Johnson service manual tenth edition 5th grade pdf

1. A-14 APPENDIX STARTER ROPE SPECIFICATIONS ENGINE SIZE MODEL DIAMETER LENGTH INCHES INCHES 1.5 hp 1968-70 382712 Note 2 3.0 hp 1956-61 5/32 65-1/4- 3.0 hp 1962-67 5/32 71-1/2 3.0 hp 1968 0.130 56 4-.0 hp 1969-70 0.130 64- 5.0 hp 1965-67 0.130 64- 5.0 hp 1968 0.130 56 5.5 hp 1956-61 5/32 70 5.5 hp 1962-64- 5/32 71-1/2 6.0 hp 1965-67 0.130 64- 6.0 hp 1968-70 0.130 56 7.5 hp 1956-5~ 5/32 70 9.5 hp 1964--70 5/32 71-1/2 10 hp 1956-61 7/32 70-3/16 10 hp 1962-63 7/32 75-3/4- 15 hp 1956 7/32 70-3/16 18 hp 1957-61 7/32 70-3/16 18 hp 1962-70 7/32 75-3/4- 20 hp 1966-70 7/32 75-3/4- 25 hp 1969-70 7/32 75-3/4- 28 hp 1962-64- 7/32 75-3/4- 30 hp 1956 7/32 69-3/4- 33 hp 1965-70 7/32 75-3/4- 35 hp 1957-59 7/32 73-3/4- 4-0hp 1960-70 7/32 75-3/4- Notes 1- Purchase a good grade of nylon rope. 2- Order OMC part number. Rope includes handle. 2. 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In order to protect this investment and to receive the maximum amount of enjoyment from your boat it must be cared for properly while being used and when it is out of the water. Always store your boat with the bow higher than the stern and be sure to remove the transom drain plug and the inner hull drain plugs. If you use any type of cover to protect your boat, plastic, canvas, whatever, be sure to allow for some movement of air through the hull. Proper ventilation will assure evaporation of any condensation that may form due to changes in temperature and humidity. 1-2 CLEANING, VAXING, AND POLISHING An outboard boat should be washed with clear water after each use to remove sur- face dirt and any salt deposits from use in sal t water. Regular rinsing will extend the time between waxing and polishing. It will also give you "pride of ownership", by having a sharp looking piece of equipment. Elbow grease, a mild detergent, and a brush Whenever the boat is stored, for long or short periods, the bow should be slightly higher than the stern and the drain plug in the transom removed to ensure proper drainage of rain water. will be required to remove stubborn dirt, oil, and other unsightly deposits. Stay away from harsh abrasives or strong chemical cleaners. A white buffing com- pound can be used to restore the original gloss to a scratched, dull, or faded area. The finish of your boat should be thoroughly cleaned, buffed, and polished at least once each season. Take care when buffing or polishing with a marine cleaner not to over- heat the surface you are working, because you will burn it. A small outboard engine mounted on an aluminum boat should be removed from the boat and stored separately. Under all cir- cumstances, any outboard engine must AL- WA YS be stored with the power head higher than the lower unit and exhaust system. This position will prevent water trapped in the lower unit from draining back through the exhaust ports into the power head. Lower unit badly corroded because the zinc was not replaced. Once the zinc is destroyed, more costly parts will be damaged. Attention to the zinc condition is extremely important during boat operation in salt water. 7. 1-2 SAFETY A new zinc prior to installation. This inexpensive item will save corrosion on more valuable parts. Most outboard engines have a flat area on the back side of the powerhead. When the engine is placed with the flat area on the power head and the lower unit resting on the floor, the engine will be in the proper altitude with the power head higher than the lower unit. 1-3 CONTROLLING CORROSION Since man first started out on the water, corrosion on his craft has been his enemy. The first form was merely rot in the wood and then it was rust, followed by other forms of destructive corrosion in the more modern materials. One defense against cor- rosion is to use similar metals throughout the boat. Even though this is difficult to do in designing a new boat, particularly the undersides, similar metals should be used whenever and wherever possible. A second defense against corrosion is to insulate dissimilar metals. This can be done by using an exter ior coating of Sea Skin or by insulating them with plastic or rubber gaskets. Using Zinc The proper amount of zinc attached to a boat is extremely important. The use of too much zinc can cause wood burning by plac- ing the metals close together and they be- come "hot". On the other hand, using too DIAMETER Diameter and pitch are the two basic dimensions of a propeller. The diameter is measured across the circumference of a circle scribed by the propeller blades, as shown. small a zinc plate will cause more rapid deterioration of the metal you- are trying to protect. If in doubt, consider the fact that is is far better to replace the zincs than to replace planking or other expensive metal parts from having an excess of zinc. When installing zinc plates, there are two routes available. One is to install many different zincs on all metal parts and thus run the risk of wood burning. Another route, is to use one large zinc on the tran- som of the boat and then connect this zinc to every underwater metal part through internal bonding. Of the two choices, the one zinc on the transom is the better way to go. Small outboard engines have a zinc plate attached to the cavitation plate. Therefore, the zinc remains with the engine at all times. 1-4 PROPELLERS As you know, the propeller is actually what moves the boat through the water. This is how it is done. The propeller oper- ates in water in much the manner as a wood screw does in wood. The propeller "bites" into the water as it rotates. Water passes between the blades and out to the rear in the shape of a cone. The propeller "biting" through the water in much the same manner as a wood auger is what propels the boat. Propeller and associated parts in order, washer, shear-pin, and nut, ready for installation. 8. Arrangement of propeller and associated parts, in order, for a small horsepower engine. Diameter and Pitch Only two dimensions of the propeller are of real interest to the boat owner: the diameter and the pitch. These two dimen- sions are stamped on the propeller hub and always appear in the same order: the diam- eter first and then the pitch. For instance, the number 15-19 stamped on the hub, would mean the propeller had a diameter of 15 inches with a pitch of 19. The diameter is the measured distance from the tip of one blade to the tip of the other as shown in the accompanying illus- tration. The pitch of a propeller is the angle at which the blades are attached to the hub. This figure is expressed in inches of water travel for each revolution of the propeller. In our example of a 15-19 propeller, the propeller should travel 19 inches through the water each time it revolves. If the propel- ler action was perfect and there was no slippage, then the pitch multiplied by the propeller rpms would be the boat speed. Most outboard manufacturers equip their units with a standard propeller with a diam- eter and pitch they consider to be best suited to the engine and the boat. Such a propeller allows the engine to run as near to the rated rpm and horsepower (at full throt- tle) as possible for the boat design. The blade area of the propeller deter- mines its load-carrying capacity. A two- blade propeller is used for high-speed run- ning under very light loads. PROPELLERS 1-3 Shear-pin installed behind the propeller instead of in front of the propeller. A four-blade propeller is installed in boats intended to operate at low speeds under very heavy loads such as tugs, barges, or large houseboats. The three-blade pro- peller is the happy medium covering the wide range between the high performahce units and the load carrying workhorses. Propeller Selection There is no standard propeller that will do the proper job in very many cases. The list of sizes and weights of boats is almost endless. This fact coupled with the many boat-engine combinations makes the propel- ler selection for a specific purpose a diffi- cult job. In fact, in many cases the propel- ler is changed after a few test runs. Proper selection is aided through the use of charts set up for various engines and boats. These charts should be studied and understood when buying a propeller. However, bear in mind, the charts are based on average boats -----10 .. Diagram to explain the pitch dimension of a propeller. The pitch is the theoretical distance a propeller would travel through the water if there was no slippage. 9. 1-4 SAFETY with average loads, therefore, it may be necessary to make a change in size or pitch, in order to obtain the desired results for the hull design or load condition. A wide range of pitch is available for each of the larger horsepower engines. The choice available for the smaller engines, up to about 25 hp, is restricted to one or two sizes. Remember, a low pitch takes a smaller bite of the water than the high pitch propeller. This means the low pitch propel- ler will travel less distance through the water per revolution. The low pitch will require less horsepower and will allow the engine to run faster and more efficiently. It stands to reason, and it's true, that the high pitch propeller will require more horse- power, but will give faster boat speed if the engine is allowed to tu rn to its rated rpm. If a higher-pitched propeller is installed on a boat, in an effort to get more speed, extra horsepower will be required. If the extra power is not available, the rpms will be reduced to a less efficient level and the actual boat speed will be less than if the lower-pitched propeller had been left in- stalled. All engine manufacturers design their units to operate with full throttle at, or slightly above, the rated rpm. If you run your engine at the rated rpm, you will increase spark plug life, receive better fuel economy, and obtain the best performance CAVITATION BURN o Cavitation (air bubbles) formed at the propeller. Manufacturers are constantly fighting this problem, as explained in the text. from your boat and engine. Therefore, take time to make the proper propeller selection for the rated rpm of your engine at full throttle with what you consider to be an average load. Your boat will then be cor- rectly balanced between engine and pro- peller throughout the entire speed range. A reliable tachom eter must be used to measure engine speed at full throttle to ensure the engine will achieve full horse- power and operate efficiently and safely. To test for the correct propeller, make your run in a body of smooth water with the lower unit in forward gear at full throttle. Observe the tachometer at full throttle. NEVER run the engine at a high rpm when a flush attachment is installed. If the reading is above the manufacturer's recommended operating range, you must try propellers of greater pitch, until you find the one that allows the engine to operate continually within the recommended full throttle range. If the engine is unable to deliver top performance and you feel it is properly tuned, then the propeller may not be to blame. Operating conditions have a marked effect on performance. For instance, an engine will lose rpm when run in very cold water. It will also lose rpm when run in salt water as compared with fresh water. A hot, low-barometer day will also cause your en- gine to lose power. Example of a damaged propeller. This unit should have been replaced long before this amount of damage was sustained. 10. Ventilation Ventilation is the forming of voids in the water just ahead of the propeller blades. Marine propulsion designers are constantly fighting the battle against the formation of these voids due to excessive blade tip speed and engine wear. The voids may be filled with air or water vapor, or they may actual- ly be a partial vacuum. Ventilation may be caused by installing a piece of equipment too close to the lower unit, such as the knot indicator pickup, depth sounder, or bait tank pickup. Vibration Your propeller should be checked reg- ularly to be sure all blades are in good condition. If any of the blades become bent or nicked, this condition will set up vibra- tions in the drive unit and the motor. If the vibration becomes very serious it will cause a loss of power, efficiency, and boat perfor- mance. If the vibration is allowed to con- tinue over a period of time it can have a damaging effect on many of the operating parts. Vibration in boats can never be com- pletely eliminated, but it can be reduced by keeping all parts in good working condition and through proper maintenance and lubr i- cation. Vibration can also be reduced in some cases by increasing the number of blades. For this reason, many racers use Rubber hub removed from a propeller. This hub was removed because the hub was slipping in the propeller. PROPELLERS 1-5 two-blade props and luxury cruisers have four- and five-blade props installed. Shock Absorbers The shock absorber in the propeller plays a very important role in protecting the shafting, gears, and engine against the shock of a blow, should the propeller strike an underwater object. The shock absorber al- lows the propeller to stop rotating at the instant of impact while the power train continues turning. How much impact the propeller is able to withstand before causing the clutch hub to slip is calculated to be more than the force needed to propel the boat, but less than the amount that could damage any part of the power train. Under normal propulsion loads of moving the boat through the water, the hub will not slip. However, it will slip if the propeller strikes an object with a force that would be great enough to stop any part of the power train. I ~~ - 00 RAKE illustration depicting the rake of a propeller, as explained in the text. 11. 1-6 SAFETY If the power train was to absorb an impact great enough to stop rotation, even for an instant, something would have to give and be damaged. If a propeller is subjected to repeated striking of underwater objects, it would eventually slip on its clutch hub under normal loads. If the propeller would start to slip, a new hub and shock absorber would have to be installed. Propeller Rake , If a propeller blade is examined on a cut extending directly through the center of the hub, and if the blade is set vertical to the propeller hub, as shown in the accompanying illustration, the propeller is said to have a zero degree (00) rake. As the blade slants back, the rake increases. Standard propel- o 0 lers have a rake angle from a to 15 • A higher rake angle generally improves propeller performance in a cavitating or ventilating situation. On lighter, faster boats, higher rake often will increase per- formance by holding the bow of the boat higher. Progressive Pitch Progressive pitch is a blade design inno- vation that improves performance when for- ward and rotational speed is high and/or the propeller breaks the surface of the water. Progressive pitch starts low at the lead- ing edge and progressively increases to the trailing edge, as shown in ,the accompanying illustration. The average pitch over the entire blade is the number assigned to that propeller. In the illustration of the progres- sive pitch, the average pitch assigned to the propeller would be 21. CONSTANT PITCH Propeller with a "cupped" leading edge. "Cupping" gives the propeller a better "hold" in the water. Cupping If the propeller is cast with a edge curl inward on the trailing edge, the blade is said to have a cup. In most cases, cupped blades improve performance. The cup helps the blades to "HOLD" and not break loose, when operating in a cavitating or ventilating situ- ation. This action permits the engine to be trimmed out further, or to be mounted high- er on the transom. This is especially true on high-performance boats. Either of these two adjustments will usually add to higher speed. PROGRESSIVE PITCH Comparison of a constant and progressive pitch propeller. Notice how the pitch of the progressive pitch propeller, right, changes to give the blade more thrust and therefore, the boat more speed. 12. The cup has the effect of adding to the propeller pitch. Cupping usually will reduce full-throttle engine speed about 150 to 300 rpm below the same pitch propeller without a cup to the blade. A propeller repair shop is able to increase or decrease the cup on the blades. This change, as explained, will al ter engine rpm to meet specific operating demands. Cups are rapidly becoming standard on propellers. in order for a cup to be the most effec- tive, the cup should be completely concave (hollowed) and finished with a sharp corner. If the cup has any convex rounding, the effectiveness of the cup will be reduced. Rotation Propellers are manufactured as right- hand rotation (RH), and as left-hand rota- tion (LH). The standard propeller for out- boards is RH rotation. A right-hand propeller can easily be identified by observing it as shown in the accompanying illustration. Observe how the blade slants from the lower left toward the upper right. The left-hand propeller slants in the opposite direction, from upper left to lower right, as shown. When the propeller is observed rotating from astern the boat, it will be rotating clockwise when the engine is in forward gear. The left-hand propeller will rotate counterclockwise. 1-5 FUEL SYSTEM With Built-in Fuel Tank All parts of the fuel system should be selected and installed to provide maximum COUNTERCLOCKWISE OR LEFT HAND CLOCKWISE OR RIGHT HAND Right- and left-hand propellers shOWing how the angle of the blades is reversed. Right-hand propellers are by far the most popular; PROPELLERS 1-7 service and protection against leakage. Re- inforced flexible sections should be installed in fuel lines where there is a lot of motion, such as at the engine connection. The flaring of copper tubing should be annealed after it is formed as a protection against hardening. CAUTION: Compression fittings should NOT be used because they are so easily overtightened, which places them un- der a strain and subjects them to fatigue. Such conditions will cause the fitting to leak after it is connected a second time. The capacity of the fuel filter must be large enough to handle the demands of the engine as specified by the engine manufac- turer. A manually-operated valve should be in- stalled if anti-siphon protection is not pro- vided. This valve should be installed in the fuel line as close to the gas tank as possible. Such a valve will maintain anti-siphon pro- tection between the tank and the engine. Fuel tanks should be mounted in dry, well ventilated places. Ideally, the fuel tanks should be installed above the cockpit floors, where any leakage will be quickly detected. In order to obtain maximum cir- culation of air around fuel tanks, the tank should not come in contact with the boat hull except through the necessary supports. The supporting surfaces and hold-downs must fasten the tank firmly and they should be insulated from the tank surfaces. This insulation material should be non-abrasive and non-absorbent material. Fuel tanks installed in the forward portion of the boat should be especially well secured and pro- tected because shock loads in this area can be as high as 20 to 25 g's, A three-position valve permits fuel to be drawn from either tank or to be shut off completely. Such an arrangement prevents accidental siphoning of fuel from the tank. 13. 1-8 SAFETY Taking On Fuel The fuel tank of your boat should be kept full to prevent water from entering the system through condensation caused by tem- perature changes. Water droplets forming is one of the greatest enemies of the fuel system. By keeping the tank full, the air space in the tank is kept to an absolute minimum and there is no room for moisture to form. It is a good practice not to store fuel in the tank over an extended period, say for six months. Today, fuels contain ingre- dients that change into gums when stored for any length of time. These gums and varnish products will cause carburetor prob- lems and poor spark plug performance. An additive (Sta-Bil) is available and can be used to prevent gums and varnish from forming. Static Electricity In very simple terms, static electricity is called fr icti onal electr ici ty. It is generated by two dissimilar materials moving over each other. One form is gasoline flowing through a pipe or into the air. Another form is when you brush your hair or walk across a synthetic carpet and then touch a metal object. All of these actions cause an elec- trical charge. In most cases, static electri- city is generated during very dry weather conditions, but when you are filling the fuel tank on your boat it can happen at any time. Fuel Tank Grounding One area of protection against the build- up of static electricity is to have the fuel An OMC fuel tank equipped with a quick-disconnect fitting. This type of arrangement is handy when the tank must be removed from the boat to obtain fuel. Old style pressure-type tank showing the fuel line to the engine and quick-disconnect fitting. tank properly grounded (also known as bond- ing). A direct metal-to-metal contact from the fuel hose nozzle to the water in which the boat is floating. If the fill pipe is made of metal, and the fuel nozzle makes a good contact with the deck plate, then a good ground is made. As an economy measure, some boats use rubber or plastic filler pipes because of compound bends in the pipe. Such a fill line does not give any kind of ground and if your boat has this type of installation and you do Adding fuel to a six-gallon OMC fuel tank. Some fuel must be in the tank before oil is added to prevent the oil from accumulating on the tank bottom. 14. not want to replace the filler pipe with a metal one, then it is possible to connect the deck fitting to the tank with a copper wire. The wire should be 8 gauge or larger. The fuel line from the tank to the engine should provide a continuous metal-to-metal contact for proper grounding. If any part of this line is plastic or other non-metallic material, then a copper wire must be con- nected to bridge the non-metal material. The power train provides a ground through the engine and drive shaft, to the propeller in the water. Fiberglass fuel tanks pose problems of their own. One method of grounding is to run a copper wire around the tank from the fill pipe to the fuel line. However, such a wire does not ground the fuel in the tank. Manufacturers should imbed a wire in the fiberglass and it should be connected to the intake and the outlet fittings. This wire would avoid corrosion which could occur if a wire passed through the fuel. CAUTION: It is not advisable to use a fiberglass fuel tank if a grounding wire was not installed. Anything you can feel as a "shock" is enough to set off an explosion. Did you know that under certain atmospheric con- ditions you can cause a static explosion yourself, particularly if you are wearing synthetic clothing. It is almost a certainty you could cause a static spark if you are NOT wearing insulated rubber-soled shoes. As soon as the deck fitting is opened, fumes are released to the air. Therefore, to be safe you should ground yourself before A fuel tank properly grounded to prevent static electricity. Static electricity could be extremely dan- gerous when taking on fuel. LOADING 1-9 opening the fill pipe deck fitting. One way to ground yourself is to dip your hand in the water overside to discharge the electricity in your body before opening the filler cap. Another method is to touch the engine block or any metal fitting on the dock which goes down into the water. 1-6 LOADING In order to receive maximum enjoyment, with safety and performance, from your boa t, take care not to exceed the load capacity given by the manufacturer. A plate attached to the hull indicates the U.S. Coast Guard capacity information in pounds for persons and gear. If the plate states the maximum person capacity to be 750 pounds and you assume each person to weigh an average of 150 lbs., then the boat could carry five persons safely. If you add anoth- er 250 lbs. for motor and gear, and the maximum weight capacity for persons and gear is 1,000 Ibs. or more, then the five persons and gear would be within the limit. Try to load the boat evenly port and starboard. If you place more weight on one side than on the other, the boat will list to the heavy side and make steering difficult. You will also get better performance by placing heavy supplies aft of the center to keep the bow light for more efficient plan- ing. • •u.s. COAST GUARD MAXIMUM CAPACITIES PERSONS OR LBS LBS PERSONS,MOTOR,GEAR H.P. MOTOR u.s. Coast Guard plate affixed to all new boats. Whenthe blanks are filled in, the plate will indicate the Coast Guard's recommendations for persons, gear, and horsepower to ensuresafe operation of the boat. These recommendations should not be exceeded, as explained in the text. 15. 1-10 SAFETY CJar ifica tion Much confusion arises from the terms, certification, requirements, approval, regu- lations, etc. Perhaps the following may clarify a couple of these points. 1- The Coast Guard does not approve boats in the same manner as they "Approve" life jackets. The Coast Guard applies a formula to inform the public of what is safe for a particular craft. 2- If a boat has to meet a particular regulation, it must have a Coast Guard certification plate. The public has been led to believe this indicates approval of the Coast Guard. Not so. 3- The certification plate means a will- ingness of the manufacturer to meet the Coast Guard regulations for that particular craft. The manufacturer may recall a boat if it fails to meet the Coast Guard require- ments. 4- The Coast Guard certification plate, see accompanying illustration, mayor may not be metal. The plate is a regulation for the manufacturer. It is only a warning plate and the public does not have to adhere to the restrictions set forth on it. Again, the pla te sets forth information as to the Coast Guard's opinion for safety on that particular boat. Type I PFD Coast Guard approved life jacket. This type flotation device provides the greatest amount of buoyancy. NEVER use them for cushions or other purposes. 5- Coast Guard Approved equipment is equipment which has been approved by the Commandant of the U.S. Coast Guard and has been determined to be in compliance with Coast Guard specif ica tions and regula- tions relating to the materials, construction, and performance of such equipment. 1-7 HORSEPOWER The maximum horsepower engine for each individual boat should not be increased by any great amount without checking re- quirements from the Coast Guard in your area. The Coast Guard determines horse- power requirements based on the length, beam, and depth of the hull. TAKE CARE NOT to exceed the maximum horsepower listed on the plate or the warranty and possibly the insurance on the boat may be- come void. 1-8 FLOTATION If your boat is less than 20 ft. overall, a Coast Guard or BIA (Boating Industry of America) now changed to NMMA (National Marine Manufacturers Association) require- ment is that the boat must have buoyant material built into the hull (usually foam) to keep it from sinking if it should become swamped. Coast Guard requirements are mandatory but the NMMA is voluntary. "Kept from sinking" is defined as the ability of the flotation material to keep the boat from sinking when filled with water A Type N PFD cushion device intended to be thrown to a person in the water. If air can be squeezed out ot the cushion it is no longer fit for service as a PFD. 16. and with passengers clinging to the hull. One restriction is that the total weight of the motor, passengers, and equipment aboard does not exceed the maximum load capacity listed on the plate. Life Preservers -Personal Flotation Devices (PFDs) The Coast Guard requires at least one Coast Guard approved life-saving device be carried on board all motorboats for each person on board. Devices approved are identified by a tag indicating Coast Guard approval. Such devices may be life preserv- ers, buoyant vests, ring buoys, or buoyant cushions. Cushions used for seating are serviceable if air cannot be squeezed out of it. Once air is released when the cushion is squee zed, it is no longer fit as a flota tion device. New foam cushions dipped in a rubberized material are almost indestruct- ible. Life preservers have been classified by the U.S. Coast Guard into five distinct categories. PFDs presently acceptable on recreational boats fall into one of these five designations. AllPFDs MUST be U.S. Coast Guard approved, in good and serviceable condition, and ofan appropriate size for the persons who intend to wear them. Wearable PFDs MUST be readily accessibleand throwable devices MUST be immediately avail- able for use. Type I PFD has the greatest required buoyancy and is designed to turn most UNCONSCIOUS persons in the water from a face down position to a vertical or slightly backward posi tion, The adul t size dev ice provides a minimum buoyancy of 22 pounds and the child size provides a minimum buoy- ancyof 11 pounds. The Type I PFD provides the greatest protection to its wearer and is most effective for all waters and conditions. Type II PFD is designed to turn its wear- er in a vertical or slightly backward position in the water. The turning action is not as pronounced as with a Type I. The device will not turn as many different type persons under the same conditions as the Type I. An adul t size device provides a minimum buoy- ancy of 15Y2 pounds, the medium child size provides a minimum of 11 pounds, and the infant and small child sizes provide a min- imum buoyancy of 7 pounds. FLOTATION I-II Type III PFD is designed to permit the wearer to place himself (herself) in a vertical or slightly backward position. The Type III device has the same buoyancy as the Type II PFD but it has little or no turning ability. Many of the Type III PFD are designed to be particularly useful when water skiing, sailing, hunting, fishing, or en- gaging in other water sports. Several of this type will also provide increased hypothermia protection. Type IV PFD is designed to be thrown to a person in the water and grasped and held by the user until rescued. It is NOT design- ed to be worn. The most common Type IV PFD is a ring buoy or a buoyant cushion. Type V PFD is any PFD approved for restricted use. Coast Guard regulations state, in general terms, that on all boats less than 16 ft. overall, one Type I, II, III, or IV device shall be carried on board for each person in the boat. On boats over 26 f t., one Type I, II, or III device shall be carried on board for each person in the boat plus one Type IV device. It is an accepted fact that most boating people own life preservers, but too few actually wear them. There is little or no excuse for not wearing one because the modern comfortable designs available today do not subtract from an individual's boating pleasure. Make a life jacket available to Type IV PFD ring buoy designed to be thrown. On ocean cruisers, this type device usually has a weighted pole with flag, attached to the buoy. 17. 1-12 SAFETY your crew and advise each member to wear it. If you are a crew member ask your skipper to issue you one, especially when boating in rough weather, cold water, or when running at high speed. Naturally, a life jacket should be a must for non-swim- mers any time they are out on the water in a boat. 1-9 EMERGENCY EQUIPMENT Visual Distress Signals The Regulation Since January 1, 1981, Coast Guard Reg- ulations require all recreation boats when used on coastal waters, which includes the Great Lakes, the territorial seas and those waters directly connected to the Great Lakes and the territorial seas, up to a point where the waters are less than two miles wide, and boats owned in the United States when operating on the high seas to be equip- ped with visual distress signals. Internationally accepted distress signals. The only exceptions are during daytime (sunrise to sunset) for: Recrea tional boats less than 16 ft. (5 meters) in length. Boats participating in organized events such as races, regattas or marine parades. Open sailboats not equipped with propul- sion machinery and less than 26 ft. (8 me- ters) in length. Manually propelled boats. The above listed boats need to carry night signals when used on these waters at night. Pyrotechnic visual distress signaling de- vices MUST be Coast Guard Approved, in serviceable condition and stowed to be read- ily accessible. If they are marked with a date showing the serviceable life, this date must not have passed. Launchers, produced before Jan. 1, 1981, intended for use with approved signals are not required to be Coast Guard Approved. USCG Approved pyrotechnic visual dis- tress signals and associated devices include: Pyrotechnic red flares, hand held or aer- ial. Pyrotechnic orange smoke, hand held or floating. Launchers for aerial red meteors or par- achute flares. Moisture-protected flares should be carried on board for use as a distress signal. 18. None-pyrotechnic visual distress signal- ing devices must carry the manufacturer's certification that they meet Coast Guard requirements. They must be in serviceable condition and stowed so as to be readily accessible. This group includes: Orange distress flag at least 3 x 3 feet with a black square and ball on an orange background. Electric distress light -- not a flashlight but an approved electric distress light which MUST automatically flash the international SOS distress signal (.•• - - -. ..) four to six times each minute. Types and Quantities The following variety and combination of devices may be carried in order to meet the requirements. 1- Three hand-held red flares (day and night). 2- One electric distress light (night on- ly). 3- One hand-held red flare and two par- achute flares (day and night). 4- One hand-held orange smoke signal, two floating orange smoke signals (day) and one electric distress light (day and night). If young children are frequently aboard your boat, careful selection and proper sto- wage of visual distress signals becomes es- pecially important. If you elect to carry pyrotechnic devices, you should select those in tough packaging and not easy to ignite should the devices fall into the hands of children. Coast Guard Approved pyrotechnic de- vices carry an expiration date. .This date can NOT exceed 42 months from the date of An adequately stocked first-aid kit should be on board for the safety of crew and guests. COMPASS 1-13 manufacture and at such time the device can no longer be counted toward the min- imum requirements. SPECIAL WORDS In some states the launchers for meteors and parachute flares may be considered a firearm. Therefore, check with your state authorities before acquiring such a launcher. First Aid Kits The first-aid kit is similar to an insur- ance policy or life jacket. You hope you don't have to use it but if needed, you want it there. It is only natural to overlook this essential item because, let's face it, who likes to think of unpleasantness when plan- ning to have only a good time. However, the prudent skipper is prepared ahead of time, and is thus able to handle the emer- gency without a lot of fuss. Good commercial first-aid kits are avail- able such as the Johnson and Johnson "Ma- rine First-Aid Kit". With a very modest expenditure, a well-stocked and adequate kit can be prepared at home. Any kit should include instruments, sup- plies, and a set of instructions for their use. Instruments should be protected in a water- tight case and should include: scissors, tweezers, tourniquet, thermometer, safety A sounding device should mounted close to the helmsman for use in sounding an emergency alarm. 19. 1-14 SAFETY pins, eye-washing cup, and a hot water bot- tle. The supplies in the kit should include: assorted bandages in addition to the various sizes of "band-aids", adhesive tape, absorb- ent cotton, applicators, petroleum jelly, an- tiseptic (liquid and ointment), local oint- ment, aspirin, eye ointment, antihistamine, ammonia inhalent, sea-sickness pills, ant- acid pills, and a laxative. You may want to consult your family physician about includ- ing antibiotics. Be sure your kit contains a first-aid manual because even though you have taken the Red Cross course, you may be the patient and have to rely on an untrained crew for care. Fire Extinguishers All fire extinguishers must bear Under- writers Laboratory (UL) "Marine Type" ap- proved labels. With the UL certification, the extinguisher does not have to have a Coast Guard approval number. The Coast Guard classifies fire extinguishers according to their size and type. Type B-1or B-II Designed for extinguishing flammable liquids. This type extinguisher is required on all motorboats. The Coast Guard considers a boat having one or more of the following conditions as a "boat of closed construction" subject to fire extinguisher regulations. A suitable fire extinguisher should be mounted close to the helmsman for emergency use. 1- Inboard engine or engines. 2- Closed compartments under thwarts and seats wherein portable fuel tanks may be stored. 3- Double bottoms not sealed to the hull or which are not completely filled with flotation materials. 4- Closed living spaces. 5- Closed stowage compartments in which combustible or flammable material is stored. 6- Permanently installed fuel tanks. Detailed classification of fire extingui- shers is by agent and size: B-1contains 1-1/4gallons foam, or 4 pounds carbon dioxide, or 2 pounds dry chemical agent, or 2-1/2 pounds Halon. B-II contains 2-1/2 gallons foam, or 15 pounds carbo dioxide, or 10pounds dry chemi- cal agent, or 10 pounds Halon. The class of motorboat dictates how many fire extinguishers are required on board. One B-II unit can be substituted for two B-1 extinguishers. When the engine compartment of a motorboat is equipped with a fixed (bull t-in) extinguishing system, one less portable B-1 unit is required. Dry chemical fire extinguishers without At least one gallon of emergency fuel should be kept on board in an approved container. 20. gauges or indicating devices must be weigh- ed and tagged every 6 months. If the gross weight of a carbon dioxide (CO?) fire extin- guisher is reduced by more than 10% of the net weight, the extinguisher is not accept- able and must be recharged. READ labels on fire extinguishers. If the extinguisher is U.L. listed, it is approved for marine use. DOUBLE the number of fire extinguish- ers recommended by the Coast Guard, be- cause their requirements are a bare MINI- MUM for safe operation. Your boat, family, and crew, must certainly be worth much more than "bare minimum". 1-10 COMPASS Selection The safety of the boat and her crew may depend on her compass. In many areas wea ther conditions can change so rapidly that within minutes a skipper may find him- self "socked-in" by a fog bank, a rain squall, or just poor visibility. Under these condi- tions, he may have no other means of keep- ing to his desired course except with the compass. When crossing an open body of water, his compass may be the only means of making an accurate landfall. During thick weather when you can nei- ther see nor hear the expected aids to navigation, attempting to run out the time on a given course can disrupt the pleasure of the cruise. The skipper gains little comfort in a chain of soundings that does not match those given on the chart for the expected area. Any stranding, even for a short time, can be an unnerving experience. A pilot will not knowingly accept a cheap parachute. A good boater should not accept a bargain in lifejackets, fire ex- tinguishers, or compass. Take the time and spend the few extra dollars to purchase a compass to fit your expected needs. Re- gardless of what the salesman may tell you, postpone buying until you have had the chance to check more than one make and model. Lift each compass, til t and turn it, sim- ulating expected motions of the boat. The compass card should have a smooth and stable reaction. The card of a good quality compass will come to rest without oscillations about the lubber's line. Reasonable movement in your hand, comparable to the rolling and pitching MISCELLANEOUS EQUIPMENT 1-15 The compass is a delicate instrument and deserves respect. It should be mounted securely and in position where it can be easily observed by the helmsman. of the boat, should not materially affect the reading. Installation Proper installation of the compass does not happen by accident. Make a critical check of the proposed location to be sure compass placement will permit the helms- man to use it with comfort and accuracy. First, the compass should be placed directly in front of the helmsman and in such a position that it can be viewed without body stress as he sits or stands in a posture of relaxed alertness. The compass should be in the helmsman's zone of comfort. If the compass is too far away, he may have to bend forward to watch it; too close and he must rear backward for relief. Do not hesitate to spend a few extra dollars for a good reliable compass. If in doubt, seek advice from fellOW boaters. 21. 1-16 SAFETY Second, give some thought to comfort in heavy weather and poor visibil ty conditions during the day and night. In some cases, the compass position may be partially deter- mined by the location of the wheel, shift lever, and throttle handle. Third, inspect the compass site to be sure the instrument will be at least two feet from any engine indicators, bilge vapor de- tectors, magnetic instruments, or any steel "Innocent" objects close to the compass, such as diet coke in an aluminum can, may cause serious problems and lead to disaster, as these three photos and the accompanying text illustrate. or iron objects. If the compass cannot be placed at least two feet (six feet would be better) from one of these influences, then either the compass or the other object must be moved, if first order accuracy is to be expected. Once the com pass loca tion appears to be satisfactory, give the compass a test before installation. Hidden influences may be con- cealed under the cabin top, forward of the cabin aft bulkhead, within the cockpit ceil- ing, or in a wood-covered stanchion. Move the compass around in the area of the proposed location. Keep an eye on the card. A magnetic influence is the only thing that will make the card turn. You can quickly find any such influence with the compass. If the influence can not be moved away or replaced by one of non-magnetic ma terial, test to determine whether it is merely magnetic, a small piece of iron or steel, or some magnetized steel. Bring the north pole of the compass near the object, then shift and bring the south pole near it. Both the north and south poles will be attracted if the compass is demagnetized. If the object attracts one pole and repels the other, then the compass is magnetized. If your compass needs to be demagnetized, take it to a shop equipped to do the job PROPERLY. After you have moved the compass a- round in the proposed mounting area, hold it down or tape it in position. Test everything you feel might affect the compass and cause a deviation from a true reading. Rotate the wheel from hard over to hard over. Switch on and off all the lights, radios, radio direc- tion finder, radio telephone, depth finder and the shipboard intercom, if one is instal- led. Sound the electric whistle, turn on the windshield wipers, start the engine (with water circulating through the engine), work the throttle, and move the gear shift lever. If the boat has an auxiliary generator, start it. If the card moves during anyone of these tests, the compass should be reloca t- ed. Naturally, if something like the wind- shield wipers cause a slight deviation, it may be necessary for you to make a differ- ent deviation table to use only when certain pieces of equipment is operating. Bear in mind, following a course that is only off a ~ degree or two for several hours can make considerable difference at the end, putting you on a reef, rock, or shoal. 22. Check to be sure the intended compass site is solid. Vibration will increase pivot wear. Now, you are ready to mount the com- pass. To prevent an error on all courses, the line through the lubber line and the compass card pivot must be exactly parallel to the keel of the boat. You can establish the fore-and-aft line of the boat with a stout cord or string. Use care to transfer this line to the compass site. If necessary, shim the base of the compass until the stile-type lubber line (the one affixed to the case and not glrnbaled) is vertical when the boat is on an even keel. Drill the holes and mount the compass. Magnetic Items After Installation Many times an owner will install an expensive stereo system in the cabin of his boat. It is not uncommon for the speakers to be mounted on the aft bulkhead up against the overhead (ceiling). In almost ever y case, this position places one of the speakers in very close proximity to the compass, mounted above the ceiling. As we all know, a magnet is used in the operation of the speaker. Therefore, it is very likely that the speaker, mounted al- most under the compass in the cabin will have a very pronounced affect on the com- pass accuracy. Consider the following test and the ac- companying photographs as prove of the statements made. First, the compass was read as 190 de- grees while the boat was secure in her slip. Next a full can of diet coke in an alum- inum can was placed on one side and the compass read as 204 degrees, a good 14- degrees off. Next, the full can was moved to the opposite side of the compass and again a reading was observed. This time as 189 degrees, 11 degrees off from the original reading. Finally the contents of the can were consumed, the can placed on both sides of the compass with NO affect 'on the compass reading. 'Two very important conclusions can be drawn from these tests. 1- Something must have been in the con- tents of the can to affect the compass so drasticall v- NAVIGATION 1-17 2- Keep even "innocent" things clear of the compass to avoid any possible error in the boat's heading. REMEMBER, a boat moving through the water at 10 knots on a compass error of just 5 degrees will be almost 1.5 miles off course in only ONE hour. At night, or in thick weather, this could very possibly put the boat on a reef, rock, or shoal, with disastrous resul ts. 1-11 STEERING USCG or BIA certification of a steering system means that all materials, equipment, and installation of the steering parts meet or exceed specific standards for strength, type, and maneuverability. Avoid sharp bends when routing the cable. Check to be sure the pulleys turn freely and all fittings are secure. 1-12 ANCHORS One of the most important pieces of equipment in the boat next to the power plan t is the ground tackle carr ied, The engine makes the boat go and the anchor and its line are what hold it in place when the boat is not secured to a dock or on the beach. The weight of the anchor MUST be adequate to secure the boat without dragging. 23. 1-18 SAFETY The anchor must be of suitable size, type, and weight to give the skipper peace of mind when his boat is at anchor. Under certain conditions, a second, smaller, lighter anchor may help to keep the boat in a favorable position during a non-emergency daytime situation. In order for the anchor to hold properly, a piece of chain must be attached to the anchor and then the nylon anchor line at- tached to the chain. The amount of chain should equal or exceed the length of the boat. Such a piece of chain will ensure that the anchor stock will lay in an approximate horizontal position and permit the flutes to dig into the bottom and hold. 1-13 MISCELLANEOUS EQUIPMENT In addition to the equipment you are legally required to carry in the boat and those previously mentioned, some extra items will add to your boating pleasure and safety. Practical suggestions would include: a bailing device (bucket, pump, etc.), boat The bilge pump line must be cleaned frequently to ensure the entire bilge pump system will function properly in an emergency, hook, fenders, spare propeller, spare engine parts, tools, an auxiliary means of propul- sion (paddle or oars), spare can of gasoline, flashlight, and extra warm clothing. The area of your boating activity, weather con- ditions, length of stay aboard your boat, and the specific purpose will all contribute to the kind and amount of stores you put aboard. When it comes to personal gear, heed the advice of veteran boaters who say, "Decide on how little you think you can get by with, then cut it in half". Bilge Pumps Automatic bilge pumps should be equip- ped with an overriding manual switch. They should also have an indica tor in the opera- tor's position to advise the helmsman when the pump is operating. Select a pump that will stabilize its temperature within the manufacturer's specified limits when it is operated continuously. The pump motor should be a sealed or arcless type, suitable for a marine atmosphere. Place the bilge pump inlets so excess bilge water can be removed at all normal boat trims. The intakes should be properly screened to pre- vent the pump from sucking up debris from the bilge. Intake tubing should be of a high quali ty and stiff enough to resist kinking and not collapse under maximum pump suction condition if the intake becomes blocked. To test operation of the bilge pump, operate the pump switch. If the motor does not run, disconnect the leads to the motor. Connect a vol tm eter to the leads and see if voltage is indicated. If voltage is not indi- cated, then the problem must be in a blown fuse, defective switch, or some other area of the electrical system. If the meter indicates voltage is present at the leads, then remove, disassemble, and inspect the bilge pump. Clean it, reassem- ble, connect the leads, and operate the switch again. If the motor still fails to run, the pump must be replaced. To test the bilge pump switch, first disconnect the leads from the pump and connect them to a test light or ohmmeter. Next, hold the switch firmly against the mounting location in order to make a good ground. Now, til t the opposite end of the switch upward until it is activated as indica- ted by the test light coming on or the ohmmeter showing continuity. Finally, low- er the switch slowly toward the mounting 24. position until it is deactivated. Measure the distance between the point the switch was activated and the point it was deactivated. For proper service, the switch should deact- ivate between l/2-inch and 1I4-inch from the planned mounting position. CAUTION: The switch must never be mounted lower than the bilge pump pickup. 1-14 BOATING ACCIDENT REPORTS New federal and state regulations re- quire an accident report to be filed with the nearest State boating authority within 48 hours if a person is lost, disappears, or is injured to the degree of needing medical treatment beyond first aid. Accidents involving only property or equip- ment damage MUST be reported within 10 days, if the damage is in excess of $500.00. Some states require reporting of accidents with propery damage less then $500.00 or a total boat loss. A $1,000.00 PENALTY may be assessed for failure to submit the report. WORD OF ADVICE Take time to make a copy of the report to keep for your records or for the insurance company. Once the report is filed, the Coast Guard will not give out a copy, even to the person who filled the report. The report must give details of the acci- dent and include: 1- The date, time, and exact location of the occurrence. 2- The name of each person who died, was lost, or injured. 3- The number and name of the vessel. 4- The names and addresses of the own- er and operator. If the operator cannot file the report for any reason, each person on aboard MUST notify the authorities, or determine that the report has been filed. 1-15 NAVIGATION Buoys In the United States, a buoyage system is used as an assist to all boaters of all size craft to navigate our coastal waters and our navigable rivers in safety. When properly read and understood, these buoys and mark- ers will permit the boater to cruise with comparative confidence that he will be able NAVIGATION 1-19 to avoid reefs, rocks, shoals, and other haz- ards. In the spring of 1983, the Coast Guard began making modifications to U.S. aids to navigation in support of an agreement spon- sored by the International Associaiton of Lighthouse Authorities (IALA) and signed by representatives from most of the maritime nations of the wor ld, The primary purpose of the modifications is to improve safety by making buoyage systems around the world more alike and less confusing. The modifications shown in the accom- panying illustrations should be completed by the end of 1989. Lights The following information regarding lights required on boats between sunset and sunrise or during restricted visibility is tak- en directly from a U.S. Coast Guard publi- cation dated 1984. The terms "PORT" and "STARBOARD" are used to refer to the left and right side of the boat, when looking forward. One easy way to remember this basic fundamen- tal is to consider the words "port" and" lef ttl both have four letters and go together. Hookup for testing an automatic bilge pump switch. 25. 1-20 SAFETY Waterway Rules On the water, certain basic safe- operat- ing practices must be followed. You should learn and practice them, for to know, is to be able to handle your boat with confidence and safety. Knowledge of what to do, and not do, will add a great deal to the enjoy- ment you will receive from your boating investment. Rules of the Road The best advice possible and a Coast Guard requirement for boats over 39' 4" (12 meters) since 1981, is to obtain an official copy of the "Rules of the Road", which includes Inland Waterways, Western Rivers, and the Great Lakes for study and ready reference. The following two paragraphs give a VERY brief condensed and abbreviated almost a synopsis of the rules and should not be considered in any way as covering the entire subject. Powered boats must yield the right-of- way to all boats without motors, except when being overtaken. When meeting an- other boat head-on, keep to starboard, un- less you are too far to port to make this practical. When overtaking another boat, the right-of-way belongs to the boat being overtaken. If your boat is being passed, you must maintain course and speed. When two boats approach at an angle and there is danger of collision, the boat to port must give way to the boat to starboard. Always keep to starboard in a narrow chan- nel or canal. Boats underway must stay clear of vessels fishing with nets, lines, or trawls. (Fishing boats are not allowed to fish in channels or to obstruct navigation.) MODIFICATIONS: Port hand aids will be green with green lights. All starboard hand aids will have red lights. MODIFICATIONS: Green will replace black. Light rhythm will be changed to Composite Gp Fl (2 + 1). 26. 2 TUNING 2-1 INTRODUCTION The efficiency, reliability, fuel economy and enjoyment available from engine perfor- mance are all directly dependent on having it tuned properly. The importance of per- forming service work in the sequence detail- ed in this chapter cannot be over emphasiz- ed. Before making any adjustments, check the Specifications in the Appendix. NEVER rely on memory when making critical ad- justments. Before beginning to tune any engine, check to be sure the engine has satisfactory compression. An engine with worn or bro- ken piston rings, burned pistons, or badly scored cylinder walls, cannot be made to perform properly no matter how much time and expense is spent on the tune-up. Poor Damaged piston, probably caused by inaccurate fuel mixture, or improper point setting. compression must be corrected or the tune- up will not give the desired results. The opposite of poor compression would be to consider good compression as evidence of a satisfactory cylinder. However, this is not necessarily the case, when working on an outboard engine. As the professional mechanic has discovered, many times the compression check will indicate a satisfac- tory cylinder, but after the head is pulled and an inspection made, the cylinder will require service. A clean exterior engine appearance reflects this owner's pride in his unit. Keeping the interior well lubricated and properly adjusted will give him the enjoyment deserved for his investment. 27. Thank you very much for your reading. Please Click Here Then Get More Information. 28. 2-2 TUNING A practical maintenance program that is followed throughout the year, is one of the best methods of ensuring the engine will give satisfactory performance at any time. The extent of the engine tune-up is usu- ally dependent on the time lapse since the last service. A complete tune-up of the entire engine would entail almost all of the work outlined in this manual. A logical sequence of steps will be presented in gen- eral terms. If additional information or detailed service work is required, the chap- ter containing the instructions will be refer- enced. Each year higher compression ratios are built into modern outboard engines and the electr ical systems become more complex, especially with electronic (capacitor dis- charge) units. Therefore, the need for reli- able, authoratative, and detailed instruc- tions becomes more critical. The informa- tion in this chapter and the referenced chapters fulfill that requirement. 2-2 TUNE-UP SEQUENCE If twenty different mechanics were ask- ed the question, "What constitutes a major and minor tune-up?", it is entirely possible twenty different answers would be given. As the terms are used in this manual and other Seloc outboard books, the following work is normally performed for a minor and major tune-up. Minor Tune-up Lubricate engine. Drain and replace gear oil. Adjust points. Adjust carburetor. Clean exterior surface of engine. Tank test engine for fine adjustments. The time, effort, and expense of a tune-up will not restore an engine to satisfactory performance, if the pistons are damaged. Major Tune-up Remove head. Clean carbon from pistons and cylinders. Clean and 0ver haul carbu retor . Clean and overhaul fuel pump. Rebuild and adjust ignition system. Lubricate engine. Drain and replace gear oil. Clean exterior surface of engine. Tank test engine for fine adjustments. During a major tune-up, a definite se- quence of service work should be followed to return the engine to the maximum per- formance desired. This type of work should not be confused with attempting to locate problem areas of "why"! the engine is not performing sat isfac tor ily, This work is clas- sified as "troubleshooting". In many cases, these two areas will over lap, because many times a minor or major tune-up will correct the malfunction and return the system to normal operation. The following list is a

suggested se- quence of tasks to perform during the tune- up service work. The tasks are merely listed here. Generally procedures are given in subsequent sections of this chapter. For more detailed instructions, see the refer- enced chapter. 1- Perform a compression check of each cylinder. See Chapter 3. 2- Inspect the spark plugs to determine their condition. Test for adequate spark at the plug. See Chapter 5. 3- Start the engine in a body of water and check the water flow through the engine. See Chapter 8. 4-'- Check the gear oil in the lower unit. See Chapter 8. A boat and lower unit covered with marine growth. Such a condition is a serious hinderance to satisfactory performance. 29. 5- Check the carburetor adjustments and the need for an overhaul. See Chap- ter 4. 6- Check the fuel pump for adequate performance and delivery. See Chapter 4. 7- Make a general inspection of the igni- tion system. See Chapter 5. 8- Test the starter motor and the sole- noid. See Chapter 6. 9- Check the internal wiring. 10- Check the synchronization. See Chapter 5. 2-3 COMPRESSION CHECK A compression check is extremely im- portant, because an engine with low or un- even compression between cylinders CAN- NOT be tuned to operate satisfactorily. Therefore, it is essential that any compres- sion problem be corrected before proceeding with the tune-up procedure. See Chapter 3. If the powerhead shows any indication of overheating, such as discolored or scorched paint, especially in the area of the top (No. l) cylinder, inspect the cylinders visually thru the transfer ports for possible scoring. A more thorough inspection can be made if the head is removed. It is possible for a cylinder with satisfactory compression to be scored slightly. Also, check the water pump. The overheating condition may be caused by a faulty water pump. Removing the spark plugs for inspection. Worn plugs are one of the major contributing factors to poor engine performance. COMPRESSION CHECK 2-3 An overheating condition may also be caused by running the engine out of the water. For unknown reasons, many opera- tors have formed a bad habit of running a small engine without the lower unit being submerged. Such a practice will result in an overheated condition in a matter of seconds. It is interesting to note, the same operator would never operate or allow anyone else to run a large horsepower engine without water circulating through the lower unit for cool- ing. Bear-in-mind, the laws governing oper- ation and damage to a large unit ALL apply equally as well to the small engine. Checking Compression Remove the spark plug wires. ALWAYS grasp the molded cap and pull it loose with a twisting motion to prevent damage to the connection. Remove the spark plugs and keep them in ORDER by cylinder for evalua- tion later. Ground the spark plug leads to the engine to render the ignition system inoperative while performing the compres- sion check. Insert a compression gauge into the No.1, top, spark plug opening. Crank the engine with the starter, or pull on the starter cord, thru at least 4 complete strokes with the throttle at the wide-open position, or until the highest possible read- ing is observed on the gauge. Record the reading. Repeat the test and record the compression for each cylinder. A variation A compression check should be. taken in each cylin- der before spending time and money on tune-up work. Without adequate compression, efforts in other areas to regain engine performance will be wasted. 30. 2-4 TUNING Damaged spark plugs. Notice the broken electrode on the left plug. The broken part must be found and removed before returning the engine to service. between cylinders is far more important than the actual readings. A variation of more than 5 psi between cylinders indicates the lower compression cylinder may be de- fective. The problem may be worn, broken, or sticking piston rings, scored pistons or worn cylinders. These problems may only be determined after the head has been remov- ed. Removing the head on an outboard engine is not that big a deal and may save many hours of frustration and the cost of purchasing unnecessary parts to correct a faulty condition. 2-4 SPARK PLUG INSPECTION Inspect each spark plug for badly worn electrodes, glazed, broken, blistered, or lead fouled insulators. Replace all of the plugs, if one shows signs of excessive wear. Make an evaluation of the cylinder per- formance by comparing the spark condition with those shown in Chapter 5. Check each spark plug to be sure they are all of the same manufacturer and have the same heat range rating. FOULED ELECTRODES A foul spark plug. The condition of this plug indicates problems in the cylinder that should be cor- rected. Inspect the threads in the spark plug opening of the head and clean the threads before installing the plug. If the threads are damaged, the head should be removed and and a Hell-coil insert installed. If an at- tempt is made to drill out the opening with the head in place, some of the filings may fall into the cylinder and cause damage to the cylinder wall during operation. Because the head is made of aluminum, the filings cannot be removed with a magnet. When purchasing new spark plugs, AL- WAYS ask the marine dealer if there has been a spark plug change for the engine being serviced. Crank the engine through several revo- lutions to blowout any material which might have become dislodged during clean- mg. Install the spark plugs and tighten them to a torque value of 17 ft-lbs. ALWAYS use a new gasket and wipe the seats in the block clean. The gasket must be fully compressed on clean seats to complete the heat transfer process and to provide a gas tight seal in the cy Iinder, If the torque value is too high, the heat will dissipate too rapidly. Conversely, if the torque value is too low, heat will not dissipate fast enough. 2- 5 IGNITION SYSTEM Only one ignition system, a flywheel- magneto, is used on outboard engines cover- ed in this manual. If the engine perfor- mance is less than expected, and the igni- tion is diagnosed as the problem area, refer to Chapter 5 for detailed service proce- dures. To properly synchronize the ignition system with the fuel system, see Chapter 5. Today, numerous type spark plugs are available for service. ALWAYS check with your local marine dealer to be sure you are purchasing the proper plugs for the engine being serviced.

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