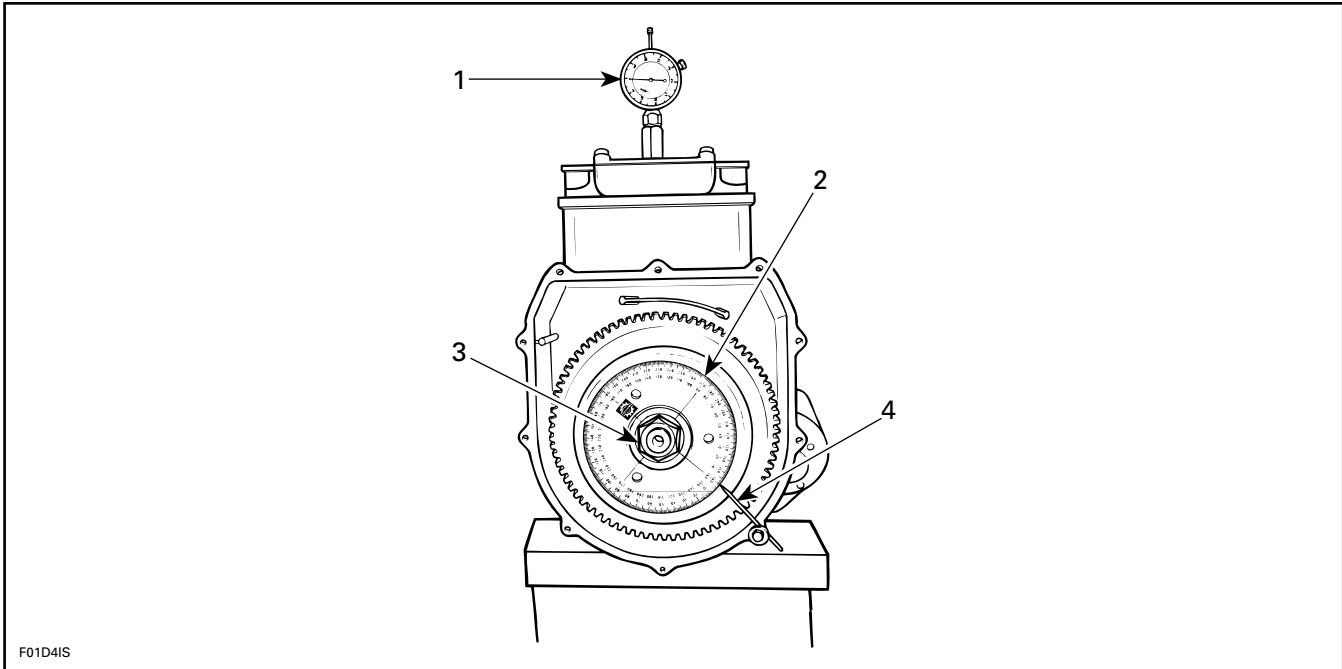
1. Connecting rod journal alignment here

CRANKSHAFT ALIGNMENT AT CENTER MAIN JOURNAL

To accurately check crankshaft alignment, proceed as follows:

- Remove ignition housing cover.
- Remove MAG flywheel nut.
- Install Bombardier degree wheel (P / N 295 000 007) on crankshaft end. Hand-tighten nut only.
- Remove both spark plugs.
- Install a TDC gauge (P / N 295 000 065) in spark plug hole on MAG cylinder side.
- Bring MAG piston at Top Dead Center.
- As a needle pointer, secure a wire with a cover screw and a washer.
- Rotate degree wheel (NOT crankshaft) so that needle pointer reads 360°.
- Remove TDC gauge and install on PTO side.
- Bring PTO piston at Top Dead Center.

SECTION 03 - ENGINE PREPARATION



1. TDC gauge
2. Degree wheel
3. Hand tighten nut
4. Needle pointer

Interval between cylinders must be exactly 180° therefore, needle pointer must indicate 180° on degree wheel ($360^\circ - 180^\circ = 180^\circ$).

Any other reading indicates a misaligned crankshaft.

CRANKSHAFT ALIGNMENT AT CONNECTING ROD JOURNAL

Crankshaft misalignment at connecting rod journal may cause the crankshaft to be hard to manually turn. Verification can be done by measuring deflection at each end of crankshaft. Refer to **INSPECTION** in this section.

If deflection is found to be greater than specified tolerance, this indicates worn bearing(s), bent and/or misaligned crankshaft.

For engine disassembly procedure, refer to appropriate model year *Shop Manual*.

INSPECTION

Visually inspect parts for corrosion damage.

Inspect crankshaft bearings. Check for scoring, pitting, chipping or other evidence of wear. Make sure plastic bearing retainer cage is not melted. Rotate and make sure bearings turn smoothly.

If crankshaft and/or components are found worn or damaged, it must be replaced or repaired by a shop specializing in this type of work.

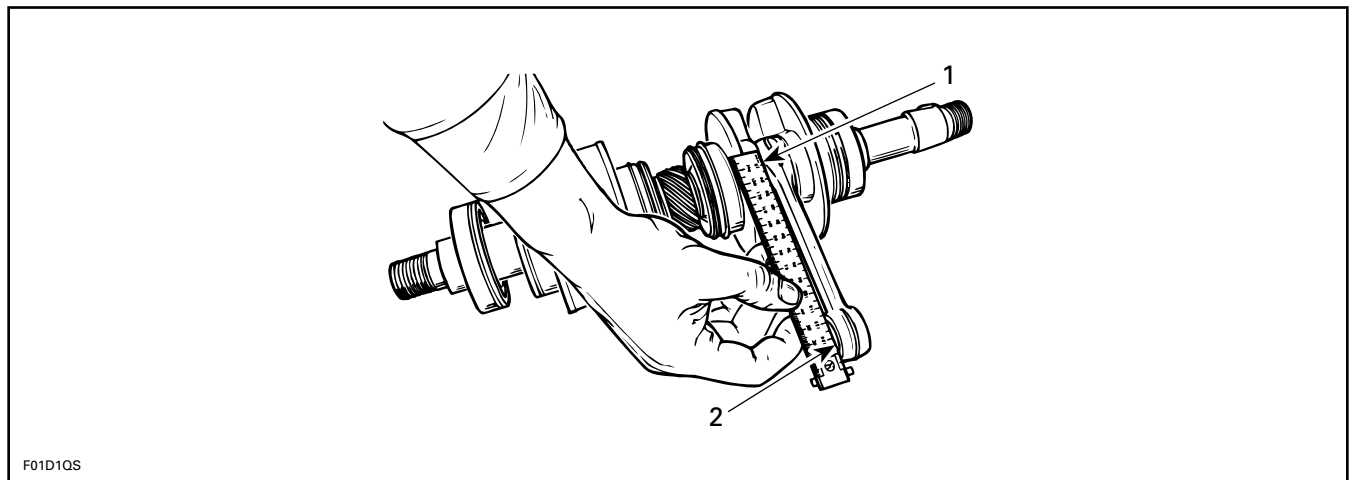
SECTION 03 - ENGINE PREPARATION

The inspection of engine crankshaft should include the following measurements:

MEASUREMENTS	TOLERANCES		
	NEW PARTS (min.) (max.)		WEAR LIMIT
Crankshaft deflection	0	0.05 mm (.002 in)	0.08 mm (.0031 in)
Connecting rod big end axial play	0.39 mm (.015 in)	0.737 mm (.029 in)	1.2 mm (.047 in)

CONNECTING ROD STRAIGHTNESS

Align a steel ruler on edge of small end connecting rod bore. Check if ruler is perfectly aligned with edge of big end.



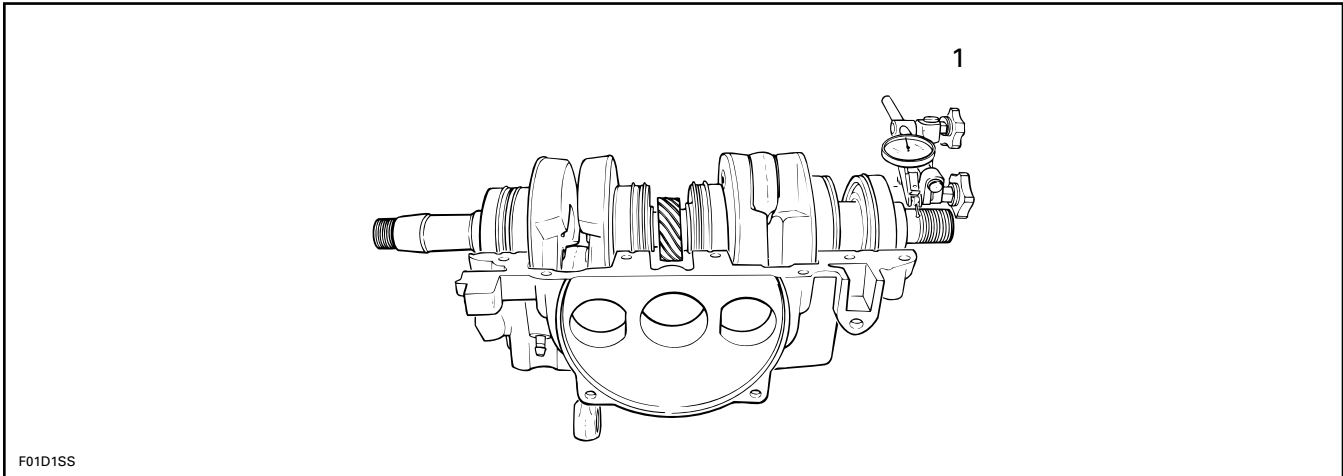
1. Ruler must be aligned with edge of connecting rod here
2. Align ruler here

CRANKSHAFT DEFLECTION

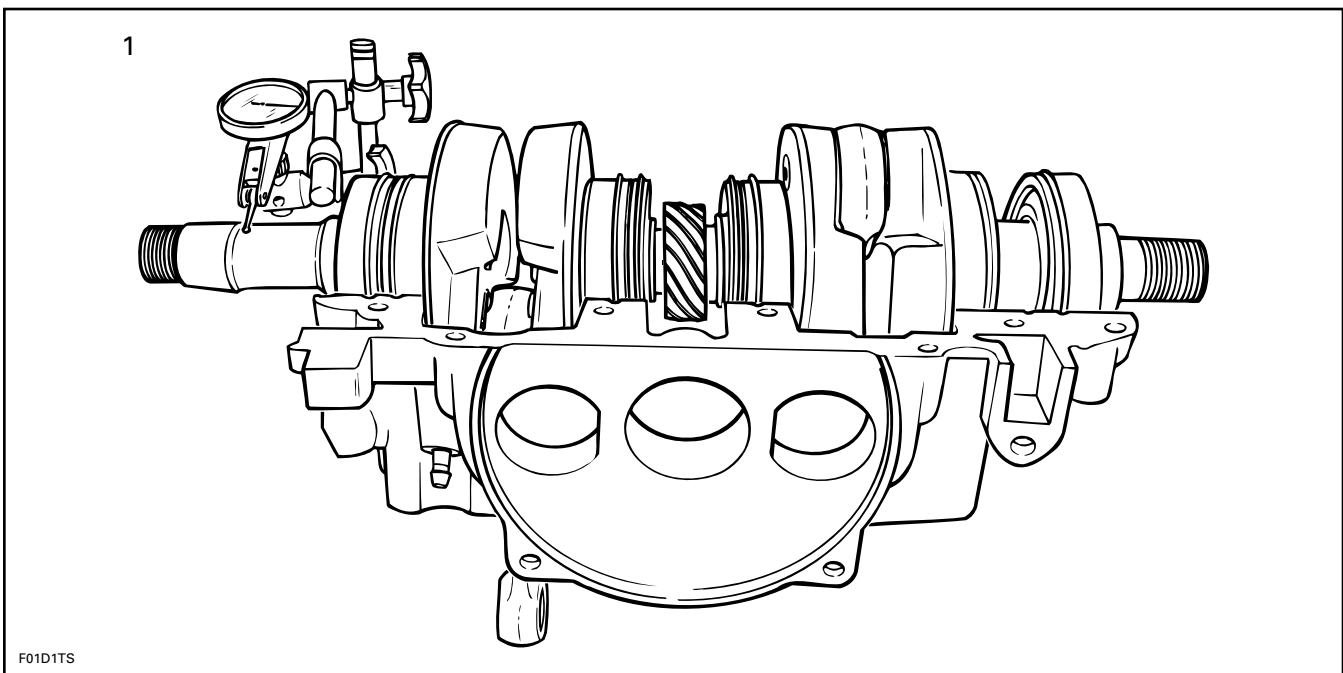
Crankshaft deflection is measured at each end with a dial indicator.

SECTION 03 - ENGINE PREPARATION

First, check deflection with crankshaft in crankcase. If deflection exceeds the specified tolerance, it can be either ball bearing wear, bent or twisted crankshaft at connecting rod journal.



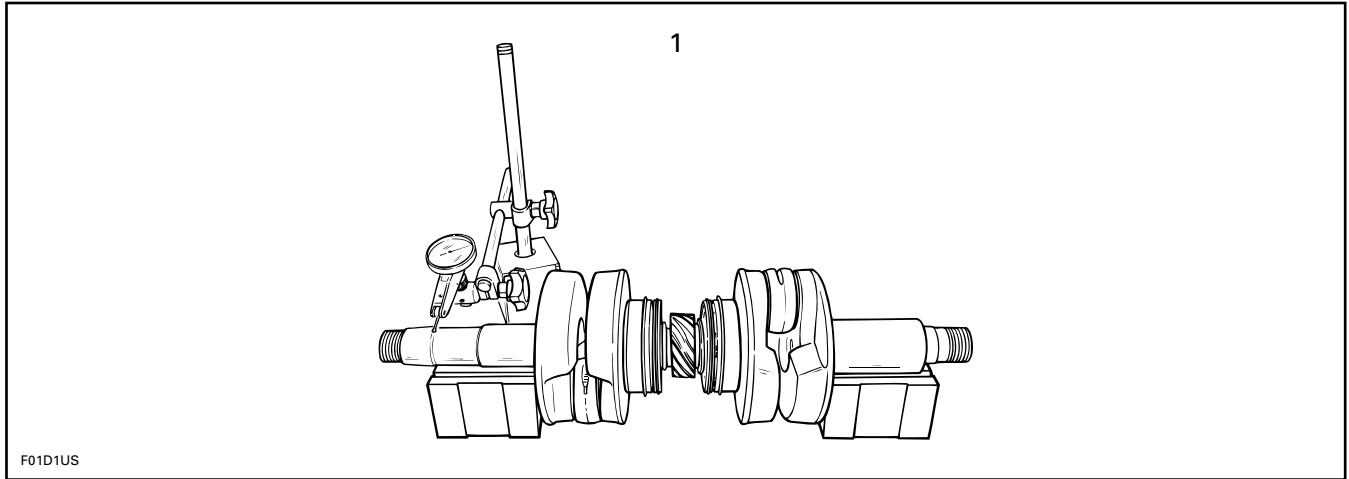
1. Measuring PTO side deflection in crankcase



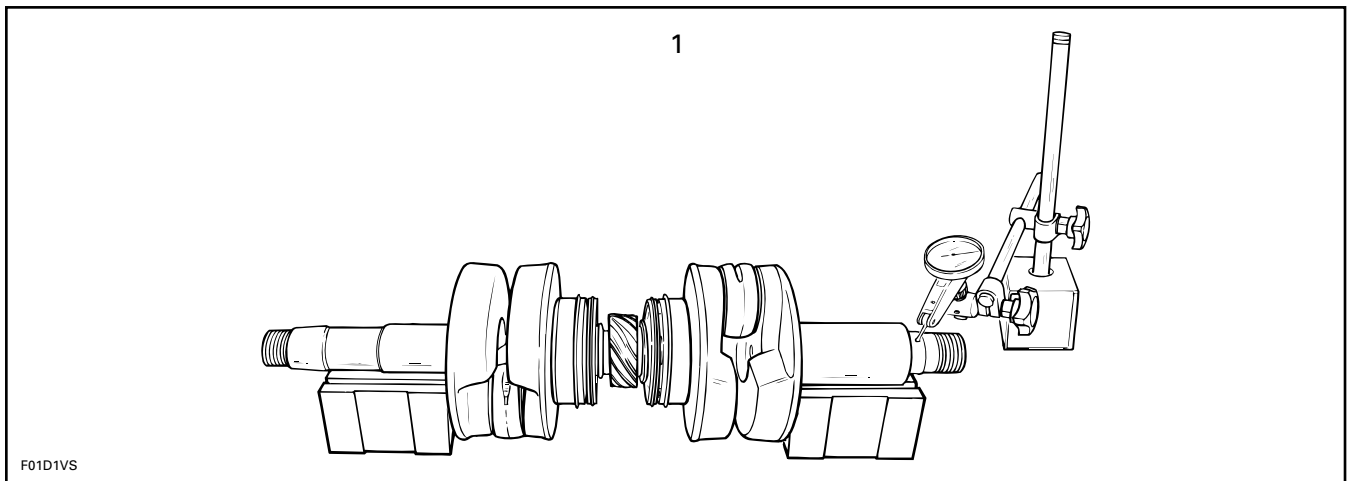
1. Measuring MAG side deflection in crankcase

Remove crankshaft bearings and check deflection again on v-shaped blocks as illustrated.

SECTION 03 - ENGINE PREPARATION



1. Measuring MAG side deflection on V-shaped blocks



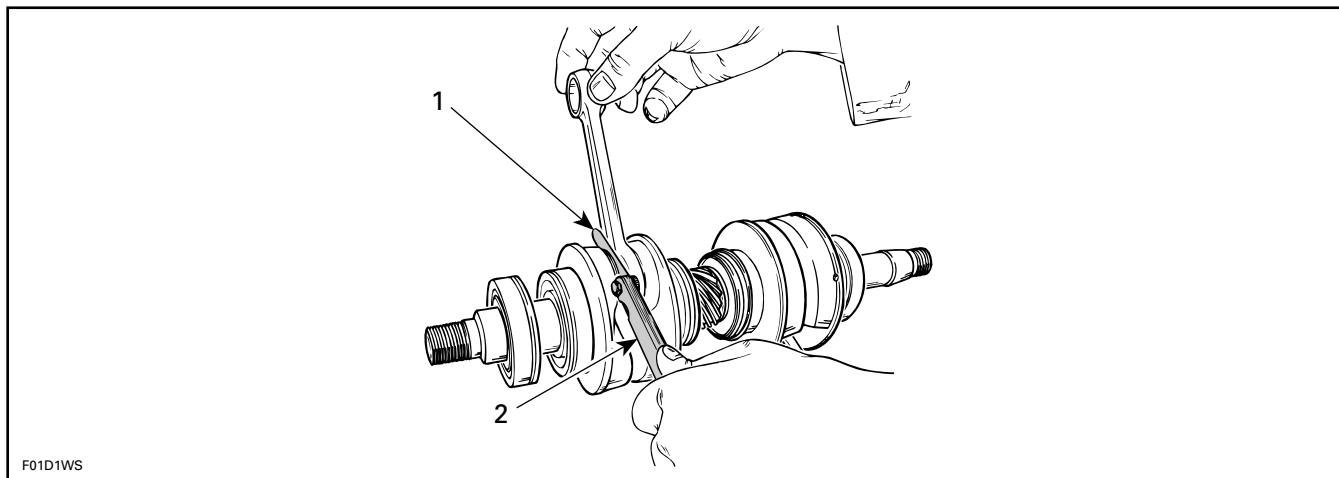
1. Measuring PTO side deflection on V-shaped blocks

NOTE: Crankshaft deflection can not be accurately measured between centers of a lathe.

SECTION 03 - ENGINE PREPARATION

CONNECTING ROD BIG END AXIAL PLAY

Using a feeler gauge, measure distance between thrust washer and crankshaft counterweight.



1. Measuring big end axial play
2. Feeler gauge

ASSEMBLY

Assembly is essentially the reverse of disassembly procedures. However, pay particular attention to the following.

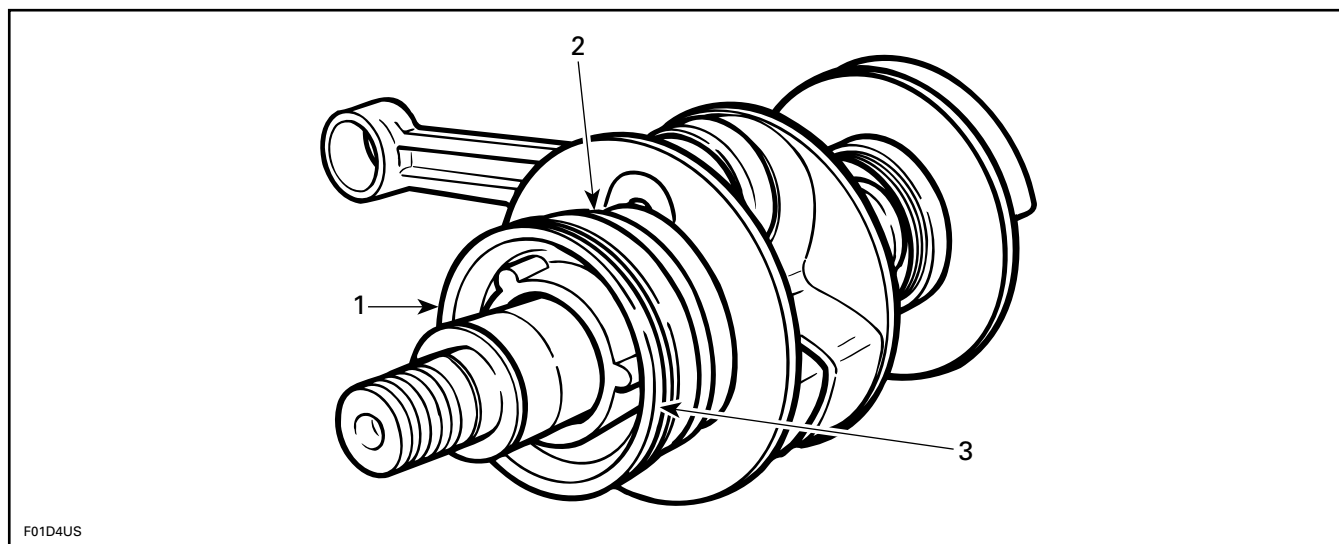
BEARING

Apply Loctite 767 anti-seize lubricant (P / N 293 550 001) on bearing seats.

Prior to installation, place bearings into a container filled with oil, previously heated to 75°C (167°F). This will expand bearings and ease installation.

LABYRINTH SLEEVE (DUAL CARB MODELS)

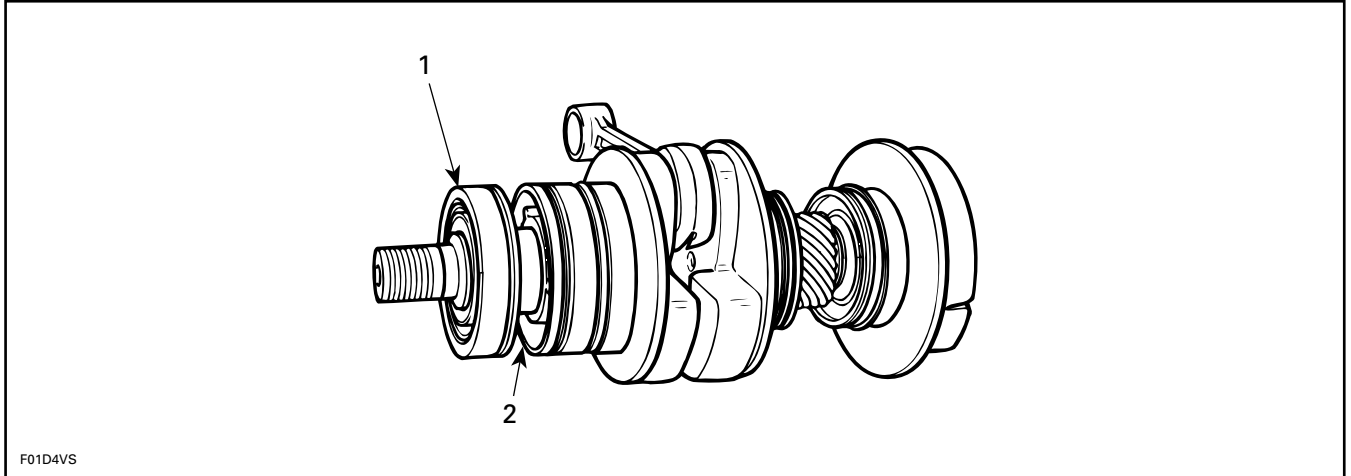
To properly locate outer PTO bearing, install labyrinth sleeve against inner bearing side.



1. Labyrinth sleeve
2. Inner bearing
3. O-ring

SECTION 03 - ENGINE PREPARATION

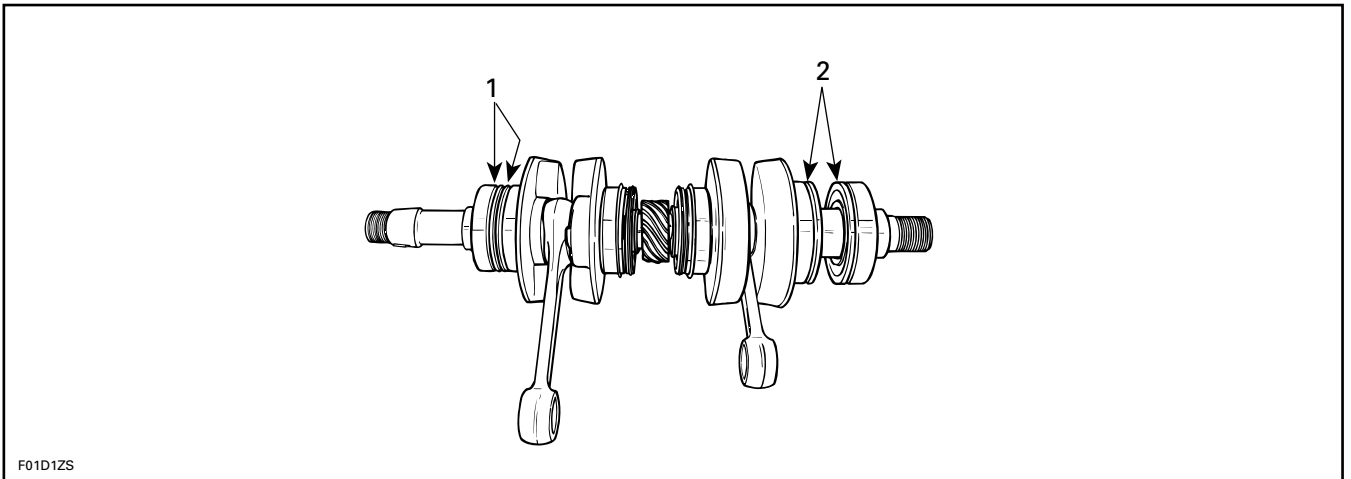
NOTE: Be sure to install labyrinth sleeve with its hollow side facing PTO side outer bearing.



1. PTO side outer bearing
2. Hollow side

Slide on outer bearing until it touches sleeve.

Install bearings so that their peripheral grooves will be located as shown in the following illustration.



1. Peripheral grooves on inner side (if applicable)
2. Peripheral grooves on inner side

Not all engines are equipped with the labyrinth sleeve between the PTO crankshaft bearings. For racing purposes, it would be advantageous for models with dual carburetors to have the labyrinth sleeve installed to help displace crankcase volume, thus increasing primary compression.

SECTION 03 - ENGINE PREPARATION

CYLINDER PORTING MAPS

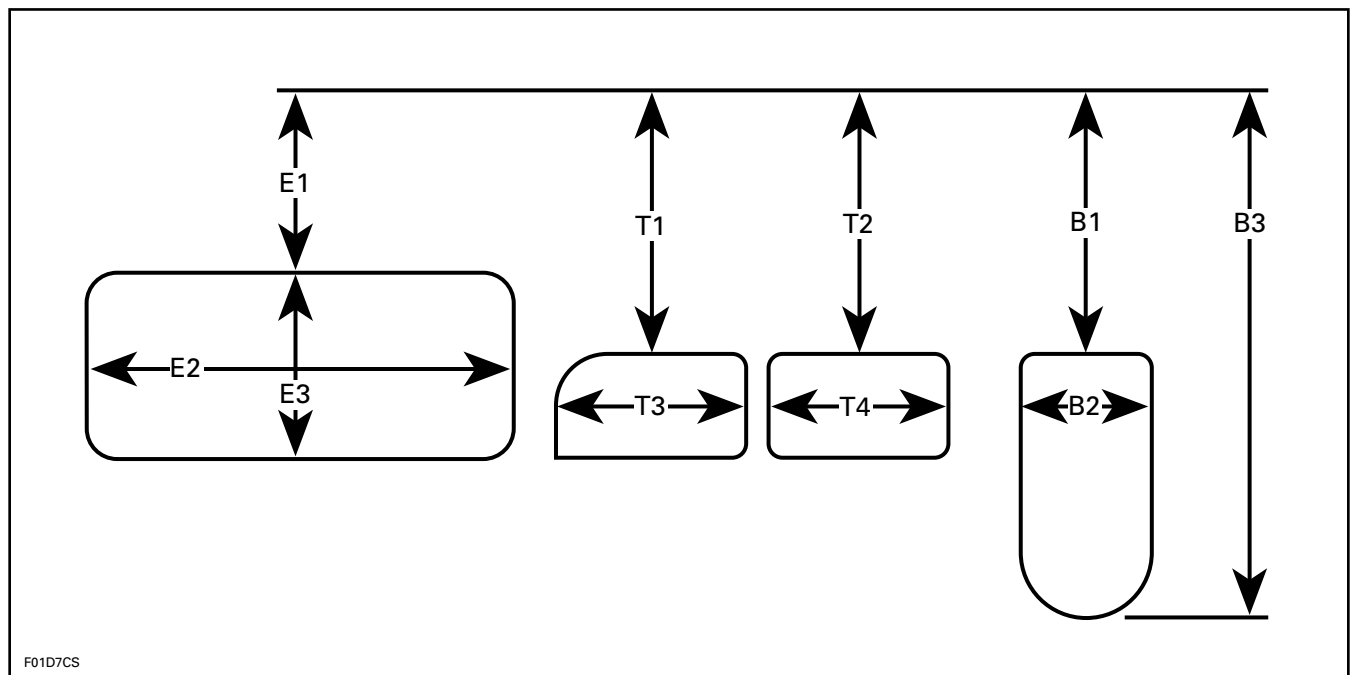
 **NOTE:** See page 03-62 for the chart where these measurements are to be taken.

SEA-DOO ENGINE SPECIFICATIONS		587	657
Exhaust port height	E1	34.0 mm	34.5 mm
Exhaust port width	E2	50.0 mm	53.0 mm
Exhaust port height bottom to top	E3	34.0 mm	35.0 mm
Rear transfer height	B1	52.0 mm	55.5 mm
Rear transfer width	B2	17.0 mm	20.0 mm
Rear transfer length bottom to top	B3	91.5 mm	97.5 mm
Main transfer height	T1 T2	50.5 mm 51.0 mm	54.0 mm 54.0 mm
Bottom width of main transfers	T3 T4	26.0 mm 21.0 mm	26.0 mm 21.0 mm
Total cylinder height		109.5 mm	113.5 mm
Exhaust outlet width at Y-pipe		49.0 mm	53.0 mm
Exhaust outlet height at Y-pipe		32.0 mm	33.0 mm
Squish band clearance		1.5 mm	1.1 mm
Cylinder head volume (without piston)		40.8 cc	42.2 cc
Combustion chamber volume with .012" base gasket		27.7 cc	29.5 cc
Uncorrected compression ratio		11.5:1	12.25:1
Bore		76 mm	78 mm
Stroke		64 mm	68 mm

SECTION 03 - ENGINE PREPARATION

PORTING MAP FOR THE '95 MODELS

ENGINE TYPE / MODEL YEAR		587 / 95	657 / 95	657 X / 95	717 / 95	787 / 95
Exhaust port height	E1	35.0 mm	36.0 mm	34.1 mm	34.2 mm	35.2 mm
Exhaust port width	E2	47.8 mm	50.9 mm	50.9 mm	51.1 mm	54.4 mm
Exhaust port height bottom to top	E3	30.1 mm	33.1 mm	35.1 mm	34.7 mm	39.3 mm
Rear transfer height	B1	54.1 mm	57.5 mm	57.5 mm	59.5 mm	57.3 mm
Rear transfer width	B2	14.8 mm	17.8 mm	17.8 mm	20.1 mm	21.5 mm
Rear transfer height bottom to top	B3	90.8 mm	96.7 mm	96.7 mm	77.1 mm	104.8 mm
Main transfer height	T1 T2	48.1 mm 48.1 mm	54.3 mm 54.3 mm	54.3 mm 54.3 mm	53.6 mm 53.9 mm	58.2 mm 58.6 mm
Bottom width of main transfer	T3 T4	24.1 mm 21.9 mm	24.2 mm 22.3 mm	24.2 mm 22.3 mm	26.5 mm 24.5 mm	28.5 mm 26.5 mm
Total cylinder height		109.4 mm	113.4 mm	113.4 mm	117.8 mm	122.5 mm
Exhaust outlet width at Y-pipe		49.0 mm	53.0 mm	53.0 mm	53.0 mm	56.0 mm
Exhaust outlet height at Y-pipe		32.0 mm	33.0 mm	33.0 mm	33.0 mm	36.0 mm
Squish band clearance		1.5 mm	1.1 mm	1.1 mm	1.5 mm	1.5 mm
Cylinder head volume (without piston)		40.8 cc	42.2 cc	37.9 cc	42.2 cc	48.5 cc
Combustion chamber volume with .012" base gasket		27.7 cc	28.9 cc	28.9 cc	32.7 cc	36.4 cc
Uncorrected compression ratio		11.5:1	12.25:1	12.25:1	12.25:1	11.75:1
Bore		76 mm	78 mm	78 mm	82 mm	82 mm
Stroke		64 mm	68 mm	68 mm	68 mm	74 mm



SECTION 03 - ENGINE PREPARATION

PORTING MAP FOR THE '96 MODELS

ENGINE TYPE / MODEL YEAR		587 / 96	657 / 96	717 / 96	787 / 96
Exhaust port height	E1	33.4 mm	32.4 mm	32.4 mm	34.6 mm
Exhaust port width	E2	50.0 mm	53.0 mm	51.3 mm	54.4 mm
Exhaust port height bottom to top	E3	32.3 mm	35.3 mm	34.7 mm	38.4 mm
Boost port height	B1	52.5 mm	55.0 mm	55.0 mm	56.7 mm
Boost port width	B2	17.0 mm	20.0 mm	25.0 mm	22.0 mm
Boost port length bottom to top	B3	38.2 mm	40.7 mm	40.0 mm	104.5 mm
Main transfer height	T1	49.5 mm	51.8 mm	51.8 mm	56.7 mm
	T2	49.5 mm	51.8 mm	51.8 mm	56.7 mm
Main transfer width at bottom	T3	20.0 mm	20.0 mm	25.0 mm	28.7 mm
	T4	21.0 mm	21.0 mm	20.0 mm	22.8 mm
Total cylinder height		109.6 mm	114.3 mm	114.3 mm	122.0 mm
Exhaust outlet height at Y-type		49.0 mm	53.0 mm	53.0 mm	56.0 mm
Exhaust outlet width at Y-type		32.0 mm	33.0 mm	33.0 mm	36.0 mm
Squish band clearance		1.5 mm	1.1 mm	1.5 mm	1.4 mm
Cylinder head volume		40.0 cc	37.9 cc	42.4 cc	47.7 cc
Combustion chamber volume with .012" base gasket		27.7 cc	28.9 cc	32.6 cc	36.3 cc
Uncorrected compression ratio		11.5-1	12.25-1	12.0-1	11.75-1
Bore		76 mm	78 mm	82 mm	82 mm
Stroke		64 mm	68 mm	68 mm	74 mm

IGNITION SYSTEM

Two stroke engines in watercraft rely on an electric spark to initiate combustion of the air / fuel charge which has been inducted into the combustion chamber. For the engine to operate efficiently, the spark must be delivered at precisely the right moment in relation to the position of the piston in the cylinder and the rotation at speed of the crankshaft. Additionally, the spark must be of sufficient intensity to ignite the air / fuel mixture, even at high compression pressure and high RPM.

It is the function of the ignition system to generate this voltage and provide it to the spark plug at the correct time.

The Nippondenso capacitor discharge ignition (CDI) system has 4 magnets located on the crankshaft flywheel. AC voltage is induced in the generating coil(s) as the poles of the magnets rotate past the poles of the coils. Timing is controlled by the position of the coil poles relative to the magnet poles, which are directly related to piston position. The CD box (or amplifier) contains the electronic circuitry to store and control the initial voltage and deliver it to the ignition coil (and then the spark plug) at the correct moment. The ignition coil is a transformer that steps up the relatively low voltage (150-300 V) of the generating coil to the 20,000 - 40,000 volts necessary to jump the spark plug gap and initiate the burning of the air / fuel mixture in the combustion chamber.

Maximum power from a given engine configuration is produced when peak combustion chamber pressure (about 750 PSI) takes place at about 15° after crankshaft rotation ATDC. Normal combustion is the controlled burning of the air / fuel mixture in the cylinder. The flame is initiated at the spark plug and spreads to the unburned at the edges of the cylinder.

The flame front travels through the cylinder at about 30 m (100 ft) per second. In order to achieve maximum pressure at about 15° ATDC, the spark must occur about 15° before TDC.

Complete combustion will finish at about 35° ATDC. The actual amount of spark advance BTDC is dependent upon bore size, combustion chamber shape, operating RPM, mixture turbulence and the actual flame speed.

Flame speed is directly proportional to piston speed in an almost linear fashion. Though it is not completely understood why this relationship exists, it is thought to be related to intake speed and mixture turbulence. Hence, flame speed increases as RPM increases. It also increases as the air / fuel ratio becomes leaner.

Because the flame speed is slower at lower RPM's, more advance at low RPM is necessary for maximum performance. Advancing the spark too much BTDC for the needs of the engine will cause the engine to detonate.

Ignition advance on Rotax engines is measured by a linear distance of piston travel BTDC. A dimension taken through a straight spark plug hole in the center of the head is a direct measurement. A direct measurement can be converted to degrees of crankshaft rotation by the appropriate formulas. Initial ignition timing procedures can be found in the appropriate model year *Shop Manual*.

When working with modified engines it may be necessary to alter ignition timing from stock specifications to achieve maximum power output or to prevent engine damage.

Select a fuel that meets the octane requirement for the compression ratio of your engine (REFER TO OCTANE REQUIREMENTS FOR ROTAX ENGINES). Once you have chosen the fuel, you will be tuning the engine (IGNITION TIMING) for maximum efficiency for that fuel. If you change to another brand of fuel or a different octane it will be necessary to re-tune the engine. Failure to do so may cause engine damage or power loss.

SECTION 03 - ENGINE PREPARATION

NOTE: For initial tuning it is recommended that you test using 1 heat range colder spark plug than stock. If upon completion of tuning the center insulator shows excessive carbon deposits go back to the stock heat range spark plug.

If you have increased the engine compression the fuel mixture will normally burn at a faster rate. Because of this effect combustion chamber pressure may peak sooner than desired. If this occurs, the engine will over heat leading to detonation and extreme engine damage. Because of these possibilities it is recommended that you pay particular attention to your spark plug readings during your initial tuning. If there are any signs of over heating or if detonation is heard it is advisable to:

1. Determine that the carburetion is not adjusted too lean.
2. Try a higher octane fuel.
3. Retard ignition timing to remedy the problem.
4. Determine that the exhaust system is providing for adequate flow.

IGNITION TIMING SPECIFICATIONS

Refer to appropriate model year *Shop Manual*.

IGNITION TIMING

It is very important that timing specification is checked at 6000 RPM with a cold engine. When preparing an engine for racing, the flywheel should be checked for the correct phazing between the firing points of the MAG and PTO spark plugs. The firing points should be exactly 180° apart; if there is any deviation between the firing points, the flywheel should be changed for a perfect unit to obtain maximum performance.

In order to check the flywheel for proper phazing, the crankshaft itself must first be checked for the 180° phasing (refer to crankshaft cautions and inspection). Use the procedure for verifying PTO flywheel timing mark position, and repeat the procedure that was done to the MAG side cylinder on the PTO cylinder. There should be 2 marks on the PTO flywheel 180° apart. The ignition fires every 180° of crankshaft rotation (at TDC and BDC) so the marks should line up exactly when viewed with a timing light. If they do not line up exactly and the crankshaft is correctly phased, the flywheel magnets may not be phased exactly 180° apart.

VERIFYING PTO FLYWHEEL TIMING MARK POSITION

Flywheel timing mark position verification is required to:

1. Troubleshoot a missing or broken magneto flywheel woodruff key.
2. Troubleshoot a magneto flywheel corresponding to a different engine type.
3. Scribe the timing mark on a new service PTO flywheel.

Always verify PTO flywheel timing mark position before checking ignition timing.

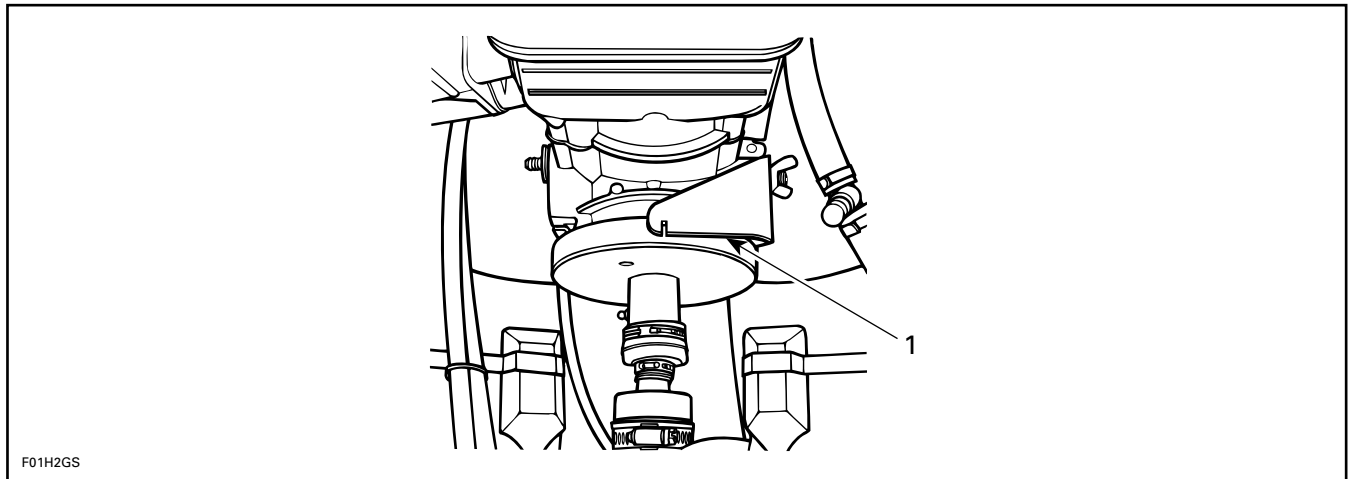
SECTION 03 - ENGINE PREPARATION

PROCEDURE

Disconnect MAG side spark plug wire and connect wire to grounding device if applicable; then, remove spark plug.

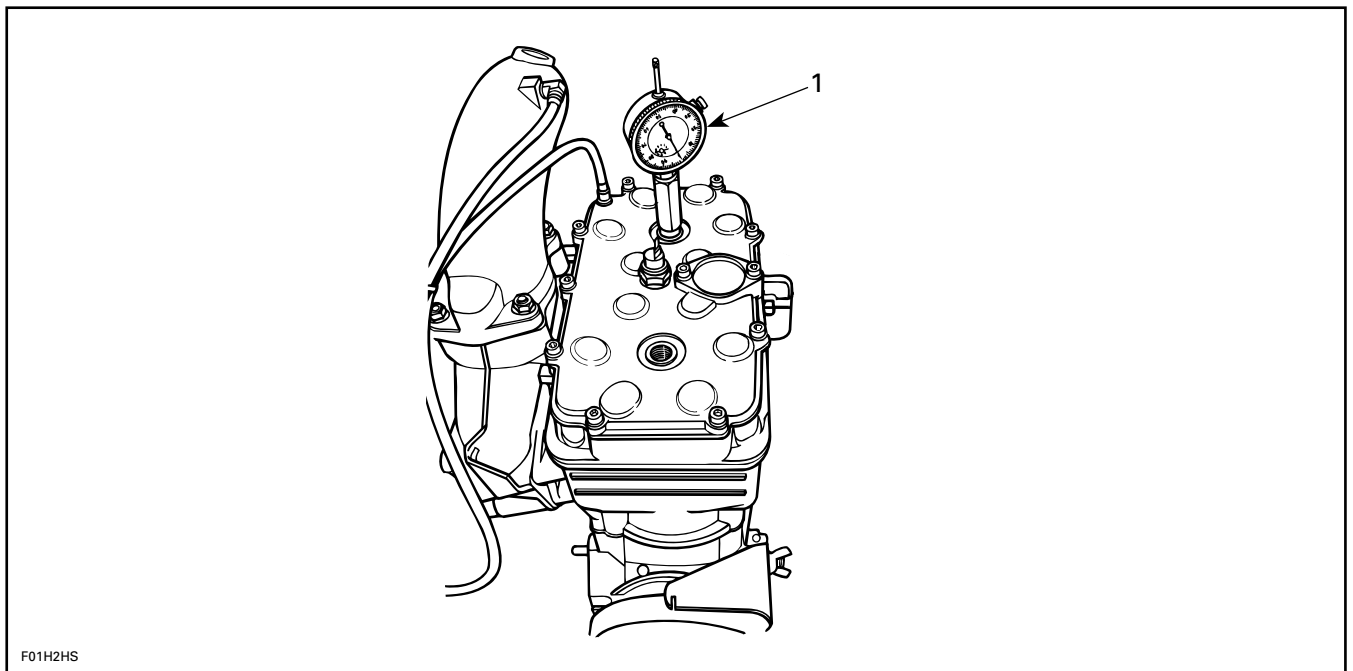
Remove PTO flywheel guard.

Install timing mark tool (P / N 295 000 102) on engine right side using wing nut previously removed.



1. Timing mark tool

Install and adjust a TDC gauge (P / N 295 000 065) in spark plug hole as follows :



1. TDC gauge on MAG side

Rotate PTO flywheel counterclockwise (when facing it) until piston is just before Top Dead Center.

SECTION 03 - ENGINE PREPARATION

Loosen adaptor lock nut; then, holding gauge with dial facing toward PTO, screw adaptor in spark plug hole.

Slide gauge far enough into adaptor to obtain a reading; then, finger tighten adaptor lock nut.

Rotate PTO flywheel counterclockwise until piston is at Top Dead Center.

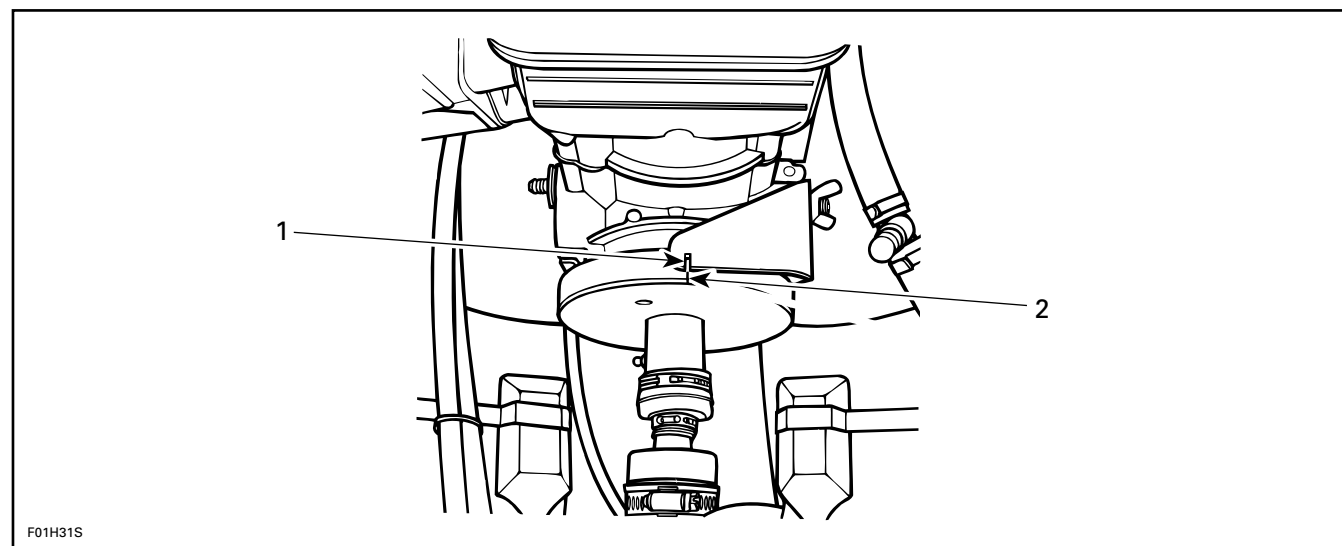
Unlock outer ring of dial and turn it until zero on dial aligns with pointer.

Lock outer ring in position.

From this point, rotate PTO flywheel 1/4 turn clockwise; then, rotate it counterclockwise to reach the position listed in the chart. (Before Top Dead Center).

IGNITION TIMING CHART	
Engine Type	mm (in) BTDC
587	2.65 (.104)
657	2.85 (.112)
657 X	2.59 (.102)
717	2.59 (.102)
787	2.54 (.100)

Using timing tool slot as reference mark, scribe in middle of tool slot a mark on PTO flywheel.



1. Tool slot
2. Flywheel mark

This mark becomes the reference when using stroboscopic timing light.

CAUTION: Timing mark position verification cannot be used as a timing procedure, therefore, always check the timing with a stroboscopic timing light at 6000 RPM after the marks have been checked.

SECTION 03 - ENGINE PREPARATION

CHECKING IGNITION TIMING

NOTE: To perform this procedure it is recommended to use a stroboscopic timing light rated to work up to 6000 RPM.

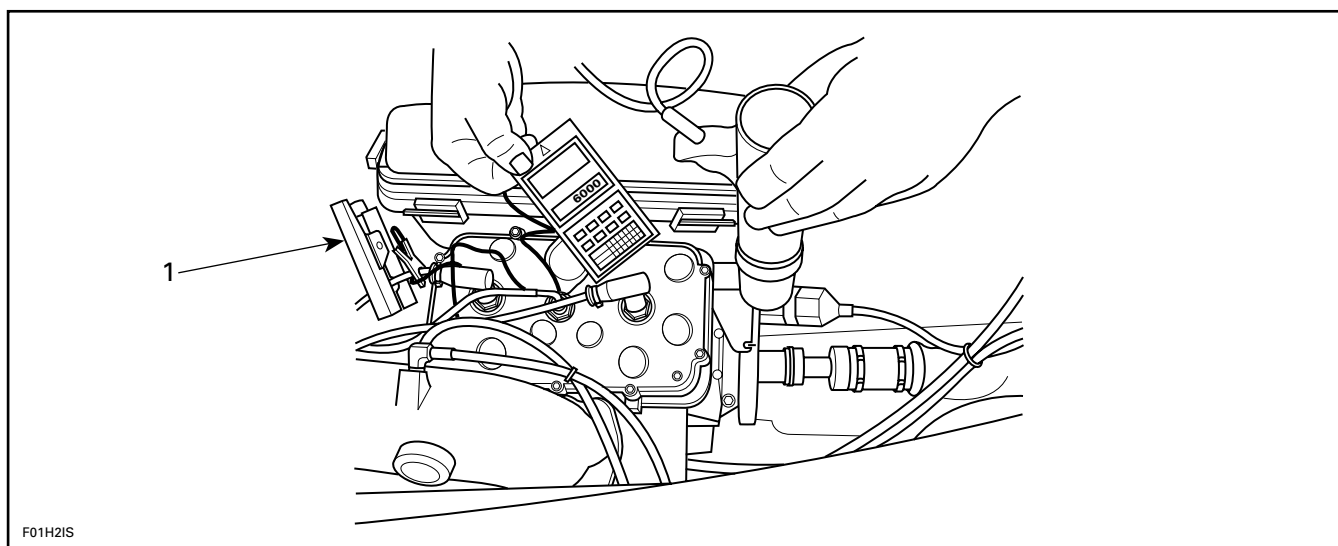
To check ignition timing, use a timing light (P / N 295 000 078).

NOTE: This timing light is battery powered and therefore needs no auxiliary power source.

The ignition components are affected by temperature variation, therefore timing must be checked when engine is cold, after MAXIMUM 20 seconds idling.

PROCEDURE

Connect timing light pick-up to MAG side spark plug lead.



1. Timing light pick-up on MAG side

Connect an induction-type tachometer to spark plug wire.

Start engine and point timing light straight in line with timing tool slot. Bring engine to 6000 RPM for a brief instant.

NOTE: On this NIPPONDENSO system, timing advance decreases as engine speed increases. When marks are aligned at 6000 RPM spark occurrence is still before Top Dead Center.

Check if PTO flywheel mark (or reference one previously scribed) aligns with timing tool slot.

CAUTION: If engine is to be run more than a few minutes, connect coupler hose (P / N 295 500 099) to properly cool engine.

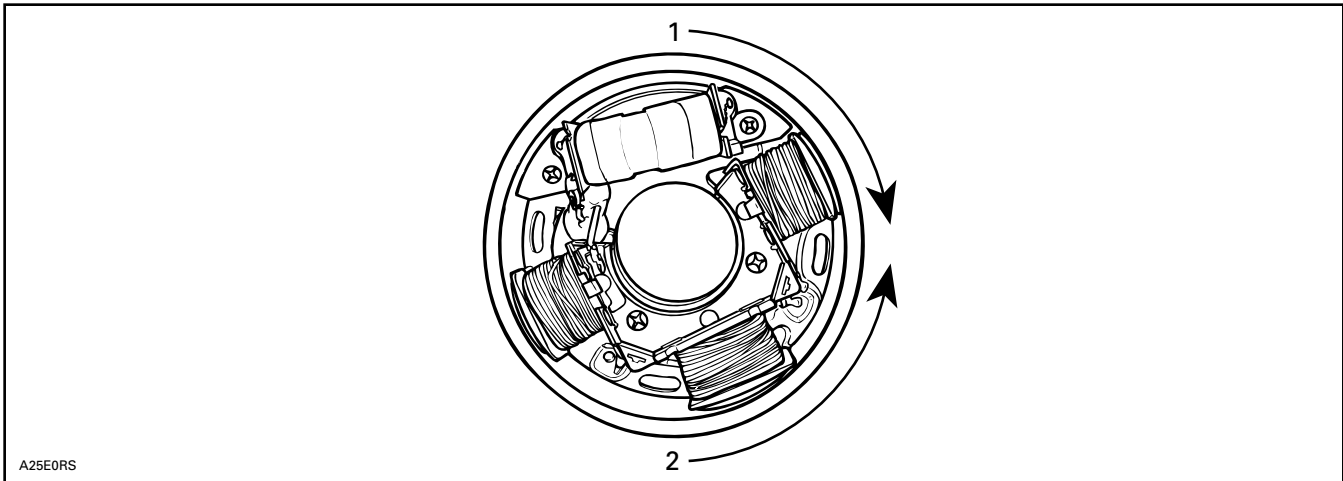
If timing marks align, timing is correct.

CAUTION: Always verify timing marks with TDC gauge before checking the timing. Particularly if PTO flywheel has been removed or replaced, it could possibly move slightly.

SECTION 03 - ENGINE PREPARATION

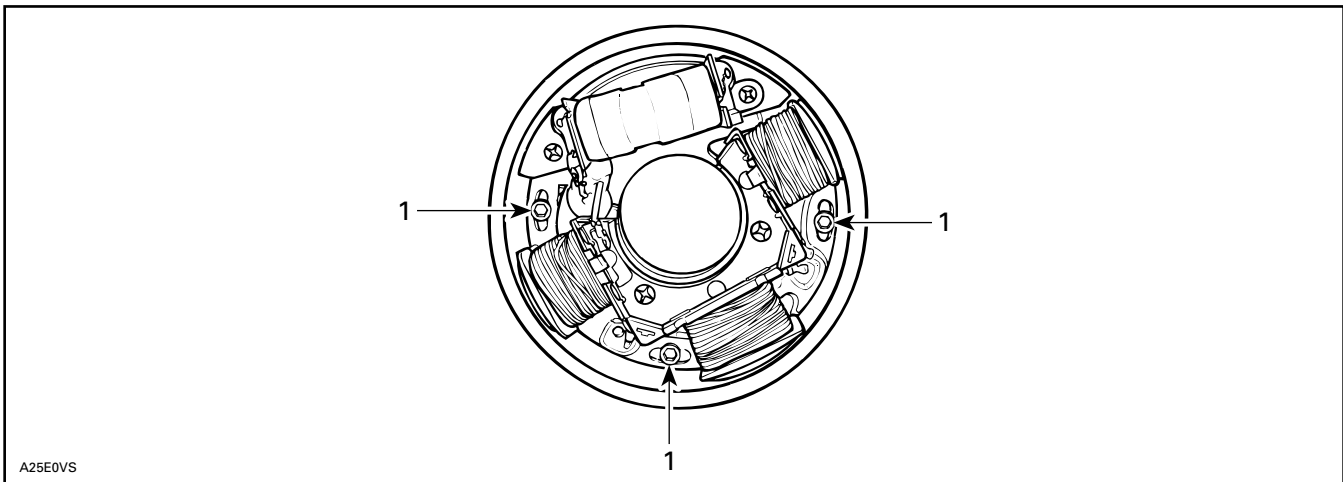
IGNITION TIMING ADJUSTMENT

Timing adjustment on all engines (except the 787 model) is performed by moving armature plate; clockwise to retard spark or counterclockwise to advance.



- 1. To retard
- 2. To advance

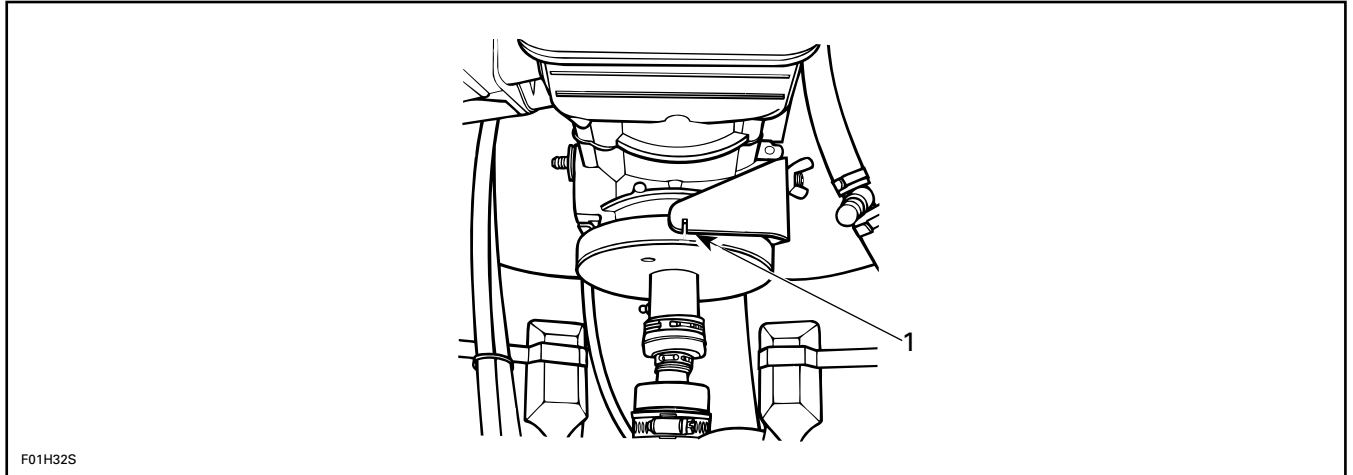
To adjust, loosen 3 armature plate retaining screws slightly and carefully rotate armature plate in proper direction. A small amount of rotational movement will advance or retard timing.



- 1. Retaining screw

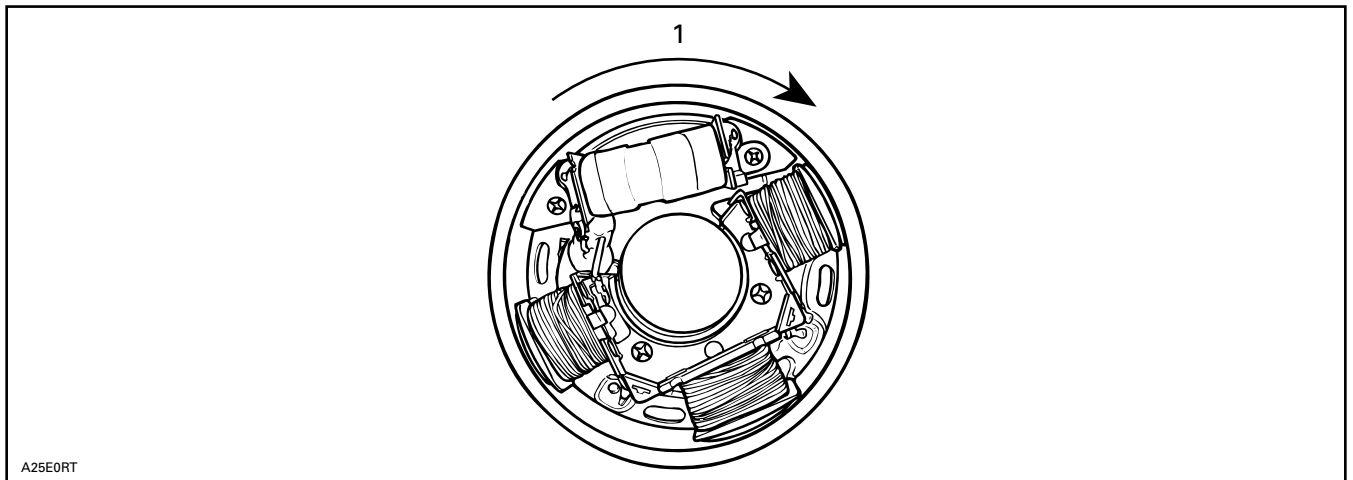
SECTION 03 - ENGINE PREPARATION

When PTO flywheel mark is on right side of timing tool slot, it indicates advanced timing.



1. *Too advanced timing*

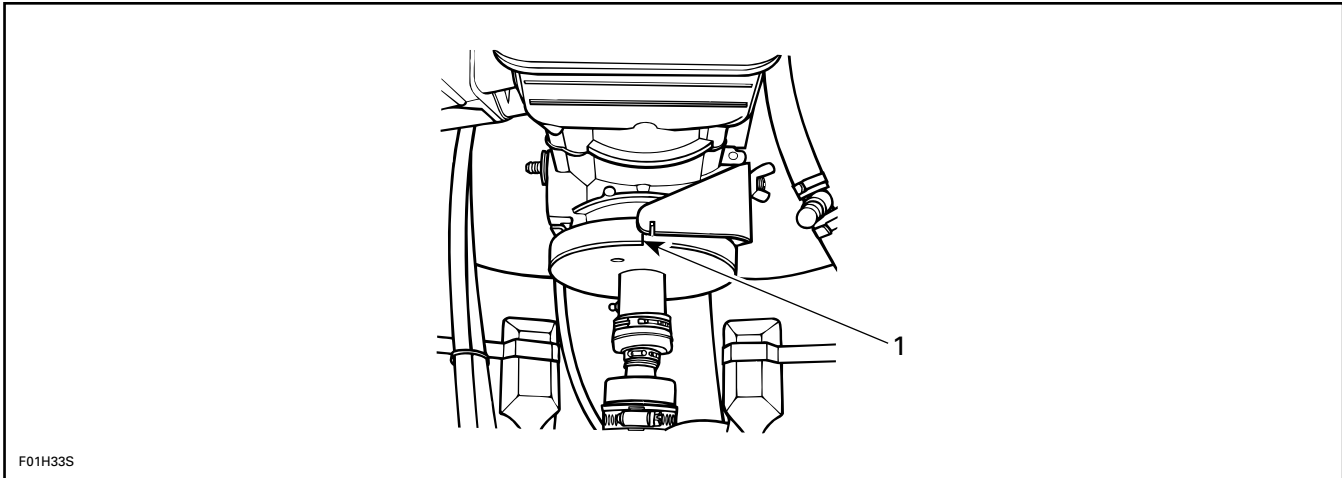
In this case, turn armature plate clockwise.



1. *Turn clockwise to retard*

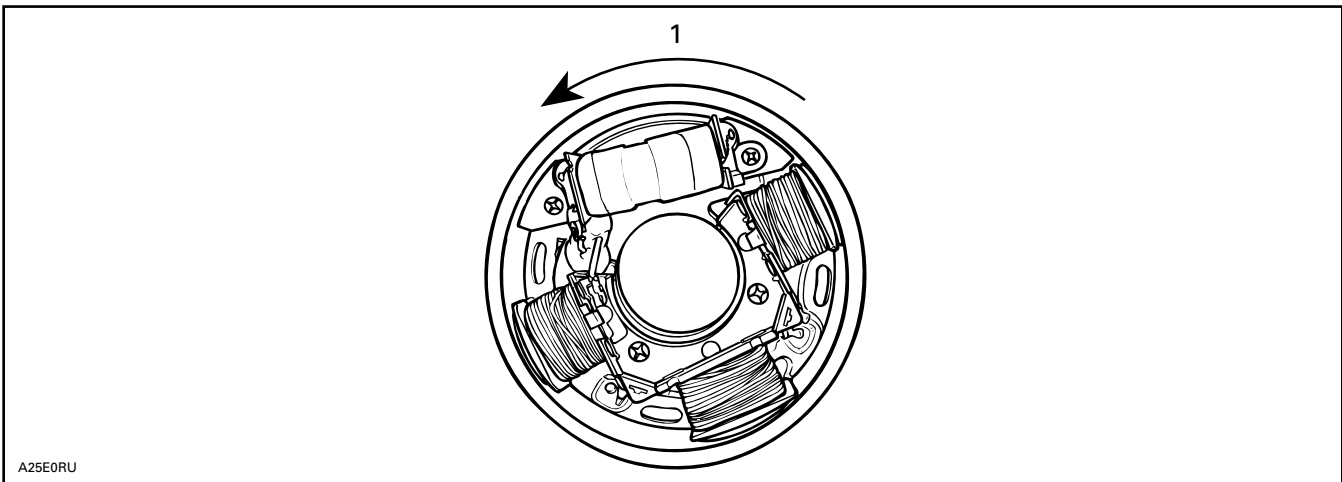
SECTION 03 - ENGINE PREPARATION

When PTO flywheel mark is on left side of timing tool slot, it indicates retarded timing.



1. Retarded timing

In this case, turn armature plate counterclockwise.



1. Turn counterclockwise to advance

After adjustment, tighten armature plate retaining screws.

CAUTION: Make sure armature plate screws are well secured. Armature plate screws must have Loctite 242 (P / N 293 800 015) applied before tightening. If you are going to apply loctite to the screws, remove one screw, apply loctite and reinstall the screw. This way you will retain the timing you just set. Torque screws to 6 N·m (53 lbf·in).

Reinstall removed parts.

Recheck ignition timing (make sure engine is cold).

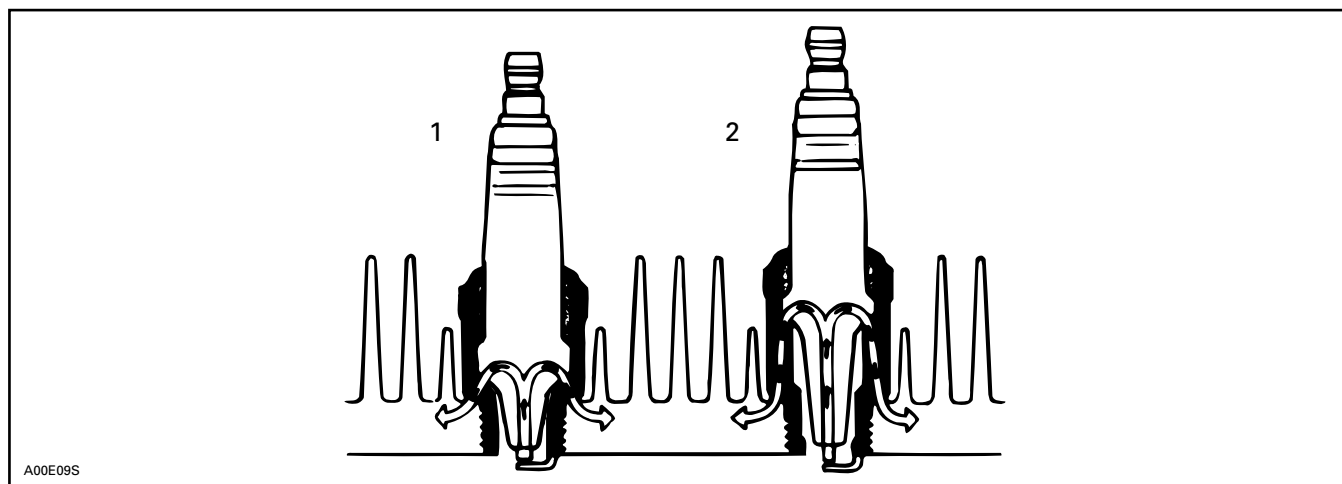
The timing adjustment for the DC CDI ignition used on the 787 engine types must be accomplished electronically. The Sea Doo dealer in your area has an MPPEM programmer necessary to perform the task. If you are able to tell the dealer how many degrees you want the timing advanced or retarded, the price of the adjustment will usually be reduced.

SPARK PLUG INFORMATION

Spark plug heat ranges are selected by measuring actual combustion chamber temperatures. A colder spark plug, 1 that dissipates heat more rapidly, is often required when engines are modified to produce more horsepower.

The proper heat range of the spark plugs is determined by the spark plugs ability to dissipate the heat generated by combustion.

The longer the heat path between the electrode tip to the plug shell, the higher the spark plug operating temperature will be, and inversely, the shorter the heat path, the lower the operating temperature will be.



- 1. Cold
- 2. Hot

A “cold” type plug has a relatively short insulator nose and transfers heat very rapidly into the cylinder head.

Such a plug is used in heavy duty or continuous high speed operation to avoid overheating.

The “hot” type plug has a longer insulator nose and transfers heat more slowly away from its firing end. It runs hotter and burns off combustion deposits which might tend to foul the plug during prolonged idle or low speed operation.

Generally speaking, if you have increased horsepower by 10-15%, you will have to change to the next colder heat range spark plug.

Sea-Doo watercraft are equipped stock with NGK BR7ES spark plugs, in all 587 type engines and NGK BR8ES in all 657, 717, 787 type engines. The spark plug gap should be 0.5 - 0.6 mm (.020 -.024 in) for all models.

These are resistor-type plugs which help reduce radio frequency interference.

SECTION 03 - ENGINE PREPARATION

DESIGN SYMBOLS USED ON NGK SPARK PLUGS

PREFIX

B

P

5

E

S

-

15

WIDE GAP

10 : 1.0 mm (.040")

11 : 1.1 mm (.044")

13 : 1.3 mm (.050")

14 : 1.4 mm (.055")

15 : 1.5 mm (.060")

20 : 2.0 mm (.080")

Thread diameter

A : 18 mm

B : 14 mm

C : 10 mm

D : 12 mm

E : 8 mm

J : 12 mm x 19 mm Reach

Construction

M : Compact Type

P : Projected Insulator Type

R : Resistor Type

U : Surface Discharge

Z : Inductive Suppressor Type

Heat rating numbers

2 Hot

4

5

6

7

8

9

10 Cold

Reach

E : 19 mm (3/4")

F : Taper Seat

H : 12.7 mm (1/2")

L : 11.2 mm (7/16")

Z : 21 mm (53/64")

Blank

18 mm ø 12 mm (31/64")

14 mm ø 9.5 mm (3/8")

Firing end construction

A : Special Design

B : Single Ground Special Alloy

C : Dual Ground Special Alloy

G : Racing Type

GV : Racing Version of V-Type

L : Half Heat Range

S : Standard Center Electrode

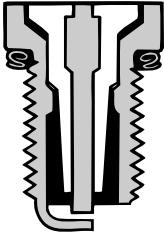
V : Fine Wire Center Electrode

X : Booster Gap

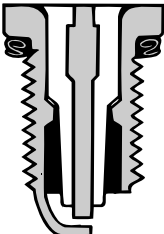
Y : V-Grooved Center Electrode

F02H08S

CROSSCUTS AND GAP STYLES OF SPARK PLUGS



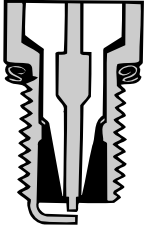
Standard Type



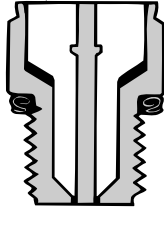
Projected Insulator Type



Taper Seat Type



V-Type



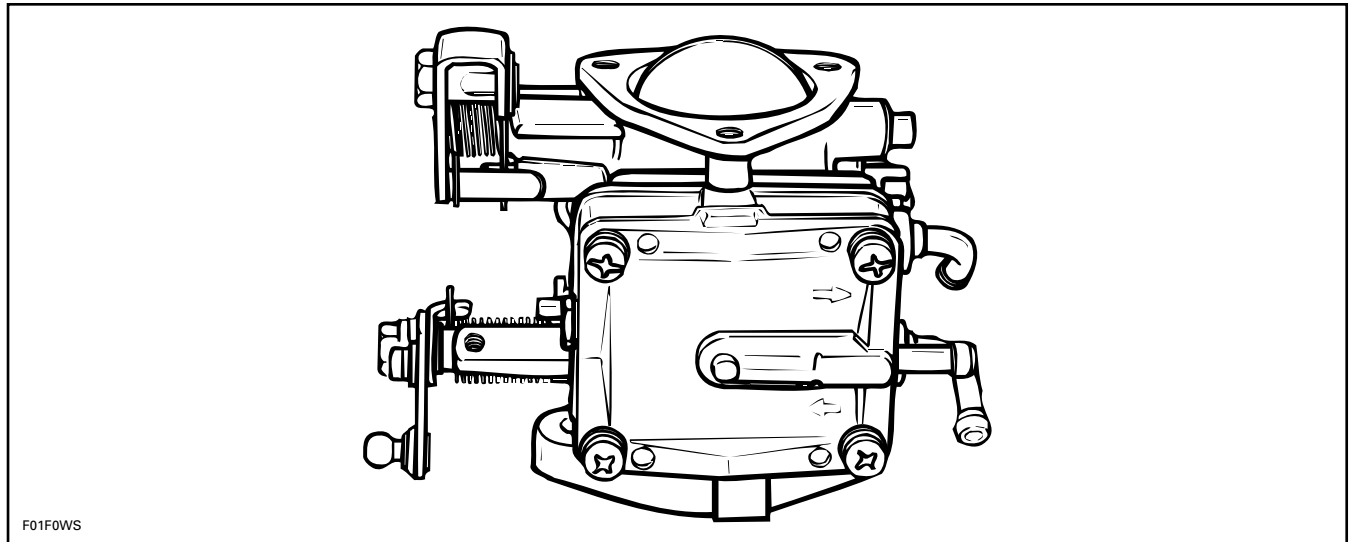
Surface Discharge Type

A01E1PS

MIKUNI BN CARBURETORS

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INTRODUCTION OF THE SUPER BN CARBURETOR



The Super BN carburetor is the latest in a series of watercraft carburetors from Mikuni. The Super BN earns its name because of the increased performance it delivers over previous model Mikuni BN carburetors.

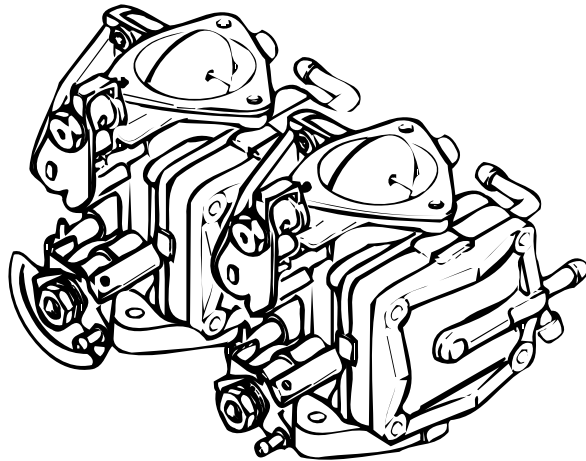
What differentiates the Super BN from its predecessors?

- 1) The fuel pump and jet sections are separated for easier maintenance.
- 2) It has an integral fuel filter.
- 3) The fuel pump capacity is increased by almost 20%.
- 4) Air flow is increased by 9%.
- 5) It is easily tuneable with replaceable jets (in a wide range of sizes) and an array of other tuning components.

With the introduction of the Super BN Series of carburetors, Mikuni American has made a renewed commitment to the watercraft industry by researching carburetor tuning applications and disseminating this information to the consumer. In the past, jetting information was available through many different sources, but unfortunately there were as many different recommendations as there were sources. With this information we will be able to provide a reliable and consistent source of approved technical details.

SECTION 03 - ENGINE PREPARATION

CARBURETOR INSTALLATION



F01F29S

Mikuni Super BN38 mm Dual Carburetor Set for high performance applications

▼ **CAUTION:** Exercise caution when changing carburetion components and any time you work with the fuel system on your watercraft. Work in a well ventilated area. Do not turn the engine over while fuel lines are disconnected. Immediately clean up any fuel spill that might occur during carb installation.

○ **NOTE:** As when installing any performance product, a degree of mechanical ability is required. If after reviewing the parts and instructions you do not feel that you can properly complete this installation, take your watercraft to a competent professional. Proper installation and adjustment will save time, money and aggravation.

○ **NOTE:** In most cases your new Super BN Carburetor will be installed in conjunction with an aftermarket manifold and flame arrestor/air filter system. We recommend using this manual, together with the appropriate model year *Shop Manual* for your watercraft, and the instructions from the aftermarket manifold manufacturer to help you with the installation and tuning of the BN carburetor system.

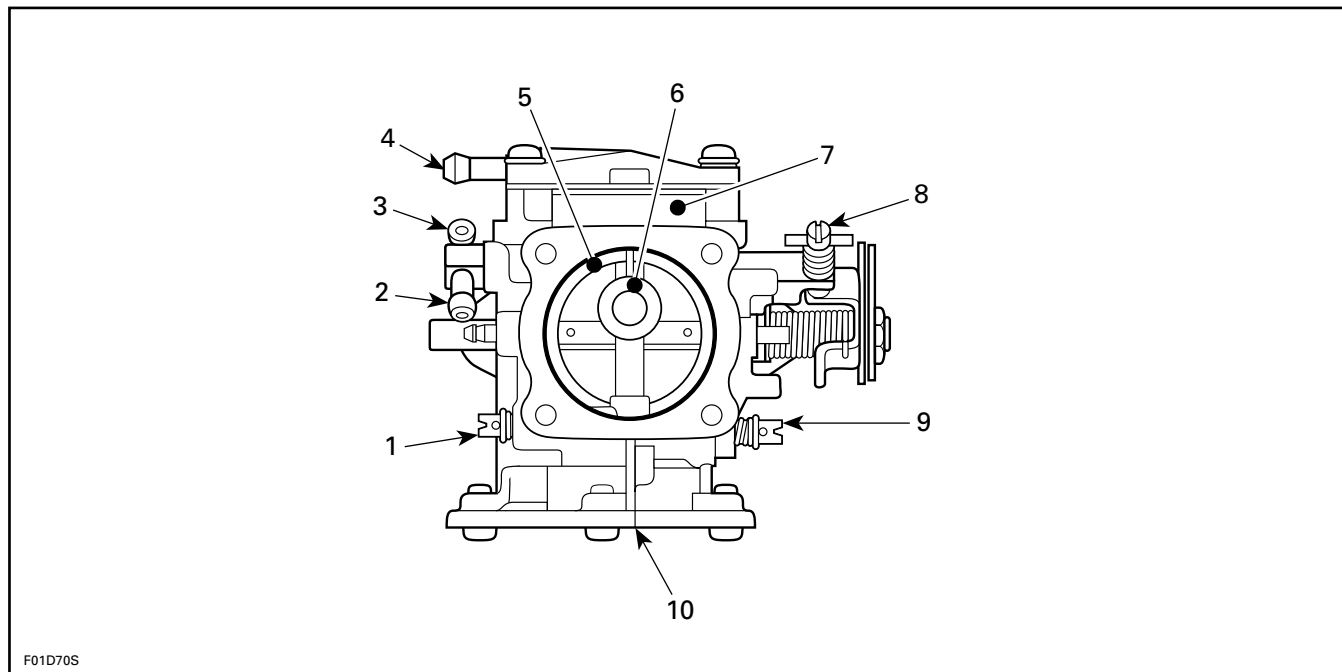
BASIC INSTRUCTIONS

- 1) Use a new gasket between the carburetor(s) and intake manifold.
- 2) Use flat washers and lock nuts to secure the carburetor(s).
- 3) Be sure that the fuel lines are of the correct diameter for the carb fittings. Secure all hose connections with cable ties and proper clamps.
- 4) When installing the throttle cable, be sure to securely tighten the jam nuts. Allow a small amount of free play at the throttle lever. Check to see if the throttle is opened as the handlebar is turned from side to side; correct the cable routing if necessary.

▼ **CAUTION:** Be careful at carburetor cleaning not to remove paint. Paint removal will cause carburetor to corrode very rapidly. Repaint if necessary.

▼ **CAUTION:** Heavy duty carburetor cleaner may be harmful to rubber parts, O-rings, etc. Therefore, it is recommended to remove those parts prior to cleaning.

EXTERNAL COMPONENTS



- F01D70S
1. High speed adjuster
 2. Fuel return
 3. Fuel inlet
 4. Pulse nipple
 5. Outer venturi
 6. Inner venturi
 7. Fuel pump assembly
 8. Idle stop screw
 9. Low speed adjuster
 10. Regulator diaphragm high and low speed jets needle valve assembly

INTERNAL COMPONENTS

At first look the cutaway drawing (see next page) appears somewhat straight forward, but some interesting things appear as you study it. Follow the fuel flow through the low speed circuit. Fuel flows through the low speed jet and then is divided, with part of the fuel being metered by the low speed screw. An additional route the low speed fuel takes is through the by-pass holes (transition circuit). Fuel is drawn through the by-pass holes as the throttle is opened and the butterfly valve exposes them to the air flow. The ability for fuel to pass through the low speed circuit and its transition is controlled first by pop-off pressure, then by the size of the low speed jet.

NOTE: If the low speed jet size is changed, it affects the mixture both at idle speed and off idle.

Viewing the high speed circuit, notice that fuel is divided at the high speed jet, so that even if the high speed screw was fully closed, fuel would still pass through the jet. The fuel flow chart illustrates the adjustability of total fuel flow with the high speed screw. It is possible, with the Super BN, to adjust the desired fuel flow with the screw closed, by changing the size of the jet alone. In this way, if the screw was used later, the fuel mixture could not get lean enough to cause an engine seizure.

SECTION 03 - ENGINE PREPARATION

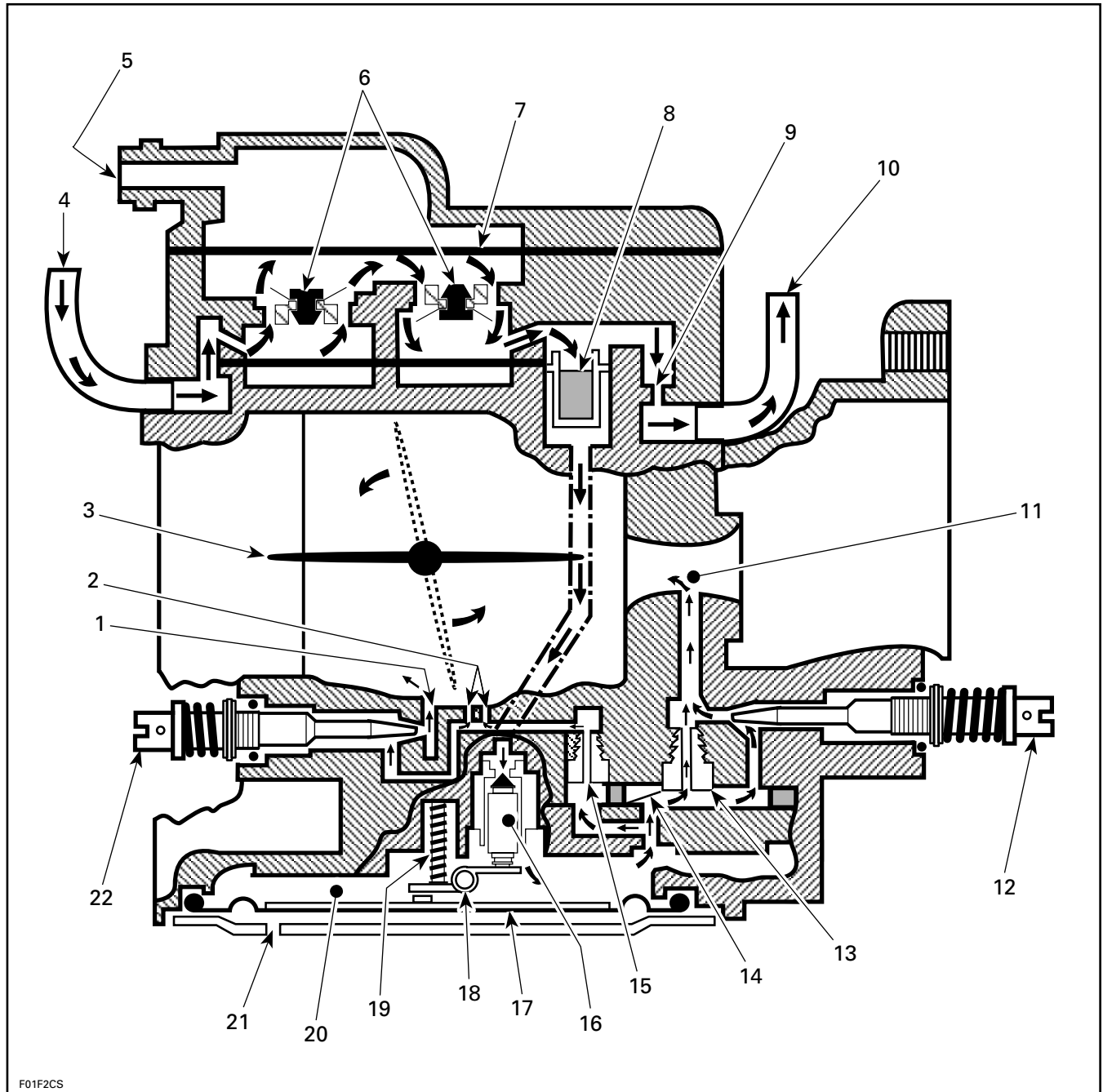
Trace to the needle valve and notice the relationship between the spring and the needle. The spring exerts pressure through the arm onto the needle. The size of the fuel passage hole in the valve seat contributes to the performance of the carb in a couple of different ways. First, and most important, the hole size helps determine pop-off pressure. 4 things combine to create pop-off:

- 1) Suction within the carb (manifold pressure)
- 2) Atmospheric pressure
- 3) Arm spring pressure
- 4) Fuel pressure acting on the needle valve

Hydraulic principles apply in this instance. There is fuel pressure acting against the exposed end of the needle valve with this pressure being measured in PSI. For example, with a 2.0 size needle valve, the fuel pressure pushes against the needle through the opening with a certain force. If you increase the needle valve size to 2.5 and retain the same arm spring, the fuel has a larger surface to push against and can move the needle more easily. So, increasing needle valve size effectively decreases pop-off; conversely, decreasing the size of the needle valve will increase pop-off.

The arm spring is also an adjustable component. There are currently 4 springs available with different gram ratings. You can refer to the pressure chart (further along in this section) to obtain approximate pop-off pressures with spring pressure and needle valve combinations.

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F01F2CS

1. Low speed outlet
2. Bypass holes
3. Throttle plate
4. Fuel inlet
5. Pulse
6. Check valves
7. Pump diaphragm
8. Filter
9. Restrictor
10. Fuel return
11. Inner venturi

12. High speed adjuster
13. Main jet
14. Anti-siphon valve
15. Low speed jet
16. Needle valve assembly
17. Regulator diaphragm
18. Arm
19. Arm spring
20. Fuel chamber
21. Vent to atmosphere
22. Low speed adjuster

SECTION 03 - ENGINE PREPARATION

NOTE: It is important to NOT select a needle valve that is too small for your application due to the fact that the needle valve can be a limiting factor in maximum fuel flow. In other words, in some applications, engines require more fuel than small needle valves can deliver. The needle valve sizes in Mikuni special set carbs have been carefully selected and should not be decreased. However, in the case of watercraft with very high fuel demands, it may be necessary to increase the needle valve size. Keep in mind that when the needle valve size is changed it will affect the pop-off pressure.

STANDARD NEEDLE VALVE SIZE FOR VARIOUS SEA-DOO CARBURETORS

BN38I-37BI	BN38-34-45B	BN38-34-58	BN38-34-59
BN38-34-64	BN38-34-65	BN38-34-73	BN38-34-74
BN38-34-92	BN38-34-93	BN38-34-110	BN38-34-111

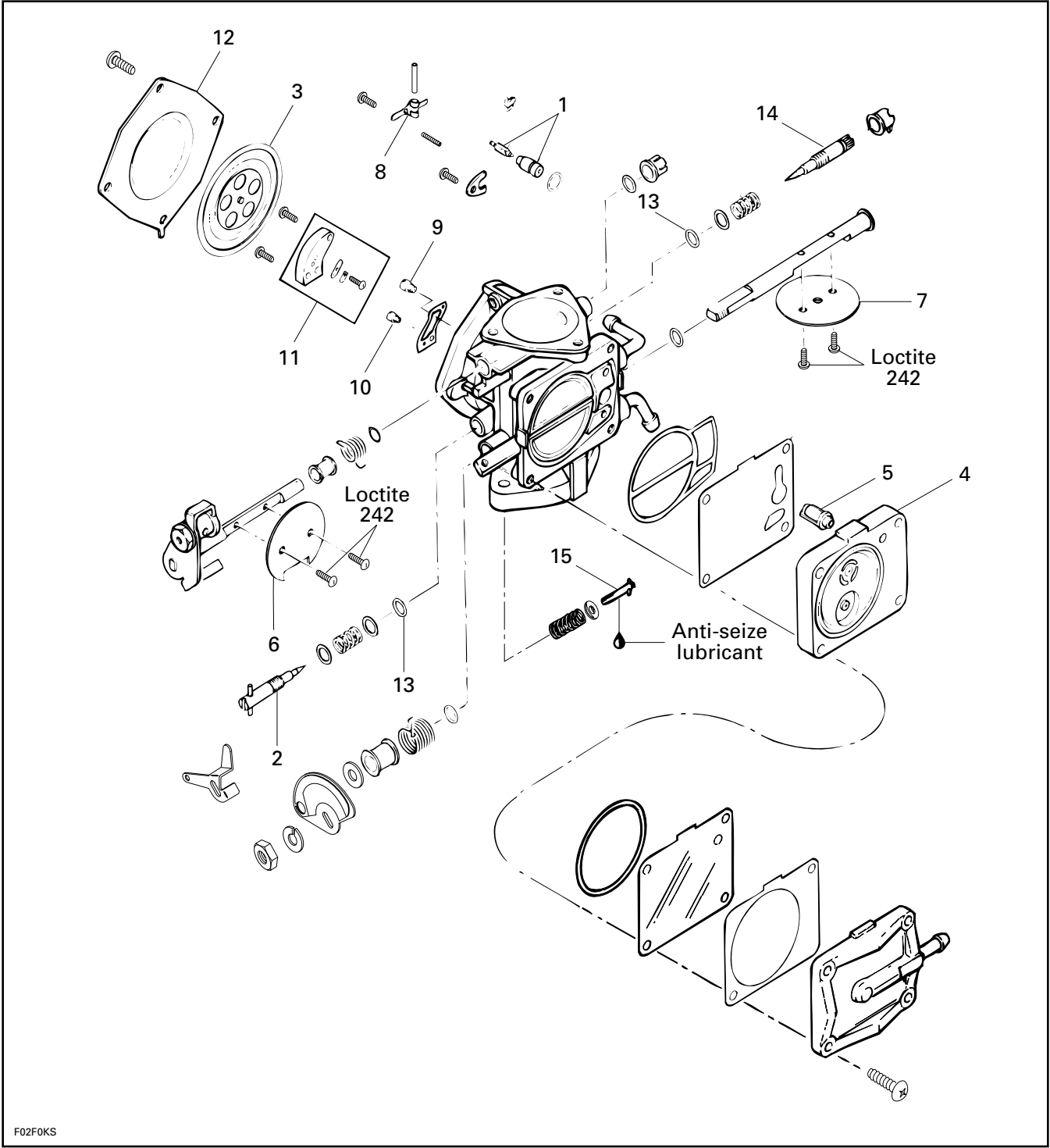
(All use 2.0 needle valve)

CAUTION: It is recommended that you select an arm spring that is the correct length rather than cutting or stretching an existing spring, the results are more consistent over the long run. Cut or stretched springs tend to change in strength over time.

The anti-siphon valve is located in the valve body assembly, attached directly above the high speed jet. It is responsible for retaining fuel in the fuel chamber when the engine is shut off. When the engine is running, suction will cause the anti-siphon valve to flex, allowing fuel to flow to the jet. If the valve becomes worn or does not seal correctly, the symptoms will appear as a rich condition from 1 half to full throttle.

The throttle plate (butterfly valve) is worth a closer look. It's quite obvious that the throttle plate controls the entire operation of the carb. At idle, the throttle plate blocks off almost all air flow through the carb, creating a very high amount of manifold pressure within the carb. This high pressure is 1 reason that the low speed screw is as sensitive as it is; small adjustments will make a big difference. Notice that when the throttle plate is in the idle position, the bypass holes are actually above the throttle plate (with the carb in the down draft position). The bypass holes are actually having air drawn through them in this position. It isn't until the throttle plate opens over the bypass holes that fuel actually passes through them.

SECTION 03 - ENGINE PREPARATION



F02F0KS

SECTION 03 - ENGINE PREPARATION

- | | |
|---------------------------------|------------------------------------|
| 1. Sealing Ring (2) | 31. Pilot Jet |
| 2. Sleeve | 32. O-Ring |
| 3. Spring | 33. Washer (2) |
| 4. Throttle Lever | 34. Spring |
| 5. Throttle Lever Stopper | 35. Low Speed Mixture Screw |
| 6. Lock Washer | 36. Screw (2) |
| 7. Nut | 37. Check Valve Housing |
| 8. Ring | 38. Pin |
| 9. Washer | 39. Plate |
| 10. Lock Washer | 40. Needle Valve |
| 11. Screw | 41. O-Ring |
| 12. Choke Valve | 42. Needle Valve Lever |
| 13. O-Ring | 43. Clip |
| 14. Gasket | 44. Spring |
| 15. O-Ring | 45. Gasket |
| 16. Pump Body | 46. Diaphragm |
| 17. Diaphragm | 47. Cover |
| 18. Gasket | 48. Screw (4) |
| 19. Pump Cover | 49. Screw (2) |
| 20. Screw (4) | 50. Spring (2) |
| 21. Throttle Valve | 51. Washer (2) |
| 22. Screw and Spring Washer (5) | 52. Screw |
| 23. Sealing Ring (2) | 53. Washer (4) |
| 24. Sleeve | 54. O-Ring |
| 25. Spring | 55. Cap |
| 26. Main Jet Screw | 56. Loctite 242 |
| 27. Ring | 57. Carburetor Linkage |
| 28. Filter | 58. Synthetic Grease |
| 29. Screw and Spring Washer | 59. Bracket (twin carburetor only) |
| 30. Main Jet | |

TUNING

Tuning the Super BN carburetor(s) can be a fairly simple matter if you look at it with a logical perspective. As modern and technologically advanced as the Super BN is, it is still a fuel regulator, due to the fact that fuel entry into the carb and fuel delivery is regulated by a spring and diaphragm system. Using the cut-away drawing as a reference, you can see that as fuel is drawn out of the fuel chamber, atmospheric pressure pushes inward on the regulator diaphragm, moving it against the spring pressure on the needle valve arm. When the combined forces, the suction within the carb, the fuel pressure at the needle valve, and the atmospheric pressure are great enough to overcome the arm spring pressure, the needle valve will open, allowing fuel (under pressure from the pump) to enter the fuel chamber. This combined force is commonly referred to as “pop-off” pressure: The force required to “pop” the needle valve “off” the seat.

NOTE: As soon as the fuel chamber has been filled, fuel flow into the chamber ceases and the carb returns excess fuel, via a restriction, to the fuel tank.

There are a number of factors that can modify or change the effectiveness of an engine to overcome this pop-off pressure. The engine’s ability to create a strong “suction” signal within the carb, and the outside air pressure are 2 variable factors. Engines can be modified in many ways that can increase, or in most instances, decrease the suction generated. Listed here are examples of changes and the effect on engine suction:

Modified porting from mild to wild can have the effect (in most cases) of reducing suction at lower throttle openings, and with it, hindering carburetion and clean running in the engine’s lower RPM range. Hopefully the porting is good and will increase air flow at higher RPM’S for better carburetor response and increased power.

Freer exhaust systems decrease suction. Even though they flow more freely, they reduce manifold pressure within the carb. Manifold pressure is a way of measuring the strength of engine suction. Although air flow is increased initially, there isn’t enough air flow until high engine speeds to replace manifold pressure.

Freer air intake systems. Free flowing (unrestricting) air intakes increase air flow, but once again, at low throttle openings may reduce manifold pressure. Increasing air flow is a good thing, but, be aware that adjustments have to be made in your carb to compensate for pressure changes.

Atmospheric pressure changes with altitude and temperature. BN carbs adjust automatically to minor changes in either altitude or temperature in this way: As air thins out, for example, less air is drawn through the engine, which enriches the air/fuel mixture, but, there is also less pressure acting on the regulator diaphragm; this tends to lean the air/fuel mixture. These 2 factors off-set each other to a small degree, but this effect must be taken into account when you consider readjustment for a large change in altitude or temperature.

Needle valve arm adjustment is from the top surface of the arm being level with the cast surface of the carb, to a maximum of the surface of the arm raised 1 mm (.040”) above the carb surface. The arm is a convenient way to make minor adjustments in pop-off pressures. Bending the arm upwards by the mentioned 1 mm (.040”) will noticeably decrease pop-off pressure.

Idle stop screw adjusts the idle speed (RPM) by opening or closing the throttle plate (butterfly). Refer to your *Operator’s Guide* for the correct idle speed for your watercraft. As a rule of thumb, adjust the idle to approximately 1100 RPM.

Low speed screw is used in conjunction with the idle stop screw to maintain idle speed and smoothness. Use the low speed screw to adjust the smoothness of the idle. Experiment turning the low speed screw in and out in small increments until a smooth idle is obtained. As the idle stop screw is turned in or out to raise or lower idle speed, the low speed mixture is also affected. The

SECTION 03 - ENGINE PREPARATION

low speed screw is very sensitive and adjustments should be made in small increments only. For clarification, if the idle stop screw is turned out to lower idle speed, the low speed air/fuel mixture will richen slightly and a small adjustment will need to be made with the low speed screw inward to compensate.

NOTE: To get a good “feel” for the correct low speed adjustment, experiment with the idle stop and low speed screws. You will find that a small adjustment with 1 of the screws requires an equal readjustment of the other. **Correct low speed adjustment will result in improved throttle response.**

Transition circuit is made up of the low speed screw, low speed jet, bypass holes and pop-off pressure. To adjust the transition circuit, change the low speed jet or pop-off pressure. If a slight lean or rich condition exists while accelerating from just off idle to half throttle, change the low speed jet. Increasing the jet size will richen the mixture. Make any jet changes in small increments of jet sizes. If a severely lean or rich condition exists in transition, it will be necessary to readjust the pop-off pressure. Refer to the pop-off chart to determine how to change components for pop-off adjustment.

NOTE: To accurately check and adjust pop-off pressure, it will be necessary to use a pop-off pump and gauge, which are available through your dealer. The pop-off chart in this section is for approximating pressure only.

High speed screw adjusts the air/fuel mixture, in conjunction with the high speed jet, for maximum full throttle performance. The initial setting for the high speed screw is closed. If you are uncertain that this setting will provide enough fuel, do not hesitate to start with the screw out more turns. Turning the screw clockwise (inward) will lean the mixture, counterclockwise will richen the mixture. The high speed screw is effective up to 3 full turns out. The plastic cap must be removed for adjustments over 1/4 turn.

What is manifold pressure and how does it differ from air velocity?

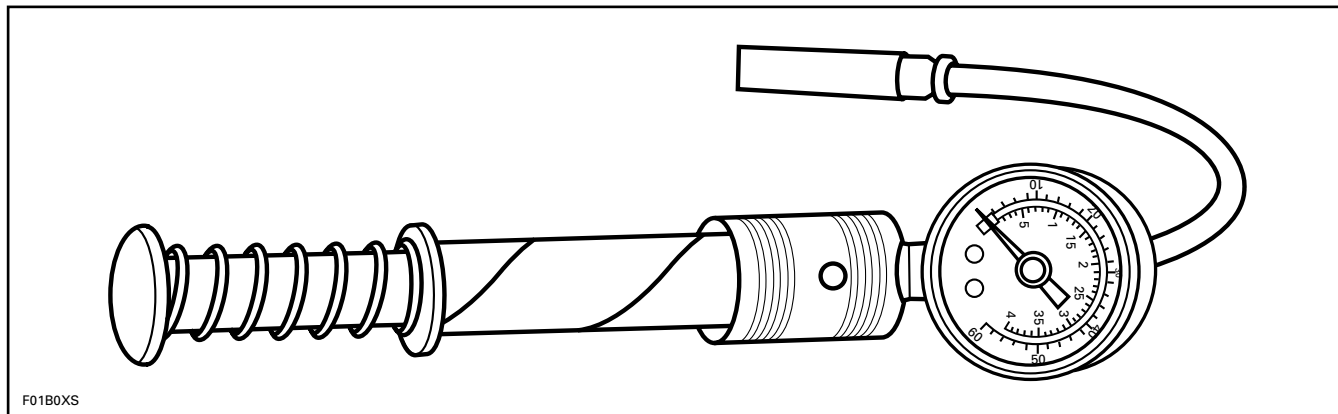
Manifold pressure is the “suction” generated by the engine against a restriction; the strength of this suction is measured in inches of mercury. In the case of the Mikuni BN carburetor, the main restriction is considered to be the throttle plate. When the throttle plate is closed, it offers the greatest amount of restriction and manifold pressure is high. As the throttle plate is opened, the restriction is reduced and manifold pressure decreases.

The carburetor sees manifold pressure as a potentially strong suction drawing on any exposed openings within the carb. As the throttle is opened, more internal openings are exposed to this suction. To begin with, only the low speed fuel outlet is exposed, but as the throttle is opened further, the bypass holes and the high speed fuel from the inner venturi are exposed to the suction. At this point, with the throttle wide open, if there was no fuel in the carb, the engine would not rev up and because the throttle plate was open fully, the manifold pressure would be very low. However, we do have fuel and the engine does rev, drawing an increasing amount of air velocity through the carb. As the air velocity through the carb increases, it replaces manifold pressure as the “suction” force within the carburetor.

What are the dynamics of manifold pressure and air velocity? As the engine is idling we know that manifold pressure is high and there is good signal strength within the carb, which makes adjustment easy. As the throttle is opened quickly, manifold pressure disappears and if the jetting within the carb is correct, the engine revs quickly and air velocity increases to accelerate you on your way.

Now you can see the importance of the transition circuit; it is there to aid in the transition from high manifold pressure to high air velocity. **Correct adjustment of the transition circuit is vital to smooth acceleration and good performance.**

TESTING POP-OFF PRESSURE



Pop-off Pump with gauge (P / N 295 000 114).

Testing pop-off pressure requires a small pump used in conjunction with an air pressure gauge such as the Bombardier Pop-Off Gauge P/N 295 000 114. The gauge should be calibrated in at least 1/2 PSI increments and read up to 30 PSI. The readings taken from the gauge are used for comparison before and after changes, so the actual accuracy of the gauge is not critical.

The pop-off pressure chart in this section shows very accurate PSI values between needle valve sizes and spring pressures. Before making any changes in pop-off, test your carb and see how it compares to the chart.

STEPS IN TESTING:

- 1) Attach the pump hose to the fuel inlet on the carb.
- 2) Cover, or in some way completely plug the fuel return line.
- 3) It is recommended that the regulator diaphragm and its cover be removed during testing.
- 4) During testing, it is important to obtain consistent readings. To accomplish this, it is necessary to keep the needle valve wet. Use Sea-Doo lube (P / N 293 600 006) to wet the needle valve.

◆ **WARNING: Do not use gasoline due to the hazard of fire. Protect your eyes from the spray when the needle valve pops-off.**

- 5) Pressurize the carb with the pump until the needle valve pops-off. Check at what pressure the valve closes and seals. This illustrates quality of valve sealing. Test the valve at least 3 times to assure an accurate reading. Be sure to keep the needle valve wet.

The reason for wetting the needle valve is to duplicate actual conditions during operation. When the engine is running, the needle valve has gasoline running through to wet it and engine vibrations to actually help the needle obtain a good seal.

As you adjust pop-off pressure to tune your carb, make changes in small increments only (approximately 2 PSI) because small changes in pop-off can equate to big differences in engine performance. **Increasing or decreasing pop-off dramatically affects how the low speed jet performs. Pop-off enhances the fuel flow of the low speed jet.** Example: The low speed jet is a #100 and the pop-off is 16 PSI. If the pop-off is increased to 20 PSI, the amount of fuel that passes through the jet decreases even though the jet size remains unchanged. If the pop-off was decreased to 13 PSI, the #100 jet would flow proportionally more fuel. The low speed jet and pop-off work together in the transition circuit. As a rule of thumb, **adjusting pop-off is for making big changes in the transition circuit, the low speed jet is used for fine tuning.**

SECTION 03 - ENGINE PREPARATION

What we have been considering and learning is pop-off pressure, what it is and what affects it. What effect does this have on your fuel system? Pop-off pressure controls throttle response from just off idle until approximately 1/2 throttle. As a rule of thumb, piston ported and rotary valve engines use generally higher pop-off pressures, as where reed valve engines require lower pop-off pressures.

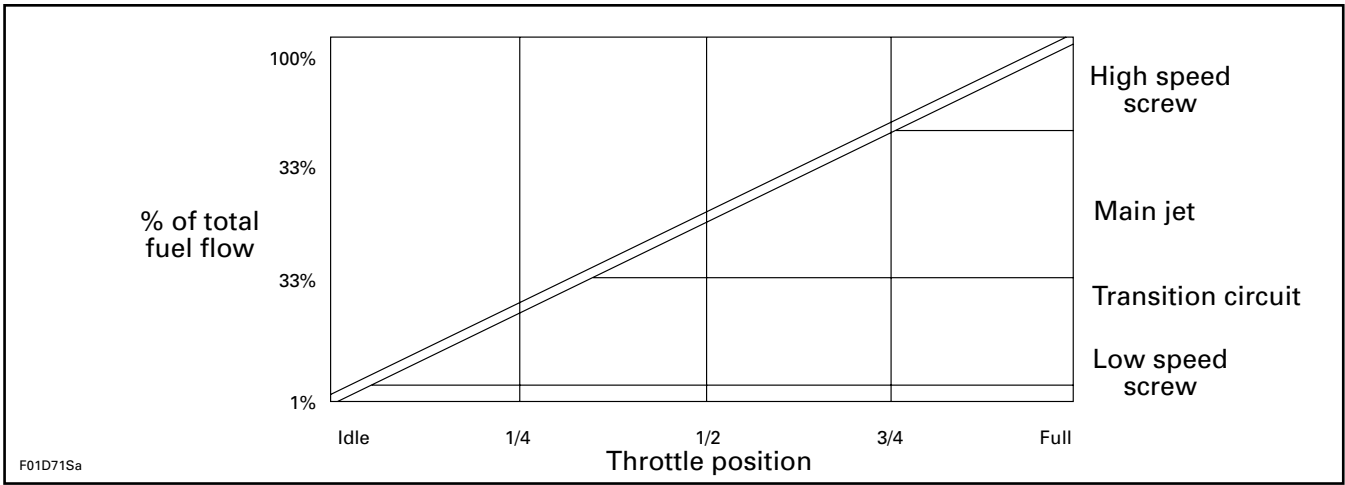
SPRING SELECTION

When changing the pop-off, it is recommended that you select a spring from the chart that combines with your needle valve size to obtain the desired pressure. If no spring size is appropriate, it is acceptable to take a spring of greater pressure and cut it shorter to achieve the correct pop-off. Use your gauge to verify the pop-off. Do not stretch lesser springs to increase pressure, as the metal has a memory and will eventually shrink back to its original size.

POP-OFF PRESSURE CHART

Needle Valve Size	Arm Springs			
	115 g	95 g	80 g	65 g
1.5	55 PSI	43 PSI	38 PSI	32 PSI
2.0	32 PSI	25 PSI	21 PSI	18 PSI
2.3	22 PSI	20 PSI	17 PSI	15 PSI
2.5	19 PSI	17 PSI	14 PSI	12 PSI

FUEL FLOW CHART



NOTE: This chart depicts the approximate amount of fuel that each circuit contributes to the total fuel flow of the Super BN'S. Fuel flow is in percentage.

Low speed circuit contributes fuel all the way to full throttle. All fuel circuits within the carb work in this manner: as the throttle opens, each circuit in turn contributes to the total fuel requirements of the engine.

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Transition circuit controls the fuel flow for a smooth “transition” to the high speed circuit. If the transition circuit is far enough out of adjustment, it may become difficult to get to the high speed circuit and the engine will not rev up.

High speed circuit controls the fuel flow in addition to the low speed and transition circuits. The high speed screw can control up to as much as 1/2 of the fuel delivered by the high speed circuit, depending on the relative size of the high speed jet. This adjustability allows for a wide range of tuning without changing an internal jet.

CARBURETOR TUNING

GENERAL

The oxygen content of air varies with different atmospheric conditions. Cool, dry air at a high barometric pressure has more oxygen molecules per cubic foot than does hot moist air at low barometric pressure readings. Hot air expands; therefore, there are less oxygen molecules per cubic foot. At low barometric pressure also allows air to expand. An increase in altitude results in a decrease in barometric pressure. Air with high humidity has more water molecules which take up space so there is less room for oxygen molecules. Since oxygen is what is needed to mix fuel to provide a burnable mixture, changing atmospheric conditions will require a change in fuel flow.

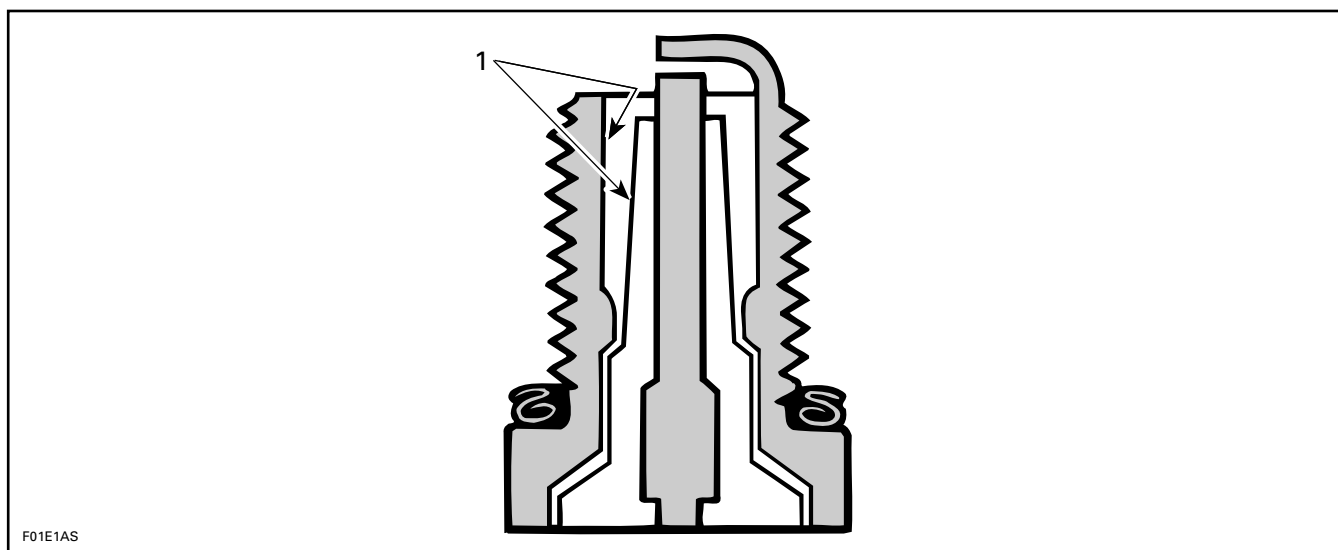
JETTING

Pilot and main jets are replaceable. Different jet sizes are available to suit altitude and/or temperature conditions. Different jetting may be required as engine performance is increased.

Always inspect spark plug and piston dome color before selecting jetting options. Spark plug or piston dome color is an indication of carburetion mixture conditions.

Dark brown or black coloration indicates a rich condition, while light tan or white indicates a lean condition. Medium brown coloration may indicate a correct jetting range.

Location to check spark plug coloration



1. Location to check spark plug coloration

Refer to the appropriate *Shop Manual* of your watercraft for instructions on changing carburetor jetting.

SECTION 03 - ENGINE PREPARATION

JETS FOR MIKUNI SUPER BN CARBURETORS

SIZE	PART NUMBER
MAIN JETS	
102.5	270 500 157
105	270 500 158
107.5	270 500 116
110	270 500 159
115	270 500 181
120	270 500 160
122.5	270 500 161
125	270 500 162
130	270 500 163
132.5	270 500 225
135	270 500 174
142.5	270 500 209
147.5	270 500 210
PILOT JETS	
55	270 500 202
57.5	270 500 201
60	270 500 180
62.5	270 500 164
65	270 500 117
67.5	370 500 165
70	270 500 175
72.5	270 500 166
75	270 500 149
77.5	270 500 167

If in doubt with carburetion jetting, always begin with a rich setting and work toward a lean adjustment.

NOTE: It is recommended you always race with your fuel tank valve on the “reserve” position. This should eliminate any possibility of air entering in the fuel system should the fuel tank level be lower than a quarter full.

BREAK-IN PROCEDURE

When preparing an engine for racing, many details must be made exactly to specification to achieve the maximum performance.

To obtain the most benefit from your labor and money, a proper break-in is essential.

The proper break-in procedure allows all of the "rough" metallic surfaces to slowly begin to "fit" each other resulting in minimum friction loss and maximum power output.

The importance of this procedure should not be underestimated.

With Bombardier-Rotax watercraft engines, a break-in period is required before operating the engine at full throttle. Engine manufacturer recommendation is about 10 operating hours.

During this period, maximum throttle should not exceed 3/4, however, brief full acceleration and speed variations contribute to a good break-in. Continued wide open throttle accelerations, prolonged cruising speeds and overloading the engine are detrimental during the break-in period.

To assure additional protection during the initial engine break-in, 250 ml of SEA-DOO INJECTION OIL should be added in the fuel tank for the first full fuel tank filling only.



CAUTION: Replace spark plugs after engine break-in.

RECOMMENDED OIL

On the 95 and 96 Sea Doo XP and HX models use only SEA-DOO FORMULA XP-S SYNTHETIC INJECTION OIL.

All other Sea Doo watercraft can use SEA-DOO INJECTION OIL (P / N 293 600 005 - 1L or 293 600 004 - 4L) which is available from authorized dealers. It is a blend of specially selected base oils and additives which provides outstanding lubrication, engine cleanliness and minimum spark plug fouling. Sea Doo Formula XP-S can also be used.

If SEA-DOO INJECTION OIL is not available, substitute with BOMBARDIER SNOWMOBILE INJECTION OIL (P / N 496 013 300 - 1L) or BOMBARDIER BLIZZARD OIL (P / N 496 014 500 - 500 ml).



NOTE: High quality low ash API TC injection oil for 2-cycle engines can be used if SEA-DOO INJECTION OIL is not available.



CAUTION: Never use petroleum or synthetic 4-cycle motor oil and never mix with outboard oil. Do not use NMMA TC-W, TC-W2 or TC-W3 outboard oils or other ashless type 2 cycle oils. Avoid mixing different brands of API TC oil as resulting chemical reaction may cause severe engine damage.

SUMMARY

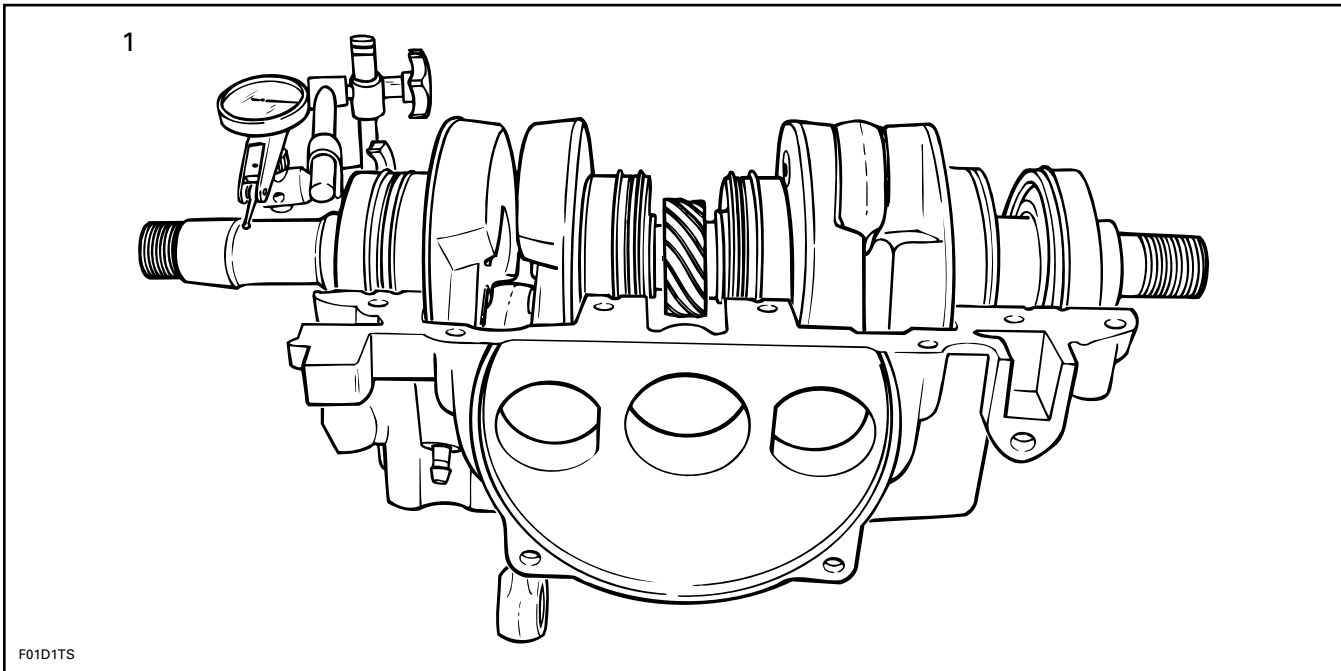
RACING ENGINE PREPARATION SUMMARY



NOTE: Most machining and/or grinding is illegal in limited class racing. Keep your machine legal: check the rules.

SECTION 03 - ENGINE PREPARATION

1. Remove and disassemble the engine according to appropriate model year *Shop Manual* procedures.
2. With the crankshaft resting in the lower half of the crankcase, set up a dial indicator and check the runout of the crankshaft at both ends. You should see no more than .05 mm (.002 in) runout. If you have the capability, adjust the crankshaft as close to perfect as possible.



1. Measuring MAG side deflection in crankcase

3. Set your cylinder base gaskets and cylinders on the upper half of the crankcase, and lightly torque the cylinders to the half. Be sure to install exhaust manifold on the cylinders before tightening them to the upper crankcase half, to ensure the same position of the cylinders on final assembly.

Check the match of the gaskets and cylinders to the base; match them perfectly with a die grinder in the areas of transfer port passages. Also check for any overlap of the exhaust manifold gaskets where the exhaust manifold joins the cylinders. Before reassembling, make sure that parts are free of any dust or particles.

4. Check ports alignment between the cylinder casting and the sleeve. If the sleeve is off in 1 direction on all ports, heat the cylinder in the oven at 176°C (350°F) for 45 minutes. Drop a rag that has been soaked in ice water into the sleeve, and quickly align the sleeve with the cylinder casting. Apply constant pressure with some type of heavy object not affected by extreme heat to the top of the sleeve while letting the sleeve and cylinder cool down at room temperature.
5. Check piston to cylinder clearances, ring end gap, cylinder taper and out of-round. Check compression ratios, and squish areas of both cylinders. Make sure that they are equal to each other in both respects, and that the proper fuel is used for the compression ratio and squish area of the engine.

SECTION 03 - ENGINE PREPARATION

6. Assemble the engine using the correct sealants where specified. Rotary valve timing should be correctly set for your application. Refer to FUNCTION OF THE ROTARY VALVE INTAKE SYSTEM in this section. For maximum power output, a dual carburetor set-up should be used. When converting a single carburetor engine to a dual carburetor type, some very important changes need to be made; the rotary valve cover, intake manifold, intake manifold o-ring, flame arrester and housing, throttle cable and other hardware must be changed. Also, a labyrinth sleeve should be installed on the crankshaft PTO side. The carburetor from a single type set-up cannot be used in a dual carburetor application.
7. Check the match of mating surfaces through out entire engine exhaust system. Smooth or blend in any mismatched mating surfaces if allowed by your racing association rules.

ROTARY VALVE TIMING

ENGINE TYPE	P / N	OPENING° ± 5°	CLOSING° ± 5°	VALVE DURATION°
587 single carb	290 924 508	115	80	147
587 dual carb	290 924 508	130	65	147
657 dual carb	290 924 508	130	65	147
657 X dual carb	290 924 502	149	65	158
717	290 924 502	147	65	158
787	290 924 502	147	65	158

8. The engine should be pressure tested for leakage. It should hold 6 PSI for 6 minutes with no more than 1 PSI per minute loss.
9. Adjust ignition timing to the recommended advance before Top Dead Center. All '92 and '93 engines (except the '93 XP 5852) are equipped with a single magneto coil and may need to be changed to either the pre-'92 ignition or '93 XP 5852 dual magneto coil ignition. If the engine maximum RPM has been increased due to impeller changes, it would be advantageous to use the dual magneto coil because the advance curve of the ignition will be better suited to the higher RPM. Ensure that the rev limiter is properly calibrated for the RPM range you wish to operate your engine. When choosing a peak operating RPM it is very important to avoid operating an engine at certain RPM's for extended periods. For the 587 type engine, 6800 RPM is the maximum harmonic imbalance, and 7400 RPM for the 657 type. If the engines are run constantly at these RPM'S., serious engine damage may occur. The 787 engine is equipped with a balancer shaft to prevent this occurrence.
10. Synchronize the carburetors and set the idle according to the appropriate model year *Shop Manual*; then, synchronize the oil pump arm. At wide open throttle, the fuel / oil ratio delivered by the oil pump is 40:1. If additional oil is desired, pre-mix a quantity of oil with the fuel to achieve the desired fuel / oil ratio.

Ensure that carburetors calibration is correct. Refer to carburetor(s) tuning in this section as a tuning guide and reference for available jets.
11. Break-in your freshly built engine. All the meticulous work that you have done could be for little or no gain if the engine is not properly broken-in. Follow the directions for engine break-in procedure as outlined in this section, and your engine will deliver more power, longer.

SECTION 04 - PROPULSION SYSTEM

BASIC FUNCTIONS OF THE SYSTEM	04-2
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— PROPULSION SYSTEM SPECIFICATIONS	04-4
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SECTION 04 - PROPULSION SYSTEM

BASIC FUNCTIONS OF THE SYSTEM

The following is a brief explanation of some of the principals behind a water jet drive system. As the impeller begins to turn (with the rotation of the engine) it will move a volume of water through the pump housing into the venturi section or venturi. As the volume of water is forced through the smaller cross section, it will be accelerated in flow, thus creating thrust or forward propulsion. However, the volume in and volume out remain the same. While the venturi section of the pump is not technically impressive or complicated in appearance, its simple shape and diameter are very crucial to pump performance. A small increase of the venturi outlet diameter will reduce watercraft top speed but improve acceleration at lower speeds. Conversely, a small decrease in venturi outlet diameter will reduce low speed acceleration but improve top speed. After exiting the venturi, the water passes through a steering nozzle where it can be directed right or left to turn the watercraft. Understanding the basic function of a jet pump should make it easy to realize that steering control is only accomplished under thrust. Steering control at lower speeds or idle is minimized.

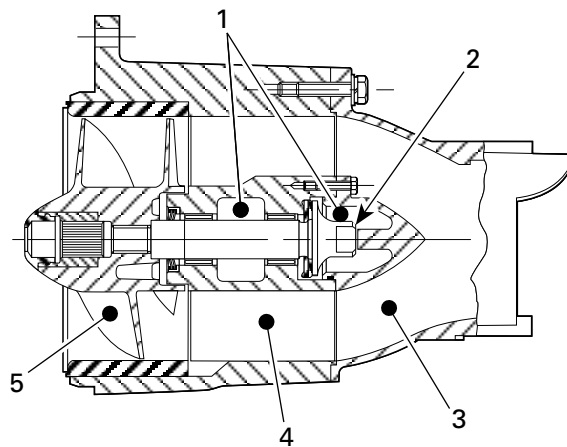
Always keep in mind that as the throttle lever is released, less directional control will be available. To control or steer the watercraft, throttle must be applied.

AXIAL FLOW PUMP

The Bombardier Formula Jet pump is an axial flow, single stage design. This term “axial flow” is defined as a single impeller axially driven by a centrally located shaft. The impeller will transfer a designated volume of water each revolution through the pump.

The axial flow jet pump characteristics are:

- low pressure
- high flow
- small size of pump
- high RPM



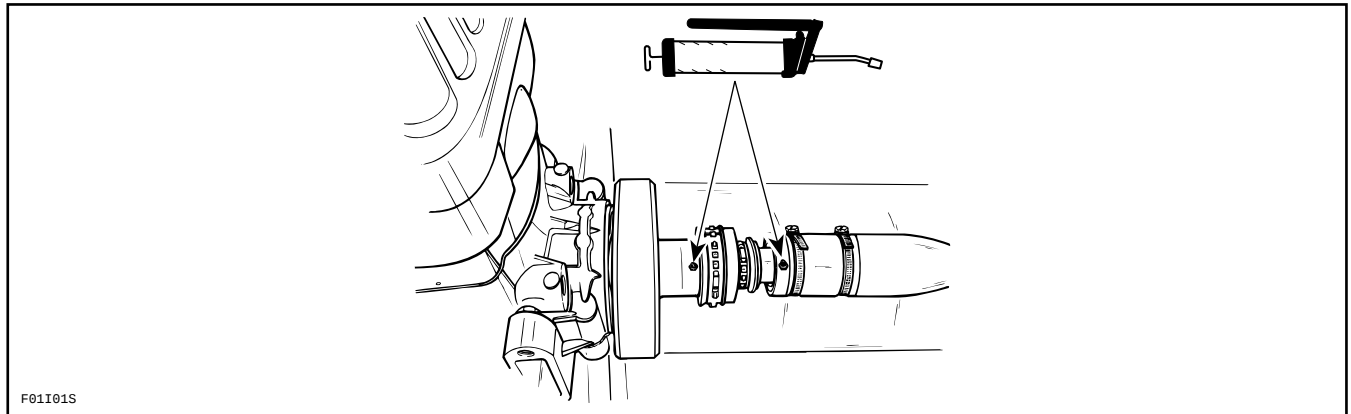
F01J4PS

1. Oil reservoirs
2. Impeller shaft end play
3. Venturi
4. Stator vanes
5. Impeller

MAINTENANCE

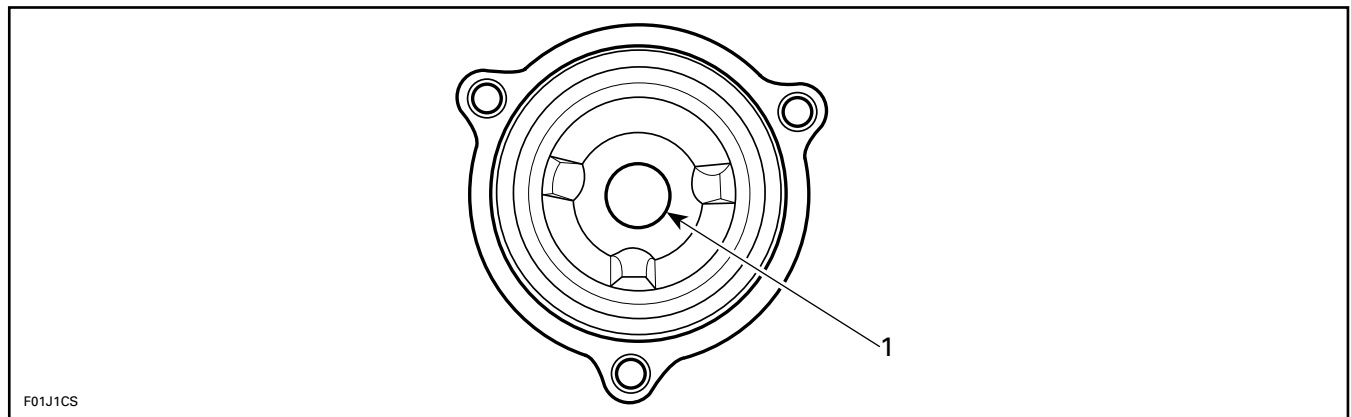
To obtain optimum efficiency of jet pump and to eliminate backlash in propulsion and drive system, the following maintenance items must be checked regularly.

- Verify oil condition and replace oil regularly. A whitish oil indicates water contamination. Use only SEA-DOO JET PUMP SYNTHETIC OIL (P / N 293 600 011).
- Using a grease gun, carefully lubricate PTO flywheel and seal carrier with synthetic grease (P / N 293 550 010). Stop greasing as soon as the first bit of grease comes out from under seals.



- Verify impeller shaft end play. For racing purposes, maximum permissible end play (new) is 0.12 - 0.54 mm (.005 - .021 in). Excessive play comes from worn protrusion (end stop) inside housing cover. Excessive end play will negatively affect performance.

Visually inspect protrusion (end stop) inside cover. If worn, a small peak in center will be apparent.

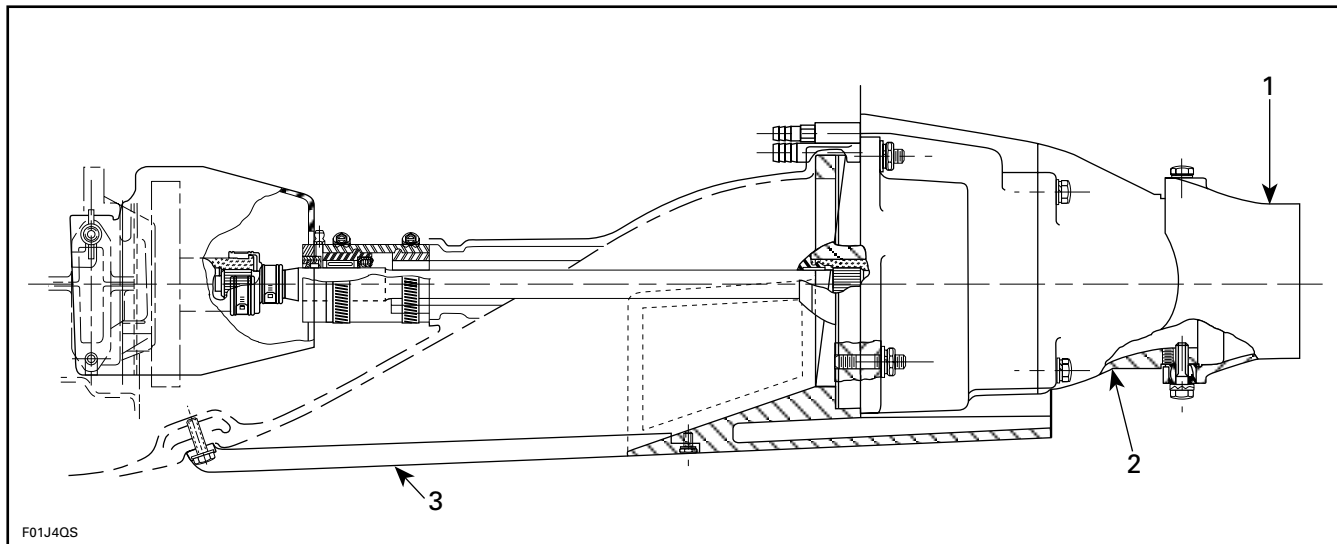


1. Protrusion

- Lubricate drive shaft and impeller splines regularly using synthetic grease. The jet pump must be disassembled and drive shaft removed to perform this maintenance. This is a good time to inspect spline condition of your drive shaft. If excessive drive shaft wear is detected both PTO flywheel and impeller should be inspected.

SECTION 04 - PROPULSION SYSTEM

PROPULSION SYSTEM ANALYSIS



1. Nozzle

2. Venturi

3. Inlet

PROPULSION SYSTEM SPECIFICATIONS

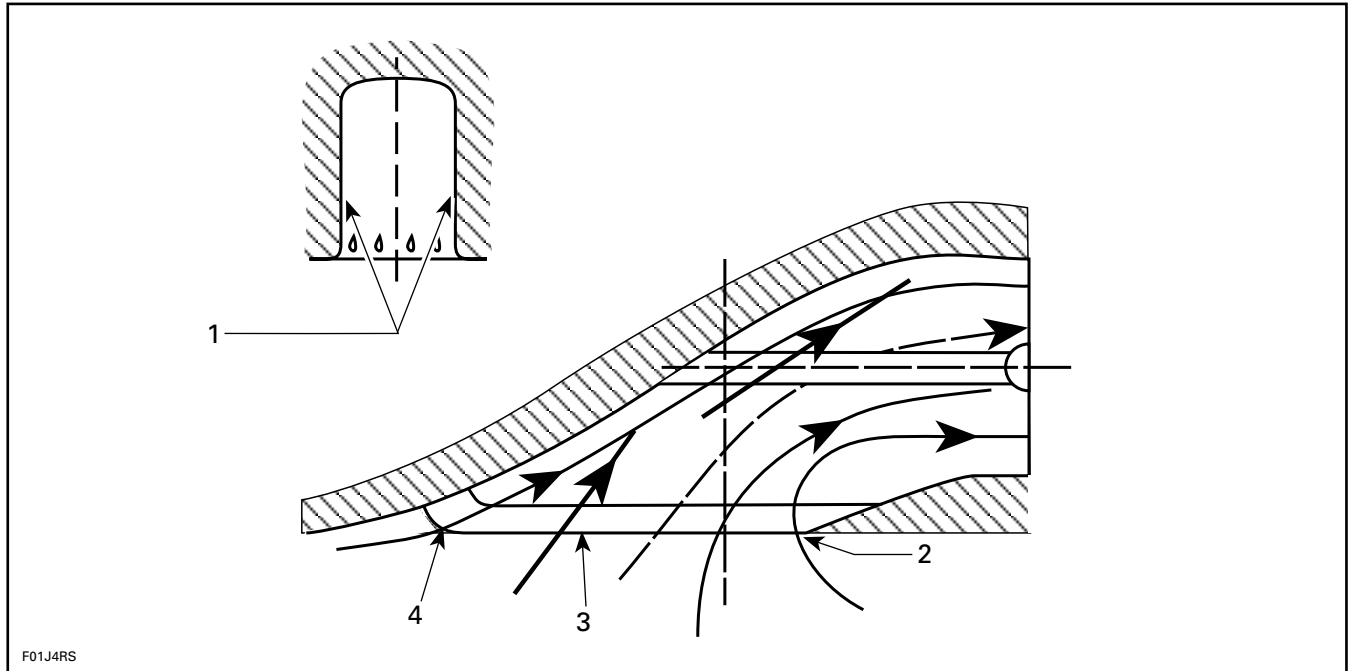
Propulsion system	Bombardier Formula jet pump
Jet pump type	Axial flow single stage
Impeller rotation (seen from rear)	Counterclockwise
Transmission	Direct drive
Coupling type	Crowned splines
Oil type	SEA-DOO JET PUMP SYNTHETIC OIL 75W90 GL5 (P / N 293 600 011)
Steering nozzle pivoting angle	26°
Trimming nozzle pivoting angle	± 10°
Minimum required water level	60 cm (24 in)
Drive shaft maximum deflection	0.5 mm (.020 in)
Impeller outside diameter	139.5 mm (5.490 in)
Impeller / wear ring clearance • Wear limit (performance) • Wear limit	0.5 mm (.020 in) 1.02 mm (.040 in) (not suggested for high performance)
Impeller shaft end play (new)	0.12 - 0.54 mm (.005 - .021 in)
Impeller shaft side play	0.025 - 0.05 mm (.001 - .002 in)
Impeller material	Aluminum or stainless steel
ADDITIONAL INFORMATION: Do not mix different brands or types of oil in the jet pump.	

SECTION 04 - PROPULSION SYSTEM

NOTE: The 95 and 96 XP models were equipped with the new composite pump housing. Because of this, pump housings of the aluminum type from previous models can not be interchanged and legally used for IJSBA competition.

INLET

The function of the inlet is to carry the water to the jet pump with minimum loss. Another very important function is to assist the jet pump in transforming water volume into thrust.



- F01J4RS
1. Ride shoe and hull sealed and blended
 2. Sealed and blended
 3. Water flow inside of the inlet
 4. Sealed and blended intake grate

The intake grill must be properly installed and blend in with the hull and ride shoe to eliminate any possible inlet flow restrictions. The water inlet and ride shoe must have surfaces sealed and blended. Certain aftermarket intake grates will enhance the performance of your watercraft. Selecting the correct intake grate will depend on your intended use and type of racing. A careful choice is highly suggested.

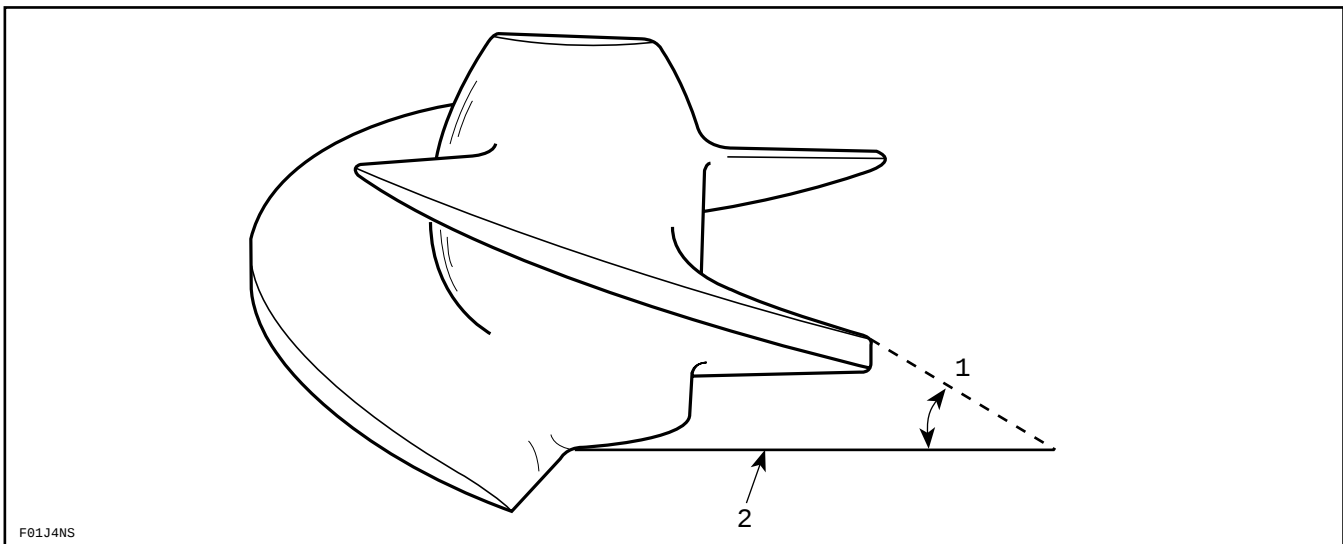
SECTION 04 - PROPULSION SYSTEM

IMPELLER

The impeller is enclosed in the housing and it creates a dynamic force. The thrust created by the impeller alone is minor, but it has a high power absorption. The stator vane and venturi are essential to create thrust and to straighten out twisted water coming of spinning impeller.

IMPELLER TYPES

Two types of impellers can be installed in the jet pump, the regular fixed pitch and the progressive pitch impellers. The meaning of the term “pitch” is the angle between the edge of the blade and the surface on which the impeller is sitting on, or the angle at which impeller moves the water.

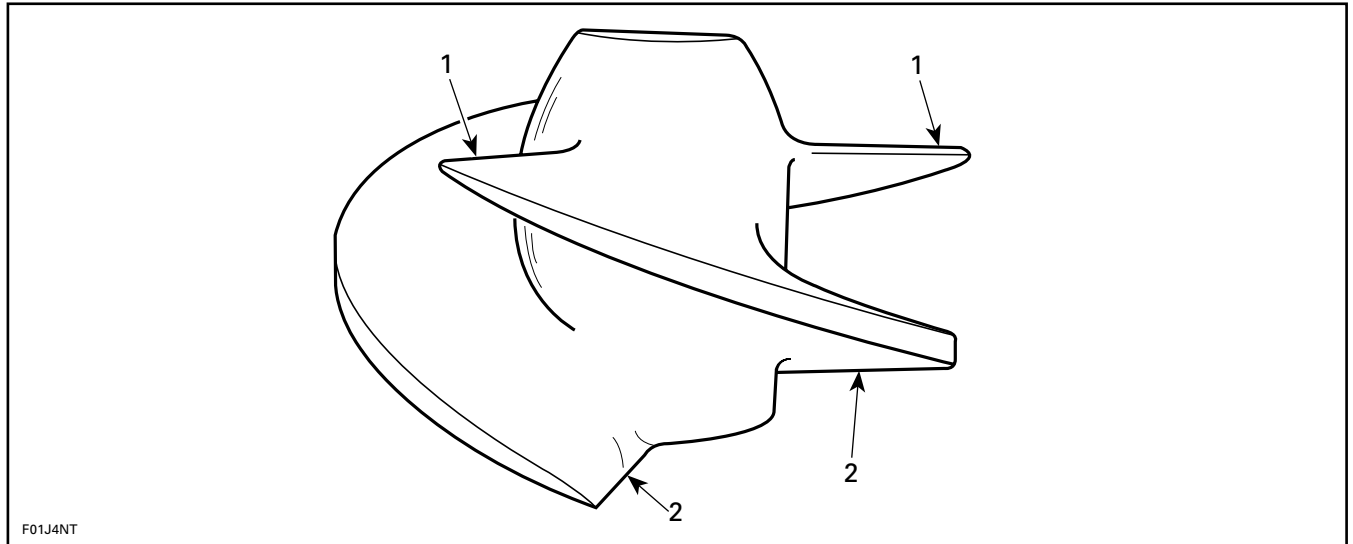


- 1. Angle
- 2. Flat surface

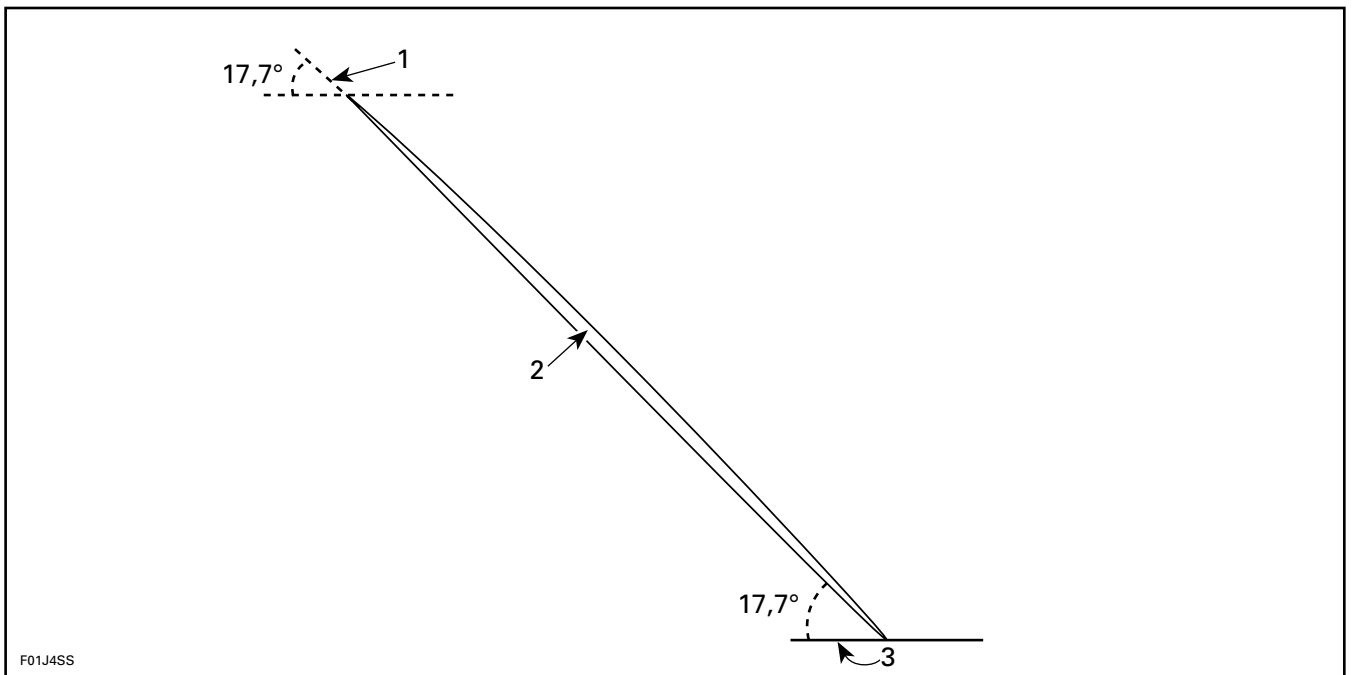
REGULAR FIXED PITCH

The impeller pitch remains constant on all the blades. The blades are straight with the same angle from leading to trailing edges.

SECTION 04 - PROPULSION SYSTEM



- 1. Leading edge
- 2. Trailing edge

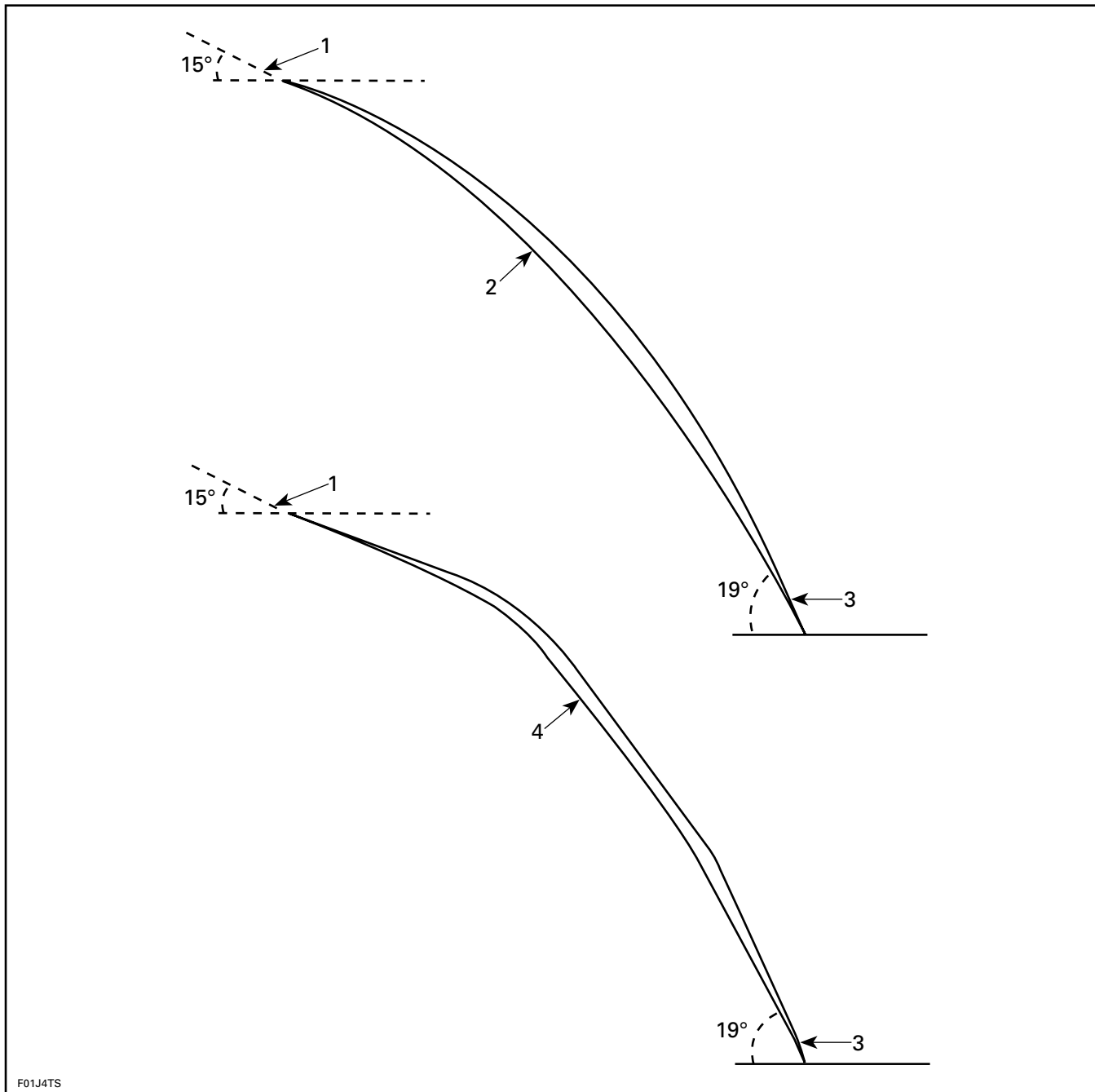


- 1. Leading edge
- 2. Straight blade
- 3. Trailing edge

SECTION 04 - PROPULSION SYSTEM

PROGRESSIVE PITCH

The impeller pitch changes progressively on each blade. The blades are bent **constantly or asymmetrically** with different angles at leading and trailing edges. The blade bending is done by using a special fixture.



- 1. Leading edge
- 2. Constant bend
- 3. Trailing edge
- 4. Asymmetrical bend

SECTION 04 - PROPULSION SYSTEM

A low pitch leading edge is important for good acceleration and a higher pitch on trailing edge will give better top speed.

IMPELLER EFFICIENCY

The impeller efficiency is related to several parameters:

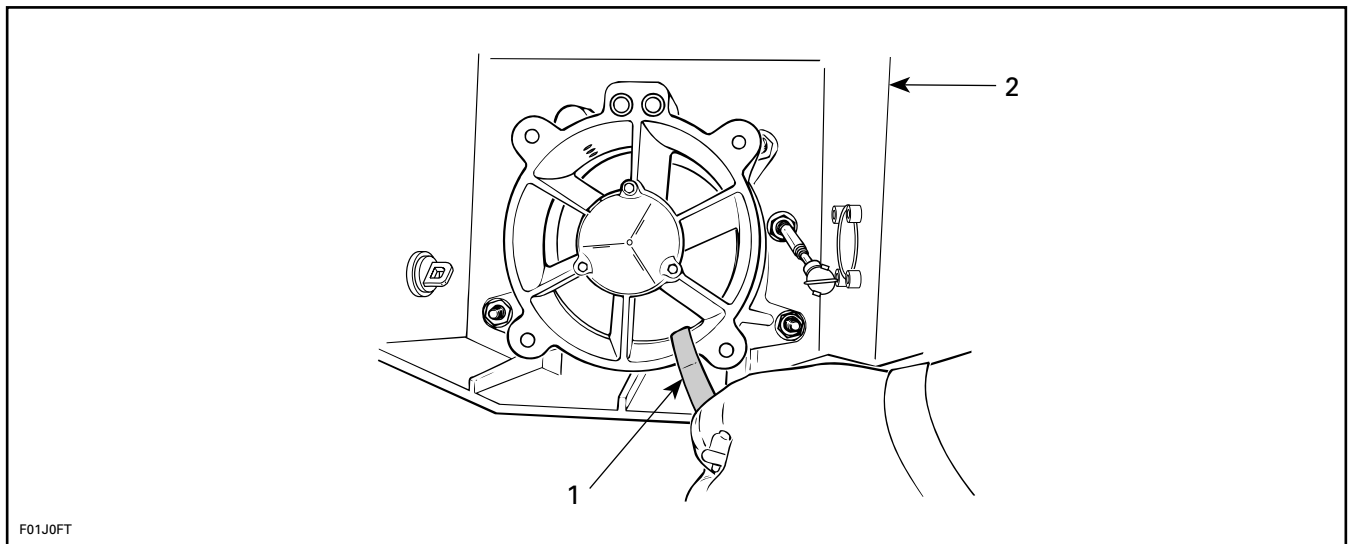
- hydrodynamic blade design
- incidence angle
- turbulence created at the inlet
- pre-rotation of water
- relative circulation
- eddy
- friction
- cavitation

Impeller / Wear Ring Clearance

This clearance is critical for jet pump performance. Excessive clearance will result in decreased performance.

Clearance can be checked from water inlet opening, after inlet grill removal, or from venturi side after venturi / nozzle assembly removal. This last method may be more difficult.

◆ **WARNING:** Prior to impeller / wear ring clearance verification, disconnect battery black negative cable.



1. Feeler gauge
2. Measuring from venturi side

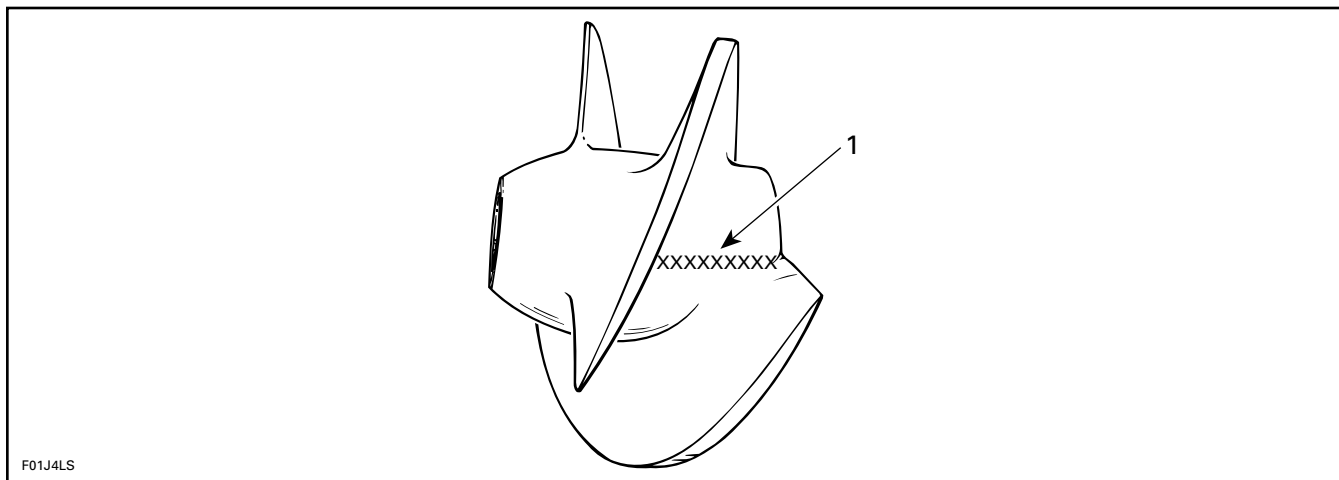
Using a long feeler gauge 30 cm (12 in), measure clearance between impeller blade tip and wear ring. Measure each blade at its center. Clearance should not exceed .5 mm (.020 in). If clearance is greater, disassemble jet pump and inspect impeller and wear ring. Replace worn parts. Refer to appropriate model year *Shop Manual*.

Remember to stay out of shallow water, avoid sand and rocks going through jet pump and damaging wear ring. Scratches in wear ring reduce efficiency.

SECTION 04 - PROPULSION SYSTEM

IMPELLER IDENTIFICATION

To identify the impellers, refer to the following illustration and charts.



1. Stamped part number

SECTION 04 - PROPULSION SYSTEM

IMPELLER APPLICATION CHART

MODEL	MODEL NUMBER	YEAR	PITCH ANGLE (in degrees)	MATERIAL	PART NUMBER
SP	5802	1989	18.8	aluminum	271 000 016
	5803	1990	18.8	aluminum	271 000 016
	5804	1991	18.8	aluminum	271 000 016
	5805	1992	18.8	aluminum	271 000 016
	5806	1993	18.8	aluminum	271 000 016
	5870	1994	18.8	aluminum	271 000 016
	5873	1995	18.8	aluminum	271 000 016
SPI	5876	1996	18.8	aluminum	271 000 016
	5808	1993	17.7	stainless	271 000 227
	5872	1994	14-21	stainless	271 000 030
	5875	1995	11-26	stainless	271 000 182
	5878	1996	11-26	stainless	271 000 182
SPX	5807	1993	14-21	stainless	271 000 030
	5871	1994	11-26	stainless	271 000 182
	5874	1995	11-23	stainless	271 000 445
	5877	1996	11-24	stainless	271 000 497
XP	5850	1991	11-26	stainless	271 000 182
	5851	1992	11-26	stainless	271 000 182
	5852	1993	11-26	stainless	271 000 182
	5854	1994	11-23	stainless	271 000 367
	5857	1995	11-24	stainless	271 000 458
	5858	1996	17-25	stainless	271 000 331
	5855	1994	11-26	stainless	271 000 182
XP 800	5856	1995	17-25	stainless	271 000 331
HX	5880	1995	11-24	stainless	271 000 458
	5881	1996	11-24	stainless	271 000 497
GTS	5812	1992	17	stainless	271 000 215b
	5813	1993	17	stainless	271 000 215b
	5814	1994	14-20	stainless	271 000 299
	5815	1995	10-25	stainless	271 000 416
GTX	5817	1996	10-25	stainless	271 000 416
	5860	1992	18.3	stainless	271 000 123
	5861	1993	18.3	stainless	271 000 123
	5862	1994	15-23	stainless	271 000 280
	5863 / 5864	1995	11-24	stainless	271 000 454
	5640	1996	17-25	stainless	271 000 331
	5810	1990	17	stainless	271 000 215
GT	5811	1991	17	stainless	271 000 215
GSX	5620	1996	17-24	stainless	271 000 596
GTI	5865 / 5866 / 5867	1996	11-24	stainless	271 000 470

 **NOTE:** Impeller may be interchangeable to suit the required performance of the course type.

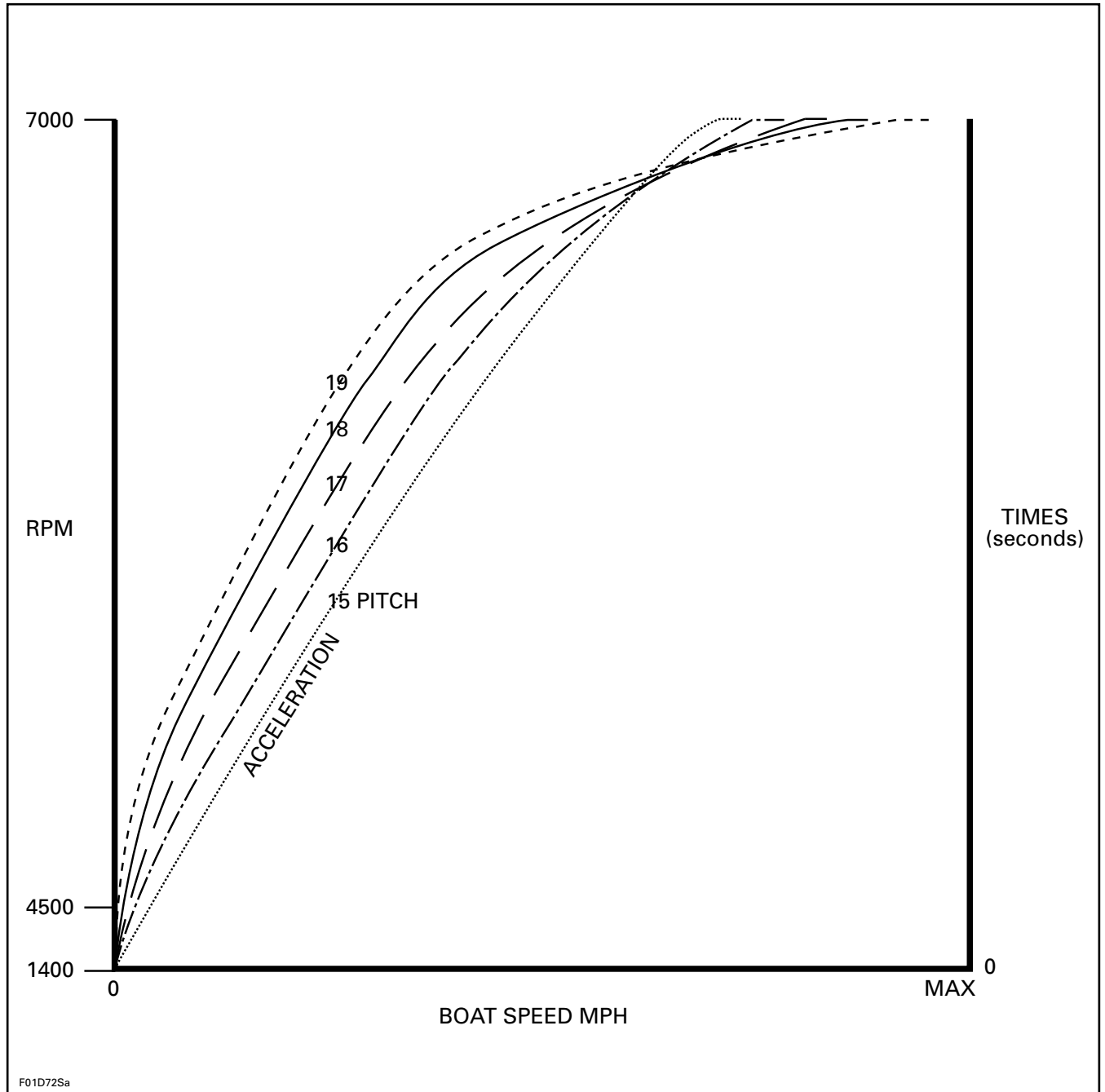
SECTION 04 - PROPULSION SYSTEM

IMPELLER SPECIFICATIONS AND BOOT APPLICATIONS

IMPELLER P/N	IMPELLER SPECIFICATION	BOOT P/N
271 000 028	18° cast aluminum	271 000 015 293 300 015 (O-ring)
271 000 086	18° die-cast aluminum	271 000 114
271 000 235	18° die cast aluminum	271 000 114
271 000 052	17° satin finish stainless steel	271 000 055
271 000 215	17° satin finish stainless steel	271 000 114
271 000 046	17.7° polished stainless steel	271 000 069
271 000 199	17.7° satin finish stainless steel	271 000 069
271 000 227	17.7° satin finish stainless steel	271 000 114
271 000 123	18.3° satin finish stainless steel	271 000 114
271 000 115	19.0° satin finish stainless steel	271 000 114
271 000 230	16 / 20.5° progressive pitch satin finish stainless steel	271 000 114
271 000 182	14 / 21° progressive pitch satin finish stainless steel	271 000 104 271 000 313 (ring)
271 000 016	18.8° Cast aluminum	271 000 114
271 000 030	14 / 21° progressive pitch satin finish stainless steel	271 000 114
271 000 299	14 / 20° progressive pitch satin finish stainless steel	271 000 114
271 000 307	16 / 24° progressive pitch satin finish stainless steel	271 000 305
271 000 280	15 / 21° progressive pitch satin finish stainless steel	271 000 305
271 000 331	progressive pitch satin finish stainless steel	271 000 104 271 000 313 (ring)
271 000 367	11 / 21° progressive pitch satin finish stainless steel	271 000 104 271 000 313 (ring)
271 000 416	15 / 21° progressive pitch satin finish stainless steel	271 000 104 271 000 313 (ring)
271 000 417	10 / 22° progressive pitch satin finish stainless steel	271 000 422 271 000 434 (ring)
271 000 445	11 / 21° progressive pitch satin finish stainless steel	271 000 104 271 000 313 (ring)
271 000 454	10 / 22° progressive pitch satin finish stainless steel	271 000 422 214 000 434 (ring)
271 000 458	10 / 22° progressive pitch satin finish stainless steel	271 000 104 271 000 313 (ring)
271 000 470	10 / 22° progressive pitch satin finish stainless steel	271 000 422 271 000 434 (ring)

SECTION 04 - PROPULSION SYSTEM

The following chart could be used as a guide to help optimize pitch for your application.
IMPELLER PITCH CHART



SECTION 04 - PROPULSION SYSTEM

STATOR VANE

The function of the stator is to transform the dynamic force created by the impeller into forward thrust.

The design principle is similar to the impeller although the stator vanes are in a fixed position.

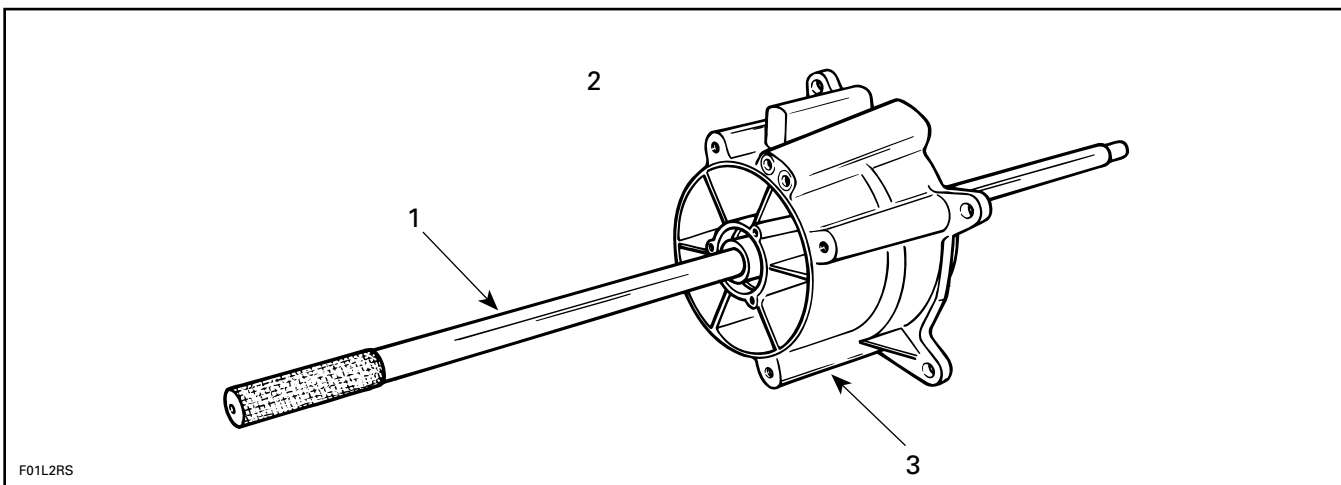
VENTURI

The venturi function is to increase the fluid velocity using static pressure to generate the thrust. Without the venturi, there would be very little thrust. The venturi outlet diameter can be adjusted to compliment the engine tuning and impeller you have selected. Generally speaking, a slightly larger (1-2 mm) outlet will improve acceleration and should give better performance for closed course competition.

ENGINE / JET PUMP ALIGNMENT

Alignment is necessary to minimize power loss and eliminate possible vibration and/or damage to components. Check alignment of your engine /jet pump using special alignment tool (P / N 295 000 089).

The alignment tool is available through your dealer.



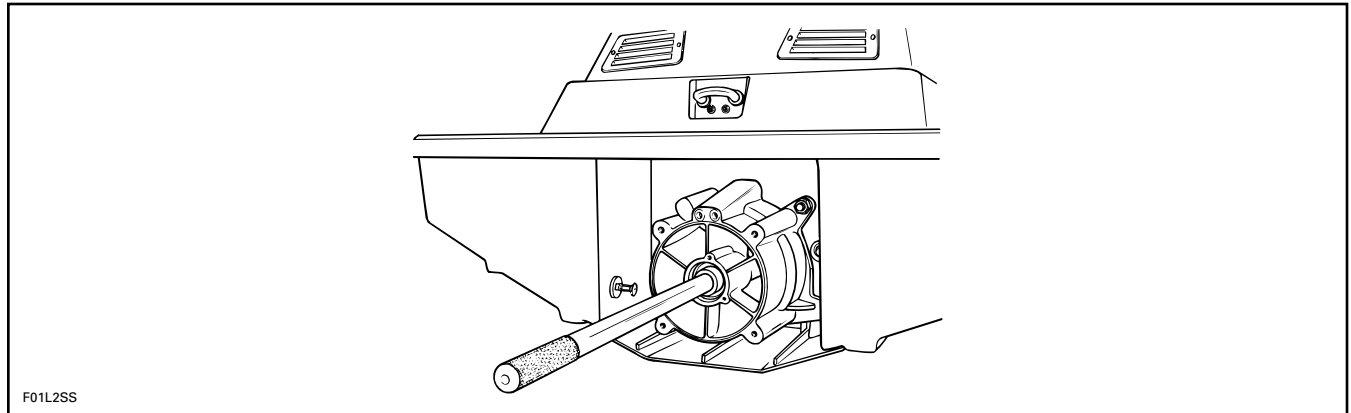
1. Shaft (P / N 295 000 093)
2. (P / N 295 000 089)
3. Housing (P / N 295 000 090)

CAUTION: Some models require a shim between hull and pump; if shim has been removed at time of pump disassembly, be sure to reinstall it. If this shim is required for your watercraft and not reinstalled, engine and jet pump alignment will be altered.

SECTION 04 - PROPULSION SYSTEM

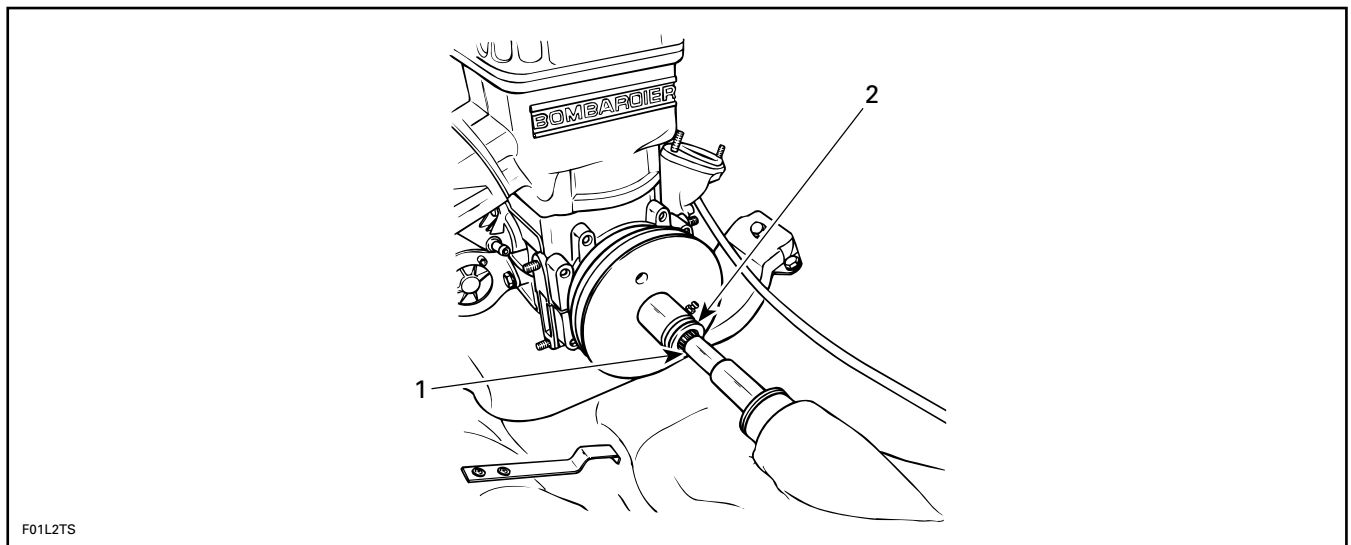
To verify alignment proceed as follows:

- Install housing on hull with 4 nuts.
- Carefully slide shaft through housing and seal carrier. Pay attention not to hit PTO flywheel.



- Insert shaft end into PTO flywheel.

NOTE: The shaft should slide easily in flywheel splines if the alignment is correct. Watch for any deflection of shaft as you slowly slide shaft into PTO flywheel splines. Try to eliminate deflection by shimming engine.

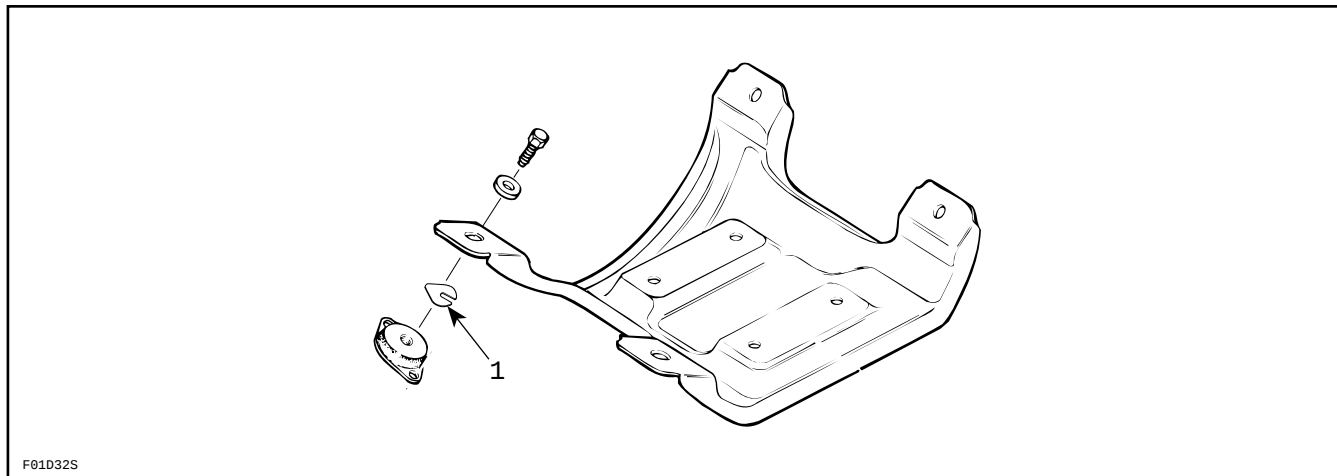


1. Shaft end
2. PTO flywheel

If the alignment is incorrect, loosen engine support screws to enable alignment of PTO flywheel with shaft end.

NOTE: Use shim(s) (P/N 270 000 024) or (P/N 270 000 025) between engine support and rubber mounts to correct alignment.

SECTION 04 - PROPULSION SYSTEM



1. Shim

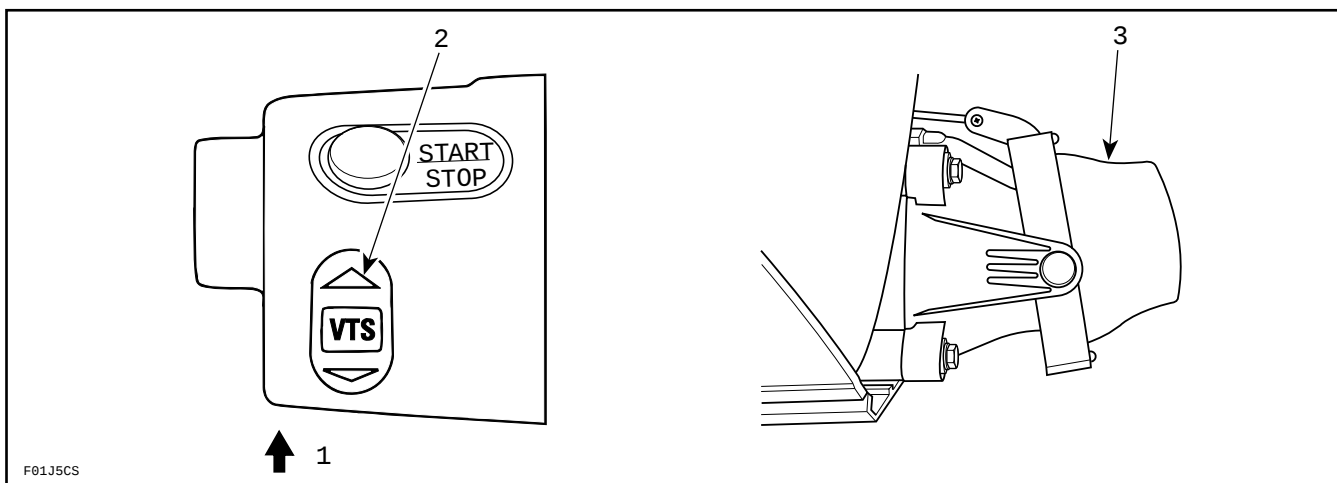
CAUTION: Whenever shims are used to correct alignment, never install more than 6 mm (0.240 in) shim thickness. If alignment cannot be obtained, verify for engine support bending.

FUNCTIONS OF THE VARIABLE TRIM SYSTEM (VTS)

To obtain optimal performance, push VTS button located on left side of handlebar, or turn knob on left side of body, depending on the model of watercraft.

This adjustment changes the jet pump steering nozzle position which compensates for load and thrust.

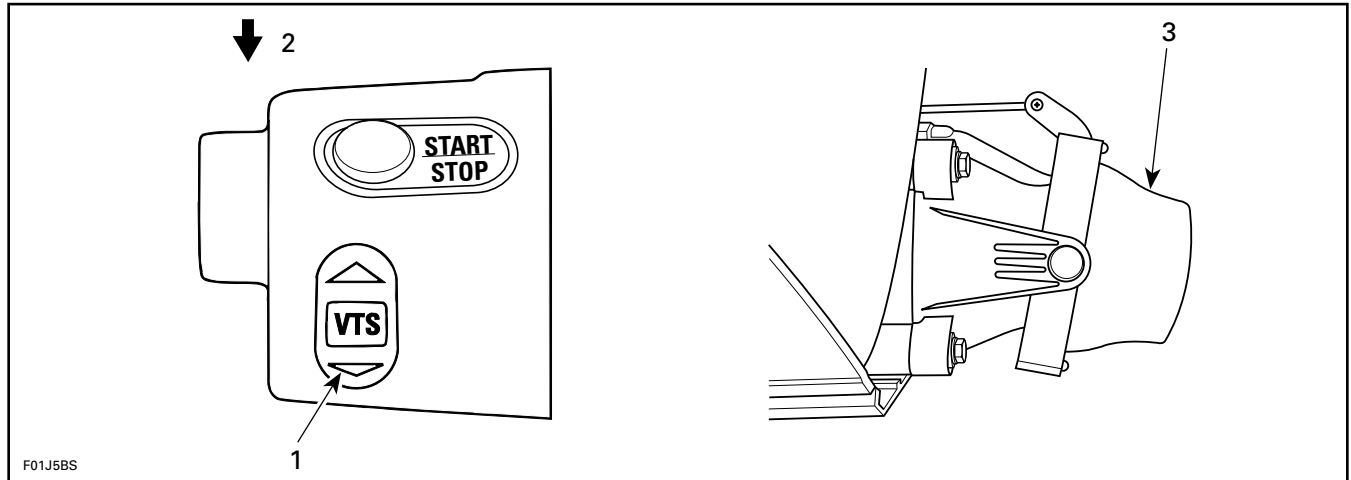
When the nozzle is up, the bow of the watercraft comes up.



1. Bow up
2. Push on VTS button UP position
3. Nozzle up

SECTION 04 - PROPULSION SYSTEM

When the nozzle is down, the bow comes down.



1. Push on VTS button Down position
2. Bow down
3. Nozzle down

According to boat load and water conditions, the driver can trim the watercraft as desired.

CAUTION: Trim ring and / or nozzle must not interfere at any position. Damage to cables and / or venturi housing will occur if adjustments are not done properly.

For adjustment procedures refer to appropriate model year *Shop Manual*.

VENTILATION (AIR LEAK)

Ventilation is caused by air being sucked through jet pump which will reduce performance of the pump. Pump ventilation reduces acceleration and will be most noticeable during initial and low speed accelerations. Engine RPM will increase tremendously with very little increase in watercraft speed. This condition feels much the same as a slipping clutch in a car or motorcycle.

Jet pump ventilation is commonly traced to a poor seal between ride shoe and hull.

To determine if jet pump is ventilating, first verify the following:

- Verify if the watercraft accelerates quickly when depressing throttle lever.
- Verify if the engine has a constant top RPM.
- Verify impeller, impeller wear ring and pump housing for wear and / or damage, or if debris is caught in the grill or around drive shaft.

WARNING: Before working on or cleaning propulsion system, battery black negative cable must always be disconnected.

If everything is in good order but the watercraft does not accelerate quickly when depressing the throttle lever and a good top speed cannot be obtained, the pump is probably ventilating; then, the ride shoe must be removed and resealed to the hull. Refer to appropriate model year *Shop Manual*.

NOTE: When resealing ride shoe ensure to eliminate any possible flow restriction (excessive sealer build up).

NOTE: When resealing ride shoe or pump to hull, use Ultra Black Heavy Duty sealer (P / N 293 800 028). Curing time is greatly reduced with this type of sealer.

SECTION 04 - PROPULSION SYSTEM

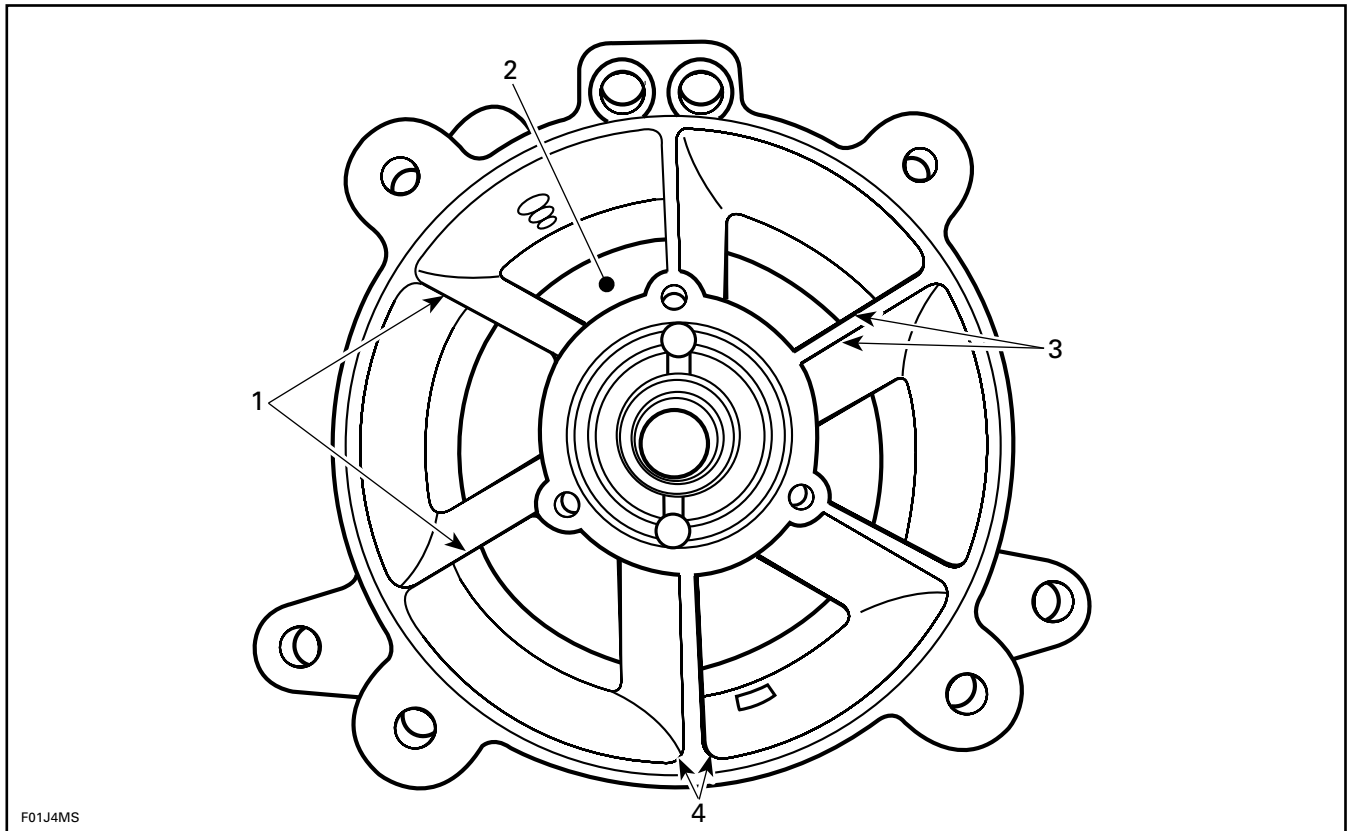
CAVITATION

Cavitation can be defined as a phenomenon where the water inside the inlet or pump becomes incapable of keeping up with the flow. Therefore a negative pressure within the system occurs creating gas vapor and ultimately cavitation. As these gas vapor bubbles implode, they generate enough force to remove microscopic particles of material within the pump assembly. This usually can be seen in the form of discolored areas or trails within the pump assembly (on the stator vanes or impeller). These areas look as though they have been sand-blasted.

A certain degree of cavitation is an accepted occurrence with a water jet propulsion system. However, some changes within the pump can reduce cavitation, such as replacing a thick bladed aluminum impeller with a thin bladed stainless steel impeller; removing any scratches or dents in the housing / impeller, or replacing wear ring if worn.

Chamfer and / or radius leading edges of stator vanes.

Using a straight file, break the square edge on both sides of stator vane to about 1.3 mm (.050 in) wide, then use about a 2 foot strip of 1 inch wide sandpaper (100 grit min.) and drape sandpaper over stator vane area already filed by placing 1 end of sandpaper in 1 tunnel and the other end in the tunnel directly adjacent to the first and finish dressing the leading edge. This procedure should be done to both the leading and trailing edges of stator vanes.



1. Reworked vanes
2. Tunnel
3. Break these edges slightly
4. Be careful not to make a sharp or square corner in these areas

It is important to realize that water conditions and repeated accelerations will increase cavitation. Verify if engine speed is high but watercraft moves slowly due to reduced jet thrust. Check jet pump components for damage.

Refer to appropriate model year *Shop Manual*.

STEERING SYSTEM ALIGNMENT

The handlebar pivots the jet pump nozzle which controls the watercraft direction.

These 2 items, handlebar and nozzle, must be adjusted properly, or centered to obtain optimum control of the watercraft.

The steering system alignment is most important to ensure the adequate control of the watercraft.

◆ **WARNING: Ensure handlebar and jet pump nozzle operate freely from side to side and that jet pump nozzle does not contact the side of venturi housing.**

For alignment procedures, refer to appropriate model year *Shop Manual*.

SECTION 05 - MISCELLANEOUS

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SECTION 05 - MISCELLANEOUS

EQUIVALENT WEIGHTS AND MEASURES CHART

LINEAR MEASURE

1 Inch = 25.4 Millimeters (mm)	1 Millimeter = .03937 Inch
1 Inch = 2.54 Centimeters (cm)	1 Centimeter = .3937 Inch
1 Foot = .3048 Meter (m)	1 Meter = 3.2808 Feet
1 Yard = .914 Meter (m)	1 Meter = 1.093 Yards

AREA

1 Sq. Foot = 144 Sq. Inches = 929.03 (cm ²)	
1 Sq. Inch = 6.4516 cm ²	1 cm ² = .155 Sq. Inch
1 Sq. Foot = .092 Sq Meter (m ²)	1 m ² = 10.8 Sq. Feet

WEIGHT

1 Ounce = 28.35 Grams (g)	1 Gram = .03527 Ounce
1 Pound = .4536 Kilogram (kg)	1 Kilogram = 2.2046 Pounds

VOLUME

1 Fl.U.S. Ounce = 29.574 Milliliters = .2957 Deciliter = .0296 Liter
1 Fl. U.S Pint = 473.18 Milliliters = 4.7316 Deciliters = .4732 Liter
1 Fl. U.S.Quart = 946.35 Milliliters = 9.4633 Deciliters = .9463 Liter
1 U.S. Gallon = 128 oz = 3.785 Liters
1 Cu. Inch = 16.387 Cu. cm
1 Cu. Centimeter = .061 Cu. Inch
1 Cu. Foot = 2.831.16 Cu. Cm.
1 Cu. Decimeter = .0353 Cu. Foot
1 Cu. Yard = .7646 Cu. Meter
1 Dry Quart = 32 oz = 1.101 Liters

TEMPERATURE

32° Fahrenheit = 0° Celsius	0° Fahrenheit = -17.8° Celsius
°F = (°C x 1.8) + 32)	°C = (°F - 32) ÷ 1.8

GLOSSARY OF TERMS IN PERSONNAL WATERCRAFT RACING

Bail:	To wipe out, to fall.
Bond flange:	The bond flange is the overlapping / mating section where the deck (upper) and hull (lower) portions are joined.
Buoy:	Floating object anchored in the water designating race course.
Course Marshall:	An official located on the race course to help control the race as well as to assist downed riders.
Deck:	The structural body of the watercraft located above the bond flange.
Holder:	The person that holds your watercraft on the starting line prior to the start of the race.
Holeshot:	The process of arriving at the first turn ahead of the competition in a race.
Hull:	The structural portion of the boat below the bond flange.
Log Jump:	An obstacle used in closed course racing that consists of a row of tires which riders must pass over.
Pit Area:	Area used by riders and mechanics to make repairs, store watercraft, etc.
Porpoise:	The act of a watercraft nose pitching up and down in the water.
Race Director:	Person responsible for organizing a race.
Sponsor:	A person or group that provides support to a rider, promoter, or association usually in exchange for promotion.
Staging Area:	Area near the starting line where riders and their watercraft wait for their scheduled race.
Starter:	Person who officially gives the signal to begin the race.
Starting Line:	A straight boundary that designates the beginning point of a race.
Technical Inspector:	Person who checks competing watercraft for safety and technical eligibility.
Wake:	The path created by a boat or watercraft in the water.

SECTION 05 - MISCELLANEOUS

RACER'S LOG

Event:	Date:	Sheet number:	
Association:	Race Director:		
Temperature:	Barometric Pressure:	Humidity:	
Water temperature:			
WATERCRAFT			NOTES:
Model Number:			
Hull Identification Number:			
Engine Identification Number:			
Weight:			
CARBURETION	PTO	MAG	NOTES:
Main Jet:			
Pilot Jet:			
Needle Valve:			
Low Speed Screw:			
High Speed Screw:			
Pop Off Pressure / Needle Valve Spring:			
Fuel Type:			
LUBRICATION			NOTES:
Fuel / Oil Mixture:			
Oil Type:			
IGNITION SYSTEM			NOTES:
Timing:			
Spark Plug:			
Rev Limiter Setting:			
PUMP			NOTES:
Impeller Pitch / Material:			
Intake Grate:			

AFTERMARKET MANUFACTURERS AND SERVICES

Aftermarket manufacturers produce products that can be used to replace the original Sea-Doo part on your watercraft. Some of these parts are designed to simply give the operator a choice of color or styling while others are intended to improve the performance characteristics of the vehicle. Sea-Doo has encountered many manufacturers of aftermarket parts that have made claims about their product that later could not be validated. Some products actually had an adverse affect on performance over the production item or caused vehicle damage. It must also be noted that Sea-Doo can not verify every product claim made by manufacturers due to the constant development of new aftermarket products.

Sea-Doo has found the following aftermarket manufacturers have proven their products to be reliable and of high quality. We recommend these manufacturers based on their previous performance records. Sea-Doo takes no responsibility for products not installed as original equipment. In fact, most applications of aftermarket parts invalidates the vehicle warranty as provided for by law.

(USE AT YOUR OWN RISK)

SECTION 05 - MISCELLANEOUS

Manufacturer

Bullett Engineering
2422 East Huntingdon
Duarte, CA. 91010
Phone (818) 357-6310
Fax (818) 357-4544

Butchs' Watersports
7357 Expressway Ct., Suite A
Grand Rapids, MI., 49548
Phone (616) 281-7475
Fax (616) 281-7515

Moto De Lile
31 Grand Blvd.
Ile Perrot, Qc.
Canada, J7V 4V9
Phone (514) 453-9663
Fax (514) 453-6784

Novi Performance Products
2 Rutledge Circle
Fletcher, NC. 28732
Phone (704) 687-7555
Fax (704) 687-7556

Rossier Engineering
1340 Okray AV.
Plover, WI. 54467
Phone (715) 341-8742
Fax (715) 341-9875

Watercraft Magic
2264 East Alostia
Glendora, CA. 91740
Phone (818) 914-9509
Fax (818) 914-6019

Westcoast Performance Products
3100 East Coronado Street
Anaheim, CA. 92806
Phone (714) 630-4411
Fax (714) 630-7670

(Contact WCPP for a complete listing of services.)

Services

High Compression Heads
Engine Modifications
Racing Hulls and Hoods

Carburetor Kits
Engine Modifications
High Performance Parts

Lightweight Hulls – Hoods
Engine Modifications
High Performance Parts

Carburetor Kits
Engine Modifications
High Performance Parts

Modified Engines
High Performance Parts
Carburetor Kits

Carburetor Kits
Engine Modifications
Lightweight Hulls

Big Bore Engine Kits
Racing Cylinders
High Performance Parts
Carburetors & manifolds
Exhaust systems
Ride Plates & Grates