Mercruiser service manual 39

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Sterndrives - Alpha One Gen II #15 90-816463 1989-1992 Engines - GM V8 (No Hi Perf.) #16 90-823224--2 1993-1997 Engines - GM V8 454 & 502 CID (Gen V - Gen VI) #17 90-823225--1 1993-1997 Engines - GM V8 305 & 350 CID (5.0L 93-95) #18 90-823226--1 1993-1997 Engines - GM V6 Gen II Balance Shaft #19 90-823227 1994-1996 Engines - Diesel, V8, 7.3L (IDI) #20 90-823228 1994-1998 Sterndrive - Blackhawk #21 90-806934 1994 - Engines - Diesel, 5 & 6 Cyl. 3.0L, 3.6L & 4.2L (IDI) #22 90-860074 1997 - Engines - Diesel, D-Tronic 2.8L and 4.2L (DI) #23 90-861326--1 1998 - Engines - GM V8 454 & 502 CID (Gen VI and L-29) #24 90-861327--1 1998 - Engines - GM V8 305 & 350 CID #24 Suppliment 90-861327000 1998 - Engines - GM V8 377 CID (6.2L) #25 90-861328--1 1998 - Engines - GM V6 #26 90-861329--1 1998 - Engines - GM 4 Cyl. #27 90-861784 1998 - Engines - V-8 Diesel, D7.3L D-Tronic (DI) #27 Suppliment 90-861784990 1998 - Engines - V-8Diesel D7.3L D-Tronic & D-Tronic LD #28 90-863160 1999 - Sterndrive–Bravo One-Two-Three & XZ/XR #29 90-863016001 All D1.7L DTI In-Line Diesel #30 90-863161 1998- Engines - 496 CID/8.1L Gasoline Engine #31 90-864260 2001- Engines - 5.0L (305), 5.7L (350), and 6.2L (377) #32 90-864261 2001- Engines - 4.3L (262) #33 90-863757--1 2001- Engines - PCM555 Diagnostics #34 90-863616 2001- Engines - D4.2L LD In-line Diesel #35 90-864212 2001- Precision Pilot #36 90-864573001 2001- Engines - ECM555 Diagnostics #37 90-864260020 2002- Dry Joint Exhaust System #38 90-866211 2004- Jet #39 90-865612T00 2006- Bravo Sterndrives #40 90-865376 2004- Engines - Gen III Cool Fuel suppliment to 30 & 31 #41 90-866202 2004- Engines - Turn Key Start (TKS) Suppliment to 25, 26 & 31 #42 90-866025 2006- Engines - 2.8L Diesel HP #1 90-817110 1989-1992 Engines - Hi-Performance (Mark IV HP420/HP425/HP465, HP500 Bulldog, HP575) HP #2 90-815526 1982 - Sterndrives - III & II, III, IV & V SSM HP #2 Suppliment 90-849776 All Sterndrives - III A HP #3 90-848294-1 1992-1998 Engines - Hi-Performance (Gen V HP425/HP450/HP465/HP500, Mark IV & Gen V HP525SC & HP600SC, HP 800SC) HP #4 90-848656 All Sterndrives - VI & VII (Non Dry Sump) HP #5 90-840250 1999- Sterndrives - VI (Dry Sump) HP #6 90-840283 1999- HP500 EFI HP #7 90-840500 1999- Engines - HP377 EFI Important. There are NO RETURNS on Manuals for any reason. Return Policy Notice To Users Of This Manual Throughout this publication, Dangers, Warnings and Cautions (accompanied by the International HAZARD Symbol !) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. OBSERVE THEM CAREFULLY! These safety alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus common sense operation, are major accident prevention measures. ! DANGER DANGER�indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. ! WARNING WARNING�indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury. ! CAUTION CAUTION�indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury or property damage. It may also be used to alert against unsafe practices. This manual has been written and published by the Service Department of Mercury MerCruiser to aid our dealers� mechanics and company service personnel when servicing the products described herein. We reserve the right to make changes to this manual without prior notification. � 2006, Mercury Marine Mercury, Mercury Marine, MerCruiser, Mercury MerCruiser, Mercury Racing, Mercury Precision Parts, Mercury Propellers, Mariner, Quicksilver, #1 On The Water, Alpha, Bravo, Pro Max, OptiMax, Sport-Jet, K-Planes, MerCathode, RideGuide, SmartCraft, Zero Effort, M with Waves logo, Mercury with Waves logo, and SmartCraft logo are all registered trademarks of Brunswick Corporation. Mercury Product Protection logo is a registered service mark of Brunswick Corporation. This manual assumes that personnel are familiar with marine product installation and are familiar with, if not trained in, the recommended installation procedures of Mercury MerCruiser products. We cannot anticipate all conceivable installations and their possible hazards or results. Therefore, the personnel are responsible for any installation that does not fulfill the requirements of this manual. All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell or service these products. Refer to dealer service bulletins, operation maintenance and warranty manuals and installation manuals for other pertinent information concerning the products described in this manual. Page L Work Precautions The electrical systems described are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery. Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started. Any time the sterndrive internal components are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the sterndrive and cause damage. Please note that during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage, malfunction, or personal injury. Therefore, when removing fasteners, save them for reuse in the same locations whenever possible. When fasteners are not satisfactory for reuse, ensure that the replacement matches the original. Personnel should not work on or under an engine or sterndrive that is suspended. Engines or sterndrives should be attached to work stands or lowered to the ground as soon as possible. Replacement Parts Use of parts other than the recommended service replacement parts will void the warranty on those parts that are damaged as a result. ! WARNING Electrical, ignition, and fuel system components on Mercury MerCruiser engines and sterndrives are designed and manufactured to comply with U.S. Coast Guard rules and regulations to minimize risks of fire or explosion. The use of replacement electrical, ignition, or fuel system components that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided. When servicing the electrical, ignition, and fuel systems, it is extremely important that all components be properly installed and tightened. Otherwise, any opening in the electrical or ignition system would permit sparks to ignite fuel vapors from leaks in the fuel system, if they existed. Cleanliness And Care Of Product A Mercury MerCruiser power product is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in thousandths of a mm/in. When servicing any component, care and cleanliness are important. Throughout this manual, it should be understood that proper cleaning and protection of machined surfaces and friction areas is a part of the repair procedure. Cleanliness is considered standard shop practice. Whenever components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed. Page iL Manual Outline 1 - Important Information A - General Information B - Maintenance C - Troubleshooting D - Corrosion Protection 2 - Installation and Adjustments A - All Models 3 - Bravo Sterndrive A - Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation B - Driveshaft Housing Disassembly, Repair, and Reassembly C - Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation D - Bravo One Gear Housing Disassembly, Repair, and Reassembly E - Bravo Two Gear Housing Disassembly, Repair, and Reassembly F - Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4 - Transom Assembly A - Transom Removal and Service Procedures B - Transom Disassembly, Repair, and Reassembly 5 - Power Trim A - Oildyne Trim Pump B - Trim Cylinders C - Dual Power Trim System 6 - Steering Systems A - Power-Assisted Steering B - Compact Hydraulic Steering Important Information 1 Installation and Adjustments 2 Bravo Sterndrive 3 Transom Assembly 4 Power Trim 5 Steering Systems 6 Page iiL Page iY Important Information Section 1A - General Information Table of Contents General Information 1 A Notice..1A-2 Notice to Users of This Manual........................1A-2 Precautions..1A-2 Engine Mechanical Components....................1A-3 Models Covered In This Manual.....................1A-3 Replacement Parts..1A-4 Introduction..1A-4 How To Use This Manual................................1A-4 Service Manual Page Identification..........1A-4 Bravo Sterndrive Models.........................1A-5 Directional References....................................1A-9 Propeller Rotation...1A-9 Sterndrive Decal Identification......................1A-10 Transom Decal Identification........................1A-11 Sterndrive 10-Hour Break-In Period (New or With Replacement Gears).....................................1A-11 Bravo Three Notice: Trim-in Limit Insert........1A-11 Multiple Sterndrive Steering Tie Bar Arrangements ....1A-12 Internal Power-Assisted Steering With Internal Tie Bar Only...1A-12 Internal Power-Assisted Steering With Internal and External Tie Bar..............................1A-12 External Power-Assisted Steering ....1A-12 External Power-Assisted Steering With Low External Tie Bar.....................................1A-12 90-865612010 FEBRUARY 2006 Page 1A- General Information Notice This publication uses warnings and cautions (accompanied by the international hazard symbol) to alert the mechanic about special instructions concerning a particular service or operation that may be hazardous if it is performed incorrectly or carelessly. Observe Them Carefully! These safety alerts alone cannot eliminate the hazards that they signal. Complying with these safety alerts must also be accompanied by the exercise of common sense to prevent accidents. ! DANGER DANGER�indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury ! WARNING WARNING�indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury ! CAUTION CAUTION�indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury or property damage. It may also be used to alert against unsafe practices. Notice to Users of This Manual This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein. This manual assumes that these personnel are familiar with procedures for servicing marine products. Furthermore, it assumes that they have been trained in the recommended service procedures for Mercury MerCruiser products, including the use of mechanics' common hand tools and the special tools of Mercury Marine or recommended tools from other suppliers. We cannot anticipate all conceivable installations and their possible hazards or results. Therefore, anyone who uses a service procedure or tool that is not recommended by Mercury Mercruiser must first determine that doing so will not damage the product or cause injury to persons. All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell or service these products. We reserve the right to make changes to this manual without prior notification. Refer to dealer service bulletins, operation, maintenance, and warranty manuals, and installation manuals for additional information concerning the products described in this manual. Precautions Note that the electrical system and ignition system are capable of violent, damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, disconnect the battery cables at the battery. Page 1A-2 90-865612010 FEBRUARY 200 General Information Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started. IMPORTANT: During any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, but most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injuryTherefore, you should save removed fasteners for reuse in the same locations whenever possible. For situations in which the fasteners are not satisfactory for reuse, select a replacement that matches the original. Engine Mechanical Components Many of the engine mechanical components are for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and operation at wide-open throttle and therefore require heavy-duty components. Marine engine parts must also be able to resist the corrosive action of salt water or brackish water, each of which will rust or corrode standard automotive parts within a short period of time. We have manufactured special marine engine parts that meet specifications required for long life and dependable performance. Failure to use recommended Quicksilver service replacement parts can result in poor engine performance or durability, rapid corrosion of parts subjected to salt water, and possibly complete failure of the engine. Models Covered In This Manual Model Bravo OnH Bravo One Q Bravo One X DieseQ Bravo One XK Bravo TwT Bravo Two Q Bravo Two X DieseQ Bravo ThreH Bravo Three Q Bravo Three X DieseQ Bravo Three XK Transom StandarI Transom High PerformancH Serial Number 0M198373 and Above 0W240000 and Above 0M198373 and Above 0W240000 and Above 0W173658 and Above 0W150260 and Above 90-865612010 FEBRUARY 2006 Page 1A- General Information Replacement Parts ! WARNING Electrical, ignition, and fuel system components on Mercury MerCruiser engines and sterndrives are designed and manufactured to comply with U.S. Coast Guard rules and regulations to minimize risks of fire or explosion. The use of replacement electrical, ignition, or fuel system components that do not comply with these rules and regulations could result in a fire or explosion hazard and should be avoided. When servicing the electrical, ignition, and fuel systems, it is extremely important that all components be properly installed and tightened. Otherwise, any opening in the electrical or ignition system would permit sparks to ignite fuel vapors from leaks in the fuel system, if they existed. Introduction This overhaul and repair manual is intended as a comprehensive service guide for the models listed earlier. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair these products. Before attempting repairs we suggest that the procedure first be read in its entirety to gain knowledge of the methods and tools used and of the cautions and warnings required for safety. How To Use This Manual This manual is divided into sections, which represent major components and systems. Some sections are further divided into parts that more fully describe the component. Refer to the Service Manual Outline following Models Covered in this manual for section titles. Service Manual Page Identification The service manual number and section title appear at the top of the page. Two number groups appear at the bottom of each page. Following is an example and a description. Page 1A-3 90-865612 FEBRUARY 200 a b c d e 18407 a - Section number d - Manual number b - Section part e - Month and year of publication c - Page number Page 1A-4 90-865612010 FEBRUARY 200 General Information Bravo Sterndrive Models BRAVO ONE MODELS 18201 Bravo One 18202 Bravo One X 18203 Bravo One X Diesel 90-865612010 FEBRUARY 2006 Page 1A- General Information 18204 Bravo One XR BRAVO TWO MODELS 18205 Bravo Two 18206 Bravo Two X Page 1A-6 90-865612010 FEBRUARY 200 General Information 18207 Bravo Two X Diesel BRAVO THREE MODELS 18208 Bravo Three 18209 Bravo Three X 90-865612010 FEBRUARY 2006 Page 1A- General Information 18210 Bravo Three X Diesel 18211 Bravo Three XR Page 1A-8 90-865612010 FEBRUARY 200 General Information Directional References The front of the boat is the bow; the rear is the stern. Starboard side is the right side; the port side is the left side. In this document, all directional references are given as they appear when viewing boat from the stern, looking toward the bow. 9515 a b c d a - Fore or bow (front) c - Starboard (right) b - Aft or stern (rear) d - Port (left) Propeller Rotation Propeller rotation for sterndrive can be clockwise or counterclockwise, as viewed from the aft (rear) end of the propeller. 4802 4747 Clockwise rotation Counterclockwise rotation 90-865612010 FEBRUARY 2006 Page 1A- General Information Sterndrive Decal Identification All Bravo models: The Drive Serial No. is located on the decal of the port side a 15256 a - Drive Serial No. All Bravo models: The Drive Ratio is located on the decal of the starboard side. a 15255 a - Drive Ratio Page 1A-10 90-865612010 FEBRUARY 200 General Information Transom Decal Identification The Transom Serial No. is located on the decal a 20432 a - Transom serial number Sterndrive 10-Hour Break-In Period (New or With Replacement Gears) It is important that the following procedure be used on new sterndrive units. This break-in procedure allows the proper seating of drive unit gears and related components, which greatly reduces the likelihood of problems. � Avoid full throttle starts. � Do not operate at any one constant speed for extended periods of time. � Do not exceed 75% of full throttle during the first 5 hours. During the next 5 hours, operate at intermittent full throttle. � Sterndrive should be shifted into forward gear a minimum of 10 times during break-in, with run-in time at moderate rpm after each shift. Bravo Three Notice: Trim-in Limit Insert NOTE: Bravo One, Two and Three Models are equipped with a trim-in limit insert. It has been brought to our attention that some boats (predominantly deep-V heavy boats) will roll up on their side under certain operating conditions. The roll can be either to port or starboard and may be experienced while moving straight ahead or making a turn. The roll occurs most frequently at or near maximum speed, with the sterndrive trimmed at or near full trim-in. Although the boat will not roll completely over, the roll may be sufficient to unseat the operator or passengers and thereby create an unsafe situation. The roll is caused by stern lift created from excessive trim-in of the sterndrive. Redistributing the weight sternward can reduce stern-lift and help to control the condition. The distribution of weight forward, to port, or starboard may worsen the condition. The trim-in limit insert reduces stern lift by preventing the sterndrive from reaching the last few degrees of full trim-under. Although this device should reduce the tendency to roll, it may not eliminate the tendency entirely. The need for this trim-in limit insert, and its effectiveness, can only be determined through boat testing and is ultimately the responsibility of the boat manufacturer. 90-865612010 FEBRUARY 200 Page 1A-1 General Information ! WARNING We recommend that only qualified personnel adjust the trim-in limit inserts. The boat must be water-tested after adjusting the trim-in limit inserts to ensure that the modified trim-in range does not cause the boat to handle poorly when the sterndrive is trimmed in at higher speeds. On some boats, increased trim-in range may cause handling problems, which could result in personal injury. Multiple Sterndrive Steering Tie Bar Arrangements With multiple sterndrives you must select one of several possible steering systems. ! CAUTION Failure to observe the recommended tie bar arrangements could result in serious damage to the steering or components of the trim system. This damage could adversely affect control of the boat. Observe the recommended tie bar arrangements in this section. Internal Power-Assisted Steering With Internal Tie Bar Only For boats at the lower end of the performance spectrum�not capable of speeds in excess of 97 km/h (60 MPH)�we recommend the basic internal tie bar. An internal tie bar connects the slave sterndrive to the sterndrive which is directly connected to the factory power-assisted steering output. This internal tie bar is available in a variety of lengths from the sterndrive manufacturer. Internal Power-Assisted Steering With Internal and External Tie Bar For boats in the moderate performance range of 97�113 km/h. (60�70 MPH) or for a reduction in steering backlash, we recommend adding an external tie bar. External tie bars usually attach at the aft power trim cylinder bosses. This location is an excellent choice because of its proximity to the propeller. HOWEVER, because of the potential overstress that can occur if one sterndrive is trimmed much differently than the other, a dual trim control kit (part number 90362A3) should be installed to limit this potential tilt differential to about 20�. IMPORTANT: Mercury Marine does not recommend the use of an external tie bar ONLY with no internal tie bar when using the internal power-assisted steering system. Doing so can cause excessive loads on the steering components on the sterndrive connected to the internal power-assisted steering system. These increased loads can damage the steering components, resulting in increased play in the steering. External Power-Assisted Steering For boats in the higher performance range�speeds in excess of 113 km/h (70 MPH)�or for reduction of additional steering backlash, we recommend external power-assisted steering. This normally will include an external tie bar mounted in the vicinity of the power-assisted steering cylinders, which are generally attached at the top of the driveshaft housing of the sterndrive. This steering system should not use an internal tie bar. You can attach these external steering cylinders either inboard (between) or outboard of the sterndrives. External Power-Assisted Steering With Low External Tie Bar For the fastest boats, over 129 km/h (80 MPH), or for the ultimate in steering backlash reduction, we recommend use of an external power-assisted steering, BUT (where mechanically possible) with the external tie bar mounted at the location of the trim cylinder boss as previously described in Internal Power-Assisted Steering with Internal and External Tie Bar. Again, this system does not use an internal tie bar. Page 1A-12 90-865612010 FEBRUARY 200 Important Information Section 1B - Maintenance Table of Contents MaintenancW 1 B Specifications...1B-3 Torque Specifications..............................1B-3 Approved Paints......................................1B-3 Power-Assisted Steering and Power Trim Fluids...1B-3 Fluid Capacities..1B-4 Maintenance Schedules.................................1B-4 Maintenance Intervals.............................1B-4 Sterndrive...1B-5 Inspection and Maintenance Schedule�Bravo Sterndrive...1B-5 Scheduled Maintenance..........................1B-5 Maintaining Fluid levels...................................1B-6 Power Trim Fluid......................................1B-6 Sterndrive Gear Lube..............................1B-7 Sterndrive Gear Lube Inspection............1B-12 Checking The Steering Fluid Level.........1B-13 Steering Fluid Level For The Remote Reservoir ....1B-15 Checking The Sterndrive Water Passages....1B-15 Sterndrive Water Inlets Check...............1B-15 Sterndrive Water Drain Check...............1B-16 Maintaining Lubrication................................1B-16 Steering System...................................1B-16 Transom Assembly.................................1B-18 Propeller Shaft.......................................1B-18 Engine Coupler......................................1B-19 Driveshaft Extension Models.................1B-20 Sterndrive, Bellows, and Engine Alignment ....1B-20 Steering Head and Remote Control Maintenance ....1B-21 Shift Cable...1B-21 Maintaining Torques....................................1B-22 Gimbal Ring U-bolt Nuts.......................1B-22 Rear Engine Mount................................1B-22 Corrosion Prevention ....1B-23 Maintaining Ground Circuit Continuity....1B-23 Anodes and MerCathode System Locations ....1B-23 Checking the Quicksilver MerCathode System ....1B-24 Power Package Exterior Surfaces..........1B-24 Boat Bottom Care.................................1B-25 Anti-fouling Paint...................................1B-25 Propeller..1B-27 Bravo One Propeller Hub General Information ....1B-27 Bravo Sterndrive Propeller Removal......1B-29 Bravo Sterndrive Propeller Installation...1B-33 Power Package Storage...............................1B-38 Engine Storage......................................1B-38 Sterndrive Storage................................1B-38 Flushing The Power Package.......................1B-38 Sterndrive Water Pickups.....................1B-38 Power Package Recommissioning...............1B-40 Engine..1B-40 Sterndrive...1B-40 90-865612010 FEBRUARY 2006 Page 1B- MaintenancW Senses and electrical current in the water when testing the MerCathode system. Use to check hull potential. 9188 Propeller Nut Tool 91-805457T 1 Aids in the removal and installation of the front propeller nut. Flushing Device 91-44357Q 2 10677 Attaches to the water intakes; provides a fresh water connection when flushing the cooling system or operating the engine. 9192 Lubricant, Sealant, AdhesiveX 25 Tube Ref No. Description Liquid Neoprene 34 Special Lubricant 101 42 U-joint and Gimbal Bearing Grease 80 SAE Engine Oil 30W 87 91 94 95 114 120 134 High Performance Gear Lube Engine Coupler Spline Grease Anti-Corrosion Grease 2-4-C Marine Lubricant with Teflon Power Trim and Steering Fluid Corrosion Guard Loctite 380 Special Tools Reference Electrode Where Used Part No. Clamps and terminals 92-25711-3 Steering cable Propeller shaft 92-802865A1 Propeller shaft splines Gimbal bearing grease insert Transom end grease fitting, engine end 92-802870A1 grease fitting, driveshaft grease fittings Steering system pivot points Tie bar pivot points Obtain Locally Pivot points, guide contact surfaces Gear lube monitor Sterndrive unit Coupler U-joint shaft splines and O-rings Propeller shaft Propeller shaft splines Propeller shaft Propeller shaft splines Power trim pump Power Trim Pump Painted surfaces Power Trim Pump 91-76675T 1 92-802854A1 92-802869A1 92-802867A1 92-802859A1 92-802880A1 92-802878-55 Obtain Locally Page 1B-2 90-865612010 FEBRUARY 200 MaintenancW Dual Water Pickup Flush Gearcase Seal Kit 91-881150K 1 Blocks off the front water inlet holes on the dual water inlet gearcases. Flushing Kit 91-849996T 1 9194 9195 Use for flushing gearcases with low water inlets. Specifications Torque Specifications NOTE: Securely tighten all fasteners not listed below. Description Oil fill and drain screw Oil vent screw Gimbal ring locknuts 3/8 in. U-bolt Gimbal ring locknuts 7/16 in. U-bolt Bravo One propeller nut Bravo Two propeller nut Bravo Three front dual propeller nut Bravo Three rear dual propeller nut Propeller shaft anode screw Approved Paints Description Mercury Light Gray Primer Mercury Phantom Black Power-Assisted Steering and Power Trim Fluids APPROVED POWER-ASSISTED STEERING FLUIDS Description Power Trim And Steering Fluid Dextron III Automatic Transmission Fluid APPROVED COMPACT HYDRAULIC POWER STEERING FLUIDS Description Hydraulic Helm Steering Fluid Nm lb. in. lb. ft. 4.5 40 4.5 40 72 53 95 70 75 55 Then align tabs with grooves 81 60 Then align tabs with groves 136 100 81 60 19 168 Part Number 92-802878 52 92-802878Q 1 Part Number 92-802880A1 Obtain Locally Part Number 92-862014Q1 90-865612010 FEBRUARY 2006 Page 1B- MaintenancW Description Part Number SeaStar� Hydraulic Fluid HA5430 Chevron� Aviation Fluid Mobil� Aero HFA Shell� Aero 4 Obtain locally Hydraulic Fluid meeting MIL Specification H5606C APPROVED POWER TRIM FLUIDS Description Part Number Power Trim And Steering Fluid SAE Engine Oil 30W SAE Engine Oil 40W 92-802880A1 Obtain locally Obtain locally Fluid Capacities NOTE: Unit Of Measurement: Milliliters (Fluid Ounces) NOTE: All capacities are approximate fluid measures. BRAVO STERNDRIVE FLUID SPECIFICATION8 Sterndrive Model Bravo One standard Bravo One X Series Bravo One XR Bravo Two standard Bravo Two X Series Bravo Three standard Bravo Three X Series Bravo Three XR Maintenance Schedules Maintenance Intervals Fluid Capacity includeX the Sterndrive and thW Gear lube MonitoU 2736 ml (92-1/2 oz.) 3209 ml (108-1/2 oz.) 2972 ml (100-1/2 oz.) Fluid Type Fluid Part Number High Performance Gear 92-802854A1 Lubricant Maintenance intervals and the corresponding tasks to be performed are based on an average boating application and environment. However, individual operating habits and personal preferences can have an impact on the suggested intervals. We have adjusted some maintenance intervals and their corresponding tasks to allow for these differences. In some cases these changes allow for more individual tasks in a single visit to the servicing dealer. Therefore, it is very important that the boat owner and the servicing dealer discuss the current maintenance schedule and develop appropriate maintenance intervals to coincide with individual operating habits, the environment, and maintenance preferences. ! CAUTION Always disconnect the battery cables from the battery before working around electrical system components to prevent injury and damage to the electrical system if a wire should accidentally cause a short circuit. Page 1B-4 90-865612010 FEBRUARY 200 MaintenancW Sterndrive Inspection and Maintenance Schedule�Bravo Sterndrive NOTE: Only perform the maintenance that applies to the particular power package. BEFORE EACH USE � Check the sterndrive gear lube level. � Check the trim pump fluid level. � Check the power-assisted steering fluid level. � Check the steering system for binding or loose components. � Visually check the hydraulic steering fittings and hoses for leaks or signs of damage. � Check the tie bar fasteners (dual engine installations) for proper tightness. � Check the sterndrive propeller blades for damage. WEEKLY � Check the sterndrive water inlets for debris or marine growth. � Inspect the sterndrive anodes and replace if 50 percent eroded. EVERY TWO MONTHS � Lubricate the propeller shaft and the retorque the nut (if operating in only freshwater, this maintenance may be extended to every four months). Scheduled Maintenance EVERY 100 HOURS OF USE OR ONCE YEARLY, WHICHEVER OCCURES FIRST NOTE: Only perform maintenance that applies to your particular power package � Touch up the paint on the power package. � Change the sterndrive gear lube. � Retorque the gimbal ring U-bolt nuts. � Check the steering system and remote control for loose, missing or damaged parts. Lubricate the cables and the linkages. � Standard models: Check continuity circuit for loose or damaged connections. Test MerCathode� unit output on Bravo models. EVERY 200 HOURS OR 3 YEARS NOTE: Only perform the maintenance that applies to the particular power package � Inspect the sterndrive U-joints. � Inspect and lubricate the splines on the U-joint shaft. � Inspect the U-joint bellows, the exhaust bellows or exhaust tube, the shift bellows, and the clamps of the gimbal housing. � Check the engine alignment. � Lubricate the gimbal bearing and the engine coupler. NOTE: Lubricate engine coupler every 50 hours if operated at idle for prolonged periods of time or if used in heavy boat applications. � Check the continuity circuit for loose or damaged connections. Test MerCathode� unit output. 90-865612010 FEBRUARY 200 Page 1B- Maintenance Page 1B-6 90-865612010 FEBRUARY 2006 Maintaining Fluid levels Power Trim Fluid CHECKING IMPORTANT: Check the fluid level with the sterndrive in the full down (in) position only. 1. Place the sterndrive in full down (in) position. 2. Observe the fluid level. The fluid level must be between the "MIN" and "MAX" lines on the reservoir. a b 7876 a - Reservoir b - "MIN" and "MAX" lines 3. Fill as necessary with the specified fluid. Refer to Filling. Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Power trim pump 92-802880A1 FILLING 1. If the fluid level is below the "MIN" line, the specified fluid must be added. 2. Remove the fill cap from the reservoir. NOTE: Fill cap is vented. a b 7701 Power trim pump reservoir shows the fluid level is below "MIN" line a - Fill cap assembly b - Fill cap installed Maintenance 90..865612010................A........2006 ..a......1....7 3.. A...................c.............................b...a..........A............................. .... a b 7876 a .. .. b .. ..a..........A................ ..ube Ref ..o. Description Where ..sed Part ..o. 114 ....a................................ .... 92..802880A1 4.. ....a.......................ca.... C..A..GI..G ....c..a...............................b..c.........c......a......a.......................a........... ....b........ Sterndrive Gear ..ube ! ....A.......... ......IR....M......A.. ..A..ARD.. Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directedb y local authorities. C....C..I..G ......E.. The gear lube level will fluctuate during operation. The gear lube level should be checked with the engine cold.. before starting. 1.. ......c................a........b...a........b.......................................a........b............. ....c..........................a............a............................illing.. ......48 b a Gear lube level shown is at the correct operating range a .. ..A..........a.... b .. ..A............A........ Maintenance ..a......1....8 90..865612010................A........2006 IMP..R..A...... If any water is visible at the bottom of the gear lube monitor or appears at the fill and drain plug hole.. or if the gear lube appears discolored.. Refer to Sterndrive Gear lube Inspection. ..I....I..G IMP..R..A...... If more than 5.. ml ..2 fl. o..... of ..igh Performance Gear ..ube is re..uired to fill the gear lube monitor.. a seal may be leaking. Damage to the sterndrive unit may occur due to lack of lubrication. 1.. ....a........b.....................b....................a.............A..........a......................c................a........b..............b.. a.......... 2.. ....a........b...................ca.... 3.. ....a........b..c................a...............b.............a................a........b............................ ....a............a.. ......4.. b a c Gear lube monitor a .. ....a........b................a..............A..........a.... b .. ....a........b................a.......... ..........A............A........ c .. ..a.. ..ube Ref ..o. Description Where ..sed Part ..o. 87 ....a..c........a........b.. ....a........b................. 92..802854A1 4.. ....a................bb........a...a........b....................ca....a.............a................ca.... .... a ....2 a .. ....a........b...................ca.. ......E.. When filling the entire sterndrive.. refer to ....anging . Maintenance 90-865612010 FEBRUARY 2006 Page 1B-9 CHANGING 1. Remove the gear lube monitor from the bracket. 5500 c b a a - Gear lube monitor bracket b - Gear lube monitor and cap c - Retaining strap 2. Disconnect the gear lube monitor hose at the quick connect fitting. b 14625 a c a a - Hose b - Gear luge monitor c - Quick connect fitting 3. Empty the contents of the gear lube monitor into a suitable container. 4. Install the gear lube monitor in the bracket. 5. Reconnect the gear lube monitor hose at the quick connect fitting. 6. Bravo One Models: a. Remove the propeller b. Lower the sterndrive unit to the full down (in) position. c. Remove the gear lube fill and drain plug and sealing washer. Maintenance Page 1B-10 90-865612010 FEBRUARY 2006 d. Drain the gear lube into a suitable container a mc79506-1 b a - Fill and drain plug b - Sealing washer 7. Bravo Two models and Bravo Three models: a. Place the sterndrive unit in full trim limit out position. b. Remove the fill and drain plug and sealing washer. c. Drain the gear lube into a suitable container. a b 14621 a b 19777 Bravo Two Bravo Three a - Fill and drain plug b - Sealing washer 8. Remove the vent plug and sealing washer. Allow the gear lube to drain completely. a b 19066 a - Vent plug b - Sealing washer IMPORTANT: If any water drained from the fill and drain plug hole, or if the gear lube appears milky, the sterndrive is leaking. Refer to Sterndrive Gear lube Inspection. 9. Lower the sterndrive so that the propeller shaft is level. Maintenance 90..865612010................A........2006 ..a......1....11 10.. ....a..........a..c................a........b............. a....a......................a.............b.. ..ube Ref ..o. Description Where ..sed Part ..o. 87 ....a..c........a........b.. .... 92..802854A1 IMP..R..A...... ..se only Mercury....uicksilver ..igh Performance Gear ..ube in the sterndrive unit. 11.. ....a.................................a..........a............a.......... 12.. ....a........b...a..........a... ....a........b......a......a.......................a........b................... 13.. ....a........b.............................a...............a........b...a............a..................... ....4.. b a c Gear lube monitor a .. ....a........b................a..............A..........a.... b .. ....a........b................a.......... ..........A............A........ c .. ..a.. Sterndrive Model ..luid Capacity includes the Sterndrive and the Gear lube Monitor ..luid ..ype ..luid Part ..umber ....a.................a....a.... ....a............................ ....a................. 2736............92..1..2.......... ....a..c........a.. ....b.. ....a.................a....a.... 92..802854A1 ....a............................ 3209..........108..1..2.......... ....a.....................a....a.... ....a................................ ....a...................... 2972..........100..1..2.......... 14.. ....a................bb........a...a........b....................ca....a.............a.................. .... a ....2 a .. ....a........b...................ca.. Maintenance Page 1B-12 90-865612010 FEBRUARY 2006 15. Remove the pump from the sterndrive fill and drain plug hole. 16. Quickly install the sealing washer and the fill and drain plug. Tighten securely. a mc79506-1 b a b 14621 a b 19777 All Bravo Models Shown a - Fill and drain plug b - Sealing washer 17. Install the sterndrive propeller. Refer to Propeller. 18. Recheck the gear lube level at the gear lube monitor after the first use. Refer to Maintaing Fluid Levels. IMPORTANT: The gear lube level in the gear lube monitor will rise and fall during sterndrive operation; always check the gear lube level when the sterndrive is cool and the engine is shut down. Sterndrive Gear Lube Inspection 1. Periodically inspect the gear lube for water to ensure that sterndrive seals are not leaking. 2. Check for water at the bottom of the gear lube monitor. If a water leak is indicated, you must reseal the sterndrive. IMPORTANT: If the sterndrive has sat overnight or longer, check for water in the sterndrive. MaintenancW a. Bravo One: Trim the sterndrive to the full DOWN/IN position 14620 a b Bravo One modeO a - Fill and drain plug b -Sealing washer b Bravo Two and Bravo Three: Trim the sterndrive to the full UP/OUT position. a b 14621 a b 19777 Bravo Two model Bravo Three model a -Fill and drain plug b -Sealing washer c Remove the fill and drain plug. If water runs out, the sterndrive is leaking and must be resealed. Checking The Steering Fluid Level ENGINE WARM 1 Using the steering wheel, position the sterndrive so that it is in the straight ahead position. 2 Stop the engine. 90-865612010 FEBRUARY 200 Page 1B-1 MaintenancW 3. Remove fill cap from power-assisted steering pump and note fluid level a b 10053 a -Fill cap/dipstick b -Power-assisted steering pump 4. The fluid level should be between the FULL HOT and ADD marks on the dipstick. 10054 a a -Proper fluid level with the engine warm 5 If the fluid level is below the ADD mark but fluid is still visible in pump reservoir, add the required amount of fluid through the fill cap opening, to bring the level up to the FULL HOT mark on the dipstick. Do not overfill. Tube Ref No. DescriptioS Where Used Part No. 114 134 Power Trim and Steering Fluid Power Trim Pump 92-802880A Loctite 380 Power Trim Pump Obtain Locally 6. If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct. ENGINE COLD 1. Using the steering wheel, position the sterndrive so that it is in the straight ahead position. 2. Stop the engine. 3. Remove fill cap from the power-assisted steering pump and note the fluid level. 4. The fluid level should be between the FULL COLD mark and bottom of dipstick. a 10056 a -Proper fluid level with engine cold Page 1B-1 90-865612010 FEBRUARY 200 MaintenancW 5 If the fluid level is below bottom of the dipstick but fluid is still visible in the pump reservoir, add the required amount of fluid through the fill cap opening to bring level up to the FULL COLD mark on the dipstick. Do not overfill. Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Power Trim Pump 92-802880A1 134 Loctite 380 Power Trim Pump Obtain Locally 6 If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct. Steering Fluid Level For The Remote Reservoir 1 Using the steering wheel, position the sterndrive so that it is in the straight ahead position. 2 Remove fill cap from power-assisted steering pump and note fluid level. 3 The fluid level should be in the operating range on the dipstick. a b c d 21690 Remote reservoir for the 8.1 liter (496) engine power-assisted steering system a -Reservoir c -Operating range b -Fill cap d -Add range 4 If the fluid level is in the add range but fluid is still visible in pump reservoir, add the required amount of fluid through the fill cap opening, to bring the level up to the operating range on the dipstick. Do not overfill. Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Power Trim Pump 92-802880A1 134 Loctite 380 Power Trim Pump Obtain Locally 5 If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct. Checking The

Sterndrive Water Passages Sterndrive Water Inlets Check 1. Obtain a piece of wire the approprite size to insert into the water inlets holes. 2. Insert the wire in and out of the sterndrive water inlets to ensure that they are open and to remove debris or marine growth. Do not scrape the sterndrive paint. 90-865612010 FEBRUARY 200 Page 1B-1 Maintenance Page 1B-16 90-865612010 FEBRUARY 2006 3. Remove the wire from the sterndrive and retain for periodic water inlet checks. a b c 8781 a - Dual water pickup water inlets b - Low water pickup water inlets c - Side pickup water inlets Sterndrive Water Drain Check 1. Obtain a piece of wire the approprite size to insert into the water drain holes. 2. Insert the wire in and out of the sterndrive water drain holes to ensure that they are open and to remove debris or marine growth. Do not scrape the sterndrive paint. 3. Remove the wire from the sterndrive and retain for periodic water drain checks. a b d c e 14627 Sterndrive water drain holes a - Speedometer pitot tube b - Anode cavity vent hole c - Anode cavity drain passage d - Gear housing water drain hole (1 each - port and starboard) e - Gear housing cavity vent hole (Bravo II only) Maintaining Lubrication Steering System 1. Lubricate the steering system. ! CAUTION Do not grease the steering cable while its extended. Hydraulic lock could occur and cause loss of steering control. MaintenancW a. If steering cable has grease fittings, turn steering wheel until steering cable is fully retracted into cable housing. b. Apply approximately 3 pumps of grease from a typical hand-operated grease gun. NOTE: If steering cable does not have grease fitting, inner wire of cable cannot be greased 6221 a a -Steering cable grease fitting Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Steering cable 92-802865A1 c. Turn the steering wheel until the steering cable is fully extended. Lightly lubricate the exposed part of cable. a 6222 a -Extended the steering cable Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Steering cable 92-802865A1 90-865612010 FEBRUARY 2006 Page 1B-1 Maintenance Page 1B-18 90-865612010 FEBRUARY 2006 d. Lubricate the steering system pivot points. mc71904-1 a a - Steering system pivot points Tube Ref No. Description Where Used Part No. 80 SAE Engine Oil 30W Steering system pivot points Obtain Locally e. On Dual Engine Boats: Lubricate the tie bar pivot points. Tube Ref No. Description Where Used Part No. 80 SAE Engine Oil 30W Tie bar pivot points Obtain Locally f. Upon first starting engine, turn steering wheel several times to starboard and then port to ensure that the steering system operates properly before getting underway. Transom Assembly 1. Lubricate the gimbal bearing by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun. a 19979 a - Gimbal bearing grease insert Tube Ref No. Description Where Used Part No. 42 U-joint and Gimbal Bearing Grease Gimbal bearing grease insert 92-802870A1 Propeller Shaft NOTE: Refer to Propeller Removal. 1. Lubricate the sterndrive propeller shaft. Maintenance 90-865612010 FEBRUARY 2006 Page 1B-19 a. Apply a liberal coat of one of the following lubricants to the propeller shaft. a a 20335 a - Propeller shaft Tube Ref No. Description Where Used Part No. 94 Anti-Corrosion Grease Propeller shaft 92-802867A1 34 Special Lubricant 101 Propeller shaft 92-802865A1 95 2-4-C Marine Lubricant with Teflon Propeller shaft 92-802859A1 Engine Coupler 1. Lubricate engine coupler splines through grease fittings on coupler by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun. NOTE: If equipped with a sealed engine coupler, the sealed coupler and shaft splines can be lubricated without removing the sterndrive. Apply lubricant from a typical hand-operated grease gun. NOTE: If the boat is operated at idle for prolonged periods of time or if used in heavy boat applications, Bravo model aluminum coupler should be lubricated every 50 hours. a a 14535 Sealed steel coupler Steel coupler a - Engine coupler grease fitting Tube Ref No. Description Where Used Part No. 91 Engine Coupler Spline Grease Coupler 92-802869A1 MaintenancW Driveshaft Extension ModelX 1. Lubricate the transom end grease fitting and engine end grease fitting by applying approximately 10 - 12 pumps of grease from a typical hand-operated grease gun. 2. Lubricate the driveshaft grease fittings by applying approximately 3 - 4 pumps of grease from a typical hand-operated grease gun. a b a c 17014 a -Driveshaft grease fittings c -Engine end grease fitting b -Transom end grease fitting Tube Ref No. Description Where Used Part No. 42 U-joint and Gimbal Bearing Grease Transom end grease fitting, engine end grease fitting, driveshaft grease fittings 92-802870A1 Sterndrive, Bellows, and Engine Alignment NOTE: The sterndrive is removed from the boat for this procedure. Refer to Section 3A� Bravo Sterndrive Removal. 1. Lubricate the U-joint shaft splines and the O-rings. b a 19867 a -U-joint shaft splines b -U-joint shaft O-rings Tube Ref No. Description Where Used Part No. 91 Engine Coupler Spline Grease U-joint shaft splines and O-rings 92-802869A1 2. Inspect U-joint bellows for cracks or other signs of deterioration. Ensure that the bellows clamps are tight. Page 1B-20 90-865612010 FEBRUARY 200 Maintenance 90-865612010 FEBRUARY 2006 Page 1B-21 3. Rotate the bell housing in the upward and side to side directions to inspect the exhaust bellows, exhaust tube, shift bellows, and clamps. 4. a f b c d e 19783 a - U-joint bellow b - Exhaust bellow c - Bell housing d - Gimbal ring e - Gimbal housing f - Shift bellows 5. Check the engine alignment. Refer to Section 2A�Engine Alignment. Steering Head and Remote Control Maintenance 1. Lubricate the steering head and remote control at recommended intervals. Inspect steering head and remote control for ease of operation. Tube Ref No. Description Where Used Part No. 80 SAE Engine Oil 30W Pivot points, guide contact surfaces Obtain Locally Shift Cable 1. Lubricate the pivot points and the guide contact surfaces. a a a b b 14528 Typical a - Pivot points b - Guide contact surfaces MaintenancW Tube Ref No. Description Where Used Part No. 80 SAE Engine Oil 30W Pivot points, guide contact surfaces Obtain Locally Maintaining Torques Gimbal Ring U-bolt Nuts NOTE: The gimbal ring is a componant of the transom assembly. 1. Torque the gimbal ring U-bolt nuts. 19624 a b a -Transom assembly b -Gimbal ring U-bolt nuts Description Gimbal ring U-bolt nuts for 3/8 in. U-bolt Gimbal ring U-bolt nuts for 7/16 in. U-bolt Rear Engine Mount Nm 72 95 lb. in. lb. ft. 53 70 NOTE: Not required on some engine models. Refer to the engine manufacturer for engine mount torque maintenance . Page 1B-22 90-865612010 FEBRUARY 200 Maintenance 1 ....b..........a................a.............a............... 19978a b c ..ypical gasoline engine package a .. ....a.........................W c .. ..W b .. ....a.............a.............W Description ..m lb. in. lb. ft. ....a............................b......4735 Corrosion Prevention ....U ....R ......H ..Mercury Precision Parts .. Marine Corrosion Protection Guide ..90..881813003.. Maintaining Ground Circuit Continuity ....a..........a.......b......a..........................a..................................a..........................c....c.......................H ......G ....c......caO ..c...............\ ..b..........Q ......H ....a......P ..a........b.... ..a..G ....H c................. ....G ..c................\ ....V ....aO ......U ......H ....a........H ....P ....R ....c......Q ....c.................................Section ..D.. Corroision Protection Anodes and MerCathode System ..ocations IMP..R..A...... Replace sacrificial anodes if eroded 50 percent or more. ....ac........c..a....a...........a.............a...........a..........................ca..ac..a.... ....a..............................c....a..a...........a....a....c..c................b......ac........c....................a..........b.............\ ....a......................a....c...ac..a.... MerCathode System.. ......c............a........b.............ac.............A..........b....c.................................bH ....a........a...b..................................b..a..................... ....c............................c..........c...........a......................... 90..865612010................A........2006 ..a......1....23 Maintenance Page 1B-24 90-865612010 FEBRUARY 2006 Description Location Figure Gearcase anode plate Mounted on the underside of the lower gearcase. 20336 Ventilation plate anode Mounted on the front of the gearcase. 20338 MerCathode System The MerCathode electrode is mounted to the underside of the gimbal housing. The MerCathode controler is mounted on the engine or on the boat transom. The controler harness connects to the electrode harness. 20340 Anode kit (if equipped) Mounted to the boat transom. 20341 Trim cylinder anodes Mounted on each of the trim cylinders. 20342 Bearing carrier anode (Bravo One) Located in front of the propeller, between the front side of the propeller and the gear housing. 20343 Propshaft anode (Bravo Three) Located behind the aft propeller. 20344 Checking the Quicksilver MerCathode System The MerCathode system should be tested to ensure adequate output. Perform the test where boat is moored, using the reference electrode and test meter. Refer to Section 1D � Corrosion Protection. Reference Electrode 91-76675T 1 Power Package Exterior Surfaces 1. Spray the entire power package at recommended intervals with Corrosion Guard. Follow the instructions on the can for proper application. MaintenancW Tube Ref No. DescriptioS Where Used Part No. 120 Corrosion Guard Painted surfaces 92-802878-55 2 Clean the entire power package. External surfaces that have become bare should be repainted with the recommended primer and spray paint at recommended intervals. Description Part Number Mercury Light Gray Primer Painted surfaces 92-802878 52 Mercury Phantom Black 92-802878Q 1 Boat Bottom Care To achieve maximum performance and fuel economy, the boat bottom must be kept clean. Accumulation of marine growth or other foreign matter can greatly reduce boat speed and increase fuel consumption. To ensure best performance and efficiency, periodically clean the boat bottom in accordance with manufacturer's recommendations. In some areas, it may be advisable to paint the bottom to help prevent marine growth. Refer to the following information for special notes about the use of anti-fouling paints. Anti-fouling Paint IMPORTANT: Corrosion damage that results from the improper application of anti-fouling paint will not be covered by the limited warranty. You may apply anti-fouling paint to theboat hull and boat transom but you must observe the following precautions: IMPORTANT: Do not paint or pressure-wash the anodes or the MerCathode System reference electrode and anode. Doing so will render them ineffective as inhibitors of galvanic corrosion. 90-865612010 FEBRUARY 200 Page 1B-2 Maintenance Page 1B-26 90-865612010 FEBRUARY 2006 IMPORTANT: If anti-fouling protection is required for the boat hull or boat transom, you can use copper-based paint if it is not prohibited by law. If you are using copper based anti-fouling paint, observe the following precaution: � Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 40 mm (1-1/2 in.) UNPAINTED area on transom of the boat around these items. 8107 b a a - Painted boat transom b - Minimum 40 mm (1-1/2 in.) unpainted area around transom assembly NOTE: Sterndrive and transom assembly can be painted with a good marine paint or an anti-fouling paint that DOES NOT contain copper or any other material that could conduct electrical current. Do not paint drain holes, anodes, the MerCathode system or items specified by the boat manufacturer. ! CAUTION Improper boat-cleaning procedures can cause product damage. Washing the MerCathode assembly, especially with a brush or high-pressure washer, will damage the MerCathode assembly making it unable to inhibit galvanic corrosion. When cleaning the boat, do not use a brush or a high-pressure washer to wash the MerCathode assembly found on the bottom of the transom assembly. Maintenance 90-865612010 FEBRUARY 2006 Page 1B-27 Do not power-wash a sterndrive that has a MerCathode assembly. Doing so can damage the coating on the reference wire of the MerCathode assembly and increase corrosion. 21563 b a a - Reference electrode b - Anode plate Propeller Bravo One Propeller Hub General Information BRAVO ONE PROPELLER HUBS RATED FOR UNDER 400 HP a b c d e 20527 Flo-Torq II Hub a - Forward thrust washer b - Aft adaptor c - Plastic drive sleeve d - Prop nut e - Tab washer MaintenancW a b c d ef 20529 Flo-Torq II Hub with bushing a -Forward thrust washer d -Bushing b -Aft adaptor e -Tab washer c -Plastic drive sleeve f -Prop nut BRAVO ONE PROPELLER HUB RATED FOR 400 HP AND OVER d -Prop nut e -Tab washer a b c d e 20530 Flo-Torq II Solid Hub a -Forward thrust washer b -Steel drive sleeve c -Aft adaptor Page 1B-28 90-865612010 FEBRUARY 200 MaintenancW BRAVO ONE XR PROPELLER HUB a b c d e 20531 Flo-Torq II HD (heavy duty) Solid HuT a -Prop nut b -Steel drive sleeve with snubber stripes c -Washer d -Washer e -Thick washer Bravo Sterndrive Propeller Removal ! WARNING Avoid Injury: Remote Control must be in NEUTRAL and ignition key removed from switch before removing and/or installing propeller. ! WARNING Avoid Injury: Place a block of wood between anti-ventilation plate and propeller to protect hands from propeller blades and to prevent propeller from rotating when removing propeller nut. BRAVO ONE MODELS NOTE: Bravo One XR models do not use the tab washer. 1. If Equipped, straighten the bent tabs of the tab washer on the propeller shaft. e c d ba 4750 a -Prop b -Tab washer c -Drive sleeve adapter d -Tab bent down e -Propeller nut 90-865612010 FEBRUARY 2006 Page 1B-29 MaintenancW 2. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. a b c 4826 a -Wood block b -Propeller c -Propeller nut under socket 3. 4. Turn the propeller shaft nut counterclockwise and remove the nut. Slide the propeller and the attaching hardware from the propeller shaft. a b c d e f g 5301 Bravo One models a -Propeller shaft splines e -Drive sleeve adapter b -Forward thrust hub f -Tab washer c -Flo-Torque II drive hub g -Propeller nut d -Propeller Page 1B-30 90-865612010 FEBRUARY 200 MaintenancW a b c d e f g 19816 Bravo One XR models a -Propeller shaft e -Washer b -Propeller hub insert with snubbers f -Washer c -Propeller g -Propeller nut d -Thrust washer BRAVO TWO MODELS 1. Straighten the bent tabs of the tab washer on the propeller shaft e c d ba 4750 a -Prop d -Tab bent down b -Tab washer e -Propeller nut c -Drive sleeve adapter 90-865612010 FEBRUARY 2006 Page 1B-3 MaintenancW 2. Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. a b c 4826 a -Wood block b -Propeller c -Propeller nut under socket 3. 4. Turn propeller shaft nut counterclockwise to remove nut. Slide the propeller and attaching hardware from the propeller shaft. 8566 a b c f d e Bravo Two a -Propeller shaft splines d -Spline washer b -Forward thrust hub e -Tab washer c -Propeller f -Propeller nut BRAVO THREE MODELS 1 Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. 2 Remove the bolt and washers securing the propeller shaft anode. Page 1B-3 90-865612010 FEBRUARY 200 Maintenance 90-865612010 FEBRUARY 2006 Page 1B-33 3. Remove the propeller shaft anode. b d c e f 19058 a a - Propeller b - Propeller shaft nut c - Propeller shaft anode d - Propeller shaft anode screw e - Flat washer f - Star washer 4. Turn aft propeller shaft nut counterclockwise to remove nut. 5. Slide propeller and thrust hub off propeller shaft. 6. Use the Propeller Nut Tool, turn the front propeller shaft nut counterclockwise and remove the nut. Propeller Nut Tool 91-805457T 1 7. Slide the propeller and the thrust hub off the propeller shaft. e f a b c d 5304 g h i j Bravo Three a - Aft propeller nut b - Aft propeller c - Aft propeller thrust hub d - Front propeller nut e - Front propeller f - Front propeller thrust hub g - Propeller shaft anode screw h - Flat washer i - Star washer j - Propeller shaft anode Bravo Sterndrive Propeller Installation ! WARNING Ensure that remote control is in NEUTRAL position and ignition key is removed from switch prior to installing propeller. MaintenancW ! WARNING Place a block of wood between the anti-ventilation plate and propeller to protect handX from propeller blades and to prevent propeller from turning when tightening propeller nut. a b c 4826 a -Wood block c -Propeller nut under socket b -Propeller BRAVO ONE MODELS IMPORTANT: Use the correct rotation propeller. The propeller rotation MUST match the direction of rotation of the propeller shaft. 1. Liberally coat the propeller shaft spline with one of the following Quicksilver lubricants. Tube Ref No. Description Where Used Part No. Special Lubricant 101 Propeller shaft splines 92-802865A1 2-4-C Marine Lubricant with Teflon Propeller shaft splines 92-802859A1 Anti-Corrosion Grease Propeller shaft splines 92-802867A1 34 95 94 NOTE: Anti-corrosion grease is for salt water applications only. 2. Install the propeller with the attaching hardware as shown. 3. Torque the propeller nut. a b c d e f g 5301 Typical Bravo One models a -Propeller shaft splines e -Drive sleeve adapter b -Forward thrust hub f -Tab washer c -Flo-Torque II drive hub g -Propeller nut d -Propeller Page 1B-34 90-865612010 FEBRUARY 200 MaintenancW a b c d e f g 19816 Bravo One XR models a -Propeller shaft e -Washer b -Propeller hub insert with snubbers f -Washer c -Propeller g -Propeller nut d -Thick washer NOTE: The propeller torque stated is a minimum torque value. Then align tabs with grooves Description Nm lb. in. lb. ft. 75 55 Bravo One propeller nut NOTE: Bravo One XR models do not use the tab washer. 4 Models equipped with the tab washer: Continue to tighten the propeller nut until the 3 tabs on the tab washer align with the grooves on the spline washer. 5 Bend the 3 tabs down into the grooves. e c d ba 4750 a -Prop d -Tab bent down b -Tab washer e -Propeller nut c -Drive sleeve adapter BRAVO TWO MODELS IMPORTANT: Use the correct rotation propeller. The propeller rotation MUST match the direction of rotation of the propeller shaft. 1 Liberally coat the propeller shaft spline with one of the following Quicksilver lubricants. 90-865612010 FEBRUARY 200 Page 1B-3 MaintenancW Tube Ref No. Description Special Lubricant 101 2-4-C Marine Lubricant with Teflon Anti-Corrosion Grease 34 95 94 Where Used Part No. Propeller shaft splines 92-802865A1 Propeller shaft splines 92-802859A1 Propeller shaft splines 92-802867A1 NOTE: Anti-corrosion grease is for salt water applications only. 2. Install the propeller with the attaching hardware as shown. 3. Torque the propeller nut. 8566 a b c f d e Bravo Two a -Propeller shaft splines d -Spline washer b -Forward thrust hub e -Tab washer c -Propeller f -Propeller nut NOTE: The propeller torque stated is a minimum torque value. Then align tabs with groves Description Nm lb. in. lb. ft. 81 60 Bravo Two propeller nut 4 Continue to tighten the propeller nut until the 3 tabs on the tab washer align with the grooves on the spline washer. 5 Bend the 3 tabs down into the grooves. e c d ba 4750 a -Prop d -Tab bent down b -Tab washer e -Propeller nut c -Drive sleeve adapter Page 1B-3 90-865612010 FEBRUARY 200 MaintenancW BRAVO THREE 1. Liberally coat the propeller shaft spline with one of the following Quicksilver lubricants. Tube Ref No. Description Special Lubricant 101 2-4-C Marine Lubricant with Teflon 2-4-C Marine Lubricant with Teflon 34 95 95 Where Used Part No. Propeller shaft splines 92-802865A1 Propeller shaft splines 92-802859A1 Propeller shaft splines 92-802859A1 NOTE: Anti-corrosion grease is for salt water applications only. 2. Slide forward thrust hub onto propeller shaft, with tapered side toward propeller hub. 3. Align splines and place front propeller on propeller shaft. 4. Install front propeller locknut and torque using the Propeller Nut Tool. Propeller Nut Tool 91-805457T 1 Description Nm lb. in. lb. ft. Bravo Three front propeller nut 136 100 5. Slide aft thrust hub onto propeller shaft with tapered side toward propeller hub 6. Align splines and install aft propeller. 7. Install propeller nut and torque. NOTE: The propeller torque stated is a minimum torque value. Description Nm lb. in. lb. ft. Bravo Three rear propeller nut 81 60 8. Install propeller shaft anode and screw and torque. e f a b c d 5304 g h i j Bravo Three a -Rear propeller nut b -Rear propeller c -Rear propeller thrust hub d -Front propeller nut e -Front propeller f -Front propeller thrust hub g -Propeller shaft anode screw h -Flat washer i -Star washer j -Propeller shaft anode Description Nm lb. in. lb. ft. Propeller shaft anode screw 19 168 90-865612010 FEBRUARY 2006 Page 1B-3 Maintenance Page 1B-38 90-865612010 FEBRUARY 2006 Power Package Storage Engine Storage Refer to the appropriate Engine Service Manual. Sterndrive Storage 1. Perform all procedures listed. Refer to Section 1B� Maintenance for procedure instruction: Sterndrive Gear Lube�Changing Sterndrive Water Drain Check Sterndrive Water Inlet Check Steering System Shift Cable Transom Assembly Propeller Shaft Engine Coupler Driveshaft Extension Models Sterndrive, Bellows and Engine Alignment Gimbal Ring U-Bolt Nuts Rear Engine Mount (if applicable) 2. Store the sterndrive in the trim-in (down) position. Flushing The Power Package IMPORTANT: Bravo sterndrive power packages have various flushing procedures. Refer to the appropriate Mercury MerCruiser Engine Service Manual. Sterndrive Water Pickups There are three types of water pickups available on Mercury MerCruiser sterndrives: low water, dual water, and side water pickups. a b c 8781 a - Dual water pickup b - Low water pickup c - Side water pickup INSTALLING STERNDRIVE FLUSHING ATTACHMENTS NOTE: Flushing is needed only for salty, brackish, mineral laden, or polluted water applications. Flushing is recommended after each outing for best results. MaintenancW IMPORTANT: Bravo sterndrive power packages have various flushing procedures. Refer to the appropriate Mercury MerCruiser Engine Service Manual. 1. Dual water pickups: a. Install the dual water pickup flush gearcase seal kit. b. Install the flushing device. c. Attach a garden hose to the hose attachment on the flushing device. a b c 21514 Flushing attachments for the sterndrive with dual water pickup a -Flushing device c -Dual water pickup flush gearcase b -Hose attachment seal kit Flushing Device 91-44357Q 2 Dual Water Pickup Flush Gearcase Seal Kit 91-881150K 1 2. Side water pickups: a. Install the flushing device. b. Attach a garden hose to the hose attachment on the flushing device. a b 21515 Flushing attachment for the sterndrive with side water pickups a -Flushing device b -Hose attachment Flushing Device 91-44357Q 2 90-865612010 FEBRUARY 2006 Page 1B-3 MaintenancW 3 Low water pickups: a. Install the flushing kit. b. Attach a garden hose to the hose attachment on the flushing kit. b a 21513 Flushing attachment for the sterndrive with low water pickupX a -Flushing kit b -Hose attachment Engine Power PaFlushing Kit ckage Recommissioning 91-849996T 1 Refer to appropriate Mercury MerCruiser Engine Service Manual. Sterndrive 1 Perform ALL maintenance specified for completion annually in Maintenance Chart except items that were performed at the time of sterndrive layup. 2 Apply a thin coat of petroleum based grease to clamps and terminals to help retard corrosion. Tube Ref No. DescriptioS Where Used Part No. 25 Liquid Neoprene Clamps and terminals 92-25711-3 3 After recommissioning and starting engine, check steering system and shift control for proper operation. 4 Check all fluid levels before and after first use. Page 1B-4 90-865612010 FEBRUARY 200 1 C Troubleshooting Important Information Section 1C - Troubleshooting Table of Contents Troubleshooting...1C-2 Power Shift...1C-5 Performance Troubleshooting.........................1C-6 Power-Assisted Steering................................1C-7 Compact Hydraulic Steering..........................1C-8 Important Information..............................1C-8 Power Trim Electrical System.........................1C-9 Power Trim System Wiring Diagram.............1C-14 Power Trim System...............................1C-14 Power Trim Hydraulic System......................1C-15 Power Trim Hydraulic Schematic..................1C-17 Corrosion Protection.....................................1C-18 Testing Procedure for Corrosion Protection ....1C-20 Corrosion Symptoms.............................1C-21 MerCathode System ....1C-21 90-865612010 FEBRUARY 2006 Page 1C- Troubleshooting Troubleshooting This section is a guide for performance and product troubleshooting. Cross-references to specific sections of this manual are made where special tests or repair procedures are to be performed. Because of the relationship between power package components (engine and sterndrive), it will be necessary in some cases to simultaneously refer to the appropriate Mercury MerCruiser engine service manual for further troubleshooting information. Effective troubleshooting is performed best when: � Enhanced by the personal product knowledge and experience of the trained mechanic or technician � Adequate time is allowed for testing and analysis � Utilizing these charts as a guide, a starting point Sterndrive Will Not Slide Into Bell Housing Cause Drive installs into bell housing but stops short about one inch and will not allow complete contact with the bell housing. U-joint shaft splines are not aligned with the engine coupler splines. Engine is not aligned. Gimbal bearing not properly installed. Damaged U-joint shaft splines or engine coupler splines. Special Instructions Align U-joint splines with engine coupler, grease o-ring on U-joint splined shaft. Rotate the propeller shaft COUNTERCLOCKWISE to align the splines. Check engine alignment. Check engine alignment to determine if the gimbal bearing is angled or improperly installed in the gimbal housing. Inspect and replace if necessary. Sterndrive Does Not Shift Into Gear; Remote Control Shift Handle MoveV Cause Shift cable core wire missed the shift slide in the drive when the drive was installed. Shift cables improperly adjusted. Shift cables not connected. Inner core wire broken or loose. Special Instructions Remove the drive and make sure the cable engages into the shift slide when the drive is reinstalled. Adjust the shift cables. Install and adjust the shift cables. Reconnect or replace the inner core wire. NOTE: For additional information on troubleshooting, refer to Section 2A� Troubleshooting Shift Problems. Sterndrive Does Not Shift Into Gear; Remote Control Shift Handle Does Not Move Cause Control box is not properly assembled. Broken or damaged linkage in the control box. Controls are improperly adjusted, or cable end guide is hitting the brass barrel. Special Instructions Properly reassemble the control box. Repair the linkage. Adjust the shift cables. NOTE: For additional information on troubleshooting, refer to Section 2A� Troubleshooting Shift Problems. Page 1C- 90-865612010 FEBRUARY 200 Troubleshootinb Sterndrive Shifts Har_ Cause Shift cables are improperly adjusted. A damaged remote control or sterndrive shift cable. Shift cable is too short (sharp bends) or too long (loops and long bends). Corroded shift cables Internal wear in the remote control box. Shift cable attaching nuts are too tight (the end cannot pivot). Shift cable pivot ends are corroded or not lubricated. Special Instructions Adjust the shift cables. Replace cables and adjust. Select and install a cable of proper length. Replace, adjust, and check for water leakage. Repair as needed. Install nuts properly. Clean and lubricate. NOTE: For additional information on troubleshooting, refer to Section 2A� Troubleshooting Shift Problems Sterndrive In Gear, Will Not Shift Out Of Gear Cause Shift cable is broken. Cable end is not connected in the sterndrive. Remote control is damaged. Internal shift mechanism is damaged. Special Instructions Replace the cable and adjust it. Remove and reinstall the sterndrive. Repair or replace the remote control. Repair or replace as necessary. NOTE: For additional information on troubleshooting, refer to Section 2A� Troubleshooting Shift Problems Gear Housing Noise Cause Metal particles in the sterndrive lubricant. Propeller is incorrectly installed. Propeller with untrue or out-of-balance blades. Propeller shaft is bent. Incorrect gear shimming. Worn or damaged gears and/or bearings caused by impact, overheating or improper shimming. Driveshaft Housing Noise Cause Engine flywheel housing is making contact with the inner transom plate or exhaust pipe. Abnormal sterndrive operation. Special Instructions Disassemble, clean, and inspect and replace the necessary components. (Refer to Section 3B, 3C, or 3D.) Inspect the mounting hardware. Install the propeller correctly. Repair or replace the propeller as required. Inspect and replace if necessary. (Refer to Section 3B, 3C, or 3D.) Check the backlash of the gear housing and the height of the pinion gear. (Refer to Section 3B, 3C, or 3D.) Disassemble, inspect and replace. (Refer to Section 3B, 3C, or 3D.) Special Instructions Determine the cause for the interference (loose engine mounts, transom that is too thin, etc.) and correct as necessary. Instruct the operator on proper operating technique. 90-865612010 FEBRUARY 2006 Page 1C- Troubleshootinb Caus` Special Instructions Ensure that the retaining rings are the proper U-joint cross and bearing retaining rings are improperly thickness and that the rings are fully seated installed or of incorrect size. in U-joint bearing cap grooves. (Refer to Section 3A.) Excessive side-to-side play in the U-joint cross and bearing Replace the cross and bearing. Ensure that proper cross and bearing U-joint bearing caps making contact with U-joint bellows assemblies are used. If interference is retention sleeve. severe, replace cross and bearing assembly and / or sleeve assembly. Replace the U-joint cross and bearings. Signs of scoring, galling, or roughness are U-joint cross and bearings are damaged or worn. the result of a lack of lubricant. (Refer to Section 3A). O-rings on U-joint shaft missing or flattened out, causing the Install new O-rings. (Refer to Section 3A.) shaft to rattle against inner race of gimbal bearing. Remove U-joint coupling end yoke and insert into gimbal bearing and engine coupling. Worn U-joint shaft splines and/or engine coupler splines Rotate shaft back and forth. If play is excessive, replace U-joint coupling end yoke and/or engine coupler, as necessary. Engine alignment is incorrect or the engine coupler is crooked. Gimbal bearing is rough. Loose gimbal bearing. Adjust the alignment. Ensure that the alignment tool moves in and out of the coupler freely. Upon completion of proper alignment, check for a crooked coupler by rotating the engine coupler 1/2 turn and rechecking alignment. The coupler is crooked and must be replaced if proper alignment is no longer observed. (Refer to Section 2.) Replace the gimbal bearing. (Refer to Section 4). IMPORTANT: The gimbal bearing and carrier must be replaced as an assembly because they are a matched set. Failure to change the assembly as a matched set may result in a loose bearing fit in the carrier. If the carrier is loose in the gimbal housing, reinstall the bearing assembly using a new tolerance ring. If the bearing is loose in the carrier, the bearing assembly must be replaced. (Refer to Section 4.) Press sterndrive bearing assembly into Gimbal bearing is not fully seated in the gimbal housing. place. Excessive clearance between the gimbal ring and the gimbal Check and adjust the clearance. (Refer to housing, causing misalignment between bell housing and Section 4.) gimbal housing. May also allow the gimbal ring to vibrate. Check for uneven mount height, or loose or soft mounts. Make sure there is clearance Improperly installed or failed rear engine mounts, affecting between flywheel housing and fiber washer. engine alignment, but usually is not detectable with engine If no clearance exists, mounts have probably alignment tool. sagged. Install mounts correctly or replace, as necessary. Boat transom too thin. Thickness: 51 mm (2 in.) minimum, Add thickness to the transom. 57 mm (2-1/4 in.) maximum. Page 1C- 90-865612010 FEBRUARY 200 Troubleshootinb Caus` Special Instructions Boat transom thickness uneven. This could affect engine to transom assembly alignment and is usually not detectable with Repair boat as necessary. alignment tool. Variation: 3 mm (1/8 in.) maximum. Check for soft or split trim cylinder bushings Bell housing contacting gimbal ring. This would cause knocking and loose or worn hinge pin bushings. (Refer in the fully trimmed IN position only. to Section 5B.) Stringer height uneven or transom assembly installed angled on boat transom. This will affect engine alignment, but is usually not detectable with alignment tool. Measure the distance between the engine flywheel housing and the inner transom plate on both sides. If distances are uneven, the problem may be due to uneven stringer height or a cocked transom assembly. Adjust the stringer height or relocate the transom cutout as required. This condition can sometimes be detected by Weak boat transom or boat bottom that flexes under power and having someone apply force to the top of the causes engine misalignment - this condition will usually cause sterndrive while watching the inner transom engine coupler failure. plate. If movement can be observed, the transom is weak and must be repaired. Rear engine mount attaching hardware improperly installed or Reinstall hardware correctly. missing. Ensure that the holes are equally spaced fore Engine mounting holes drilled off-center in inner transom plate and aft and are equal distance from the engine supports or engine flywheel housing. center line. Contact your service center and arrange to Misalignment between bell housing, gimbal housing and engine have a technical service representative coupler. check the unit using a special gauge. Power Shift System Does Not React Cause Special Instructions With engine running, check for vacuum leaks. Squirt oil on fitting and hose Vacuum leaks. connections and on the shift cylinder-to-end plate joint. If oil is sucked in at any point, a vacuum leak exists. Repair leak. Improper installation. Reinstall. System Binds Cause Special Instructions Remote control binds. Disconnect input cable at power shift cylinder. Disconnect throttle cable at carburetor or injector pump. Operate remote control. If binding occurs, find cause of binding in either cable or remote control and correct binding. If no binding occurs, check vacuum. Check vacuum drop-off. If vacuum drops off Slow or no shift to "0" psi in less than 5 seconds, install repair kit. Check movement of cable from shift plate to sterndrive including shifting linkage Cable movement binds or is incomplete movement in sterndrive for binding. Replace or adjust shift cable following procedures in Section 2A. 90-865612010 FEBRUARY 200 Page 1C- Troubleshooting Performance Troubleshooting Low WOT Engine RPM Cause Improper sterndrive trim angle. Damaged propeller. Improper propeller pitch. Dirty or damaged hull. Sterndrive installation too low on transom. Permanent hook in hull (some boats are built with a slight hook for correct boat performance). Power hook or weak hull. High WOT Engine RPM Cause Propeller is ventilating. Improper propeller pitch. Propeller hub slipping. Sterndrive installation too high on transom. Engine coupler hub spun. Propeller Ventilating and Cavitating Cause Sterndrive is trimmed too high. Incorrect propeller. Special Instructions Properly adjust the sterndrive trim angle. Repair or replace. Water-test boat using a propeller with a lower pitch . Clean or resurface hull. Contact boat manufacturer for installation specifications. Check for a hook in the hull by placing a straight edge, at least 2 m (6 ft) long, under the bottom edge of the transom. Contact the boat manufacturer if a hook is found. Water test the boat. The boat will perform normally until the hook develops at high speed, at which time the boat will lose RPM and speed. Contact the boat manufacturer. Special Instructions Determine the cause for ventilation. Water-test the boat using a higher pitch propeller. Replace the hub or replace the propeller. Contact the boat manufacturer for installation specifications. Replace coupler. Special Instructions Trim the sterndrive IN/DOWN. Install the correct propeller. Page 1C-6 90-865612010 FEBRUARY 200 Troubleshooting Poor Boat Performance And/Or Poor Maneuverability - Bow Too Low Cause Improper sterndrive trim angle. Boat is bow-heavy. Boat is underpowered. Permanent hook in boat bottom (Some boats are built with a slight hook for correct boat performance.) Power hook or weak boat bottom. Special Instructions Adjust the trim angle. Redistribute the load to stern. If the bow is overweight due to permanently installed fuel tanks, contact the boat manufacturer. Check the horsepower-to-weight ratio. Contact the boat manufacturer. Check for a hook in the boat bottom by placing a straight edge, at least 2 m (6 ft) long, under the bottom edge of the transom. If a hook is found, contact the boat manufacturer. Water test the boat. The boat will perform normally until the hook develops at high speed, at which time the boat will lose RPM and speed. Contact the boat manufacturer. Poor Boat Performance And/Or Poor Maneuverability - Bow Too Higc Cause Improper sterndrive trim angle Boat is stern heavy. Propeller pitch is too high. Permanent rocker in the hull (Some boats are built with a slight rocker for correct boat performance.) Power hook or weak hull. Power-Assisted Steering Hard Steering�Helm And Cable Cause Damaged steering cable. Steering cable is too short (sharp bends) or too long (loops and long bends). Steering cable is corroded or not lubricated. Cable is over-lubed . RideGuide� rack or rotary head is not lubricated. Special Instructions Adjust trim angle. Redistribute the load to bow. If the stern is overweight because of permanently installed fuel tanks, contact the boat manufacturer. Water-test the boat using a propeller with a lower pitch. Check for a rocker in the boat bottom by placing a straight edge, at least 2 m (6 ft) long, under bottom edge of the transom. If a rocker is found, contact the boat manufacturer. Water test the boat. The boat will perform normally until the hook develops at high speed, at which time the boat will lose RPM and speed. Contact the boat manufacturer. Special Instructions Replace the cable. (Refer to Section 2) Select and install a cable of proper length. (Refer to Section 2A.) Lubricate or replace the cable. Replace the cable. Disassemble and lubricate. 90-865612010 FEBRUARY 2006 Page 1C- Troubleshooting Hard Steering (Engine Running)�Power-Assisted Steering System Cause Low fluid level for the power-assisted steering pump. Loose belt on the sterndrive power-assisted steering pump. Air in the system. Fluid leak. Power-assisted steering system malfunction. Power-Assisted Steering System External Fluid Leaks Cause Pump reservoir is leaking at the fill cap (reservoir is too full). Pump reservoir is leaking at the fill cap (air or water is in the fluid). Loose hose connections. Damaged hose. Bad seal of the cylinder piston rod. Damaged or worn seals of the control valve. Bad seals or O-rings on the power-assisted steering pump. Cracked or porous metal parts. Compact Hydraulic Steering Important Information Special Instructions Check the fluid level. (Refer to Section 6A.) Adjust the tension of the belt. (Refer to Section 6A.) Cycle to remove the air. (Refer to Sectioi 6A.) Locate and correct the source of the leak (Refer to Section 6A.) Test the power-assisted steering system (Refer to Section 6A.) Special Instructions Remove fluid to bring to proper level. Locate the source of the air or water and correct. Air may enter because of a low fluid level in the reservoir or a leak in the internal pump. Test the pump as appropriate. Refer to Section 6A.) Tighten the hose connections. Replace the hose. Replace the cylinder. Replace the cylinder. Repair the pump. Refer to Section 6A.) Replace parts. Whenever a troubleshooting solution calls for the removalof steering system components from the boat or dismantling steering system components, such work must be carried out by a qualified marine mechanic. We offer the following troubleshooting information as a guide only, and neither Mercury MerCruiser nor the helm manufacturer is responsible for any consequences resulting from erroneous repairs. Most faults occur when the installation instructions are not followed carefully, and usually appear immediately upon filling the system. These tables provide the most common errors, and their likely cause and solution are provided in the following. Sometimes, when returning the steering wheel from a full lock position, you may feel a slight resistance and a clicking noise may be heard. This occurance is completely normal caused by the releasing of the lock spool in the system. ! WARNING Avoid serious injury or death due to FIRE or EXPLOSION. Ensure that the engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION. Page 1C-8 90-865612010 FEBRUARY 200 Troubleshootinb Helm Becomes Jammed During Filling Cause Blockage in the line between the helms and the cylinders. System Difficult To Fill Cause Air in the system Steering Hard To Turn Cause Steering cylinder pivot bushings are too tight or trunnion is bent, causing mechanical binding. Restrictions in the hoses. Air in the hydraulic fluid. The wrong hydraulic fluid has been used to fill the steering system. Helm Unit Bumpy - Requires Too Many Turns Cause Dirt particles are in the inlet check of the helm pump. Power Trim Electrical System Special Instructions Ensure thatthe hoses were not kinked or pinched during installation. Kinked or pinched hoses must be removed and replaced Special Instructions Refer to Filling instructions. Special Instructions To test, disconnect the clevis pin from the steering lever and turn the steering wheel. If it now turns easily, correct the cause of the mechanical binding. Please note that excessively loose connections to the steering cylinder or steering lever can also cause mechanical binding. Find the restrictions and correct them. Refer to Filling and Purging instructions. Drain the system and fill it with approved hydraulic fluid. Special Instructions Replace the helm unit. NOTE: The numbers in quotation marks, e.g. "3", refer to the Power Trim System Wiring Diagram. 90-865612010 FEBRUARY 2006 Page 1C- Troubleshooting Power Trim Pump Motor Will Not Operate In The OUT/UP Or IN/DOWN Direction - Solenoids Do Not Click Cause Bad electrical connection at the 110 amp fuse or the battery, or the harness came unplugged from the pump 20 amp fuse blown. Power trim pump battery cables or wiring harness connections corroded or loose. Trim control wiring harness connector loose or corroded. 110 amp fuse blown (does not apply to intermittent problem). Open circuit in trim control wiring harness. Thermal circuit breaker in pump motor open. Special Instructions Check all electrical connection points. Determine cause for the blown fuse and correct. Then replace fuse. NOTE: If fuse blows while trimming OUT/UP or raising sterndrive, problem may be due to grounded trim limit switch leads. To check for grounded condition, disconnect trim limit switch leads at bullet connector "14," "15," "16," and "17." If sterndrive can now be raised (using Trailer switch), trim limit switch or leads are grounded. Clean and/or tighten connections "1," "2," "4," "10," "11," "12" and "18" as necessary. Clean and secure connection "13" as necessary. Check for voltage at terminal "4." If no voltage indicated, determine cause of blown fuse. Check for battery voltage at terminal "8" while trimming OUT/UP and at terminal "6" while trimming OUT/UP. If no voltage is indicated, check trim control for a loose or corroded connection or a damaged power supply lead in harness. Replace commutator end plate assembly. Power Trim Pump Motor Will Not Operate In The OUT/UP Or IN/DOWN Direction - Both Solenoids Clicf Cause Faulty solenoids or loose or corroded connections. Pump motor brushes stuck, corroded or worn out. Armature commutator dirty. Armature faulty. Field and frame faulty. Water or oil in motor. Pump gears frozen. Power trim pump harness or trim control harness shorted between OUT/UP and IN/DOWN circuit (pump trying to operate in OUT/UP and IN/DOWN direction simultaneously). Special Instructions Check for battery voltage at terminals "5" while trimming OUT/UP. If no voltage is indicated, check connections "2," "3," "4" and "5" and/or replace solenoids. Clean or replace as required. Clean or replace armature as required. Test for shorted, open or grounded condition and replace if needed. Check for open or grounded condition. Replace field and frame assembly if needed. Replace motor assembly. Replace pump valve body and gear assembly. Disconnect BLU/WHI lead from solenoid terminal "8." If pump motor will now operate in the OUT/UP direction, a short in the harness exists. Repair or replace harness as needed. Page 1C-10 90-865612010 FEBRUARY 200 Troubleshooting Power Trim Pump Motor Operates In The OUT/UP Direction, But Not In The IN/DOWN Direction - IN/ DOWN Solenoid Does Not Click Cause Loose or dirty solenoid connections. Open IN/DOWN circuit in trim control or pump wiring harness. Solenoid faulty. Special Instructions Check connections "6" and "7" and clean and/or tighten as required. Check for battery voltage at terminal "6" while trimming OUT/UP. If no voltage is indicated, check for a loose or corroded OUT/UP circuit connection, damaged OUT/ UP circuit lead or a faulty OUT/UP trim switch. Repair or replace as required. Replace solenoid. Power Trim Pump Motor Operates In The OUT/UP Direction, But Not In The IN/DOWN Direction - IN DOWN Solenoid Clicks Cause Loose or dirty solenoid connections. Faulty solenoid. Faulty IN/DOWN field winding. Special Instructions Check connections "4" and "5." Clean and/or tighten as necessary. Check for battery voltage at terminal "5" while trimming IN/DOWN. If no voltage is indicated, replace solenoid. Replace field and frame assembly. Power Trim Pump Motor Operates In The IN/DOWN Direction, But Not In The OUT/UP Direction - Both Trim And Trailer Switches Inoperative - OUT/UP Solenoid Does Not Click Cause Loose or dirty solenoid connections. Open OUT/UP circuit trim control or pump wiring harness. Faulty solenoid. Special Instructions Check connections "8" and "9." Clean and/or tighten as necessary. Check for battery voltage at terminal "8" while trimming OUT/UP. If no voltage is indicated, check for a loose or corroded OUT/UP circuit connection, blown fuse (if trim control is equipped), damaged OUT/UP circuit lead or a faulty OUT/UP trim switch. Repair or replace as necessary. Replace solenoid. Power Trim Pump Motor Operates In The IN/DOWN Direction, But Not In The OUT/UP Direction - Botc Trim And Trailer Switches Inoperative - OUT/UP Solenoid Clicks Cause Loose or dirty solenoid connections. Faulty solenoid. Faulty OUT/UP field winding. Special Instructions Check connections "2" and "3." Clean and/or tighten as necessary. Check for battery voltage at terminal "3" while trimming OUT/UP. If no voltage is indicated, replace solenoid. Replace solenoid. 90-865612010 FEBRUARY 2006 Page 1C-1 Troubleshooting Trim Control OUT/UP Trim Switch Inoperative - Trailer Switch Operates Cause Trim limit switch lead bullet connectors loose or corroded. Faulty trim limit switch or leads. Open trim control OUT/UP circuit. Special Instructions Clean and/or tighten connections "14," "15," "16" and "17" as necessary. Disconnect trim limit switch leads from trim harness. Connect a continuity meter between leads "16" and "17." Continuity should be indicated with sterndrive in full IN/ DOWN position. If not, check for damaged leads or poor connections. If this is not the cause, replace trim limit switch. Check for a loose or corroded OUT/UP circuit connection, damaged OUT/UP circuit lead or faulty OUT/UP trim switch. Repair or replace as necessary. Trim Control Trailer Switch Inoperative - Trim OUT/UP Switch FunctionV Cause Special Instructions Check for a faulty trailer switch, loose or Open trim control trailer circuit. corroded connections or damaged trailer circuit lead. Trim System Functions While Unattended Cause Special Instructions Faulty trim or trailer switch. Replace switch. Shorted trim pump harness or trim control harness. Repair or replace as required. Page 1C-12 90-865612010 FEBRUARY 200 Troubleshooting Notes: 90-865612010 FEBRUARY 2006 Page 1C-1 Troubleshooting Page 1C-14 90-865612010 FEBRUARY 2006 Power Trim System Wiring Diagram Power Trim System YEL/RED YEL/RED BLU/WHT BLU/WHT BLU/WHT BLU/WHT PPL/WHT GRN/WHT GRN/WHT GRN/WHT RED/PPL RED/PPL RED RED BLK BLK BLK BLK BLK BLK 21020 b a f h g d e c 1 2 3 4 5 7 6 8 9 10 11 12 13 14 15 16 17 Troubleshootinb a - 20 amp fuse e - DOWN solenoid b - Ground bolt (floor mount) f - Trailer switch extension (optional) c - UP solenoid g - Neutral switch to instrument wiring d - 10 amp fuse harness h - Trim limit switch Power Trim Hydraulic System NOTE: The numbers in quotation marks, e.g. "3," refer to the Power Trim Hydraulic Schematic. Sterndrive Cannot Be Trimmed OUT/UP, Trims Slowly Or With Jerky Movements Cause Power trim pump oil level low. Air in trim system. O-rings damaged on Manual Release Valve (if equipped) or valve not completely closed. Insufficient pump pressure or pump shuttle valve stuck. Hoses reversed on 1 cylinder only. Trim cylinders binding. Gimbal housing-to-trim pump hydraulic hose pinched. Up pressure relief valve has dirt particles under check ball. Sterndrive Will Not Stay In Trimmed OUT/UP Position Cause Air in trim system. Shuttle valve (poppet valve). Special Instructions Check for cause of low oil level and correct. Add oil and bleed trim system. Check for cause of entry and correct. Add oil to pump and bleed air from system. Replace valve and/or close completely. Test. If shuttle 1 is stuck, replace pump adapter (Refer to Section 5A). If pressure is low, replace adapter or attempt to repair by replacing the following components: � OUT/UP Pressure Relief Valve � Thermal Relief Valve Connect hoses 7 and 8 correctly. Check for cause of binding (bent piston rod, scored cylinder). Repair or replace as necessary. Replace hose 7. Replace with a new valve kit. Special Instructions Check for cause of entry. Fill and bleed system. Check for dirt. Install new poppet valve. Sterndrive Trails OUT/UP On Deceleration Or When Shifting Into Reverse - Unit Thumps When Shifting Cause Special Instructions Test according to appropriate service manual. Replace adapter or attempt to repair Trim pump IN/DOWN circuit leaking internally. by replacing the pilot check valves or seals. (Install Trim Pump Rebuild Kit) Oil Foams Out Of Pump Fill/Vent Screw Cause Special Instructions Contaminated oil. Flush system with clean oil refill pump and bleed trim system. Oil level low. Check for cause of low oil level and correct. Add oil to pump and bleed system. 90-865612010 FEBRUARY 2006 Page 1C-1 Troubleshooting Sterndrive Cannot Be Lowered From UP Position Or Lowers With Jerky Movements Caus` Special Instructions Check for cause of entry. Fill and bleed trim Air in trim system. system. Low oil level Add oil. Test. If shuttle 1 is stuck, replace pump adapter. (Refer to Section 5A) Insufficient IN/DOWN pressure or shuttle valve stuck If pressure is low, replace adapter or attempt to repair by replacing the following items: � IN/DOWN pressure relief valve 1. Check for cause of binding. Repair or replace Trim cylinders binding. as necessary. Gimbal housing-to-trim pump hydraulic hose pinched Replace IN/DOWN hose 8. Hoses reversed on 1 trim cylinder only Reconnect hoses correctly. Sterndrive binding in gimbal ring Check for cause of binding and replace. Down pressure relief valve (6) has dirt particles under check Replace with a new valve kit. ball. Sterndrive Will Not Stay In Full UP Position For Extended Periods Caus` Special Instructions Check for cause and correct. Add oil to pump External leakage. and bleed trim system. Test. (Refer to Section 5A) Replace adapter 2 or attempt to repair by replacing the following: Pump OUT/UP circuit leaking internally. � Thermal relief valve 4. � Poppet valves seals 9. Trim cylinder(s) leaking internally and pump DOWN circuit Rebuild cylinders 5 Repair or replace leaking internally (both must be faulty to cause this problem). adapter 2 as necessary. Sterndrive Will Not Stay In The Trimmed OUT/UP Position When Underway Caus` Special Instructions Check for cause of entry. Fill and bleed Air in trim system. system. Leaky poppet valve. Install repair kit for poppet valve 1. Sterndrive Trails OUT/UP On Deceleration Or When Shifting Into Reverse - Unit Thumps When Shifting Cause Special Instructions Test. (Refer to Section 5A) Rebuild or Trim cylinders leaking internally. replace cylinders as necessary. Test. (Refer to Section 5A) Replace adapter or attempt to repair by replacing the following: Trim pump IN/DOWN circuit leaking internally. � Pilot check valves or seals 9. � Install trim pump rebuild kit. Trim Motor Operates But Does Not Pump Oil Caus` Special Instructions Broken coupler between the pump and the motor. Replace the coupler. Plugged pick-up screens. Replace pick-up screens. Page 1C-1 90-865612010 FEBRUARY 200 Troubleshootinb Trim Pump Operates Slowly In Both Directions Cause Special Instructions Check the condition of the oil; it may be contaminated and thick Remove the reservoir and clean out the like honey. contaminated oil. Trim Pump Operates Slowly With A Laboring Sound Cause Special Instructions Replace the pump assembly in the adapter A possible tight adapter pump gear or water or oil in the motor. or replace the electric motor assembly. Power Trim Hydraulic Schematic 14329 1 2 34 5 5 6 7 8 9 1 - Shuttle 2 - Pump adaptor 3 - OUT/UP pressure relief valve 4 - Thermal relief valve 5 - Trim cylinder 6 - IN/DOWN pressure relief valve 7 - OUT/UP hose 8 - IN/DOWN hose 9 - Poppet valves 90-865612010 FEBRUARY 2006 Page 1C-1 Troubleshooting Corrosion Protection NOTE: The numbers in quotation marks, e.g. "3," refer to the MerCathode Controller Wiring Diagram. Corrosion On Underwater Parts, Without MerCathode Or Impressed Current Protection Cause Sacrificial anodes consumed. Stainless steel propeller installed. Sacrificial anodes not grounded to sterndrive. Loss of continuity between underwater parts and ground. Shore power causing overload of anode(s) and/or MerCathode. Paint on sterndrive heavily worn (exposing more metal). Sacrificial anodes painted. Sterndrive tilted so far that anodes are out of the water. Only power trim cylinders are corroded. Corrosion in area of exhaust outlets. Exhaust deposits can cause corrosion. Corrosion occurring after unit removed from saltwater. Corrosion and/or salt build-up between mating parts. Stainless Steel parts corroding: Tightly wrapped fishing line or foreign material excludes oxygen, causing corrosion. Iron particles, such as from a wire brush, cause rusting. Propeller pitting can occur if electrical continuity is lost. Special Instructions Replace anodes when 50% consumed. Add MerCathode (impressed current protection) or additional sacrificial anodes. Remove anodes, clean contact surface, reinstall and check continuity. Provide good ground connections. Disconnect shore power or install Quicksilver isolator. Prime and repaint and/or install additional anodes. Remove paint or replace anodes. Leave sterndrive down, install additional anode (below waterline) or transom mount a MerCathode. Provide good ground to sterndrive. All parts must be grounded. Remove deposits with marine or auto wax. Wash exterior and flush interior with fresh water. Exclude moisture from between mating parts with 2-4-C with Teflon. Clean parts, remove foreign material, ensure continuity. Page 1C-18 90-865612010 FEBRUARY 200 Troubleshooting Corrosion On Underwater Parts, With MerCathode Or Impressed Current Protection - Sterndrive Corroding Cause Special Instructions Poor connection between reference electrode (BRN) lead or anode (ORN) lead and MerCathode controller. Clean and/or tighten connection. Repair wiring. Faulty MerCathode reference electrode. Faulty MerCathode controller. MerCathode system overpowered by large Too much cathode (such as stainless steel). quantity of stainless steel below the waterline. Ensure continuity (check continuity wires Loss of continuity between sterndrive components and ground. and washers). Sacrificial anodes consumed, painted or inoperative. Replace anodes. MerCathode reference electrode or anode painted. Remove paint or replace anode or MerCathode reference electrode. No power to MerCathode controller. MerCathode system not functioning Disconnect reference electrode lead (BRN) from the controller "R" terminal. Connect the lead to positive (+) terminal of a digital multi-meter (set on 0-2000 millivolt scale). Connect negative (-) meter lead to negative (-) battery terminal. Note meter reading; then repeat the test with a test silver/silver chloride reference electrode held behind the sterndrive. The same reading should be obtained in both cases. If not, replace the reference electrode. With anode and reference electrode leads connected to controller, connect a jumper wire between "R" and negative(-) terminals on controller. Connect positive (+) lead of volt meter (set on 0-20 scale) to "A" terminal on controller. Connect the negative (-) meter lead to the negative (-) controller terminal. Reading should be as follows: � Freshwater Areas = 11.5 voltV minimum � Seawater Areas = 3.55 volts minimum If the reading is low, replace the controller. Connect positive (+) lead of volt meter (set on 0-20 volt scale) to positive (+) terminal on the controller and negative (-) volt meter lead to negative (-) terminal. Meter should indicate battery voltage. Check for blown fuse (if equipped) on a standard MerCathode system. Clean the connection or repair wiring as required. Check the fuse in the hot lead. Check battery. Check for loose connections at controller and battery. Check the grounding wire between the sterndrive and the controller. 90-865612010 FEBRUARY 200 Page 1C-1 Troubleshootinb Corrosion On Underwater Parts, With MerCathode Or Impressed Current Protection - Sterndriv` Over-protected Cause Faulty MerCathode reference electrode. Faulty MerCathode controller. Stray current corrosion (electrical current leaves a metal conductor and creates a path through the water). Poor connection between the MerCathode reference electrode lead (BRN) and the "R" terminal on the controller. MerCathode system not functioning. Testing Procedure for Corrosion Protection 1. Unplug shore power (if equipped). Special Instructions Disconnect reference electrode lead (BRN) from "R" terminal on controller. Connect the lead to the positive (+) terminal of a digital multi-meter (set on 0-2000 millivolt scale). Connect the negative (-) meter lead to the negative (-) battery terminal. Note the meter reading; then repeat the test with a test silver/ silver chloride reference electrode held behind the sterndrive. The same reading should be obtained in both cases. If not, replace the reference electrode. Check controller output. If the hull potential indicates overprotection, remove the reference electrode lead from the controller. If the controller is off (no impressed current called for) the voltage between the negative (BLK) and the anode should be less than 1 volt. Measure amperage; with the reference electrode disconnected, the amperage between the negative on the controller and the anode terminal should be less than 1 milli-amp. Replace the controller if needed. Disconnect electrical components 1 at a time and observe the multi-meter reading until you eliminate the high reading. Correct the source of the stray current. Clean and/or tighten the connection. Repair wiring as needed. Check the fuse in the hot lead. Check the battery. Check for loose connections at controller and battery. Check the grounding wire between the sterndrive and the controller. 2. Measure hull potential with silver/silver chloride reference electrode and digital volt/ ohm meter. 3. The following readings indicate the corrosion protection status of the sterndrive. Freshwater Digital Multi-Meter Salt, Polluted or Mineral Between 850 - 1100 millivolts Laden Water Below 850 millivolts Above 1100 millivolts Digital Multi-Meter Corrosion Protection Between 750 - 1050 millivolts Sterndrive is protected Below 750 millivolts Sterndrive is corroding Above 1050 millivolts Sterndrive is overprotected Corrosion Protection Sterndrive is protectel Sterndrive is corrodinJ Sterndrive is overprotectel Page 1C-20 90-865612010 FEBRUARY 200 Troubleshooting 90-865612010 FEBRUARY 2006 Page 1C-21 Corrosion Symptoms � Paint blistering (usually on sharp edges) � Loosely adhering white corrosion products on exposed aluminum surfaces (do not confuse these with tenaciously clinging calcium carbonate deposits) � Aluminum pitting MerCathode System d a b c e 19926 a - Controller b - 20 amp fuse c - Electrode d - BLACK wire - with engine harness e - Anode Troubleshootinb Notes Page 1C-22 90-865612010 FEBRUARY 200 Important Information Section 1D - Corrosion Protection Table of Contents Corrosion Protection 1 D Torque Specifications....................................1D-2 General Information..1D-3 Continuity Circuit�Bravo Sterndrive..............1D-4 Trim Cylinder Anodes....................................1D-7 Anodic Plate�Bravo Models.........................1D-7 Bravo One Sterndrive.............................1D-8 Bravo Two Sterndrive...........................1D-10 Bravo Three Sterndrive........................1D-10 Propshaft Anode..................................1D-11 Integral MerCathode System.......................1D-12 Removing Gimbal Mounted MerCathode Assembly...1D-13 Installing Gimbal Mounted MerCathode System...1D-15 Connect to MerCathode Controller Assembly ....1D-18 Wiring Diagrams of MerCathode Controller - Quick Connect Models...1D-20 Galvanic Isolator..1D-21 Corrosion Protection Testing and Troubleshooting ....1D-22 Continuity Test.......................................1D-23 Test Equipment Set-Up........................1D-25 Low Reading..1D-26 High Reading..1D-27 Normal Reading But Corrosion Is Evident ....1D-28 90-865612010 FEBRUARY 2006 Page 1D- Corrosion Protection Lubricant, Sealant, Adhesives Special Tools Tube Ref No. Description Where Used Part No. Perfect Seal Propeller shaft 92-34227-1 Liquid Neoprene All electrical connections 92-25711-3 34 Special Lubricant 101 Propeller shaft 92-802865A1 Anti-Corrosion Grease Propeller shaft 92-802867A1 2-4-C Marine Lubricant with Teflon Propeller shaft 92-802859A1 Reference Electrode 91-76675T 1 19 25 94 95 9188 Senses and electrical current in the water when testing the MerCathode system. Use to check hull potential. DMT 2004 Digital Multimeter 91-892647A01 A C O Mm A V H z mV V H z TEMP m A A IG IPOFF H z TEMP Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments. 4516 Torque Specifications NOTE: Securely tighten all fasteners not listed below. Description Anodic plate screw MerCathode assembly mounting screws Propeller shaft anode screw Nm lb. in. lb. ft. 41 30 2.8 25 27 20 Page 1D-2 90-865612010 FEBRUARY 200 Corrosion Protection General Information 21083 a b c d e f g Standard Bravo sterndrive a - Sacrificial trim cylinder anode e - Stainless steel hoses b - Sacrificial anodic plate f - Ground wire between the gimbal c - Steering lever ground wire housing and trim cylinder d - Ground wire between the gimbal g - Ground wire between the gimbal ring and bell housin\ ring and gimbal housing We recommend the following maintenance items to help keep your sterndrive corrosion-free: � Maintain a complete paint covering on the sterndrive. � Check the finish regularly. Prime and paint nicks and scratches using Mercury enamel paint and touch up paint. Use only tin�based anti�fouling paint or its equivalent on or near aluminum surfaces below the waterline. � If bare metal is showing, apply 2 coats paint. Description Where used Part number Mercury Phantom BlacP Bare metal 92- 802878-1 � Spray all electrical connections with sealant. Tube Ref No. Description Where Used Part No. 25 Liquid NeoprenZ All electrical connections 92-25711-3 � Inspect the sacrificial trim tab or anode plate if equipped, at regular intervals and replace it before it is half gone. If a stainless steel propeller is installed, additional anodes or a MerCathode System will be required. � Inspect the propeller shaft for fishing line, which can cause corrosion on a stainless steel shaft. � Remove the propeller at least every 60 days and lubricate the propeller shaft. � Do not use lubricants containing graphite on or near the aluminum in saltwater. � Do not paint trim tabs or the mounting surface. 90-865612010 FEBRUARY 200 Page 1D- Corrosion Protection Continuity Circuit�Bravo Sterndrive The transom assembly and sterndrive are equipped with ground�circuit wires to ensure good electrical continuity between the engine, transom assembly, and sterndrive components. Good continuity is essential for the anode and MerCathode System to function most effectively. 1 Inspect the steering lever ground wire for loose connections or broken or fraying wire. a 7004 a - Steering lever ground wire 2 Inspect the inner transom plate ground wire for loose connections or broken or fraying wire. a b a - Inner transom plate�to�gimbal housing ground wire 7005 b - Driveshaft housing�to�gear housing ground plate (inside the anode cavity) Page 1D- 90-865612010 FEBRUARY 200 Corrosion Protection 3 ....c...c........c.................b.....................a................. b a 7006 a .. ..ba..............................ba..........J b .. ..ba....................................c...........U ....H ....V 4 ....c...a.............................a.............a..H ....c...........................c........c.................b.....................a................. ba c 7007b c a 7029 Gasoline models Diesel models a .. ..G c .. ..a.............a.....................J b .. ..H ..c....Z 90..865612010...............A........2006 ..a......1....5 Corrosion Protection 5 ....c.................ba..a..a.........................c........c......Q ......b......................a................. a b 7008 a .. ..ba...................b...................J b .. ..b.................................G ....H ....a..H 6 ....c...........c.....................a.................................c........c........ a 9957 a .. ..a............b..............a..............a..............a......c....a.............b....c........� ......ba...............J 7 ....c...........b.........................c............................c........c........ a b c 199757010 a .. ..b..........................c....S c .. ..a............b.................c....S b .. ..a........b..........................c......V ..a......1....6 90..865612010...............A........2006 Corrosion Protection 90..865612010...............A........2006 ..a......1....7 ..rim Cylinder Anodes ! ....A.......... Do not paint new trim cylinder anodes as this will render them ineffective as a galvanic corrosion inhibitor. 1.. ....c..............a........c...............a...c................. 2.. ....a............ 7011 a b a .. ..c........ b .. ..c..................a.......... 3.. ......a.....................a...........................a..10..32......a.....a........a..... 4.. ....a..............a..............a.........................c............ Anodic Plate..Bravo Models ! ....A.......... Do not paint new anodic plate as this will render it ineffective as a galvanic corrosion inhibitor. 9997 a b c a .. ....ca................a........c......a.... b .. A........c......a.... c .. ..a........b................ Corrosion Protection a 7078 Bearing carrier anode Bravo ..ne models only a .. A......H Bravo ..ne Sterndrive 1 ....a...............................a......acc.....................a....ac............c....... a 7079 a .. ....bb..........................a......c..caS ..a......1....8 90..865612010...............A........2006 Corrosion Protection 2 ....c........a............................a........c......a.... c b a 9980 a .. A........c......a..H c .. ....c........a.....................Q b .. ..c....Z !....A.......... Without proper contact with the gear housing.. the anodic plate will not function properly. Avoid corrosion to the gear housing and damage to the drive.. ensure that the anodic plate is installed properly. 3 ....a..............a........c......a..........c...........a......c......................a.......................................c...... c b a 9980 a .. A........c......a..H c .. ....c........a......................Q b .. ..c....Z Description ..m lb. in. lb. ft. A........c......a........c......4130 90..865612010...............A........2006 ..a......1....9 Corrosion Protection 4 ....a...a..................... a 7079 a .. ....bb..........................a......c..caS Bravo ..wo Sterndrive 1 ....c........a............................a........c......a.... 2 ....a..............a.......c......a..........c...........a......c......................a..................................c...... a b 7015 a .. ..c....Z b .. A........c......a..H Description ..m lb. in. lb. ft. A........c......a........c......4130 Bravo ..hree Sterndrive 1 ....a......c..ca...........a......acc.....................a....ac............c...............................a........ ..a......1....10 90..865612010...............A........2006 Corrosion Protection 90..865612010...............A........2006 ..a......1....11 2.. ....a....ac............c.........................c........a.............ca... ....a.................. a b c d 7016 a .. ....a......c..ca..................... b .. ..a..........a....ac............c...... c .. ....c........a..........a....ac............c...... d .. ..a.................. 3.. ....a..............a.........a......c.....................a...c........ Description ..m lb. in. lb. ft. A........c......a........c...... 41 30 4.. ....a.................a........c..ca.... Propshaft Anode 1.. ....a...a......a...a.............. 2.. ....ac...............a......a..a......a...........c........ 3.. ....ac...............a......a...a......a...........c........ ....E.. If the propeller shaft anode is removed after initial installation and is to be reinstalled.. it will be necessary to apply ..octite Thread ..ocker 2.... to the threads of the propeller shaft anode screw. 4.. ....c.......................................a......a..a......a........ ..c........a........a..c........ 6995 a a .. ..a......a........ Description ..m lb. in. lb. ft. ....a......a...........c...... 27 20 Corrosion Protection Integral MerCathode System The MerCathode system protects the drive unit from corrosion. The increased output provides greater protection for underwater aluminum parts. Its reliable, efficient operation requires an insignificant amount of current when protection is needed. The BLUE MerCathode controller output is limited to approximately 200 mA to prolong the life of the boat's battery. a b c d 9961 Single MerCathode application a - ORANGE lead�from anode on c - BLACK lead�from engine harness transom assembly or battery ground b - RED/PURPLE lead�connect to d - BROWN lead�from reference positive (+) battery terminal electrode on transom assembly Page 1D-12 90-865612010 FEBRUARY 200 Corrosion Protection ....a.......a..........a......c...............a..................................c.....................a....b....a..................a..a............R ....c....a...............c...............400....A..........a...................a.......................a............c....a.................a.................U ba.......................................Mercury Precision Parts..Marine Corrosion Protection Guide ..90..881813003.. a d b c 9981 Dual MerCathode controller application a .. ....A............a.............a............Q c .. ....A..........a............................a........V ....a..........a........b..\ ......ba......................G b .. ..a....c........c......R d .. ..a..........................cH ....ba......................aO ......c.....................a..........a........b..\ Removing Gimbal Mounted MerCathode Assembly ....a.............................a..............................c...R Corrosion Protection ..esting and ..roubleshooting......a................. 1 ......c........c............ba...............a.......................ba................................a...........c................. .... b c d 7017a b a c d 9982 Standard controller with dual anode Standard controller a .. ....a..........a.......................a........H c .. ....a...a..............H a........b...........A...... ba................................. b .. ....a..........................c..........c..............I d .. ....a.......................a.....................a..............H ....a...........a........b................. ba.................A.... 90..865612010...............A........2006 ..a......1....13 Corrosion Protection Page 1D-14 90-865612010 FEBRUARY 2006 2. Disconnect the harness connector of the MerCathode assembly. a b b 7018 a - MerCathode assembly b - Harness connector 3. Cut the wire retainer from the connector by prying the locking tabs outward and pulling the wire retainer away from the connector. 4. Remove the wire leads from the connector by gently pulling them from the back of the connector. b a b c d d 7019 A B a - Wire lead retainer b - Connector c - Locking tab d - Wire lead Corrosion Protection 5 ....c..........a........a...a...........a........b........R ....ba................. c d a b 7020a .. ..a............a........b.... b .. ..c..........2.. c .. ....a......a............2.. d .. ....c....a............2.. 6 ....a............a..........b.....a..ba................. a b b 7018a .. ..a............a........b................b .. ..a............a........b.... Installing Gimbal Mounted MerCathode System !....A.......... Rubber seal must be properly seated in groove of electrode assembly or water will leak into boat. 90..865612010...............A........2006 ..a......1....15 Corrosion Protection 1. The gimbal�mounted MerCathode assembly has a factory�installed rubber seal and does not require an O-ring. d a c b 9985 a - MerCathode assembly c - Reference electrode b - Anode d - Rubber seal 2 Form a 61 cm (2 ft.) long piece of 0.8 mm (0.032 in.) diameter wire to the dimensions specified. 9986 a b c d a - 61 cm (2 ft.) of approximately 0.8 mm (0.032 in.) diameter wire b - 12.3 cm (5 in.) c - 45� angle d - 13 mm (1/2 in.) 3. Insert angled end of the wire through the center hole in the hydraulic connector block Page 1D-1 90-865612010 FEBRUARY 200 Corrosion Protection 4. Guide the wire through the hole until wire protrudes through the cavity at the bottom of the exhaust pipe. 9992 a a - Wire 5. Secure the ring terminals to the guide wire. 6. Guide the leads through the center hole in the connector block. IMPORTANT: The ORANGE lead is approximately 15 cm (6 in.) longer than the BROWN lead. 7 Pull the leads into the boat. a b 9993 a - Guide wirZ b - LeadD ! CAUTION Do not paint sacrificial anodes or MerCathode System anode/reference electrode assembly, as this will render them ineffective as galvanic corrosion inhibitors. 8 Position and secure MerCathode assembly to gimbal housing using two 35 mm (1-3/8 in.) long screws, flat washers, and lockwashers. 90-865612010 FEBRUARY 200 Page 1D-1 Corrosion Protection 9 ....c... d a e c b 9994a .. ..a............a........b.... b .. ..c..........2.. c .. ....a......a............2.. d .. ....c....a............2.. e .. ..a......c..c........c........b....c.. Description ..m lb. in. lb. ft. ....a............a........b..........................c........2..825 Connect to MerCathode Controller Assembly ......E.. If the B..A.... (ground) wire is not available at the terminal block or from the wire harness.. install a separate lead between controller negative (..) terminal and negative (..) battery cable attaching point on engine. 1 ....c............c........c..................c......ca........a..........................a............c...................a........b.......................R Wiring Diagrams.. .... b c d 7017a b a c d 9982a .. ....a..................a.......................a.......... a........b............A........ b .. ....a...............................c..........c................ ....a...........a........b.................... c .. ....a...a..............H ba................................. d .. ....a.......................a.....................a..............H ba.................A.... 2 A..........a............c..a..............a..a............a............c......ca....c........c.......... ..a......1....18 90..865612010...............A........2006 Corrosion Protection 90-865612010 FEBRUARY 2006 Page 1D-19 Tube Ref No. Description Where Used Part No. 25 Liquid Neoprene All electrical connections 92-25711-3 3. Install the BROWN wire lead from the MerCathode assembly harness into connector terminal A by firmly pushing it into the back of the connector until it is completely seated. 4. Install the ORANGE wire lead from the MerCathode assembly harness into connector terminal B by firmly pushing it into the back of the connector until it is completely seated. A B b d e d a c c a b e A B 7021 a - Connector b - Connector terminal A c - Connector terminal B d - ORANGE wire lead e - BROWN wire lead 5. Install the wire lead retainer onto the MerCathode assembly harness wires and push it onto the connector until the locking tabs are fully engaged. 9996 a b c a - Wire lead retainer b - Connector c - Wire lead Corrosion Protection Page 1D-20 90-865612010 FEBRUARY 2006 6. Connect the MerCathode assembly harness connector. a b b 7018 a - MerCathode assembly b - Harness connector Wiring Diagrams of MerCathode Controller - Quick Connect Models d e c a b 7025 f f MERCATHODE a - MerCathode controller b - 20 Amp fuse c - MerCathode assembly d - Female terminal e - Male terminal f - Anodes Corrosion Protection Galvanic Isolator Boats that are connected to AC shore power require additional protection to prevent destructive low�voltage galvanic currents from passing through the shore power ground wire. A Quicksilver isolator (888557Q01) can be installed to block the passage of these currents, while still providing a path to ground for dangerous fault (shock) currents. ! CAUTION If AC shore power is not isolated from boat ground, the MerCathode system and sacrificial anodes may be unable to handle the increased galvanic corrosion potential. The Quicksilver galvanic isolator is a solid�state device that is series connected in line with the boat's safety grounding lead ahead of all grounding connections on the boat. This device functions as a filter, blocking the flow of destructive low�voltage galvanic (DC) currents but still maintaining the integrity of the safety grounding circuit. An improperly installed galvanic isolator kit will result in false audio and visual warnings. a b d e f j i h k c l g 7026 a - Display b - Galvanic isolator monitor c - GREEN d - Galvanic Isolator e - GREEN/BLACK f - Boat ground g - To distribution panel h - Circuit breaker i - Power conductors j - Boat shore power connection k - Safety grounding conductor l - 110 VAC power cord 90-865612010 FEBRUARY 2006 Page 1D-2 Corrosion Protection a b d e f g c 7027 a .. ....a...........................c........c......Q e .. ..a....a....c..........a....U b .. ..c........b....a....U f .. ....a..............G c .. ..c........c....U g .. ..b..............a....O d .. ..H ......E.. ..reen conductor cannot be connected to boat in this section. Corrosion Protection ..esting and ..roubleshooting ......E.. The following corrosion protection test supersedes all previously issued tests. ....a......a...........a.......b..a.....................................a..........a....................... ....b..a..................... ....a..........a.........................c..........c............a......a............a.......................... IMP..R..A...... Do not use a standard analog meter.. which is not accurate enough for this test. ....a.........................c..........c...........................a....a........c..a....c........c............a....c......a........a ....a......a......................................ca...........a............a........................ ......E.. Do not remove this plug or use analog meters. ....ac....ca....b.......................ac....................................a................ .... b a 7028 Digital Multimeter and MerCathode Reference ..ester a .. ..2004...................U b .. ..c..........c........H ....c..........c..........91..76675....1 ..a......1....22 90..865612010...............A........2006 Corrosion Protection DMT 2004 Digital MultimeteU 91-892647A01 IMPORTANT: If equipped with MerCathode System, ensure that the battery is fully charged (12.6 volts or above). IMPORTANT: Boats recently placed in service usually will produce a reading higher than normal because the sterndrive is protected by a good finish and new sacrificial anodes. To obtain an accurate diagnosis, the test should be performed after the boat has been in service at least one or two weeks. This will give the paint a chance to soak and minor abrasions and scratches will have appeared resulting in a more accurate reading. IMPORTANT: The boat should be moored, without being operated, for at least 8 hours before the tests, to allow the MerCathode system and sacrificial anodes to polarize the surrounding water. Be careful not to rock the boat boarding to perform a test because this will alter the test reading. 1. Set the meter on a scale required to read 0�2000 millivolts. 2. Connect the negative meter lead to the negative (�) battery terminal or other convenient engine ground. 3. Connect the Reference Electrode Tester lead into the positive (+) receptacle of meter. 4. Immerse the Electrode Tester in the water within 15 cm (6 in.) of the aft end of the sterndrive. IMPORTANT: The expected voltage readings will vary according to the type of MerCathode system you are testing. 5 The following readings indicate the corrosion protection status of the sterndrive. Refer to Section 1C�Troubleshooting of the appropriate Mercury MerCruiser Service Manual. Digital Multi-meter Range Between 750 and 1050 millivolts Freshwater Below 750 millivolts Above 1050 millivolts Digital Multi-meter Range Salt, Polluted, or Mineral Between 850 and 1100 millivolts Laden Water Below 850 millivolts Above 1100 millivolts ! CAUTION Corrosion Protection Sterndrive is protected Sterndrive is corroding Sterndrive is overprotected Corrosion Protection Sterndrive is protected Sterndrive is corroding Sterndrive is overprotected Removing the Silver/Silver Chloride coating from the reference wire will make the MerCathode system inoperable. Do not power wash the MerCathode or damage to the MerCathode system will occur. Continuity Test 1 Connect the end of the positive meter lead to each metallic component on the sterndrive. Ensure that each metal surface has good electrical surface. The reading should drop below 2 millivolts. 2 A reading higher than 2 millivolts indicates improper grounding. 90-865612010 FEBRUARY 200 Page 1D-2 Corrosion Protection 3 If the reading is not within specified limits, or if reading is within specifications but there is evidence of corrosion on the sterndrive, refer to the following troubleshooting charts to diagnose the problem. b a 7031 Gimbal-mounted MerCathode dual anode at the base of the transom assembly a - Reference wire b - Anode plate MERCATHODE A R b a 7030 a Transom mounted MerCathode on the boat transom a - Anode b - MerCathode controller Page 1D-2 90-865612010 FEBRUARY 200 Corrosion Protection Test Equipment Set-Up a b c d OFF ON 10042 a - 15 cm (6 in.) maximum c - Battery b - Power-package ground d - Waterline 90-865612010 FEBRUARY 2006 Page 1D-2 Corrosion Protection Low Reading Cause Special instructions Loss of continuity between sterndrive components and negative (�) battery terminal. Ensure that continuity devices are not missing or damaged and that connections are clean and tight. Disconnect shore power and verify whether Boats equipped with shore power: the shore power green safet\ the reading increases. If so, install a grounding lead is not isolated from the power package ground Quicksilver isolator (888557Q01) or an isolation transformer. Underwater metal parts on the sterndrive and/or boat are Prime and paint underwater metal parts to unpainted or the paint is in poor condition. The boat has more reduce the load on the anodes or exposed metal than the anodes and/or MerCathode System MerCathode System. can protect. Anodes are painted Remove the paint or replace the anodes. Clean the anode mounting surface or replace The anodes are improperly grounded or inactive. the anodes if they have oxidized. Replace the anodes if they are eroded 50% Anodes have been consumed (no longer protect). or more. The sterndrive or boat bottom is painted with anti-fouling paint that contains tin. Avoid any electrical interconnection between the Mercury MerCruiser product, anodic blocks, or the MerCathode system and the paint by allowing a minimum of 40 mm (1-1/2 in.) of UNPAINTED area around these items on the transom of the boat. MerCathode reference electrode or anode has been painted. Remove the paint. Anodic heads were used instead of plastic caps. Reinstall the plastic caps. No power to the MerCathode controller. Connect the positive (+) volt meter lead (set on 0�20 volt scale) to the positive (+) controller terminal and the negative (�) volt meter lead to the negative (�) terminal. The meter should indicate battery voltage. Check for a blown fuse (if equipped) on the starboard MerCathode system. Clean the connection or repair wiring as required. Poor connection between the reference electrode lead Clean and tighten the connection. Repair the (BROWN) or the anode lead (ORANGE) and the MerCathode wiring. controller. Page 1D-2 90-865612010 FEBRUARY 200 Corrosion Protection Low Reading (continued) Faulty MerCathode reference electrode. Faulty MerCathode Controller. Disconnect the reference electrode lead (BROWN) from the controller "R" terminal. Connect the lead to the positive (+) terminal of a digital multimeter (set on 0�2000 millivolt scale). Connect the negative (�) meter lead to the negative (�) battery terminal. Note the meter reading and then repeat the test using a MerCathode reference electrode tester (76675T1). You should obtain the same reading in both cases. If not, replace the reference electrode. With anode and reference electrode leads connected to the controller, connect the jumper wire between "R" and negative (�) terminals on the controller. Connect the positive (+) lead of the volt meter (set on 0�20 scale) to terminal "A" on the controller. Connect the negative (�) meter lead to the negative (�) controller terminal. The reading should be as follows: � Freshwater Areas: 750�105 millivoltD � Saltwater Areas: 850�1050 millivolts If the reading is low, replace the controller. Additional corrosion protection required. Boats that are Install additional anodes or a MerCathode equipped with a sizable amount of underwater metal (stainless system (88334A2). If the unit is already steel propeller, after planes, etc.) or moored in an area with equipped with a MerCathode System, a warm or rapidly flowing water may require additional protection. second system may be required. High Reading Cause Special instructions Observe the reading while disconnecting the Stray current corrosion. If an electrical current flowing along a electrical components one at a time until you metal conductor leaves the metal for a water path it will cause eliminate the high reading. Correct the ionization of the metal, and an area of rapid corrosion. course of stray current. Poor connection between MerCathode reference electrode Clean and tighten connection. Repair wiring lead (BROWN) and "R" terminal on controller. as required. Faulty MerCathode reference electrode. Disconnect the reference electrode lead (BROWN) from "R" terminal on the controller. Connect the lead to the positive (+) terminal of a digital multi-meter (set on 0� 2000 millivolt scale). Connect the negative (�) meter lead to the negative (�) battery terminal. Note the meter reading, and then repeat the test using a MerCathode reference electrode tester (76675T1). Both tools should produce the same reading. If not, replace the reference electrode. Faulty MerCathode controller Replace the controller. 90-865612010 FEBRUARY 200 Page 1D-2 Corrosion Protection Normal Reading But Corrosion Is Evident CORROSION ON THE ENTIRE STERNDRIVE Cause Special instructions Leave the sterndrive in the IN/DOWN The sterndrive is raised so that the sacrificial anodic trim tab is position when the boat is moored to ensure out of the water. the trim tab is in the water, providing protection. CORROSION PROBLEM DEVELOPED AFTER REFINISHING THE STERNDRIVE Cause Special instructions A steel wire brush was used to clean the aluminum casting. Steel particles became entrapped and set up a small galvanic Use only a nylon or bristle brush. cell. PAINT BLISTERING ON THE STERNDRIVE Cause Special instructions The battery charger, using 110 volt shore power was connected Ensure that the charger is connected improperly to the battery. correctly. TRIM CYLINDER CORRODING Cause Special instructions Loss of continuity between the trim cylinder and the sterndrive. Install proper continuity devices. ONLY ONE OR TWO COMPONENTS CORRODING Cause Special instructions If not already done, install a continuity circuit Loss of continuity between sterndrive and components. kit (99940A2). CORROSION IN THE EXHAUST OUTLET AREA Cause Special instructions Exhaust gas deposits are accumulating on the exterior of the Remove these deposits with marine or sterndrive can result in paint blistering and corrosion. automotive wax. CORROSION OCCURS AFTER THE UNIT IS REMOVED FROM THE WATER Cause Special instructions Salt crystals remaining on the surface components of the Wash the exterior of the sterndrive and flush sterndrive have combined with high humidity to form electrolytes that caused corrosion. CORROSION BETWEEN SURFACES Cause Salt buildup between surfaces. Tube Ref No. Description 34 Special Lubricant 101 95 2-4-C Marine Lubricant with Teflon 19 Perfect Seal the interior sterndrive with fresh water. Special instructions Protect mating parts with lubricant. Where Used Part No. Propeller shaft 92-802865A1 Propeller shaft 92-802859A1 Propeller shaft 92-34227-1 Page 1D-28 90-865612010 FEBRUARY 200 Corrosion Protection ALUMINUM CORRODING IN LUBRICATED AREAS Cause Graphite in the lubricant. Tube Ref No. Description 34 Special Lubricant 101 95 2-4-C Marine Lubricant with Teflon 19 Perfect Seal STAINLESS STEEL COMPONENTS CORRODING Cause Foreign matter (fishing line, marine growth, etc.) has covered the steel and starved it of oxygen. The lack of oxygen causes a breakdown of the protective oxide film and subsequent corrosion (known as oxygen starvation corrosion). Burying stainless steel in sand or silt can also cause this problem. STAINLESS STEEL PROPELLER CORRODING Cause Continuity lost between propeller and propeller shaft. Tube Ref No. Description 34 Special Lubricant 101 95 2-4-C Marine Lubricant with Teflon 94 Anti-Corrosion Grease 19 Perfect Seal Special instructions Never use lubricants containing graphite because they accelerate corrosion. Use specially formulated marine lubricants. Where Used Part No. Propeller shaft 92-802865A1 Propeller shaft 92-802859A1 Propeller shaft 92-34227-1 Special instructions Remove foreign matter and prevent surfaces from being covered by sand or silt. Special instructions Clean the mating surfaces on the propeller, propeller shaft, and attaching parts. If applicable, install a continuity washer. Lubricate the propeller shaft before reinstalling the propeller. Where Used Part No. Propeller shaft 92-802865A1 Propeller shaft 92-802859A1 Propeller shaft 92-802867A1 Propeller shaft 92-34227-1 PAINT BLISTERING - THE METAL UNDER THE BLISTERED PAINT IS NOT PITTED Cause Special instructions The surface was not properly prepared before paint was Sand the surface down to bare metal, prime applied. and repaint with Quicksilver spray paint. 90-865612010 FEBRUARY 2006 Page 1D-2 Corrosion Protection Notes: Page 1D-30 90-865612010 FEBRUARY 200 All ModelX Installation and Adjustments Section 2A - All Models Table of Contents 2 A Torque Specifications....................................2A-3 Special Information...2A-4 Transom Thickness and Surface.............2A-4 Trim-In Limit Insert...................................2A-4 All Models..2A-5 Engine Height Adjustment.......................2A-6 Drive Shaft Extension Models..................2A-7 Bravo Models Exhaust Preparation..........2A-7 Transom Assembly Installation.......................2A-8 Installing Inner Bravo Transom Plate ....2A-8 Connecting Speedometer Pickup............2A-9 Seawater Inlet Fitting Installation...........2A-10 Water Inlet Block-Off Plate Installation...2A-11 Gear Lube Monitor Connection At Gimbal Housing..2A-13 Alternative Mounting Of Gear Lube Monitor On Transom..2A-14 Transom Exhaust Connections..............2A-15 Power Trim Pump Installation.......................2A-16 Power Trim Pump..................................2A-16 Power Trim Pump Connections and Filling ....2A-16 Steering System Installation.........................2A-18 Hydraulic (Helm) Steering.....................2A-18 Steering Helm and Cable.......................2A-18 Steering Cable Specifications................2A-20 Installing Steering System.....................2A-20 Shift Cable Routing................................2A-24 Engine Installation..2A-25 Transom Connections..................................2A-25 Continuity Wire Connection...................2A-25 Trim Position Sender Connections.........2A-26 Trim Limit / Sender Harness..................2A-26 MerCathode Connections (If Equipped) ....2A-27 Power Trim Pump Connections.............2A-28 Gear Lube Monitor Connection..............2A-28 Power-Assisted Steering Hoses............2A-29 Seawater Inlet Fitting Connection..........2A-29 Shift Cable Installation and Adjustment.........2A-33 Bravo Models Shift Cable Installation.....2A-33 Bravo Models Shift Cable Adjustment....2A-34 Shift Cable Installation For DTS System ....2A-37 Bravo Installation...2A-38 Engine Alignment Check.......................2A-38 Bravo Sterndrive Installation..................2A-41 Speedometer Connections - Bravo Models ....2A-50 Bravo Sterndrive Shift Check (Engine Running) ....2A-51 Troubleshooting Shift Problems.............2A-53 Bravo Trim Limit Switch Adjustment - Analog Gauges ....2A-55 Trim Position Sender Adjustment - Analog Gauges ....2A-57 Trim Position Sender Adjustment - SmartCraft Gauges Scan Tool Method..........................2A-58 Trim Position Sender Adjustment - SmartCraft Gauges Multimeter Method..........................2A-59 Bravo One Propeller Hub General Information ....2A-60 Bravo One Propeller Hubs Rated for Under 400 HP..2A-60 Bravo One Propeller Hub Rated for 400 HP and Over..2A-61 Bravo One XR Propeller Hub.................2A-61 Bravo Sterndrive Propeller Installation..........2A-62 Bravo One Models................................2A-62 Bravo Two Models................................2A-64 Bravo Three..2A-65 90-865612010 FEBRUARY 2006 Page 2A- All ModelX Lubricant, Sealant, AdhesiveX Tube Ref No. 25 27 34 80 87 91 94 95 114 Special ToolX Description Liquid Neoprene Bellows Adhesive Special Lubricant 101 SAE Engine Oil 30W High Performance Gear Lubricant Engine Coupler Spline Grease Anti-Corrosion Grease 2-4-C Marine Lubricant with Teflon Power Trim and Steering Fluid Tapered insert tool Where Used Part No. MerCathode connections Battery Terminals 92-25711-3 Exhaust bellows mounting surface 92-86166Q1 Power steering bushings Upper and lower pivot bolts Clevis pin 92-802865A1 Steering cable end Shift cable stud Propeller shaft splines Shift cable pivot points Obtain Locally Gear Lube Monitor 92-802854A1 U-joint O-rings Driveshaft splines Propeller shaft splines Bell housing studs 92-802869A1 92-802867A1 O-ring Water passage seals Anchor pin threads 92-802859A1 Trim cylinder hardware Shift cable end Propeller shaft splines Power trim pump 92-802880A1 91-43579 Removes and installs the tapered insert retainer into the water inlet hose. 9197 Shift Cable Adjustment Tool 91-12427 9186 Alignment Tool Assembly 91-805475A 1 Used to align the engine to the Standard Bravo Transom Assembly for sterndrive installation. Dual Water Pick-up Flush Gearcase Seal Kit 91-881150K 1 Attaches over the shift cable, and aids in proper shift cable adjustment at the shift plate. 9183 9194 Blocks off the front water inlet holes on the dual water inlet gearcases. Page 2A-2 90-865612010 FEBRUARY 200 All ModelX Flushing Device 91-44357Q 2 Attaches to the water intakes; provides a fresh water connection when flushing the cooling system or operating the engine. 9192 Flushing Kit 91-849996T 1 9195 Use for flushing gearcases with low water inlets. Propeller Nut Tool 91-805457T 1 10677 Aids in the removal and installation of the front propeller nut. Torque Specifications NOTE: Securely tighten all fasteners not listed below. The propeller torque stated for propeller nut is the minimum torque value for Bravo One and Two. The propeller torque stated for forward and aft propeller nut is the minimum torque value for Bravo Three. Description Transom assembly attaching nuts Water inlet fitting bolts Exhaust pipe to gimbal housing bolts Exhaust block-off plate bolts Steering system pivot bolts Steering cable coupler nut Sterndrive fasteners Bravo One propeller nut Bravo Two propeller nut Bravo Three front dual propeller nut Bravo Three rear dual propeller nut Propeller shaft anode screw Nm 34 5 34 34 34 47 68 75 lb. in. lb. ft. 25 45 25 25 25 35 50 55 Then align tabs with grooves 81 60 Then align tabs with grooves 136 100 81 60 19 168 90-865612010 FEBRUARY 2006 Page 2A- All ModelX Special Information Transom Thickness and Surface IMPORTANT: Transom thickness and surface plane (flatness) must be controlled where the sterndrive mounts. Transom thickness and surface must conform to the following: Thickness Parallelism Flatness Angle Transom specifications Between 51 - 57 mm (2 - 2-1/4 in.) Inner and outer surfaces must be parallel within 3 mm (1/8 in.) Transom surfaces in area where transom assembly will be mounted (includes vertical as well as horizontal dimensions) :Inner Surface - Flat within 3 mm (1/8 in.) Outer Surface - Flat within 2 mm (1/16 in.) 10 - 16 Degrees dd b e c a 7508 a - Transom thickness d - Transom plate coverage b - Inner surface e - Transom angle c - Outer surface a c b 7682 a - Measuring thickness b - Measuring surface flatness c - Suitable mandrel to check for uniform transom thickness Trim-In Limit Insert NOTE: Bravo One, Two, and Three Models are equipped with a Trim-in limit insert. Page 2A-4 90-865612010 FEBRUARY 200 All ModelX It has been brought to our attention that some boats (predominantly deep-Vee heavy boats) will roll up on their side under certain, specific, operating conditions. The roll can be either to port or starboard and may be experienced while moving straight ahead, or while making a turn. The roll occurs most frequently at or near maximum speed, with the sterndrive trimmed at or near full trim-in. While the boat will not roll completely over, the roll may be sufficient to unseat the operator or passengers, and thereby create an unsafe situation. The roll is caused by stern-lift created from excessive sterndrive trim-in. Under these extreme stern-lift / bow-down conditions instability can be created, which may cause the boat to roll. Weight distribution to the stern can reduce stern-lift and, in some circumstances, help to control the condition. Weight distribution in the bow, port, or starboard, may worsen the condition. The Trim-in limit insert reduces stern-lift by preventing the sterndrive from reaching the last few degrees of full trim under. While this device should reduce the rolling tendency, it may not eliminate the tendency entirely. The need for this Trim-in limit insert, and its effectiveness, can only be determined through boat testing and is ultimately the responsibility of the boat manufacturer. ! WARNING We recommend that only qualified personnel adjust the trim-in limit inserts. The boat must be water-tested after adjusting the trim-in limit inserts to ensure that the modified trim-in range does not cause the boat to handle poorly when the sterndrive is trimmed in at higher speeds. On some boats, increased trim-in range may cause handling problems, which could result in personal injury. All Models IMPORTANT: The trim-in limit insert must be properly positioned before installing the trim cylinder anchor pin. NOTE: When removing the sterndrive, note the position of the insert for reference when reinstalling the sterndrive. 1 Ensure that the trim-in limit insert is positioned correctly for the appropriate Bravo model. a 8548 Bravo One and Two (positioned forward) a - Trim-in limit insert 90-865612010 FEBRUARY 200 Page 2A- All ModelX a 8557 Bravo Three (positioned aft) a - Trim-in limit insert IMPORTANT: The position of the trim-in limit insert on the Bravo Three sterndrive should only be changed after the boat has been properly tested. Contact the boat manufacturer if you are not sure of the original position for a particular boat application. Engine Height Adjustment To gain engine adjustment for alignment, raise the engine using the specified stainless steel washer. IMPORTANT: The fiber washer must be used. NOTE: Engine alignment is usually obtained using only the rear engine mount and the fiber washer. 1. Ensure that the fiber washer is in place. ba 16584 a - Transom plate b - Fiber washer Page 2A-6 90-865612010 FEBRUARY 200 All ModelX 2. Place the stainless steel washer on top of the transom plate mount a b c a - Transom plate b - Stainless steel washer 16583 a c b c - Stainless steel washer position to raise engine Drive Shaft Extension Models If the power package is equipped with a drive shaft extension, refer to the Drive Shaft Extension Installation Instructions (90-866039) included with the engine package. Extensions for the gear lube monitor and MerCathode quick connects are used with drive shaft extention installations. Refer to your parts catalog for replacement part numbers. Bravo Models Exhaust Preparation IMPORTANT: When installing through the transom exhaust, it is recommended that the exhaust bellows on the transom assembly be removed. This is necessary to avoid creating a vacuum at the exhaust outlet in the propeller at higher boat speeds. This vacuum could degrade propeller performance on some boats. 1 If required, remove and discard clamps and bellows from gimbal housing. IMPORTANT: When installing through the propeller exhaust: � With Bravo One and Bravo Two Sterndrives, an exhaust tube MAY BE INSTALLED for a slight increase in performance. � With most Bravo Three Sterndrive Models, an exhaust tube MAY BE INSTALLED for a slight increase in performance. � With a Silent Choice Exhaust System, the exhaust bellows must be removed and an exhaust tube MUST BE INSTALLED. � With any application, installation of an exhaust tube will increase exhaust noise. 2 If required, install exhaust tube on gimbal housing as follows: a. Remove and discard clamps and exhaust bellows. ! CAUTION Exhaust tube clamp may corrode if grounding clip is not installed. b. Install grounding clip on tube c. Apply adhesive to exhaust bellows/tube mounting surface Tube Ref No. DescriptioS Where Used Part No. Exhaust bellows mounting 27 Bellows Adhesive 92-86166Q1 surface d. Allow bellows adhesive to dry until no longer tacky (approximately 10 minutes). 90-865612010 FEBRUARY 200 Page 2A- All ModelX e Position tube so that "SIDE" markings on tube are facing toward the right and left sides. f Install and torque the clamp. a e bc d 8406 a - Exhaust tube d - Exhaust tube b - Clamp e - Grounding clip c - "SIDE" marking Description Exhaust tube clamp Nm 4 lb. in. 35 lb. ft. Transom Assembly Installation Installing Inner Bravo Transom Plate 1. Insert wires, hoses, and shift cable through appropriate openings in inner transom plate. 2. Position gimbal housing on transom and hold in place. IMPORTANT: Tighten the transom assembly fasteners using an X-pattern torque sequence, starting from the middle fasteners. Tighten in small increments and go around the pattern several times until the proper torque is achieved. 3. Secure transom assembly with fasteners. Torque the fasteners. DescriptioS Nm lb. in. lb. ft. Transom assembly hardware 34 25 Page 2A- 90-865612010 FEBRUARY 200 All ModelX IMPORTANT: Steering lever continuity circuit wire must be positioned as shown to avoid stressing wire when steering lever moves. a a a d c b a 18642357f e 21633 a - Locknuts and flat washers (8) d - Transom plate continuity wires b - Hydraulic hoses and MerCathode e - Torque sequence wire f - Trim sender and trim limit wires c - Steering lever continuity wires Connecting Speedometer Pickup ! CAUTION Excess water in bilge can damage engine or cause boat to sink. Do not remove plug from speedometer pickup tube fitting unless connection is to be utilized. 1. Remove the protective cap from the male quick connect. 90-865612010 FEBRUARY 2006 Page 2A- All Models Page 2A-10 90-865612010 FEBRUARY 2006 2. Connect a 4 mm (5/32 in.) speedometer hose (not provided) from speedometer to barb fitting. Secure hose with tie strap. a b c 7703 c e d b Typical a - Male quick connect b - Female quick connect c - Barbed fitting d - Hose e - Tie strap ! CAUTION Avoid water leaking into boat. Speedometer hose is filled with water, especially during boat operation. Hose contact with moving or rotating engine parts could cause damage to the hose resulting in water leaking into boat. Do not let speedometer hose contact steering system components, engine coupler or drive shaft. 3. Secure the hose to the transom with the hose clip and screw that are provided in the parts bag. Ensure that the hose does not contact the steering system components or the engine coupler and drive shaft. Seawater Inlet Fitting Installation 1. Install a new gasket, seawater inlet fitting, and screws. Torque screws. a 21634 c a b d Seawater inlet fitting shown with gear lube hose J-clip a - Seawater inlet fitting b - Screw (2) c - Gasket d - Star washers All ModelX Description Nm lb. in. lb. ft. Seawater inlet fitting screws 5 45 Water Inlet Block-Off Plate Installation ALTERNATIVE WATER PICKUPS A water inlet block-off kit must be used if the sterndrive unit water pickup will not be used to supply water to the engine. When installing the block-off plate, it is necessary to cut the water hose that is located between the bell housing and the gimbal housing. This allows water to continue to circulate through the sterndrive unit for cooling. ! CAUTION Avoid overheating the sterndrive. The seawater inlet holes must be allowed to flow water without being obstructed or damage to the sterndrive will result. Do not dead-end the seawater hose from bell housing. Cut hose as recommended in procedures. BRAVO MODELS 1 Remove the tapered insert in the gimbal housing using the tapered insert tool. Discard the insert. b a a - Tapered insert location in the gimbal housing b - Rachet and extension c d 17857 c - Tapered insert d - Tapered insert tool Tapered insert tool 91-43579 90-865612010 FEBRUARY 200 Page 2A-1 All ModelX 2. Install the block-off plate with new gasket. Secure with screws and lockwashers. Torque the screws. a a b d c 21683 a - Block-off plate c - Screw b - Gasket d - Lockwasher DescriptioS Nm lb. in. lb. ft. Water inlet block off screw 5 45 3 Move the trim limit switch wires and speedometer hose aside. Reach between the gimbal housing and the bell housing and detach the water hose from the gimbal housing where the tapered insert was removed in Step 2. a b e c d 8489 a - Trim limit switch wires d - Water hose b - Speedometer hose e - Tapered insert c - Gimbal housing ! WARNING Avoid water leakage into the boat. If the U-joint bellows is damaged, water will enter the boat. Be careful not to damage the U-joint bellows when removing the section of the water hose attached between the gimbal housing and the bell housing. NOTE: Move the trim limit switch wires and speedometer hose to avoid damaging them when cutting the water hose. The existing tie strap and clip can be reused if they are moved and repositioned after the hose is cut. 4 Cut completely through the water hose 127 mm (5 in.) in front of the aft end of the hose where it is fitted into the bell housing in the area shown. Do not damage the U-joint bellows. 5 Discard loose hose piece. Page 2A-1 90-865612010 FEBRUARY 200 All ModelX 6. Secure the trim limit switch wires and speedometer hose to the remaining section of water hose using existing tie strap and clip. d - Speedometer hose e - Trim limit wire harness f - Cutting area c e a b d f 8490 a - Tie strap b - Clip c - Water inlet hose 7 Install a through the hull or through the transom seawater pickup, seawater strainer, and seacock. 8. Connect the seawater inlet hose between seawater pump and seawater strainer. 9. Secure all hoses with hose clamps. Gear Lube Monitor Connection At Gimbal Housing ! CAUTION Avoid sterndrive unit damage. The quick release button on the gear lube monitor 90 degree hose fitting may not lock on the gimbal housing fitting if touching or depressed by the water inlet fitting, or block-off plate if equipped. Failure to lock the 90 degree hose fitting on the gimbal housing fitting could result in a loose 90 degree hose fitting causing a loss of gear lube and damage to the sterndrive unit. Ensure the 90 degree hose fitting is locked on the gimbal housing fitting. 90-865612010 FEBRUARY 200 Page 2A-1 All ModelX 1. Connect the quick release 90 degree fitting of the gear lube monitor hose to the gimbal housing. a a b c d 21623 Model with block-off plate a - Hose c - Seawater inlet fitting b - Quick release 90 degree fitting d - J-clip NOTE: The quick release button on hose fitting must be positioned away from water inlet fitting, or block-off plate if equipped. Release button must not contact water fitting or block-off plate, if equipped. 2 Position quick release button on hose fitting away from water inlet fitting. Release button must not contact water fitting. a b c 21624 Model with Quick connect seawater inlet fitting a - Gear lube monitor hose c - Quick release button b - Seawater inlet fitting NOTE: The hose must not come into contact with the steering system components or the engine coupler and drive shaft. Alternative Mounting Of Gear Lube Monitor On Transom IMPORTANT: The mounting location specified must be above the steering lever on the transom assembly. Hose must be positioned to avoid moving parts (steering system, engine coupler). 1 Install the gear lube monitor bracket in the specified location and secure with lag screws and flat washers. Page 2A-1 90-865612010 FEBRUARY 200 All Models 90-865612010 FEBRUARY 2006 Page 2A-15 2. Install the gear lube monitor in the bracket. Secure the monitor with the retaining strap. a b c d 7706 a - Bracket b - Lag screw and flat washer c - Gear lube monitor and cap d - Retaining strap Transom Exhaust Connections IMPORTANT: Exhaust pipe or block-off plate and gimbal housing mating surface must be clean and free of nicks and scratches and O-ring must be properly seated in groove or water may leak into boat. a 21630 a - Seal 1. Through The Transom Exhaust Models: Install block-off plate using 4 bolts and lockwashers. Torque bolts. a 21625 b c a a - Block-off plate b - Bolts c - Lockwashers Description Nm lb. in. lb. ft. Exhaust block-off plate bolts 34 25 All ModelX 2. Through The Propeller Exhaust Models: Install exhaust pipe. Torque bolts a 18976 a 16231 a - Engine exhaust pipe DescriptioS Nm lb. in. lb. ft. Exhaust pipe to gimbal housing bolts 34 25 Power Trim Pump Installation Power Trim Pump 1. Select an appropriate mounting location (floor or transom) for the trim pump that: � Is within length limits of BLACK and GRAY hydraulic hoses coming from gimbal housing assembly. � Is close to the battery so that trim pump battery leads can be connected. � Allows easy access to trim pump oil fill and vent locations. � Is in an area where pump will not be exposed to water. � Prevents the power steering booster cylinder from coming in contact with the trim pump when the steering wheel is turned in either direction (right or left). NOTE: Template 90-863152 provides mounting hole location for floor or transom mounting. 2. Mount the pump in the desired location. Power Trim Pump Connections and Filling IMPORTANT: Make hydraulic connections as quickly as possible to prevent oil from leaking from the system. Page 2A-1 90-865612010 FEBRUARY 200 All Models 90-865612010 FEBRUARY 2006 Page 2A-17 1. Connect hydraulic hoses to the trim pump. Ensure that the quick- connect fittings completely seat when connecting the hoses. a b c e d g f h 7698 a - Positive battery lead b - Negative battery lead c - Harness connector d - BLACK hydraulic hose (UP hose) e - GRAY hydraulic hose (DOWN hose) f - Fill/vent cap g - Dual mount trim pump bracket h - Trim limit switch connected and secured 2. Connect power trim pump control harness to trim pump. b a 7699 a - Control harness b - Trim pump connector FILLING 1. If the oil level is below the "MIN" line specified fluid must be added. 2. Remove the fill cap from the reservoir. All Models Page 2A-18 90-865612010 FEBRUARY 2006 NOTE: Fill cap is vented. a b 7701 Power tim pump reservoir showes the oil level is below "MIN" line a - Fill cap assembly b - Fill cap installed 3. Add lubricant to bring level to the within the "MIN" and "MAX" lines on the reservoir. a b 7876 a - Reservoir b - "MIN" and "MAX" lines Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Power trim pump 92-802880A1 4. Install the fill cap. Steering System Installation Hydraulic (Helm) Steering If your power package is equipped with Compact Hydraulic Steering, refer to the Compact Hydraulic (Helm) Steering Installation Instructions . Steering Helm and Cable Transom assembly is shipped with the steering cable guide tube preset for cables with end dimensions that comply with ABYC standards as outlined in the NMMA certification handbook. The steering cable coupler nut must also have a means of locking it to the guide tube, as specified in ABYC requirements. All ModelX ! WARNING Failure to use a steering cable locking device could cause loss of steering, causing possible damage to the boat or injury. NOTE: All current production Quicksilver RideGuide steering cables have a self-locking coupler nut and do not require an external locking device. (Other cable manufacturers also make cables with self-locking coupler nut.) a 7255 a - Quicksilver RideGuide steering cable self-locking coupler nut (identified by groove) IMPORTANT: If using a steering cable that does not have a self-locking coupler nut, an external locking device such as a locking sleeve must be used. ! CAUTION If steering cable with improper dimensions is installed, severe damage to transom assembly and/or steering system may result. 1. Steering cable must be the correct length, particularly when installed in larger boats. 2. Avoid sharp bends, kinks, or loops in cable. 3. Fully extended steering cable end dimension must be as specified. 90-865612010 FEBRUARY 2006 Page 2A-1 All Models Page 2A-20 90-865612010 FEBRUARY 2006 Steering Cable Specifications IMPORTANT: Power-assisted steering pump lugging (squealing) in a hard right turn (against lock) may mean a steering cable has been installed that does not have the correct dimensions. CL a b c d e f g h i j k l 7254 a - Coupler nut - 7/8 - 14 UNF - 28 thread b - 298 mm (11-3/4 in.) minimum c - Interface point d - 12.7 mm (1/2 in.) maximum e - 10.7 mm (27/64 in.) minimum flat f - 3.1 mm (7/64 in.) minimum radius g - 15.9 mm (5/8 in.) maximum diameter end fitting h - 9.5 mm (3/8 in.) i - 9.8 mm (3/8 in.) diameter through hole (chamfered each side) j - 34.9 mm (1-3/8 in.) maximum k - 15.9 mm (5/8 in.) diameter tube l - Cable travel: mid-travel position - 429 mm (16-7/8 in.) total travel to be 203 mm (8 in.) minimum to 228 mm (9 in.) maximum travel each side of mid-travel position - 102 mm (4 in.) minimum to 114 mm (4-1/2 in.) maximum Installing Steering System NOTE: For dual installations, power-assisted steering unit can be mounted on port or starboard transom assembly. Measure exact distance between power package center lines. Select a tie bar from Mercury Precision Parts / Quicksilver Accessory Guide. Refer to tie bar installation instructions before proceeding. 1. Remove the protective shipping caps. 2. Inspect the bushings for debris. Lubricate the power steering bushings. 3. a 7709 a - Bushings All ModelX Tube Ref No. DescriptioS Where Used Part No. 34 Special Lubricant 101 Power steering bushings 92-802865A1 4. Remove the upper and lower pivot bolts and ensure that the threads are well lubricated. a b a - Upper pivot bolt 21631 b - Lower pivot bolt Tube Ref No. Description Special Lubricant 101 Where Used Upper and lower pivot bolts Part No. 92-802865A1 34 5 Position the steering assembly so that the pivot bolts will enter the bushings in the power-assisted steering control valve. 6 Install the upper and lower pivot bolts along with tab washers. Ensure that the tab washer tangs straddle the ridge on the inner transom plate. a b b a a 21632 Upper Pivot Bolt And Tab Washer Shown (Lower Similar) a - Tab washer tang b - Ridge 7. 8. 9. Turn the pivot bolts all the way in, by hand, to ensure proper steering assembly alignment. Ensure that the steering assembly pivots freely. Torque the pivot bolts. Bend the tab washer tabs against the corresponding flats on the bolt heads. 90-865612010 FEBRUARY 200 Page 2A-2 All ModelX NOTE: It may be necessary to tighten the pivot bolts further to align the flats on bolt head with the tabs on the washer. a a b b 21691 a - Pivot bolt b - Bent tab Description Nm lb. in. lb. ft. Upper and lower pivot bolt 34 25 ! CAUTION MOVING THE CONTROL VALVE RAM with the hoses disconnected will expel fluid from the control valve ports. Wear eye protection. 10. While wearing eye protection to avoid expelled fluid, move the control valve cable guide tube as shown, so that it will be less difficult to pull it out or push it in during connection. a ab b 8496 a - Port b - Control valve cable guide tube 11. Connect the clevis to the steering lever. a. Lubricate the clevis pin. Tube Ref No. 34 Description Special Lubricant 101 Where Used Clevis pin Part No. 92-802865A1 Page 2A-22 90-865612010 FEBRUARY 200 All ModelX b. Insert the clevis pin b a a - Clevis 20396 b - Clevis pin c. d. Insert the cotter pin. Spread both ends of the cotter pin. c b aa c 20399 a - Cotter pin b - Clevis pin c - Steering lever IMPORTANT: Quicksilver RideGuide steering cable has a self-locking coupler nut and does not require an external locking sleeve or locking plate. a 7255 a - Self-locking coupler nut 90-865612010 FEBRUARY 2006 Page 2A-2 All ModelX ! CAUTION Proper steering system function requires that the steering cable and outer casing musY be free to move back and forth. Items fastened to the steering cable and outer casinL prevent free movement. Do not fasten any items to the steering cable and outer casing 7827 a a - Steering cable and outer casing a. 12. CoCoat the steering cable end with a libennect the steering cable as follows: ral amount of lubricant. Tubb. e Ref No. Description Where Used 34 Special Lubricant 101 Steering cable end Install the steering cable and secure with hardware as shown. Part No. 92-802865A1 IMPORTANT: Cable guide tube flat surfaces must be positioned vertically or slight feedback in the steering system could be encountered. c Using a suitable wrench hold the flat surfaces on the cable guide tube in the vertical position. Torque the coupler nut. Ensure that the flat surfaces are still aligned vertically after torque is applied to the coupler nut. d h d c ba g fe 7830 a - Steering cable e - Steering cable end b - Grease fitting f - Clevis c - Cable coupler nut g - Clevis pin d - Cable guide tube h - Cotter pin Shift Cable Routing 1 Route the intermediate shift cable from the transom assembly to the shift actuator as follows: Page 2A-2 90-865612010 FEBRUARY 200 All ModelX a The cable should come through the transom, above the exhaust pipe and make a turn toward the starboard side of the boat between the exhaust pipe and the engine flywheel housing. b. The cable should then be routed under the starboard rear engine mount and turn toward the transom. c. The cable should then go up behind the power-assisted steering valve and loop over to the shift actuator on the engine. NOTE: Following this routing will prevent the engine coupler from damaging the cable. 8995 Refer to Section 8 - Remote Control. Engine Installation Refer to the appropriate Mercury MerCruiser Sterndrive Models installation Manual. 1. Install the engine. Transom Connections Continuity Wire Connection 1. Connect continuity circuit wire from engine to transom assembly. IMPORTANT: Do not attach any accessory ground (-) wires to transom plate ground point. Accessory ground wires can only be attached to ground stud on engine. a 7794 a - Continuity wire 90-865612010 FEBRUARY 200 Page 2A-2 All ModelX Trim Position Sender Connections 1 Connect trim position sender wires (from transom assembly) to engine harness. Use the ORG/GRY wire for analog gauges and the ORG/WHT wire for digital gauges. BLK BLKa b a b BLK ORG/WHT ORG/GRY 9292 a - Engine harness bullet connector b - Transom assembly bullet connector Trim Limit / Sender Harness 1 Install the harness terminal leads into the trim limit/sender harness terminal connector block as follows: a Insert the terminal lead "A" into the terminal marked "A" on the terminal connector Push the terminal lead into the terminal block until the terminal lead clicks into place and cannot be pulled out. b. Repeat Step a. for terminals "B" and "C" ensure that all 3 terminals are securely locked in place. c. Place the terminal lead retaining clip over the leads at the rear of the terminal connector block. d. Push the the retaining clip onto the terminal connector block until it snaps into place over the locking tabs located on ether side of the terminal connector block. Page 2A-2 90-865612010 FEBRUARY 200 All ModelX e. Connect the trim limit/sender connector to the transom harness connector at the engine. c - Retaining clip d - Locking tab a b cd d 11912 a - Trim limit/sender harness terminal lead b - Terminal connector block MerCathode Connections (If Equipped) The MerCathode controller assembly is located on the back of the front lifting eye. 1 Connect wires to MerCathode controller assembly and MerCathode quick connect. Apply a thin coat of sealant to all connections. IMPORTANT: Opposite end of RED/PURPLE wire must be connected directly to battery positive (+) terminal. Do not connect it to a switched positive (+) circuit. MerCathode system must function continuously for proper corrosion protection. d a b c 8507 a - ORANGE lead - from anode on transom assembly (part of quick connect) b - RED/PURPLE wire - to positive (+) battery terminal c - BLACK wire - from engine harness d - BROWN wire - from electrode on transom assembly(part of quick connect) 90-865612010 FEBRUARY 2006 Page 2A-27 All Models Page 2A-28 90-865612010 FEBRUARY 2006 Tube Ref No. Description Where Used Part No. 25 Liquid Neoprene MerCathode connections 92-25711-3 Power Trim Pump Connections 1. Connect power trim pump BLACK (-) battery cable to negative (-) battery terminal and pump RED (+) battery cable to positive (+) battery terminal. a b 6842 a - Positive battery lead b - Negative battery lead Tube Ref No. Description Where Used Part No. 25 Liquid Neoprene Battery Terminals 92-25711-3 Gear Lube Monitor Connection IMPORTANT: Avoid using excessive hose when routing it to gear lube monitor. Hose should be routed directly to oil reservoir in as straight a line as possible to avoid low spots (traps) in the system. ! CAUTION Ensure that hose is not kinked when connecting in the following step. If hose is kinked, gear lube monitor will not function properly and damage to sterndrive unit could occur. 1. Locate the gear lube monitor quick connect at the rear of the engine. 2. Locate the gear lube monitor quick connect at transom. IMPORTANT: Hose must not come in contact with steering system components, engine coupler, U-joint shaft, or drive shaft. All ModelX 3. Fasten the quick connect 7800 b c a a - Gear lube monitor hose assembly c - Quick connect fitting from transom b - Gear lube monitor hose assembly from gear lube monitor Power-Assisted Steering Hoses IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leaks. 1. Disconnect the quick connect fittings on the power-assisted steering hoses. 2. Connect the power-assisted steering hoses to the control valve. Ensure that the quick connects snap into place. 3. Route hoses as appropriate to avoid contact with the steering system components. 4. Use extra hose clips to secure hose to transom. a b a b a a 16225 a - Hydraulic lines b - Power-assisted steering control valve NOTE: Steering Fluid can be added at this time if desired. Seawater Inlet Fitting Connection ! CAUTION Excess water in the bilge can damage the engine or cause the boat to sink. An improperly connected seawater inlet hose could result in excess water in the bilge. Ensure that the seawater inlet hose is connected properly by performing the specified pull test. NOTE: The retainer clip must be in the closed position prior to installation. 1. Install the seawater inlet hose assembly to the water inlet fitting. 90-865612010 FEBRUARY 2006 Page 2A-2 All Models Page 2A-30 90-865612010 FEBRUARY 2006 a. Position the retainer clip in the closed position. 8512 a b c Seawater inlet hose assembly a - Retainer clip closed b - Quick connect fitting c - Hose decal b. Position the seawater inlet hose assembly with the center of the retainer clip and the hose decal toward the engine. IMPORTANT: Tabs and slots are sized to only mate at the correct orientation. Mate the small tab with the small slot. c. Align the slots of the quick connect fitting to the tabs of the water inlet fitting. g b c a h e f d 8513 a - Quick connect fitting b - Small slot c - Large slot d - Seawater inlet fitting e - Small tab f - Large tab g - Center of retainer clip (toward engine) h - Centerline of water inlet fitting (toward engine) d. Ensure that the center line of the water inlet fitting and the center of the retainer clip are positioned toward the engine. 2. Push the seawater inlet hose assembly onto the water inlet fitting until connected. All Models 90-865612010 FEBRUARY 2006 Page 2A-31 NOTE: The retainer clip snaps into place and resumes the closed position when properly connected. 8514 c a b Shown with engine removed for visual clarity a - Centerline of water inlet fitting b - Retainer clip in closed position c - Hose decal ! CAUTION Excess water in the bilge can damage the engine or cause the boat to sink. An improperly connected seawater inlet hose could result in excess water in the bilge. Ensure that the seawater inlet hose is connected properly by performing the specified pull test. IMPORTANT: A pull test must be performed at the seawater inlet connection. 3. Perform a pull test on the water hose quick connection. a. Pull on the seawater inlet hose near the connection point with an approximate force of 111 N (25 lbf). If the seawater inlet hose does not become separated from the seawater inlet fitting when force is applied, the seawater inlet hose is connected and sealed properly. b a c 8515 Shown with engine removed for visual clarity a - Seawater inlet hose b - Quick connect fitting c - Seawater inlet fitting b. If the seawater inlet hose does become separated from the seawater inlet fitting, reinstall as specified. c. When all steps have been completed, check for any leaks at this connection. 4. Connect the seawater inlet hose to the engine seawater pump. All Models Page 2A-32 90-865612010 FEBRUARY 2006 NOTE: The seawater inlet hose connects to the engine and the transom. a c 8516 e b d e Seawater inlet hose assembly a - Seawater inlet hose b - To engine c - Quick connect fitting d - Seawater inlet fitting e - Hose clamps 5. Models Using The Seawater Extension Hose Assembly: NOTE: The seawater inlet hose connects to the engine and the transom, the seawater extension hose assembly connects to the transom and the seawater inlet hose. a. When connecting the seawater extension hose assembly to the seawater inlet hose assembly, position the center of the retainer clip away from the engine. b c e d a 8517 Shown with engine removed for visual clarity a - Retainer clip position (away from engine) b - Seawater extension hose c - Seawater inlet hose (to engine seawater pump) d - Quick connect fitting (to seawater inlet fitting) e - Seawater inlet fitting (to transom) ! CAUTION Excess water in the bilge can damage the engine or cause the boat to sink. An improperly connected seawater inlet hose could result in excess water in the bilge. Ensure that the seawater inlet hose is connected properly by performing the specified pull test. b. Perform a pull test and ensure that the requirements for checking the integrity of the connection are met. All Models 90-865612010 FEBRUARY 2006 Page 2A-33 NOTE: The seawater extension hose assembly connects to the transom and the seawater inlet hose. d a b c e f g g g g 8518 a - Seawater inlet hose b - Quick connect fitting to extension hose c - Quick connect male fitting d - Extension hose e - Quick connect fitting to seawater inlet fitting f - Seawater inlet fitting g - Hose clamp Shift Cable Installation and Adjustment Bravo Models Shift Cable Installation NOTE: Bravo Models Only: Using shift cable adjustment tool (91-12427), shift cables can be adjusted with or without the sterndrive installed, using the following procedure. Shift Cable Adjustment Tool 91-12427 IMPORTANT: Sterndrive propeller rotation is determined by the shift cable installation in the remote control. � Bravo One/Two - If shift cable end guide moves in direction A when control lever is placed in FORWARD, remote control is set up for RIGHT-HAND (RH) propeller rotation. � Bravo One/Two - If shift cable end guide moves in direction B when control lever is placed in FORWARD, remote control is set up for LEFT-HAND (LH) propeller rotation. A B 21620 Arrow indicates direction of motion � Bravo Three - Front propeller on sterndrive is always LH Rotation and rear propeller is always RH Rotation. Shift cable end guide must move in direction A, when control lever is placed in FORWARD gear position. A 21621 IMPORTANT: When installing shift cables, ensure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. Do not fasten any items to shift cables. All ModelX Bravo Models Shift Cable Adjustment 1. Remove the adjustment tool. a 21611 a - Adjustment tool 2. Loosen the adjustable stud and move it to dimension, as shown. Retighten stud. a 21612 b a - Adjustable stud b - 76 mm (3 in.) (center of pivot bolt to center of stud) 3. 4. Install sterndrive shift cable. Install cotter pin. Page 2A-34 90-865612010 FEBRUARY 200 All ModelX 5. Insert cotter pin from top and spread ends fully a 21616 b c a - Sterndrive shift cable c - Short cotter pin b - Long cotter pin 6 Place adjustment tool over sterndrive shift cable, as shown. Hold tool in place using a piece of tape over the barrel retainer. a 21615 b a - Adjustment tool b - Sterndrive shift cable 7 Locate center of remote control and control cable play (backlash). IMPORTANT: Keep center mark "C" aligned with control cable end guide edge when making the following adjustment. a. Shift remote control to NEUTRAL. b. Push in on control cable end with enough pressure to remove play and mark position "a" on tube. c. Pull out on control cable end with enough pressure to remove play and mark position "b" on tube. 90-865612010 FEBRUARY 200 Page 2A-3 All ModelX d. Measure distance between marks "a" and "b" and mark position "c" half-way between marks "a" and "b." a c b 7815 8 Temporarily install control cable end guide into shift lever and insert anchor pin. 9 Adjust control cable barrel so that hole in barrel centers with vertical center line of stud. Ensure that backlash center mark is aligned with edge of control cable end guide. ! CAUTION Do not attempt to install or remove control cable barrel from stud without first removing end guide anchor pin from shift lever and removing cable. Attempting to bend control cable to install or remove barrel will place undue stress on cable end guide and shift lever and damage to both could occur. 10. Remove control cable end guide from shift lever by removing clevis pin. d - Control cable barrel e - Stud, washer and cotter pin c d e b a c d 21613 a - Control cable end guide b - Clevis pin c - Backlash center 11. Install the control cable. 12. Install the washer and cotter pin to secure the barrel. 13. Install the clevis pin. 14. Install the cotter pin into the clevis pin from the top and spread the ends. 15. Remove the adjustment tool. 16. Shift remote control lever into FORWARD position. Place end of adjustment tool in barrel retainer. If slot does not fit over stud, loosen shift lever stud and slide stud up or down until slot in tool fits over stud. When adjustment is correct, retighten stud. 17. Lift the adjustment tool so that the slot is above the stud. Page 2A-3 90-865612010 FEBRUARY 200 All ModelX 18. Shift the remote control into REVERSE and repeat the adjustment process b a 21614 b - LH rotation Bravo One and Two FORWARD, RH rotation Bravo One, Two and Three REVERSE slot a - RH rotation Bravo One, Two, Three FORWARD, LH rotation Bravo One and Two REVERSE slot 19. Remove adjustment tool. 20. Ensure that all cotter pins are secure and that the ends of the cotter pins are spread to 180 degrees. 21. Lubricate shift cable pivot points. Tube Ref No. 80 Description SAE Engine Oil 30W Where Used Shift cable pivot points Part No. Obtain Locally Shift Cable Installation For DTS System IMPORTANT: Do not move the shift cable stud on the shift arm. IMPORTANT: The shift cable barrel is preset and CANNOT be adjusted. 1 Route the intermediate shift cable from the transom assembly to the shift actuator as follows: a The cable should come through the transom, above the exhaust pipe and make a turn toward the starboard side of the boat between the exhaust pipe and the engine flywheel housing. b. The cable should then be routed under the starboard rear engine mount and turn toward the transom. c. The cable should then go up behind the power-assisted steering valve and loop over to the shift actuator on the engine. NOTE: Following this routing will prevent the engine coupler from damaging the cable. 8995 90-865612010 FEBRUARY 200 Page 2A-3 All Models Page 2A-38 90-865612010 FEBRUARY 2006 NOTE: A final check of the adjustments should be made with the boat in the water and engine running. If this cannot be done or is not done at your manufacturing facility, arrangement should be made with the dealer to do this as part of the pre-delivery inspection. 2. SeaCore Models: Apply lubricant to the threads of the shift cable stud. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Shift cable stud 92-802865A1 3. Install the intermediate shift cable to the shift actuator on the engine. 4. Tighten locknut until it contacts and then loosen 1/2 turn. a b c f e d 8996 a - Shift actuator b - Shift cable c - Locknut d - Shift cable stud e - Shift cable barrel f - Washers 5. Insert cotter pin from top and spread ends. a 8997 a - Cotter pin Bravo Installation Engine Alignment Check The engine alignment tool must slide in and out of the engine coupler and the gimbal bearing with little or no friction. All ModelX ! CAUTION Damage to engine and sterndrive can result from improper engine alignment. Align your engine as specified in the Mercury MerCruiser Installation Manual for your engine package. ! CAUTION Do not use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool may cause improper alignment and damage to gimbal bearing and/or engine coupler. 1. Check the engine alignment as follows. a. Insert the solid end of the alignment tool through the gimbal bearing and into the engine coupler splines. a 21671 a - Alignment tool Alignment Tool Assembly 91-805475A 1 b Hit the sides of the alignment tool with a synthane hammer at 90 degree increments to help align the gimbal bearing to the coupler as shown in the following steps: ad c b 4889 a - Alignment tool c - Engine coupler b - Gimbal bearing d - 90 degree increments 90-865612010 FEBRUARY 200 Page 2A-3 All ModelX c. Hit the alignment tool upward and downward a b a b 21672 a - Synthane hammer b - Alignment tool d. Hit the alignment tool on the port side and on the starboard side a b a b 21673 a - Synthane hammer b - Alignment tool e. Pull the tool out and insert it through the gimbal bearing and into the engine coupler splines. f. If the alignment tool does not fit, or is very tight, remove the tool. NOTE: Apply grease to the alignment tool before checking alignment. When the tool is removed the tool is wiped clean on the tight side. This can help determine where the engine adjustment is needed. � Adjust the engine mounts as necessary: Refer to the appropriate Mercury MerCruiser Engine Service Manual. � Perform the Engine Alignment Check. g The engine alignment is good when the alignment tool can slide in and out of the engine coupler and the gimbal bearing with little or no friction. Page 2A-4 90-865612010 FEBRUARY 200 All ModelX IMPORTANT: Engine alignment tool must slide in and out of the engine coupler and the gimbal bearing with little or no friction. 4781a b c a - Alignment tool c - Gimbal bearing b - Gimbal housing Bravo Sterndrive Installation 1 If applicable, remove trim cylinder support and dust cover from bell housing studs. (Retain elastic stop nuts and flat washers.) 8993 b a Typical a - Dust cover b - Trim cylinder support 90-865612010 FEBRUARY 200 Page 2A-4 All Models Page 2A-42 90-865612010 FEBRUARY 2006 2. Remove gear lube monitor cap. Fill the gear lube monitor to the "OPERATING RANGE". 5497 a b Gear lube monitor a - Gear lube monitor cap b - "OPERATING RANGE" line Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Gear Lube Monitor 92-802854A1 3. To purge air from the system, push in on the dribble valve stem until the new gear lube appears. a 21440 a - Dribble Valve 4. Release the dribble valve. All Models 90..865612010...............A.......2006 ..a......2A..43 5.. ....a.. ......b.. ....b........ ....a.. ......b.. ....A...........A...c... ......4.. b a c Gear lube monitor a .. ....a........b...............a.............A..........a.... b .. ....a........b...............a......... ..........A...........A........ c .. ..a.. ..ube Ref ..o. Description Where ..sed Part ..o. 87 ....a..c........a.. ....b....ca.... ....a........b................ 92..802854A1 6.. ....a.................a........b..................ca......................a...............bb........a.. ca..ca.... a ....2 a .. ....a........b...................ca.. 7.. ....a..b....ca.... a a 21441 a .. .. All ModelX 8. Coat the splines on the sterndrive U-joint with lubricant a 21442 a - Splines Tube Ref No. Description Where Used Part No. Engine Coupler Spline Grease U-joint O-rings 92-802869A1 Engine Coupler Spline Grease Driveshaft splines 92-802869A1 9. Ensure that the U-joint bellows are clean and free of debris. 91 91 a b 21456 Bell housing of the transom assembly a - U-joint bellows edge b - U-joint bellows 10. Lubricate the bell housing studs. a b a 21457 a - Bell Housing Studs (6) b - Tube of lubricant Tube Ref No. Description Where Used Part No. 2-4-C Marine Lubricant with Teflon Bell housing studs 92-802859A1 95 Page 2A-44 90-865612010 FEBRUARY 200 All ModelX 11. Lubricate the shift linkage O-ring 21678 a a - Shift linkage O-ring Tube Ref No. Description 2-4-C with Teflon 12. Lubricate the water passage seal. Where Used O-ring Part No. 92-802859A1 95 21679 a a - Water passage seal Tube Ref No. Description Where Used Part No. 2-4-C Marine Lubricant with Teflon Water passage seals 92-802859A1 95 90-865612010 FEBRUARY 2006 Page 2A-4 All ModelX 13. Pull out the shift linkage as far as it moves. Jaws will open a b c c 5311 a a - Shift linkage assembly b - Jaws open c - Underside of lower lip 21471 IMPORTANT: As the sterndrive is inserted into the entry of the bell housing, the shift cable must be closely checked to ensure that it enters the jaws of the shift linkage assembly of the sterndrive. 14. Place remote control in NEUTRAL position. NOTE: As bell housing shift cable enters the shift linkage assembly, it pushes the assembly back into the sterndrive housing, and the jaw closes, securing the cable, as shown in steps "A", "B" and "C." A B C 5312 IMPORTANT: If bell housing shift cable does not line up to properly enter jaws of shift linkage assembly, use your hand to guide the cable into place while installing the sterndrive. 15. Place driveshaft housing in position on bell housing and install sterndrive, as follows: Page 2A-46 90-865612010 FEBRUARY 200 All ModelX a. Remove the nuts from the trim cylinders a b a - Socket b - Wrench c - Anchor pin 21521 c d e d - Ground wires e - Trim cylinders b Position the sterndrive so that the universal joint shaft aligns with the bell housing bore. a b c d 21518 a - Universal joint b - Bell housing c - Shift linkage d - Shift cable c Guide the U-joint shaft through the bearing in gimbal housing and into the engine coupler. Ensure that shift linkage jaws engage the bell housing shift cable assembly. a b c 21519 a - Shift cable c - Shift linkage jaws engage the shift b - Shift linkage jaws open cable 90-865612010 FEBRUARY 200 Page 2A-4 All ModelX d If necessary, rotate the propeller shaft COUNTERCLOCKWISE slightly (using a propeller) to align U-joint shaft splines with splines in engine coupling, then slide sterndrive all the way into bell housing. b ca 21520 a - Bell housing studs c - Shift cable b - Dribble valve 16. Secure sterndrive to bell housing with 5 flat washers and 6 locknuts. Start from the center and torque the nuts. c b a 21680 a - Locknut (6) flat washers (5) c - Torque wrench b - Ground plate (washer not used here) DescriptioS Nm lb. in. lb. ft. Sterndrive fasteners 68 50 TRIM CYLINDER INSTALLATION 1. Install the mounting hardware of the trim cylinder forward as shown 2. Lubricate anchor pin threads to prevent threads from galling. Page 2A-4 90-865612010 FEBRUARY 200 All ModelX 3. Hand thread locknuts onto the pin. Do not tighten at this time e - Bushing f - Flat washer (small I.D.) g - Locknut h - Plastic cap a b c d e e f g h 14326 Front a - Anchor pin b - Retainer clip groove c - Flat washer (large I.D.) d - Retainer clip Tube Ref No. Description Where Used Part No. 95 2-4-C Marine Lubricant with Anchor pin threads 92-802859A1 Teflon IMPORTANT: On Bravo One, Two, and Three Models the trim-in limit insert must be properly positioned before installing the trim cylinder anchor pin in the following steps. NOTE: Ensure that the trim-in limit insert is reinstalled in the same position as before removal of the sterndrive. If you are not sure of the original position, contact the boat manufacturer for their recommendation. Refer to Special Information at the front of this section before reinstalling the trim-in limit insert. a b 14571 a - Trim-in limit insert Bravo One and Two (positioned forward) b - Trim-in limit insert Bravo Three (positioned aft) 4. 5. 6. Install the mounting hardware of the trim cylinder aft as shown. Lubricate anchor pin threads to prevent the threads from galling. Hand-thread locknuts onto the anchor pin. 90-865612010 FEBRUARY 2006 Page 2A-4 All ModelX IMPORTANT: The position of the trim-in limit insert on the Bravo Three sterndrive should only be changed after the boat has been properly tested. Contact the boat manufacturer if you are not sure of the original position for a particular boat application. a c f ed cc b 9295 a - Aft anchor pin d - Small ID flat washers (2) b - Larger flat washers (2) e - Locknuts (2) c - Bushings (4) f - Plastic caps (2) Tube Ref No. DescriptioS Where Used Part No. 2-4-C Marine Lubricant with 9 Trim cylinder hardware 92-802859A1 Teflon 7. Tighten the locknuts until the washer and locknut contact the shoulder on the anchor pin. 8. Install plastic caps and tighten hand-tight only. NOTE: Upon installation of hardware apply lubricant to all components except plastic caps. a b ab c 21677 c - Plastic cap (4) a - Socket and tool b - Wrench tool Speedometer Connections - Bravo Models 1 Raise sterndrive to gain access to area between gimbal housing and sterndrive, immediately atop the transom end of the anti-ventilation plate. Page 2A-5 90-865612010 FEBRUARY 200 All ModelX 2. Insert speedometer tube fitting into opening on topside of anti-ventilation plate, in position shown. a 5319 b a - Tube fitting b - Opening 3. With fitting fully seated, turn handle to left to a tightly seated position, as shown. a 5320 a - Fitting installed (handle pointing forward) Bravo Sterndrive Shift Check (Engine Running) ! WARNING Contact with moving sterndrive components and the propeller can cause personal injury or death. To avoid possible injury , remove the propeller and ensure that no people or animals are in the area of the sterndrive. This test requires sufficient water supply to your engine and sterndrive. 1. Check sterndrive for proper gear shift with boat out of water. 90-865612010 FEBRUARY 2006 Page 2A-5 All ModelX 2. Use the sterndrive tilt switch on the remote control handle to lower the sterndrive to DOWN/IN position. Do not allow the sterndrive skeg to contact the ground 4805 b a Typical single handle remote control shown a - Drive trim switch b - Drive trailer button 3. Connect a garden water hose between flushing attachment and water source. Dual Water Pick-up Flush Gearcase Seal Kit 91-881150K 1 Flushing Device 91-44357Q 2 Flushing Kit 91-849996T 1 4. Partially open water source until water continuously leaks out around the flushing device. ! CAUTION Overheating from insufficient cooling water will cause engine and drive system damage. Ensure that there is sufficient water always available at water inlet holes during operation. IMPORTANT: Engines with the sterndrive water inlet blocked off at the gimbal housing and using a through the hull water inlet need a supply of cooling water available to both the sterndrive and to the engine during operation. 5. Place remote control handle in NEUTRAL, idle speed position and start engine. ! CAUTION Engine overheating can cause engine damage. To avoid, observe the water temperature gauge and ensure that the engine is operating in the normal range. ! CAUTION Sterndrive not shifting properly can cause engine and sterndrive damage. Contact your authorized Mercury MerCruiser dealer for proper adjustment. NOTE: The sterndrive is shifting properly when the sterndrive shifts with minimal effort in and out of each gear FORWARD, NEUTRAL, and REVERSE, at idle speed position. NOTE: The operator at the remote control handle should feel a slight detent before and after each gear. FORWARD-detent-NEUTRAL-detent-REVERSE IMPORTANT: The sterndrive is not shifting properly if the sterndrive shifts after the engine throttle is engaged. Consult your authorized Mercury MerCruiser dealer/representative for proper adjustment. 6. Move the remote control handle to FORWARD, idle speed position. Page 2A-52 90-865612010 FEBRUARY 200 All Models 90-865612010 FEBRUARY 2006 Page 2A-53 7. Check that the sterndrive propeller shaft is turning in the FORWARD direction. 8. Shift the remote control handle to NEUTRAL, idle speed position. 9. Check that the sterndrive propeller shaft is not turning. 10. Shift the remote control handle to REVERSE, idle speed position. 11. Check that the sterndrive propeller shaft is turning in the REVERSE direction. 12. If the sterndrive will not shift: a. Remove the sterndrive and check for proper shift hook ups. b. Check that the shift cables are connected IMPORTANT: Be sure that the shift cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to shift cables. Troubleshooting Shift Problems NOTE: The following information is provided to assist an installer in troubleshooting if hard shifting or chucking/racheting is encountered when shifting into FORWARD gear. 1. When installing the control box in the side panel of the boat, ensure that the cables have enough clearance to operate. This is necessary because the cables move up and down when the shift handle is moved. If the control box is mounted too far back toward any fiberglass structure, the cables will be interfered with; this will cause very hard shifting. NOTE: The control box housing can be rotated in 30 degree increments to improve cable routing. 7873 Proper cable bend 7872 Improper cable bend 2. Ensure that when the shift cable from the control box is led through the side gunnel of the hull, it does not have any extremely sharp bends in it as this will cause stiff shifting. All ModelX IMPORTANT: Remote control cables MUST BE THE CORRECT LENGTH; sharp bends on too-short cables result in kinks and too-long cables require unnecessary bends or loops. Both conditions place extra stress on the cables. IMPORTANT: Shift cable/throttle cable lubrication points use 2-4-C with Teflon. 3 Before installing the shift cable into the control box, extend the stainless rod eye end of the cable and lubricate it. Move it back and forth to allow even distribution of the lubricant. b c d a 7874 a - Remote control end c - Adjusting barrel b - Engine end d - Lubricating point Tube Ref No. Description Where Used Part No. 95 2-4-C Marine Lubricant with Teflon Shift cable end 92-802859A1 NOTE: Allow for clearance of cables directly behind panel mount remote control. The 4000 GEN II Series Panel Mount Remote Control mounting surface must not exceed 25 mm (1 in.) thickness. Cable radius at any one point must not be less than 305 mm (12 in.). 4000 GEN II Series Panel Mount Remote Control Description Specification Mounting surface maximum thickness 25 mm (1 in.) Minimum cable bend radius at any point 305 mm (12 in.) 4. Do not strap or clamp the control cables to any other cables or rigid structure within 91.4 cm (3 ft) of the control box. 5. Ensure that the cable is not permanently kinked. 6 Ensure that there is proper clearance for cable movement when the control box is installed in the side panel. The cables must have room to move up and down when the control handle is shifted into either FORWARD or REVERSE. 7 Ensure that the engine was not set down on the intermediate shift cable during installation, as this will crush the inner cable tubing and cause improper and / or stiff shifting. 8. Do not fasten the shift cable with straps or clamps to any other cable within 1.5 m (5 ft) of the shift plate. 9. Do not fasten the shift cable to the transom with any type of plastic clips or fasteners within 1.5 m (5 ft) of the shift plate. Page 2A-5 90-865612010 FEBRUARY 200 All ModelX 10. Do not overtighten the throttle or shift cable attaching nuts at the engine end. Barrel and cable end must be free to rotate on the mounting stud. NOTE: Lubricate attaching points with engine oil. DescriptioS Where Used Part Number SAE 30W Engine Oil Shift cable pivot points Obtain Locally 11. Check the intermediate shift cable routing from the transom assembly to the shift plate as follows: NOTE: Cable route is the same for through transom and through prop exhaust. a The cable should come through the transom, above the exhaust pipe and make a turn toward the starboard side of the boat between the exhaust pipe and the engine flywheel housing. b The cable should then be routed under the starboard rear engine mount and turn toward the transom. c The cable should then go up behind the power steering valve and loop over to the shift plate on the engine, where it is connected to the anchor points on the shift plate. Following this routing will prevent the engine coupler from damaging the cable. 8995 Through prop exhaust shown NOTE: NOTE: A final check of the adjustments should be made with the boat in the water and engine running. If this cannot be done or is not done at your manufacturing facility, arrangement should be made with the dealer to do this as part of the pre-delivery inspection 12. Shift effort tools will be available for new installations using certain Quicksilver Gen II Controls. Refer to 90-865523 Instruction Sheet for more information. Bravo Trim Limit Switch Adjustment - Analog Gauges ! WARNING When adjusting trim limit switch, use extreme care that the engine is not started and keep clear of the area near the propeller. Use care to prevent placing hands in an area where injury could occur because of drive unit movement. ! CAUTION Trim limit switch MUST BE adjusted exactly as outlined. If switch is adjusted incorrectly, drive unit could move out beyond the gimbal ring support flanges and cause damage to sterndrive unit. 90-865612010 FEBRUARY 200 Page 2A-5 All ModelX IMPORTANT: All Bravo models must have the trim-in-limit insert positioned properly before performing the trim position sender adjustment. 1 Ensure that the trim-in-limit insert is positioned as shown for the appropriate Bravo model. a a 854 8557 Bravo One and Two (positioned forward) Bravo Three (positioned aft) a - Trim-in-limit insert 2 Bravo sterndrive, adjust trim limit switch as follows: a. Loosen screws and turn trim limit switch clockwise to end of slots. a 16524 Trim limit switch a - Screws b. c. Ensure drive unit is in the full DOWN/IN position. Using the Trim button on the remote control, trim drive unit UP/OUT. DO NOT USE TRAILER BUTTON. Page 2A-5 90-865612010 FEBRUARY 200 All ModelX d. Slowly turn trim limit switch counterclockwise until trim cylinders extend to dimension shown. a 21675 Trim limit switch a - Rotate Counterclockwise To Adjust a 8558 Bravo trim cylinder extended a - Trim Limit Dimension 21-3/4 in. (552 mm) e. Retighten screws when adjustment is correct. Trim Position Sender Adjustment - Analog Gauges 1. Loosen both trim position sender retaining screws. a b 21676 a - Retaining screws b - Trim position sender ! CAUTION Do not start engine in the following step or damage to sterndrive unit and engine could result from lack of cooling water. 2. Turn ignition key to RUN position. 3. Trim sterndrive unit to the full DOWN/IN position. 90-865612010 FEBRUARY 2006 Page 2A-5 All ModelX 4. Rotate trim position sender as required to show full DOWN/IN position on dashboard instrument as shown. a 7883 a - Trim gauge needle 5. Tighten retaining screws and turn ignition key to the OFF position. a b 21674 a - Retaining screws b - Trim position sender Trim Position Sender Adjustment - SmartCraft Gauges Scan Tool Method a b 21076 a - Trim position sender b - Retaining screws Page 2A-58 90-865612010 FEBRUARY 200 All ModelX 1. Trim the sterndrive unit to the full DOWN/IN position. 2. Remove the weather cap from the Diagnostic Link connector and connect the DDT Scan Tool. 3. Turn ignition key switch to the RUN position. 4. Set the scan tool to display TRIM POS counts and note the value displayed. 5. TRIM POS counts must be between 20 and 24 counts. 6. If TRIM POS counts are within specified range, proceed to step 6. Otherwise: a. Loosen both trim position sender retaining screws. b. Rotate the trim position sender until TRIM POS counts are within the specified range, preferably near the middle of the range. c. Tighten the trim position sender retaining screws. d. Verify TRIM POS counts are still within the specified range. Repeat steps "a" through "c" if necessary. 7. Turn the ignition key switch to the OFF position, disconnect the scan tool from the Diagnostic Link connector, and install the weather cap in the Diagnostic Link connector. Trim Position Sender Adjustment - SmartCraft Gauges Multimeter Method a b 21076 a - Trim position sender b - Retaining screws 1. Trim the sterndrive unit to the full DOWN/IN position. 2. Disconnect trim position sender wires from engine wiring harness connections. 3. Connect Multimeter leads to trim position sender wires and set Multimeter to display resistance (Ohms). 4. Note resistance reading. Resistance must be between 16 and 20 Ohms. 5. If resistance reading is within specified range, proceed to step 6. Otherwise: a. Loosen both trim position sender retaining screws. b. Rotate the trim position sender until resistance reading is within the specified range, preferably near the middle of the range. c. Tighten the trim position sender retaining screws. d. Verify resistance reading is still within the specified range. Repeat steps "a" through "c" if necessary. 90-865612010 FEBRUARY 2006 Page 2A-5 All ModelX 6. Disconnect the trim position sender wires from the multimeter leads and reconnect trim position sender wires to engine wiring harness connections. 7. Refer to Mercury SmartCraft Operator's Manual for final Trim Calibration procedure. Bravo One Propeller Hub General Information Bravo One Propeller Hubs Rated for Under 400 HP a b c d e Flo-Torq II Hub a - Forward thrust washer b - Aft adaptor c - Plastic drive sleeve 20527 d - Prop nut e - Tab washer a b c d ef 20529 Flo-Torq II Hub with bushinL a - Forward thrust washer d - Bushing b - Aft adaptor e - Tab washer c - Plastic drive sleeve f - Prop nut Page 2A-60 90-865612010 FEBRUARY 200 All ModelX Bravo One Propeller Hub Rated for 400 HP and OveU a b c d e 20530 Flo-Torq II Solid Hub a - Forward thrust washer b - Steel drive sleeve c - Aft adaptor d - Prop nut e - Tab washer Bravo One XR Propeller Hub a b c d e 20531 Flo-Torq II HD (heavy duty) Solid HuG a - Prop nut d - Washer b - Steel drive sleeve with snubber e - Thick washer stripes c - Washer 90-865612010 FEBRUARY 2006 Page 2A-6 All ModelX Bravo Sterndrive Propeller InstallatioS ! WARNING Ensure that remote control is in NEUTRAL position and ignition key is removed from switch prior to installing propeller. ! WARNING Place a block of wood between the anti-ventilation plate and propeller to protect handX from propeller blades and to prevent propeller from turning when tightening propeller nut a b c 4826 a - Wood block c - Propeller nut under socket b - Propeller Bravo One Models IMPORTANT: Use the correct rotation propeller. The propeller rotation MUST match the direction of rotation of the propeller shaft. 1. Liberally coat the propeller shaft spline with one of the following Quicksilver lubricants. Tube Ref No. Description 34 95 94 Special Lubricant 101 2-4-C Marine Lubricant with Teflon Anti-Corrosion Grease Where Used Part No. Propeller shaft splines 92-802865A1 Propeller shaft splines 92-802859A1 Propeller shaft splines 92-802867A1 NOTE: Anti-corrosion grease is for salt water applications only. 2. Install the propeller with the attaching hardware as shown. Page 2A-62 90-865612010 FEBRUARY 200 All ModelX 3 Torque the propeller nut a b c d e f g 5301 Typical Bravo One models a - Propeller shaft splines e - Drive sleeve adapter b - Forward thrust hub f - Tab washer c - Flo-Torque II drive hub g - Propeller nut d - Propeller a b c d e f g 19816 Bravo One XR models a - Propeller shaft b - Propeller hub insert with snubbers c - Propeller d - Thick washer e - Washer f - Washer g - Propeller nut NOTE: The propeller torque stated is a minimum torque value Then align tabs with grooves Description Nm lb. in. lb. ft. 75 55 Bravo One propeller nut NOTE: Bravo One XR models do not use the tab washer. 4 Models equipped with the tab washer: Continue to tighten the propeller nut until the 3 tabs on the tab washer align with the grooves on the spline washer. 90-865612010 FEBRUARY 200 Page 2A-6 All ModelX 5. Bend the 3 tabs down into the grooves e c d ba 4750 a - Prop d - Tab bent down b - Tab washer e - Propeller nut c - Drive sleeve adapter Bravo Two Models IMPORTANT: Use the correct rotation propeller. The propeller rotation MUST match the direction of rotation of the propeller shaft. 1. Liberally coat the propeller shaft spline with one of the following Quicksilver lubricants. Tube Ref No. Description 34 95 94 Special Lubricant 101 2-4-C Marine Lubricant with Teflon Anti-Corrosion Grease Where Used Part No. Propeller shaft splines 92-802865A1 Propeller shaft splines 92-802859A1 Propeller shaft splines 92-802867A1 NOTE: Anti-corrosion grease is for salt water applications only. 2. Install the propeller with the attaching hardware as shown. 3. Torque the propeller nut. 8566 a b c f d e Bravo Two a - Propeller shaft splines d - Spline washer b - Forward thrust hub e - Tab washer c - Propeller f - Propeller nut NOTE: The propeller torque stated is a minimum torque value Page 2A-64 90-865612010 FEBRUARY 200 All ModelX Description Nm lb. in. lb. ft. 81 60 Bravo Two propeller nut Then align tabs with groves 4. Continue to tighten the propeller nut until the 3 tabs on the tab washer align with the grooves on the spline washer. 5. Bend the 3 tabs down into the grooves. e c d ba 4750 a - Prop d - Tab bent down b - Tab washer e - Propeller nut c - Drive sleeve adapter Bravo Three 1. Liberally coat the propeller shaft spline with one of the following Quicksilver lubricants. Tube Ref No. Description 34 95 95 Special Lubricant 101 2-4-C Marine Lubricant with Teflon 2-4-C Marine Lubricant with Teflon Where Used Part No. Propeller shaft splines 92-802865A1 Propeller shaft splines 92-802859A1 Propeller shaft splines 92-802859A1 NOTE: Anti-corrosion grease is for salt water applications only. 2. Slide forward thrust hub onto propeller shaft, with tapered side toward propeller hub. 3. Align splines and place front propeller on propeller shaft. 4. Install front propeller locknut and torque using the Propeller Nut Tool. Propeller Nut Tool 91-805457T 1 Description Nm lb. in. lb. ft. Bravo Three front propeller nut 136 100 5. Slide aft thrust hub onto propeller shaft with tapered side toward propeller hub 6. Align splines and install aft propeller. 7. Install propeller nut and torque. NOTE: The propeller torque stated is a minimum torque value. 90-865612010 FEBRUARY 2006 Page 2A-6 All ModelX Description Nm lb. in. lb. ft. Bravo Three rear propeller nut 81 60 8. Install propeller shaft anode and screw and torque. e f a b c d 5304 g h i j Bravo Three a - Rear propeller nut b - Rear propeller c - Rear propeller thrust hub d - Front propeller nut e - Front propeller f - Front propeller thrust hub g - Propeller shaft anode screw h - Flat washer i - Star washer j - Propeller shaft anode Description Nm lb. in. lb. ft. Propeller shaft anode screw 19 168 Page 2A-66 90-865612010 FEBRUARY 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Bravo Sterndrive Section 3A - Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Table of Contents Bravo Sterndrive Propeller Removal...............3A-2 Bravo One Models...................................3A-2 Bravo Two Models...................................3A-4 Bravo Three Models................................3A-5 Drain Gearlube From Sterndrive.....................3A-6 Inspect seal..3A-8 Bravo Sterndrive Removal From Boat............3A-8 Bravo One Driveshaft Housing and Gear Housing Separation..3A-10 Inspection...3A-12 Bravo Two Driveshaft Housing and Gear Housing Separation..3A-12 Inspection...3A-13 Bravo Three Driveshaft Housing and Gear Housing Separation..3A-13 Inspection...3A-14 Cleaning Gear Lube Monitor System............3A-14 3 A 90-865612020 FEBRUARY 2006 Page 3A- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Gear lube monitor 92-802854A1 Special Tools Propeller Nut Tool 91-805457T 1 10677 Aids in the removal and installation of the front propeller nut. Bravo Sterndrive Propeller Removal ! WARNING Avoid Injury: Remote Control must be in NEUTRAL and ignition key removed from switch before removing and/or installing propeller. ! WARNING Avoid Injury: Place a block of wood between anti-ventilation plate and propeller to protect hands from propeller blades and to prevent propeller from rotating when removing propeller nut. Bravo One Models NOTE: Bravo One XR models do not use the tab washer. 1. If Equipped, straighten the bent tabs of the tab washer on the propeller shaft. e c d ba 4750 a - Prop d - Tab bent down b - Tab washer e - Propeller nut c - Drive sleeve adapter Page 3A-2 90-865612020 FEBRUARY 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 2 Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. a b c 4826 a - Wood block b - Propeller c - Propeller nut under socket 3. 4. Turn the propeller shaft nut counterclockwise and remove the nut. Slide the propeller and the attaching hardware from the propeller shaft. a b c d e f g 5301 Bravo One models a - Propeller shaft splines e - Drive sleeve adapter b - Forward thrust hub f - Tab washer c - Flo-Torque II drive hub g - Propeller nut d - Propeller 90-865612020 FEBRUARY 200 Page 3A- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation a b c d e f g 19816 Bravo One XR models a - Propeller shaft b - Propeller hub insert with snubbers c - Propeller d - Thrust washer e - Washer f - Washer g - Propeller nut Bravo Two Models 1. Straighten the bent tabs of the tab washer on the propeller shaft. e c d ba 4750 a - Prop d - Tab bent down b - Tab washer e - Propeller nut c - Drive sleeve adapter Page 3A-4 90-865612020 FEBRUARY 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 2 Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. a b c 4826 a - Wood block b - Propeller c - Propeller nut under socket 3. 4. Turn propeller shaft nut counterclockwise to remove nut. Slide the propeller and attaching hardware from the propeller shaft. 8566 a b c f d e Bravo Two a - Propeller shaft splines d - Spline washer b - Forward thrust hub e - Tab washer c - Propeller f - Propeller nut Bravo Three Models 1 Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. 2 Remove the bolt and washers securing the propeller shaft anode. 90-865612020 FEBRUARY 200 Page 3A- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Page 3A-6 90-865612020 FEBRUARY 2006 3. Remove the propeller shaft anode. b d c e f 19058 a a - Propeller b - Propeller shaft nut c - Propeller shaft anode d - Propeller shaft anode screw e - Flat washer f - Star washer 4. Turn aft propeller shaft nut counterclockwise to remove nut. 5. Slide propeller and thrust hub off propeller shaft. 6. Use the Propeller Nut Tool, turn the front propeller shaft nut counterclockwise and remove the nut. Propeller Nut Tool 91-805457T 1 7. Slide the propeller and the thrust hub off the propeller shaft. e f a b c d 5304 g h i j Bravo Three a - Aft propeller nut b - Aft propeller c - Aft propeller thrust hub d - Front propeller nut e - Front propeller f - Front propeller thrust hub g - Propeller shaft anode screw h - Flat washer i - Star washer j - Propeller shaft anode Drain Gearlube From Sterndrive ! CAUTION ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities. Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 1. Bravo One: Trim the sterndrive to the full DOWN/IN position. 2. Remove the fill and drain plug. 14620 a b Bravo One model a - Fill and drain plug b - Sealing washer 3. 4. Bravo Two and Bravo Three: Trim the sterndrive to the full UP/OUT position. Remove the fill and drain plug. a b 14621 a b 19777 Bravo Two model Bravo Three model a - Fill and drain plug b - Sealing washer 5. Remove the oil vent screw and seal. ba 19066 a - Oil vent screw b - Seal 90-865612020 FEBRUARY 2006 Page 3A- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Inspect seal 1. Inspect the seals for nicks,tears and flattness, replace if damaged. 2. Inspect the gearlube for water. Bravo Sterndrive Removal From Boat IMPORTANT: Shift cables are connected at the sterndrive shift plate and the remote control box. 1. Move the remote control handle to NEUTRAL gear position. ! CAUTION Avoid personal injury. When lifting sterndrive with other than hydraulic system, secure the sterndrive with a suitable lifting device so that the sterndrive will not fall. ! CAUTION Avoid speedometer hose fitting damage. Disconnect the speedometer hose fitting from the driveshaft housing before removing the sterndrive. 2. Remove speedometer fitting from sterndrive: a. Press sterndrive trailer button on control handle to raise sterndrive to trailer position / full-up position. b. Locate area between gimbal housing and sterndrive immediately atop the transom end of the anti-ventilation plate. c. Rotate the speedometer connector counter clockwise and lift upward to remove. a a 5300 a - Speedometer connector handle d Press sterndrive trim switch on control handle to lower sterndrive to IN/DOWN position. Do not allow the sterndrive skeg to contact the ground. ! WARNING Avoid injury or death and product damage from an electrical shock, fire or explosion. Always disconnect both battery cables from the battery before servicing the power package. 1. Remove Sterndrive Propeller. Refer to Bravo Propeller Removal. 2. Remove trim cylinders Page 3A- 90-865612020 FEBRUARY 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation a. Remove aft power trim cylinder mounting hardware. 5477c d e f a b c 5480 a - Anchor pin d - Flat washer (2) small I.D b - Flat washer (2) large I.D. e - Locknuts (2) c - Bushing (4) f - Plastic caps (2) b. Remove front power trim cylinder mounting hardware. f - Flat washer (2) small I.D. h - Plastic caps (2) c. Retain hardware for reassembly. 19064 a b c d f i e g e h a - Gimbal ring b - Trim cylinders (port and starboard) g - Locknuts (2) c - Anchor pin d - Flat washer (2) large I.D. i - E-clip e - Bushing (4) ! CAUTION Avoid personal injury. Use a hoist to properly secure the sterndrive and to assist with maneuvering the sterndrive when removing/installing the sterndrive. ! CAUTION Back injury can result from incorrect lifting of awkward and heavy objects. Always use mechanical hoist or another person to assist. 3 Remove Sterndrive fasteners: a. Secure sterndrive with suitable lifting device. 90-865612020 FEBRUARY 200 Page 3A- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation b Remove the 6 locknuts and 5 washers that hold the sterndrive to the transom unit. a b 5305 a - Locknuts and washers b - Ground plate (washer not used here) NOTE: To ease in removal, slightly raise the sterndrive so it is not resting on the gimbal housing studs and pull straight out of gimbal housing. c. Carefully pull the sterndrive from the gimbal housing by holding the aft end of the sterndrive and pull straight out of bell housing. d. If sterndrive seems stuck to the gimbal housing, hold the aft end of the sterndrive and slightly rock sterndrive in a up and down motion. e. Carefully pull the sterndrive from the bell housing. f. Make sure the shift cable linkage jaws open and release the shift cable end. b a 5306 a - Shift linkage jaws (open) b - Shift cable end (released from jaws) IMPORTANT: Do not use a sharp object to pry the sterndrive from the bell housing, it could damage the mating surface of the bell housing and sterndrive. g If a bell housing stud backs out with the nut, retain and reinstall after sterndrive is removed. Bravo One Driveshaft Housing and Gear Housing Separation 1. Install the sterndrive to a stand and properly secure. Page 3A-1 90-865612020 FEBRUARY 200 Bravo Sterndrive Removal.. Pre..Disassembly Inspection.. and Driveshaft ..ousing and Gear ..ousing Separation 2 ....bb.............. a b 20664 a .. ....bb...........J b .. A.............a..H 3 ....c......................a.............a.... a b 18946 a .. ....c.............a..1..2........b....W b .. A.............a..H 4 ....a.............a.... a 21202 a .. A.............a..H 5 ....a........a.......... 90..865612020................A........2006 ..a......3A..11 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 6. Remove the bolt from anodic cavity a 20662 b c a - Nuts and washers (3 each side) c - Screw for anode plate b - Bolt (1) (located in the anode cavity) 7. Remove the gear case from driveshaft housing by pulling the driveshaft housing straight up. Inspection 1. Inspect the rubber plug, replace if damaged. 2. Inspect the anodic plate, replace if required. 3. Inspect all studs, bolts and washers, replace if damaged. 4. Inspect nuts, replace if damaged. Bravo Two Driveshaft Housing and Gear Housing Separation 1. Install the sterndrive to a stand and properly secure. 2. Remove the bolt aft of the anode plate.. b a 21426 a - Anode plate b - Bolt removed Page 3A-12 90-865612020 FEBRUARY 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 3. Remove the six nuts and washers a b c 21424 a - Nuts and washers (3 each side) c - Screw for anode plate b - Bolt and washer (1) 4 Remove gear case from driveshaft housing by pulling the driveshaft housing straight up. Inspection 1. Inspect the rubber plug, replace if damaged. 2. Inspect the anodic plate, replace if required. 3. Inspect all studs, bolts and washers, replace if damaged. 4. Inspect nuts, replace if damaged. Bravo Three Driveshaft Housing and Gear Housing Separation 1. Install the sterndrive to a stand and properly secure. 2. Remove the rubber plug. 3. Remove the front anode plate. 21551 a b a - Rubber plug b - Front anode plate 4. Remove the bolt from the front anodic cavity. 5. Remove the six nuts and washers. 90-865612020 FEBRUARY 200 Page 3A-1 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 6 Remove the gear case from the driveshaft housing by pulling the driveshaft housing straight up. 21548 a b c a - Nuts and washers (3 each side) b - Bolt (1) (located in the anode cavity) c - Screw for anode plate Inspection 1. 2. 3. Inspect the anode plates, replace if required. Inspect all studs, bolts and washers, replace if damaged. Inspect nuts, replace if damaged. Cleaning Gear Lube Monitor System ! CAUTION ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities. 1 To prevent contamination, the gear lube monitoring system must be cleaned if any of the following is found: a. Water is visible at the bottom of the gear lube monitor b. Gear lube oil appears discolored c. Metal particles are visible in gear lube 5499 a a - Gear lube monitor 2. Remove the gear lube monitor from the bracket Page 3A-1 90-865612020 FEBRUARY 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 90-865612020 FEBRUARY 2006 Page 3A-15 a. Empty the contents into a suitable container. 5500 c b a Typical a - Bracket b - Gear lube monitor and cap c - Retaining strap b. Reinstall the monitor in the bracket. 3. Depress the dribble valve until all remaining gear lube is drained from the system. a 5502 a - Dribble valve 4. Fill the gear lube monitor to the "OPERATING RANGE" (full) line with specified fluid. Do not overfill. 5497 a b a - Gear lube monitor cap b - "OPERATING RANGE" line Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Page 3A-16 90-865612020 FEBRUARY 2006 Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Gear lube monitor 92-802854A1 5. To purge air from the system depress the dribble valve until the gear lube appears. a 5502 a - Dribble valve. 6. Release the dribble valve. 7. If the gear lube monitor is below the (full) line: Fill the gear lube monitor to the "OPERATING RANGE" (full) line with specified fluid. Do not overfill. 5497 a b a - Gear lube monitor cap b - "OPERATING RANGE" line Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Gear lube monitor 92-802854A1 8. Install the gear lube monitor cap. Ensure that the rubber gasket is inside the monitor cap. Do not overtighten. Driveshaft Housing Disassembly, Repair, and Reassembl\ Bravo Sterndrive Section 3B - Driveshaft Housing Disassembly, Repair, and Reassembly Table of Contents Torque Specifications.....................................3B-7 U-joint Bearing Assembly Preload...........3B-7 Torque Conversion Chart For U-joint Retainer Nut Tool..3B-7 Specifications...3B-8 Starting Shim Specification.......................3B-8 Gear Tooth Count and Gear Lash...........3B-9 U-joint Pinion Gear Location....................3B-9 U-joint Pinion Gear Shim.........................3B-9 Driven Gear Thrust Race.........................3B-9 Identification..3B-10 Driveshaft Housing�Gear Ratio and U-joint Marking...3B-10 Driveshaft Housing�Gear Ratio and Gear Tooth Count...3B-10 Exploded Views..3B-12 Driveshaft Housing and Gears for Standard and X Series Models.....................................3B-12 Driveshaft Housing U-Joint and Shift Components for Standard Bravo Models ....3B-14 Driveshaft Housing U-Joint and Shift 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Gear and Bearing Assembly Preload..3B-108 Driveshaft Housing Shimming Preparation For Assembly..3B-112 U-joint Pinion Gear Shimming.............3B-112 Measuring Driven Gear Lash...............3B-119 Driveshaft Housing Reassembly.................3B-136 Reset U-joint Pinion Gear and Bearing Preload..3B-136 U-joint, Pinion Gear and Bearing Assembly Reassembly..3B-137 U-joint Pinion Gear and Bearing Assembly Preload..3B-140 Clutch and Gear Assembly Installation.3B-145 U-joint Pinion Gear and Bearing Assembly Installation..3B-145 Shift Shaft, Shift Lever, and Shift Cam and Yoke Assemblies Installation................3B-148 O-Rings and Seals Installation............3B-150 Top Cover Assembly Installation..........3B-153 3 B 90-865612020 FEBRUARY 2006 Page 3B- Driveshaft Housing Disassembly, Repair, and Reassembl\ Back Cover Assembly Installation.........3B-15 Page 3B-2 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Removes and installs the driveshaft bearing retainer nut. 10482 Spanner wrench for L-18 U-joint bearing 91-862219A1 retainer Removes and installs the driveshaft bearing retainer. 10705 Lubricant, Sealant, Adhesives Tube Ref No. Description 7 Loctite 271 Threadlocker Bellows Adhesive 27 34 Special Lubricant 101 87 High Performance Gear Lubricant Special Tools Shift handle tool Positions and removes the shift shaft. 10688 Bearing retainer wrench 91-17256 Where Used O.D. of seal Cap screws Shift linkage O-ring groove Water passage seal groove O-rings Assist spring and detent ball canister assembly of the back cover Detent ball canister and compression spring Lip of oil seal Threads of retainer nut Inner diameter of screw recess Back cover O-ring grooves Top cover roller needle bearing Top cover bearing sleeve Yoke and shift cam assembly contact surfaces O.D. of shift shaft lower bushing O.D. of shift shaft upper bushing or driveshaft housing shift shaft bore Inside diameter of roller bearing Splines Thrust bearing Garter spring U-joint pinion gear washer and retainer nut Bearings Lower thrust race Lower thrust bearing Clutch and gear assembly Thrust race Top cover O-ring 91-17302 Part No. 92-809819 92-86166Q1 92-802865A1 92-802854A1 90-865612020 FEBRUARY 2006 Page 3B- Driveshaft Housing Disassembly, Repair, and Reassembl\ Clutch assembly stand 91-17301T1 Holds the clutch assemblies for servicing. 10515 Puller/drive assembly 91-90244A1 Removes and installs the driveshaft housing bearings and sleeves. Assembly includes the following and can be purchased separately: 91-90777T1 Puller jaws 91-90774 Puller guide 91-90775 Puller bolt 91-90244T Driver guide 91-90773T Driver head Slide hammer 6761 91-34569A 1 Aids in the removal of various engine components. Use with puller jaws. Expanding rod Snap-on CG40-4 Aids in the removal of gears and bearings; use with collet. Collet Snap-On CG40A10 Aids in the removal of bearings; use with expanding rod. Bushing removal tool 91-17273 Aids in the removal of the shift shaft bushing. Bearing and seal installation tool 91-17275A1 21601 10849 12538 10485 10461 Installs the shift shaft bushings. Expanding Rod Snap-On CG40-4 12538 Aids in the removal of gears and bearings; use with collet. Page 3B-4 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Pilot washer 91-36571T Used in pinion gear and pinion bearing installation. ob01619 Seal driver 91-813653T 10852 Installs the U-joint oil seal into the bearing carrier. Also used to pilot the puller rod for the installation of the gear housing needle bearing. Seal driver tool 91-865050 10775 Aids in the removal and installation of the U-joint oil seal of the bearing retainer nut. Universal puller plate 91-37241 Removes bearings from gears and the driveshaft. Snap-Ring Driver 91-866107 8505 21565 Breaks the paint seal on the cross bearing snap-rings. Cross bearing press 91-866109 21566 Installs and removes the bearing caps on cross bearings. Cross Bearing Mandrels 91-866108 Aids in the removal and installation of the bearing caps on the cross bearings. 21572 Torque wrench, lb. in. 91-66274 10829 Dial type torque wrench that sets torque from 9 to 150 lb. in.; 3/8 in. drive. 90-865612020 FEBRUARY 2006 Page 3B- Driveshaft Housing Disassembly, Repair, and Reassembl\ Stub shaft for Standard Bravo 91-865084 Replaces the U-joint assembly during the shimming process of the driveshaft housing. Stub shaft for Bravo X Series 91-865083 10782 Replaces the U-joint assembly during the shimming process of the driveshaft housing. 10795 Pinion gear shimming tool 91-865114 Measures the pinion (drive) gear depth of the driveshaft housing. Adaptor rod tool 91- 865086 Holds the measuring tools for shimming the driveshaft housing. Gear lash flag 27/32 91-865080 Aids in checking the gear lash for 27/32 tooth gears in the driveshaft housing. Gear lash flag 27/29 91-865081 Aids in checking the gear lash for 27/29 tooth gears in the driveshaft housing. Gear lash flag 23/30 91-865082 Aids in checking the gear lash for 23/30 tooth gears in the driveshaft housing. Gear lash flag 16/19 91-865116 Aids in checking the gear lash for 16/19 tooth gears in the driveshaft housing. Clamp block and handle tool 91-865085 10779 Used to move the stub shaft when reading the gear lash on the driveshaft housing. Dial indicator holding block 91-865097 10778 10464 27/32 10799 27/29 10800 23/30 10872 16/19 10844 10781 Secures the dial indicator tool in proper location when shimming the driveshaft housing. Page 3B-6 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Dial indicator 91-58222A1 0 10 2030 40 50 60 7080 90 9479 Measures gear backlash and pinion gear location. Driven gear clamping tool 91-865115 10472 Prevents driven gear movement when measuring the gear lash of the driveshaft housing. Torque Specifications NOTE: Securely tighten all fasteners not listed below. Description Pinion gear nut U-joint retainer nut Shift cam and yoke assembly screw Shift linkage cap screw All Bravo models driveshaft housing top cover bolts All Bravo models driveshaft housing back cover bolts Shift assembly locknuts U-joint Bearing Assembly Preload NOTE: Bearings are used if spun once under load. Description New U-joint bearing preload 0.7�1.0 Nm (6�10 lb. in.) Torque Conversion Chart For U-joint Retainer Nut Tool Nm lb. in. lb. ft. Refer to U-joint Bearing Assembly Preload. Refer to Torque Conversion Chart for U-joint Retainer Nut 12�1 12�1 2 2 100�120 100�120 80 20 20 Used 0.3�0.8 Nm (3�7 lb. in.) NOTE: The click torque wrench or the dial torque wrench can be used 90-865612020 FEBRUARY 2006 Page 3B- Driveshaft Housing Disassembly, Repair, and Reassembl\ Torque wrench length mm 381 406 432 457 483 508 533 559 584 610 635 660 686 711 737 762 787 813 838 864 889 914 in. 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 Torque wrench reading in Nm (lb. ft.) to achieve 271 Nm (200 lb. ft.) Nm 151 155 159 163 167 170 172 175 178 180 183 184 187 190 191 194 195 197 200 201 202 203 lb. ft. 111 114 117 120 123 125 127 129 131 133 135 136 138 140 141 143 144 145 147 448 149 150 On beam torque wrenches, measure from square drive to fulcrum (pivot) point of handle. On click-stop or dial torque wrenches, measure from square drive to reference mark on handle (2 bands, etc.). a b 16143 Typical Bravo retainer nut tool showS a - Torque wrench length b - U-joint retainer nut tool measurement, 30.5 cm (12 in.) Specifications Starting Shim Specification Starting thrust race specification mm in. Driven gear thrust race 1.63 0.064 Page 3B-8 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Starting thrust race specification U-joint pinion gear shim mm 0.09 in. 0.035 Gear Tooth Count and Gear Lash Pinion (drive) gear tooth Driven gear tooth Driveshaft housing gear lash 27 27 23 16 U-joint Pinion Gear Location Specification Pinion gear location U-joint Pinion Gear Shim U-joint pinion gear shim 15-888927-028 15-888927-029 15-888927-030 15-888927-031 15-888927-032 15-888927-033 15-888927-034 15-888927-035 15-888927-036 15-888927-037 15-888927-038 15-888927-039 15-888927-040 Driven Gear Thrust Race Thrust bearing race 23-864596-058 23-864596-059 23-864596-060 23-864596-061 23-864596-062 23-864596-063 23-864596-064 23-864596-065 23-864596-066 23-864596-067 32 0.28�0.41 mm (0.011�0.016 in.) 29 0.33�0.46 mm (0.013�0.018 in.) 30 0.28�0.41 mm (0.011�0.016 in.) 19 0.23�0.38 mm (0.009�0.015 in.) Thickness 1.47 mm (0.058 in.) 1.50 mm (0.059 in.) 1.52 mm (0.060 in.) 1.55 mm (0.061 in.) 1.57 mm (0.062 in.) 1.60 mm (0.063 in.) 1.63 mm (0.064 in.) 1.65 mm (0.065 in.) 1.68 mm (0.066 in.) 1.70 mm (0.067 in.) mm in. 0.64 0.025 mm in. 0.71 0.028 0.74 0.029 0.76 0.030 0.79 0.031 0.81 0.032 0.83 0.033 0.86 0.034 0.89 0.035 0.91 0.036 0.97 0.037 0.97 0.038 0.99 0.039 1.02 0.040 Color code Brown White Orange Green Yellow Red Light Blue Black Pink Purple 90-865612020 FEBRUARY 2006 Page 3B- Driveshaft Housing Disassembly, Repair, and Reassembl\ Identification Driveshaft Housing�Gear Ratio and U-joint Marking NOTE: Diesel Sterndrives are listed as Bravo X series. Driveshaft Housing�Gear Ratio and U-joint Marking Sterndrive model Standard Bravo Three and Bravo Three X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo One and Bravo One X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Bravo One XR Bravo Three XR Ratio 2.43:1 2.20:1 2.00:1 1.81:1 1.65:1 1.50:1 1.36:1 1.50:1 1.35:1 1.26:1 2.00:1 U-joint shaft marking N K B G C F H R L M R Driveshaft Housing�Gear Ratio and Gear Tooth Count NOTE: Diesel Sterndrives are listed as Bravo X series. Page 3B-10 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Driveshaft Housing�Gear Ratio and Gear Tooth Count Sterndrive model Standard Bravo Three and Bravo Three X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo One and Bravo One X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Bravo One XR Bravo Three XR Ratio 2.43:1 2.20:1 2.00:1 1.81:1 1.65:1 1.50:1 1.36:1 1.50:1 1.35:1 1.26:1 2.00:1 Pinion (drive) gear teeth 23 23 27 27 27 23 27 27 27 16 27 Driven gear teeth 30 30 32 29 32 30 32 29 29 19 32 90-865612020 FEBRUARY 2006 Page 3B-1 Driveshaft Housing Disassembly, Repair, and Reassembly Page 3B-12 90-865612020 FEBRUARY 2006 Exploded Views Driveshaft Housing and Gears for Standard and X Series Models 16 12 15 14 13 17 19 26 25 20 23 21 22 23 21 20 24 19 17 18 3 4 11 10 7 8 33 9 28 30 2 27 29 1 6 5 18217 31 32 34 36 35 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 - Driveshaft housing 2 - Stud (4) 3 - Water passage seal 4 - O-ring 5 - Bearing race 6 - Needle bearing 7 - Shift shaft oil seal plug 8 - Upper shift shaft bushing 9 - Shift shaft seal 10 - Vent plug 11 - Vent plug seal 12 - Top cover (standard) 13 - Bearing sleeve 14 - Needle bearing 15 - Top cover O-ring 16 - Top cover screws (4) (standard) 17 - Thrust race 18 - Ball check assembly 19 - Thrust bearing 20 - Upper driven gear 21 - Garter spring thrust bearing 22 - Clutch 23 - Garter spring 24 - Upper driveshaft 25 - Thrust collar 26 - Keepers 27 - Washer 28 - Plug 29 - Nut 30 - Trim-in insert 31 - Top cover screws (X Series) 32 - Top cover (X Series) 33 - Lower shift shaft bushing 34 - Washers 35 - Grounding tab 36 - Self tapping screw 90-865612020 FEBRUARY 2006 Page 3B-1 Driveshaft Housing Disassembly, Repair, and Reassembly Page 3B-14 90-865612020 FEBRUARY 2006 Driveshaft Housing U-Joint and Shift Components for Standard Bravo Models 32 33 34 35 37 19 20 21 22 23 24 24 25 6 36 38 3 5 4 2 13 7 10 11 12 8 9 16 17 14 18 15 13 1 39 26 27 28 29 30 31 40 43 41 42 18436 44 45 46 47 48 49 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 - Back cover 2 - Back cover seal 3 - Detent assembly 4 - Back cover short bolt 5 - Back cover long bolt 6 - Wear pad 7 - Shift shaft 8 - Cam 9 - Yoke 10 - Cam screws 11 - Spacer 12 - Nut 13 - Screw 14 - Link bar 15 - Shift lever 16 - Washer 17 - Cotter pin 18 - Latch 19 - U-joint assembly 20 - Yoke (coupler end) 21 - O-rings 22 - O-ring 23 - Socket 24 - Cross and bearing assembly 25 - Yoke (gear end) 26 - Retainer nut 27 - O-ring 28 - Oil seal 29 - Preload washer 30 - O-ring 31 - Sealing ring 32 - U-joint bearing assembly 33 - Pinion gear 34 - Washer 35 - Nut 36 - Anode plate 37 - Screws 38 - Washers 39 - Shift shaft oil seal plug 40 - Upper shift shaft bushing 41 - Seal 42 - Shim 43 - Lower shift shaft bushing 44 - Tapered roller bearing 45 - Flanged bearing cup 46 - Bearing cup 47 - Tapered roller bearing 48 - Grounding tab 49 - Self tapping screw 90-865612020 FEBRUARY 2006 Page 3B-1 Driveshaft Housing Disassembly, Repair, and Reassembly Page 3B-16 90-865612020 FEBRUARY 2006 Driveshaft Housing U-Joint and Shift Components for X Series Models 30 31 32 33 35 6 34 36 3 5 4 2 13 7 10 11 12 8 9 16 17 14 18 15 13 1 37 38 41 39 40 10808 42 43 44 45 19 20 21 23 24 24 25 26 27 29 28 22 46 47 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 - Back cover 2 - Back cover seal 3 - Detent assembly 4 - Back cover short bolt 5 - Back cover long bolt 6 - Wear pad 7 - Shift shaft 8 - Cam 9 - Yoke 10 - Cam screws 11 - Spacer 12 - Nut 13 - Screw 14 - Link bar 15 - Shift lever 16 - Washer 17 - Cotter pin 18 - Latch 19 - U-joint assembly 20 - Yoke (coupler end) 21 - O-rings 22 - O-ring 23 - Socket 24 - Cross and bearing assembly 25 - Yoke (gear end) 26 - Retainer nut and oil seal carrier 27 - O-ring 28 - Oil seal 29 - Preload washer 30 - U-joint bearing assembly 31 - Pinion gear 32 - Washer 33 - Nut 34 - Anode plate 35 - Screw 36 - Washer 37 - Shift shaft oil seal plug 38 - Upper shift shaft bushing 39 - Seal 40 - Shim 41 - Lower shift shaft bushing 42 - Tapered roller bearing 43 - Flanged bearing cup 44 - Bearing cup 45 - Tapered roller bearing 46 - Grounding tab 47 - Self tapping screw 90-865612020 FEBRUARY 2006 Page 3B-1 Driveshaft Housing Disassembly, Repair, and Reassembly Page 3B-18 90-865612020 FEBRUARY 2006 Driveshaft Housing and Gears for XR Models 15 14 13 17 19 26 25 20 23 21 22 23 21 20 24 19 17 18 3 4 11 10 7 8 31 9 28 30 2 27 29 1 6 5 16 12 18215 32 33 34 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 - Driveshaft housing 2 - Stud (4) 3 - Water passage seal 4 - O-ring 5 - Bearing sleeve 6 - Needle bearing 7 - Shift shaft oil seal plug 8 - Upper shift shaft bushing 9 - Shift shaft seal 10 - Vent plug 11 - Vent plug seal 12 - Top cover (standard) 13 - Bearing sleeve 14 - Needle bearing 15 - Top cover O-ring 16 - Top cover screws (4) 17 - Thrust race 18 - Ball check assembly 19 - Thrust bearing 20 - Upper driven gear assembly 21 - Thrust bearing 22 - Clutch 23 - Garter spring 24 - Upper driveshaft 25 - Thrust collar 26 - Keepers 27 - Washer 28 - Plug 29 - Nut 30 - Trim-in insert 31 - Lower shift shaft bushing 32 - Washers 33 - Grounding tab 34 - Self tapping screw 90-865612020 FEBRUARY 2006 Page 3B-1 Driveshaft Housing Disassembly, Repair, and Reassembly Page 3B-20 90-865612020 FEBRUARY 2006 Driveshaft Housing U-Joint and Shift Components for XR Models 32 33 34 35 37 30 31 19 20 21 22 23 24 24 25 6 36 38 43 3 5 4 2 13 7 10 11 12 8 9 16 17 14 18 15 13 1 39 26 27 29 28 40 41 18216 42 44 45 46 47 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 - Back cover 2 - Back cover seal 3 - Detent assembly 4 - Back cover short bolt 5 - Back cover long bolt 6 - Wear pad 7 - Shift shaft 8 - Cam 9 - Yoke 10 - Cam screws 11 - Spacer 12 - Nut 13 - Shift shaft screw 14 - Link bar 15 - Shift lever 16 - Washer 17 - Cotter pin 18 - Latch 19 - U-joint assembly 20 - Yoke (coupler end) 21 - O-rings 22 - O-ring 23 - Socket 24 - Cross and bearing assembly General InformatioS 25 - Yoke (gear end) 26 - Retainer nut 27 - O-ring 28 - Oil seal 29 - Preload washer 30 - U-joint bearing assembly 31 - Pinion gear 32 - Washer 33 - Nut 34 - Anode plate 35 - Screws 36 - Washers 37 - Shift shaft oil seal plug 38 - Upper shift shaft bushing 39 - Seal 40 - Shim 41 - Grounding tab 42 - Self-tapping screw 43 - Lower shift shaft bushing 44 - Tapered roller bearing 45 - Flanged bearing cup 46 - Bearing cup 47 - Tapered roller bearing ! CAUTION Improper gear adjustment can cause severe damage to the sterndrive. Follow the gear adjustment procedure closely. All Bravo drives with the starting Serial Number of 0M198373 and above, must be shimmed during reassembly of the driveshaft housing. Assembly Changes U-JOINT SHIM The U-joint assembly is shimmed for gear depth and location. NOTE: The shim is between the shoulder of the U-joint snout and the flanged bearing cup. When the driveshaft housing is assembled, the shim fits between the flanged bearing cup and the shoulder of the U-joint snout. 90-865612020 FEBRUARY 2006 Page 3B-2 Driveshaft Housing Disassembly, Repair, and Reassembly Page 3B-22 90-865612020 FEBRUARY 2006 Adding shim thickness positions the pinion (drive) gear farther away from the driven gear and removing shim thickness positions the pinion (drive) gear closer to the driven gear. b a c c b a e 17570 Driveshaft housing cut showing shim and gear placement a - Shims position on the flanged bearing cup b - Shoulder of the U-joint snout c - Shoulder of the flanged bearing cup d - U-joint retainer nut (standard Bravo) e - Pinion (drive) gear The flanged bearing cup replaces the smaller outside diameter bearing cup and spacer of the pinion (drive) gear and bearing assembly. a c b 17584 a - Flanged bearing cup b - Shoulder c - Shim During reassembly of the driveshaft housing, use the original shim thickness that came out of the drive or use the shim thickness listed in the starting point specification chart below. Starting shim specification mm in. U-joint pinion gear shim 0.09 0.035 Shims graduate in 0.025 mm (0.001 in.) thickness. U-joint pinion gear shim mm in. 15-888927-028 0.71 0.028 15-888927-029 0.74 0.029 15-888927-030 0.76 0.030 15-888927-031 0.79 0.031 15-888927-032 0.81 0.032 15-888927-033 0.83 0.033 15-888927-034 0.86 0.034 Driveshaft Housing Disassembly, Repair, and Reassembly 90-865612020 FEBRUARY 2006 Page 3B-23 15-888927-035 0.89 0.035 15-888927-036 0.91 0.036 15-888927-037 0.94 0.037 15-888927-038 0.97 0.038 15-888927-039 0.99 0.039 15-888927-040 1.02 0.040 DRIVEN GEAR SHIM The driven gears are set by measuring the gear lash of the pinion (drive) gear to each driven gear. Driven gears in the driveshaft housing are shimmed into position by using the correct upper and lower thrust race thickness. Therefore adding upper thrust race thickness positions the upper driven gear closer to the pinion gear thereby reducing gear lash. Consequently, removing upper thrust race thickness positions the upper driven gear farther away from the pinion gear, increasing gear lash. Adding lower thrust race thickness positions the lower driven gear closer to the pinion gear, reducing gear lash. Removing lower thrust race thickness positions the lower driven gear farther away from the pinion gear, increasing gear lash. a e b c d 17585 a - Upper thrust race b - Upper driven gear c - Lower driven gear d - Lower thrust race e - Pinion (drive) gear The driveshaft housing is no longer stamped to indicate the thickness of the upper and lower thrust race. 17586 Driveshaft Housing Disassembly, Repair, and Reassembl\ During reassembly of the driveshaft housing, use the original thrust race thickness that came out of the drive or use the thrust race thickness in the starting point specification chart. Starting thrust race specification mm Driven gear thrust race 1.63 in. 0.064 Thrust race are color coded and graduate in 0.025 mm (0.001 in.) thickness. Thrust bearing race 23-864596-058 23-864596-059 23-864596-060 23-864596-061 23-864596-062 23-864596-063 23-864596-064 23-864596-065 23-864596-066 23-864596-067 Sterndrive Gear Ratio Identification Thickness Color code 1.47 mm (0.058 in.) Brown 1.50 mm (0.059 in.) White 1.52 mm (0.060 in.) Orange 1.55 mm (0.061 in.) Green 1.57 mm (0.062 in.) Yellow 1.60 mm (0.063 in.) Red 1.63 mm (0.064 in.) Light Blue 1.65 mm (0.065 in.) Black 1.68 mm (0.066 in.) Pink 1.70 mm (0.067 in.) Purple All new or un-tampered-with sterndrives: Sterndrive gear ratios are identified on the sterndrive in 2 places. � Bravo decals, a number such as "1.50R" indicates a 1.5:1 gear ratio. � The universal joint splined yoke is identified with a letter such as "F." Refer to the U-Joint Identification chart. All tampered-with sterndrives: A sterndrive could have had the gear ratio changed for high altitude, which would void the decal and the yoke information. The gear ratio would then have to be determined by counting the teeth on the sterndrive gears. � Count the teeth on the U-joint pinion (drive) gear and the driven gears in the driveshaft housing. Use the Gear Ratio Identification chart for reference. IMPORTANT: The sterndrive gear ratio is determined by the number of gear teeth on the U-joint pinion gear and the number of gear teeth on the driven gears of the driveshaft housing. Count the gear teeth to ensure accuracy. Page 3B-24 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Standard Bravo and Bravo X Series a b b 18195 Gears are positioned as assembled in driveshaft housing a - Gear teeth of the U-joint pinion b - Gear teeth of the driven gears gear Bravo XR a b b 18194 Gears are positioned as assembled in driveshaft housing a - Gear teeth of the U-joint pinion b - Gear teeth of the driven gears gear IMPORTANT: Ensure that the number of driven gear teeth match the drive gear ratio. NOTE: Diesel Sterndrives are listed as Bravo X series. 90-865612020 FEBRUARY 2006 Page 3B-2 Driveshaft Housing Disassembly, Repair, and Reassembl\ Driveshaft Housing�Gear Ratio and Gear Tooth Count Sterndrive model Standard Bravo Three and Bravo Three X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo One and Bravo One X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Bravo One XR Bravo Three XR Ratio 2.43:1 2.20:1 2.00:1 1.81:1 1.65:1 1.50:1 1.36:1 1.50:1 1.35:1 1.26:1 2.00:1 Pinion (drive) gear teeth 23 23 27 27 27 23 27 27 27 16 27 Driven gear teeth 30 30 32 29 32 30 32 29 29 19 32 Page 3B-26 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Driveshaft Housing�Gear Ratio and U-joint Marking Sterndrive model Standard Bravo Three and Bravo Three X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo One and Bravo One X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Bravo One XR Bravo Three XR Driveshaft Housing Disassembly Back Cover Assembly Removal Ratio 2.43:1 2.20:1 2.00:1 1.81:1 1.65:1 1.50:1 1.36:1 1.50:1 1.35:1 1.26:1 2.00:1 U-joint shaft marking N K B G C F H R L M R NOTE: For complete driveshaft housing repair, install the driveshaft housing to a sterndrive service stand and properly secure. 90-865612020 FEBRUARY 2006 Page 3B-2 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 Remove back cover bolts a b 15321 a - Back cover b - Bolts 2 Remove the back cover and shift detent ball canister assembly and the back cover seal. a 15322 a - Back cover BACK COVER ASSEMBLY INSPECTION 1 Inspect the back cover seal for nicks or cuts. Replace if damage is found. Page 3B-2 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2. Inspect the back cover casting for cracks and rough mating surface a 15323 b a - Back cover casting b - Back cover seal SHIFT DETENT BALL CANISTER INSPECTION 1. Inspect the detent ball canister assembly: 2 a. Assembly should move freely in the back cover casting. b. Remove the ball canister and assist spring from the housing. c. Place the ball canister on a flat surface and compress the ball inside of canister (the ball should spring back up). Replace if needed. d. Lubricate the assist spring and detent ball canister. Tube Ref No. DescriptioS Where Used Part No. 34 Assist spring and detent ball Special Lubricant 101 canister assembly of the back 92-802865A1 cover e Reassemble and position the assist spring and detent ball canister in the back cover casting; ensure that the assembly moves freely. c b a 15324 a - Detent ball canister c - Back cover b - Spring Top Cover Assembly Removal 1. Loosen and remove the top cover bolts. 2. Remove top cover by lifting straight up. 90-865612020 FEBRUARY 200 Page 3B-2 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: To assist top cover removal, insert a standard screwdriver into the slots, if necessary, and remove the top cover. b a a 15325 Standard BravR a - Top cover b - Bolts NOTE: Bravo X series uses the ribbed top cover with special bolts and washers. b a 15326 b c Bravo X series a - Top cover b - Bolts c - Washers Page 3B-30 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 3 If the thrust race remains with the top cover, remove thrust race from the top cover and place it on the thrust bearing of the clutch gear assembly. Ensure that the same side of the thrust race is placed to the thrust bearing. a b 15327 a - Top cover b - Thrust race TOP COVER ASSEMBLY INSPECTION 1 Inspect the O-ring for nicks, cuts or flatness. Replace the O-ring if you detect damage. a 15328 a a - Top cover O-ring 2. 3. Inspect the the bearing sleeve and roller needle bearing for excessive wear, spalling or pitting. Replace if damaged. Inspect the top cover casting for cracks. 90-865612020 FEBRUARY 200 Page 3B-3 Driveshaft Housing Disassembly, Repair, and Reassembl\ 4. Ensure that the mating surface of the top cover to the driveshaft housing is smooth a c e d a - Top cover (Standard Bravo) b - Top cover (Bravo X Series) c - Roller needle bearing 15329 d - Bearing sleeve e - Inspection point for casting cracks Shift Shaft Seal Removal 1. Remove shift shaft upper seal. b c e d a 15330 a - Shift shaft upper seal SHIFT SHAFT SEAL INSPECTION 1. Inspect the seal for nicks and flatness. Replace if damaged. Page 3B-32 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Shift Shaft, Shift Lever, and Shift Cam and Yoke Assemblies Removal 1. Screw the shift handle tool into the shift shaft of the driveshaft housing. a b 15331 a - Shift handle tool b - Shift shaft inside housing Shift handle tool 91-17302 2. Remove the socket head cap screw that attaches the shift cam and yoke assembly to the shift shaft. a b c 15332 a - Shift cam and yoke assembly c - Hex wrench b - Socket head cap screw 90-865612020 FEBRUARY 2006 Page 3B-3 Driveshaft Housing Disassembly, Repair, and Reassembl\ 3. Remove the socket head cap screw that attaches the shift lever assembly to the shift shaft. b a c 15333 a - Shift lever assembly c - Hex wrench b - Socket head cap screw 4 Remove the shift shaft by pulling the shift handle tool straight up. NOTE: If the shift shaft is hard to pull out, rotate the shift cam and yoke assembly to ease tension while removing the shift shaft. a b 15334 a - Shift handle tool b - Shift shaft 5. Remove the shift cam and yoke assembly. a 15336 a - Shift cam and yoke assembly 6 Remove the shift lever assembly by rotating shift lever � turn clockwise and pulling out of driveshaft housing. Page 3B-3 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 7. To ease removal, keep the assembly positioned toward the center of the drive while pulling out. a a a a 15337 a - Shift lever assembly SHIFT LEVER ASSEMBLY INSPECTION 1. Shift lever assembly should move freely. 2. Check the cotter pin at the joint for wear damage. 3. Inspect the washer for indentions on cotter pin. Replace cotter pin and washer if you detect damage. 4. Inspect the shift lever. Replace the shift lever if the detent area is excessively worn. NOTE: Standard Bravo shift lever may be referred to as "low bump." Bravo X series shift lever may be referred to as "high bump." However, specific Standard Bravo models use the high bump. b a 15338 d c d e e c b a 15339 Standard Bravo Bravo X series a - Cotter pin d - Detent area (Standard Bravo) (low b - Washer bump) c - Shift lever e - Detent area (Bravo X series) (high bump) 5 Ensure that the latch is not bent and seats in proper position. Replace the latch if it is excessively bent or worn. 90-865612020 FEBRUARY 200 Page 3B-3 Driveshaft Housing Disassembly, Repair, and Reassembl\ 6. Inspect the link bar. Replace the link bar if it is worn at the shift lever tab or in the jaw area. a c b 15341 d a - Link bar c - Latch b - Jaw area d - Tab SHIFT CAM AND YOKE ASSEMBLY INSPECTION NOTE: Broken gear and metal shavings can be trapped between cam and yoke. 1 If gear damage appears in the sterndrive, disassemble the complete assembly and look for damage. Refer to Shift Cam And Yoke Assembly Repair. 2 The shift cam and yoke assembly should be free of debris and rotate freely from side to side. 3 Inspect the yoke for burn marks or excessive wear marks at mating point with the clutch. 4 Inspect the upper and lower cam for excessive wear on the ramp area. b a a 15342 c Cam and Yoke assembly a - Yoke, mating point with the clutch c - Shift lower cam ramp area b - Shift upper cam ramp area SHIFT SHAFT, SHIFT SHAFT BUSHING AND SEAL INSPECTION IMPORTANT: The shift shaft and bushings must be replaced as a unit. Shift shaft damage will cause excessive wear in the bushing area. 1. Inspect the shift shaft for excessive wear in the bushing area. Page 3B-3 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2. Replace the bushings and seal when replacing the shift shaft ad e b b c 15343 Shift shaft bushings and seal in the driveshaft housing a - Shift shaft d - Lower bushing b - Bushing contact area e - Shift shaft oil seal c - Upper bushing U-Joint Pinion Gear and Bearing Assembly Removal 1. Standard Bravo Models: a. Using the retainer wrench tool, loosen and remove the retainer nut from the driveshaft housing. a b 15344 Standard Bravo a - Bearing retainer wrench tool b - U-joint Bearing retainer wrench 91-17256 90-865612020 FEBRUARY 2006 Page 3B-3 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: To ease removal, tap the end of the U-joint splined yoke with a brass hammer b a 21242 a - U-joint assembly b - Hammer b Remove the U-joint assembly by holding the U-joint horizontal with the driveshaft housing and pulling straight out of housing. a 15367 a - Driveshaft housing and U-joint assembly aligned 2. Bravo X Series Models: a. Use the spanner wrench U-joint bearing retainer tool to loosen and remove the retainer nut from the driveshaft housing. Page 3B-3 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: If the retainer nut cannot be removed due to lack of clearance to the U-joint, alternate backing out the retaining nut and pulling the U-joint assembly out of the driveshaft housing. c b c b a 15373 Bravo X series models a - Retainer nut c - Spanner wrench U-joint bearing b - U-joint retainer tool Spanner wrench for L-18 U-joint bearing 91-862219A1 retainer NOTE: To ease removal, tap the end of the U-joint splined yoke with a brass hammer. a b 15374 a - U-joint assembly b - Hammer 90-865612020 FEBRUARY 2006 Page 3B-3 Driveshaft Housing Disassembly, Repair, and Reassembl\ b. Pull the U-joint assembly while holding the U-joint horizontal with the driveshaft housing and pulling straight out of housing. a 21243 a - Driveshaft housing and U-joint assembly aligned 3. Carefully remove shim from the bearing assembly. 4. Measure the shim with a micrometer and record the measurement NOTE: Damaged shim must be replaced with one of the same thickness. Measure the original shim with a micrometer. b a 15377 a - Micrometer b - Shim U-JOINT PINION GEAR AND BEARING ASSEMBLY INSPECTION 1 Inspect the shim for damage. For reassembly, damaged shim must be replaced with one of the same thickness. 2 Inspect U-joint shaft O-rings for cuts, elasticity, and roundness. 3 Ensure that the U-joint shaft splines are straight. Replace the yoke assembly if the splines are twisted. Page 3B-4 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 4 The movement of each U-joint yoke, socket, and cross bearing assembly should be smooth. Replace the cross and bearing assembly if the seals are deteriorated or if movement is tight or rough. a b c d 15376 a - Shim b - O-rings (3) c - U-joint shaft splines d - U-joint yoke, socket, and cross bearing assembly Vent Screw and Seal 1 Remove the vent screw and seal. 15378 a b a - Vent screw b - Seal VENT SCREW AND SEAL INSPECTION 1. Inspect the vent screw for damage. Replace as needed. 2. Replace the seal if nicks or tears are present. Clutch and Gear Assembly Removal NOTE: The driveshaft housing vent screw must be removed before removing the clutch assembly. 1 Remove the upper thrust race. 90-865612020 FEBRUARY 200 Page 3B-4 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: The top cover and the thrust bearing is positioned to the gear and the thrust race (shim) is positioned to the driveshaft housing. a 15379 a - Upper thrust race 2 Note the orientation of the thrust race if using for reassembly. The thrust race must be installed in the same orientation as removed. 3 Measure the upper thrust race thickness. Record this measurement. a b 15380 a - Micrometer b - Thrust race 4. Remove the upper thrust bearing. a 15381 a - Upper thrust bearing 5. Remove the clutch and gear assembly. Page 3B-4 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ a Position one hand through the U-joint snout opening and one hand through the back cover opening of the driveshaft housing. b Lift assembly until the top gear is above the top of the driveshaft housing. c Secure the assembly with one hand until you can hold the top gear with your other hand. d Pull the assembly straight up to remove. a 15382 a - Clutch and gear assembly 6. Place the clutch and gear assembly on a clutch assembly stand. a c + - b c + - 1505 15060 Standard Bravo and X Series Bravo XR a - Clutch and gear assembly c - Clutch assembly stand tool (Standard Bravo and X Series) b - Clutch and gear assembly (Bravo XR) Clutch assembly stand 91-17301T1 NOTE: The thrust bearing is always positioned to the gear and the thrust race (shim) is positioned to the driveshaft housing. 90-865612020 FEBRUARY 200 Page 3B-4 Driveshaft Housing Disassembly, Repair, and Reassembl\ 7 Remove the lower thrust bearing a 15383 a - Lower thrust bearing 8. Remove the lower thrust race. a 15384 a - Lower thrust race 9 Note the orientation of the thrust race if using for reassembly. The thrust race must be installed in the same orientation as removed. 10. Measure the lower thrust race thickness. Record this measurement. a b 15380 a - Micrometer b - Thrust race Page 3B-4 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ CLUTCH AND GEAR ASSEMBLY INSPECTION NOTE: The condition of the thrust bearing and thrust race surfaces indicates the condition of the bearings on the gears of the driveshaft housing and the bearings on the top cover. 1 Inspect upper and lower thrust bearings and thrust races for pitting, groves, scoring, discoloration from overheating, uneven wear, or embedded particles. If any of these conditions exists, replace both thrust bearings and thrust races. 2 Visually inspect the gears for chipped broken gear teeth and the clutch for debris in the grooves. Replace damaged parts. a b 15386 Standard Bravo and X series showS a - Gears b - Clutch 3. Inspect the upper driveshaft for pitting or spalling at the location of the roller bearing. 4. Ensure that the upper driveshaft splines are not damaged or twisted. b a 15385 Standard Bravo and X series showS a - Roller bearing contact surface b - Splines 90-865612020 FEBRUARY 200 Page 3B-4 Driveshaft Housing Disassembly, Repair, and Reassembl\ Driveshaft Housing Inspection 1 Inspect the shift linkage O-ring, and the water passage seal for damage. Replace if required. 16708a b a - Shift linkage O-ring b - Water passage seal 2 Inspect the roller needle bearing and the bearing sleeve of the driveshaft housing for pitting, grooves, discoloration, or embedded particles. Replace if damaged. b a 15388 a - Roller needle bearing b - Bearing sleeve 3 Inspect the driveshaft housing for cracks at the base of the tower (chimney). NOTE: Standard Bravo series: Broken gear tooth or gear damage could cause the driveshaft housing to crack. Generally the housing will not be cracked unless parts are damaged severely. a 15389 a 15390 Standard Bravo Bravo X series a - Base of tower (chimney) Page 3B-46 90-865612020 FEBRUARY 2006 Driveshaft Housing Disassembly, Repair, and Reassembl\ 4 Inspect the U-joint retainer nut threads in the driveshaft housing for corrosion, stripped and/or cross threading. Excessive damage to the threads will require complete driveshaft housing replacement. NOTE: Standard Bravo: Broken gear tooth or gear damage can cause thread damage to the retainer nut and to the driveshaft housing. a 15391 b 15392 Standard Bravo Bravo X series a - U-joint retainer nut threads b - U-joint retainer nut threads (Bravo X (Standard Bravo) Series and Bravo XR) Driveshaft Housing Assembly: Teardown, Inspection and Repair Driveshaft Housing Repair Painting Procedure Use the following procedures to refinish the driveshaft and gear housings. This procedure provides the most durable paint system available in the field. The materials recommended are of high quality and approximate marine requirements. The following procedure provides a repaint job that compares with a properly applied factory paint finish. We recommended that you purchase the listed materials be purchased from a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each material shown following is sufficient to refinish several gear or driveshaft housings. 1 Wash the gear housing with a muriatic acid base cleaner to remove any type of marine growth and rinse with water. 2 Wash the gear housing with soap and water, then rinse. 3 Sand the blistered areas with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather the edges of all broken paint edges. 4 Clean the gear housing thoroughly with wax and grease remover (DX-330). 5 Spot-repair surfaces where bare metal is exposed with alodine treatment (DX-503) . IMPORTANT: Do not use any type of aerosol spray paints: The paint will not properly adhere to the surface and the coating will not be thick enough to resist future paint blistering. 6 Mix one part epoxy chromate primer (DP-40) with one part catalyst (DP-401) per manufacturer's instructions, allowing proper induction period for permeation of the epoxy primer and catalyst. 7 Allow a minimum of one hour drying time and no more than one week before top-coating assemblies. ! CAUTION Some chemicals in paint and paint vapor can cause injury. Avoid inhalation of vapors, ingestion, and contact with skin. Follow the paint manufacture's instructions about paint contact, proper ventilation, and use of respirators. 90-865612020 FEBRUARY 200 Page 3B-4 Driveshaft Housing Disassembly, Repair, and Reassembl\ 8 Use Ditzler Urethane DU9000 for Mercury Black and Ditzler Urethane DU33414M for Sea Ray White. Catalyze all three colors with Ditzler DU5 catalyst mixed 1:1 ratio. Reduce with solvents per Ditzler label. 9 The type of spray gun used will determine the proper reduction ratio of the paint. IMPORTANT: Do not paint sacrificial trim tabs or anodes. 10. Using a spray gun, apply 1/2�1 ml. film thickness evenly. Let dry for five minutes and apply another even coat of 1/2�1 ml. thickness. NOTE: This urathane paint dries to touch in a matter of hours, but remains susceptible to scratches and abrasions for days. Water Passage Seal and Shift Linkage O-ring Replacement 1 Shift linkage O-ring: a. Remove the damaged O-ring from the driveshaft housing. b. Clean the driveshaft housing surface at the groove of the shift linkage O-ring. c. Apply adhesive in the O-ring groove. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Shift linkage O-ring groove 92-86166Q1 d. e. Install the O-ring. Remove excessive adhesive. Ensuadhesive. re not to completely cover O-ring with a a 15676 a - Shift linkage O-ring 2. Water passage seal: a. Remove the damaged seal from the driveshaft housing. b. Clean the driveshaft housing surface at the groove of the water passage seal. c. Apply adhesive in the seal groove. Tubd. 27 e Ref No. Description Bellows Adhesive Install the seal. Where Used Water passage seal groove Part No. 92-86166Q1 Page 3B-4 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ e. Remove excessive adhesive. Ensure not to completely cover the seal with adhesive from seal groove. a a 15561 a - Water passage seal Top Cover Roller Bearing and Bearing Sleeve Replacement The following procedures require the use of multiple special tools listed as an assembly. The procedure refers to each tool individually as used. Puller/drive assembly 91-90244A1 BEARING SLEEVE REMOVAL 1. Place the puller jaws tool around the sleeve. a c b a - Top coverb - Puller jaws (2 halves) b 15681 c - Bearing sleeve 90-865612020 FEBRUARY 2006 Page 3B-4 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2 Install the driver guide tool 15682 a b a - Driver guide tool b - Top cover 3 Position the puller guide over the jaws and install the puller bolt. Remove the sleeve by rotating the puller bolt CLOCKWISE. c a b a - Puller guideb - Top cover a b 15683 c - Puller bolt Page 3B-5 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ ROLLER BEARING REMOVAL 1 Remove the top cover needle bearing using a slide hammer tool and puller jaws or snap-on expanding rod and collet. a b c a c 15684 a - Slide hammer tool and puller jaws c - Top cover b - Needle bearing Slide hammer 91-34569A 1 Expanding rod Snap-on CG40-4 Collet Snap-On CG40A10 NEEDLE BEARING INSTALLATION 1 Lubricate the outside diameter of the needle bearing. 2 Place the needle bearing in the chimney of the top cover. Position the needle bearing so that the numbers are facing up. 3 Place driver guide tool on top cover. a b 15685 a - Driver guide tool b - Top cover 90-865612020 FEBRUARY 200 Page 3B-5 Driveshaft Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. 87 High Performance Gear Top cover roller needle bearing 92-802854A1 Lubricant 4. Install the driver head tool onto puller guide tool and secure with the puller bolt. 5. Install the puller guide tool assembly through the driver guide tool so that the driver head tool is centered on the needle bearing. 6. Use a brass hammer to drive the puller guide tool assembly. The needle bearing is properly seated when the driver head tool contacts the top cover chimney. b a d e c d 15686 a - Driver guide tool b - Puller guide tool assembly c - Brass hammer d - Top cover e - Driver head BEARING SLEEVE INSTALLATION 1. Lubricate inside diameter of bearing sleeve. 2. Place bearing sleeve on the top cover chimney with the lettered or numbered side facing up. Align the bearing sleeve so that it presses evenly on the chimney. a c b 15687 a - Bearing sleeve c - Top cover b - Chimney Tube Ref No. Description Where Used Part No. 87 High Performance Gear Top cover bearing sleeve 92-802854A1 Lubricant Page 3B-52 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 3 Place the driver guide tool on top cover a b 15685 a - Driver guide tool b - Top cover 4. 5. 6. Install the driver head tool onto puller guide tool and secure with the puller bolt. Install the puller guide tool assembly through the driver guide tool so that the driver head tool is centered on the bearing sleeve. Use a brass hammer to drive the puller guide tool assembly. the bearing sleeve is properly seated when the driver head makes contact. b a d e c d 15686 a - Driver guide tool b - Puller guide tool assembly c - Brass hammer d - Top cover e - Driver head Shift Detent Ball Canister Replacement 1 Remove detent ball canister and compression spring. Discard. 2 Apply small amount of lubricant to the new compression spring and install into rear cover. 90-865612020 FEBRUARY 200 Page 3B-5 Driveshaft Housing Disassembly, Repair, and Reassembl\ 3. Apply small amount of lubricant to the new detent ball canister and install over the top of the compression spring in the rear cover. a b c d 15689 a - Compression spring c - Detent ball canister installed b - Detent ball canister d - Back cover Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Detent ball canister and compression spring 92-802865A1 Shift Lever, Link Bar and Latch Repair NOTE: Standard Bravo shift lever may be referred to as "low bump." Bravo X series shift lever may be referred to as "high bump". However, specific Standard Bravo models use the high bump. a c b c 15691 c - Detent area a - Standard Bravo shift lever (low bump) b - Bravo X series shift lever (high bump) Page 3B-54 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ LATCH REPAIR 1. Remove the damaged latch from the link bar. a b a - Latch 15692 b - Link bar 2. 3. Install the new latch so that the latch hook is inserted into the slot of the link bar. Ensure that the latch lies in the groove and over the jaws of the link bar. 16515 a b a - Latch b - Jaws SHIFT LEVER AND LINK BAR REPAIR 1. Remove and discard the cotter pin. 2. Remove the washer to separate the link bar from the shift lever. a d c b 15696 a c 15699 e b Standard Bravo Bravo X Series a - Link bar d - Shift lever Standard Bravo b - Cotter pin e - Shift lever Bravo X series c - Washer 3. Discard and obtain new parts for reassembly. 4. To reassemble: a. Place the shift lever on the link bar. 90-865612020 FEBRUARY 2006 Page 3B-5 Driveshaft Housing Disassembly, Repair, and Reassembl\ b. Install the washer. c. Install the cotter pin and spread the ends. d. Install latch. e. Ensure all parts are positioned correctly. b e d a f 15698 c a d e f 15701 Standard Bravo Bravo X Series a - Link bar d - Washer b - Shift lever (Standard Bravo) e - Cotter pin c - Shift lever (Bravo X Series) f - Latch 5 Position the latch so that the latch hook is inserted into the slot of the link bar and lies on the jaws of the link bar. Shift Cam and Yoke Assembly Repair 1 Disassemble the cam-and-yoke assembly. a. Remove the locknuts. a b 15702 a - Cam-and-yoke assembly b - Nut Page 3B-5 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ b. Remove shift cams, yoke, spacers and bolts aa b f d c 15703 a - Shift cam d - Nut b - Yoke e - Bolt c - Spacer 2. 3. Replace the complete assembly if the cam spacers are damaged or if the cam surface is excessively worn. To reassemble shift cam and yoke assembly: a. Coat the contact surfaces with lubricant. a a a a 15704 a - Contact surface Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Yoke and shift cam assembly contact surfaces 92-802854A1 90-865612020 FEBRUARY 2006 Page 3B-5 a Driveshaft Housing Disassembly, Repair, and Reassembl\ b. Install the bolts through one half of the upper shift cam b a 15705 a - Bolts b - Shift cam c. Install the spacers a 15706 a - Spacers d. Install the yoke. 15707 a - Yoke Page 3B-58 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ e. Install the second shift cam a 15708 a - Shift cam f. Thread the locknuts onto the bolts. a 15709 a - Locknuts g. Install the shift shaft to align the assembly. h. Evenly tighten and torque the locknuts. a b 15710 a - Shift shaft b - Shift assembly Description Shift assembly locknuts i. Remove the shift shaft. Nm 9 lb. in. 80 lb. ft. 90-865612020 FEBRUARY 2006 Page 3B-59 Driveshaft Housing Disassembly, Repair, and Reassembl\ Shift Shaft and Bushing Replacement IMPORTANT: The shift shaft and the upper and lower bushings must be replaced as a unit. Shift shaft damage will cause excessive wear in the area where the bushings make contact with the shift shaft. 1. Place the bushing removal tool in the shift shaft bore and drive the upper bushing from the driveshaft housing. a b b 15712 a - Bushing removal tool b - Bushing Bushing removal tool 91-17273 2. Place the bushing removal tool in the shift shaft bore and drive the lower bushing and oil seal from the driveshaft housing. c b a - Shift shaft lower bushing b - Oil seal b a 15713 c - Bushing removal tool Bushing removal tool 91-17273 3. Install new shift shaft lower bushing and new oil seal as follows: a. Lightly lubricate the outer surface of the bushing. Page 3B-60 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. High Performance Gear Lubricant O.D. of shift shaft lower bushing 92-802854A1 b. Install the lower bushing into bore. 87 b a a - Lower bushing b - Hammer c 15714 c - Lower shift shaft bushing installed c. Place the seal installation tool with the lip of seal facing upward. d. Apply sealant to outside diameter of seal before installation. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker O.D. of seal 92-809819 Bearing and seal installation tool 91-17275A1 e. Place the seal installation tool with the oil seal into bore from the bottom. f. Place screw pilot through bushing from top. g. Install the screw through the screw pilot and into the seal installation tool. a c b a c b a - Bearing and seal installation tool b - Screw pilot c b 15716 a c - Screw 90-865612020 FEBRUARY 2006 Page 3B-6 Driveshaft Housing Disassembly, Repair, and Reassembl\ h. Pull the oil seal into place by turning the screw CLOCKWISE until the tool contacts the casting. a a - Screwb - Casting b c a 15717 c - Seal Installation tool i. Loosen the screw and remove the tool. 4. Install shift shaft upper bushing as follows: a. Lubricate the outer surface of the bushing or the driveshaft housing bore. bore Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant O.D. of shift shaft upper bushing or driveshaft housing shift shaft 92-802854A1 b. Install bushing into bore so that bushing is flush with bottom of bore a c d b 15718 b a - Bushing c - Tool b - Bushing installed d - Brass hammer Shift Shaft Upper Seal Replacement NOTE: Replace the shift shaft upper seal if flat spots, cuts or nicks are found. 1. Pull up on the damaged seal to remove. Page 3B-62 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2. Firmly press a new seal in the driveshaft housing bore a 15330 a - Seal Driveshaft Housing Needle Bearing and Bearing Sleeve Replacement The following procedures require the use of multiple special tools listed as an assembly. The procedure refers to each tool individually as used. Puller/drive assembly 91-90244A1 1 To remove bearing sleeve a. Place puller jaws tool around sleeve a c b b 15719 a - Driveshaft housing c - Sleeve b - Puller jaws tool (2 halves) b. Install driver guide tool. 90-865612020 FEBRUARY 200 Page 3B-6 Driveshaft Housing Disassembly, Repair, and Reassembl\ c. Position puller guide tool over jaws and install puller bolt a b d d c 15720 a - Driver guide tool c - Puller bolt tool b - Puller guide tool d - Puller jaws tool d. Rotate puller bolt CLOCKWISE to remove the sleeve. b a 15721 a - Puller guide tool b - Puller bolt tool 2. To remove the needle bearing: NOTE: The needle bearing removal procedures are different for the standard Bravo models and the Bravo X series models. However, the needle bearing installation procedure is the same. Ensure that you follow the correct removal procedure. Page 3B-64 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ a. Standard Bravo: To remove needle bearing from driveshaft housing, use a suitable mandrel to drive the needle bearing down into the oil cavity b c a 15746 a - Standard Bravo c - Tool b - Brass hammer b Bravo X Series: Remove needle bearing using a slide hammer tool and puller jaws, or snap-on expanding rod and collet. 15747 a b a b a - Bravo X series b - Slide hammer puller tool Slide Hammer 91-34569A 1 Expanding Rod Snap-On CG40-4 Collet Snap-On CG40A10 3. To install the needle bearing: a. Lubricate the outside diameter of the needle bearing. b. Place the needle bearing in the driveshaft housing chimney. Ensure that the numbers on needle bearing casing are facing up. c. Install the driver head tool onto the puller guide tool and secure with the puller bolt. d. Install puller guide tool assembly through driver guide tool so that the driver head tool is centered on the needle bearing. 90-865612020 FEBRUARY 200 Page 3B-6 Driveshaft Housing Disassembly, Repair, and Reassembl\ e. Install the needle bearing by driving it into place until the tool contacts the chimney or sounds solid when hit with the hammer. c a b 15749 a - Driver guide tool c - Puller bolt b - Puller guide tool Tube Ref No. Description Where Used Part No. High Performance Gear 87 Inside diameter of roller bearing 92-802854A1 Lubricant 4. Install the bearing sleeve: a. Place bearing sleeve on drive housing chimney. b. Place driver guide tool into top of driveshaft housing. 15751 a c b a - Driver guide tool b - Bearing sleeve c - Chimney c. d. Install the driver head tool onto the puller guide tool and secure with the puller bolt. Install the puller guide tool assembly through the driver guide tool so that the driver head tool is centered on the bearing sleeve. Page 3B-66 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ e. Install the bearing sleeve by driving it into place until the tool contacts the chimney or sounds solid when hit with the hammer. 15752 c - Driver guide tool d - Bearing sleeve installed Clutch and Gear Assembly Disassembly Inspection and Repair NOTE: Note the proper order and position of thrust races, thrust bearings, and clutch assembly, if assembly components are to be replaced. 1. Place the clutch and gear assembly on the clutch assembly stand. a b c a - Brass hammerb - Puller guide tool d a c + - 15060 a - Standard Bravo clutch and gear c - Clutch assembly stand tool assembly b - Bravo X series clutch and gear assembly Clutch assembly stand 91-17301T1 15059 b c + - 90-865612020 FEBRUARY 2006 Page 3B-6 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2. Remove keepers by pressing down on the clutch and gear assembly and turning CLOCKWISE to release keepers. a b 14664 a - Down b - Clockwise 3. Remove the keepers. 21021 a a - Keeper (2) 4. Inspect the keepers. If you detect flatness or excessive wear, replace the keepers. 5. Remove the thrust collar. a 14852 a - Thrust collar Page 3B-68 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 6 Inspect the thrust collar for build-up of metal particles. Replace the top gear, bottom gear, and pinion gear if metal particles are found built-up on the thrust collar. 7 Remove the top gear. a 14853 a - Top gear 8 Inspect the gear for excessive or uneven wear and pitting. NOTE: The silver side of the thrust bearing is facing the garter spring. 9 Remove the thrust bearing. a 14854 a - Thrust bearing 10. The thrust bearing should be smooth and free of metal contamination. 90-865612020 FEBRUARY 200 Page 3B-6 Driveshaft Housing Disassembly, Repair, and Reassembl\ 11. Remove garter spring a 14857 a - Garter spring 12. Inspect garter spring for flat spots. Replace the garter spring if flat spots are found. 13. Twist clutch COUNTERCLOCKWISE while pulling up to separate clutch from shaft. a 14856 a - Clutch 14. Inspect clutch groves for worn spots or contamination. Place clutch on top of the driveshaft and release, the clutch should free-fall down the driveshaft. NOTE: The silver side of the thrust bearing is positioned to the garter spring. Page 3B-70 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 15. Remove the garter spring a 21016 a - Garter spring 16. Inspect garter spring for flat spots. Replace the garter spring if flat spots are found. 17. Remove the thrust bearing. a 14859 a - Thrust bearing 18. The thrust bearing should be smooth and free of metal contamination. 90-865612020 FEBRUARY 2006 Page 3B-7 Driveshaft Housing Disassembly, Repair, and Reassembl\ 19. Remove the bottom gear a 14860 a - Bottom gear 20. Inspect the bottom gear for excessive or uneven wear and pitting. 21. Remove the upper driveshaft from the stand. 22. Inspect the splines of the upper driveshaft for nicks or broken teeth. If any of these conditions exist, replace the shaft. 23. Inspect bearing surfaces on upper driveshaft for pitting, grooves, scoring, or discoloration. Replace the shaft if any of these conditions exist. NOTE: Replace the roller bearing of the driveshaft housing and of the top cover if you detect damage to the upper driveshaft. a b a c 15049 15051 a - Upper driveshaft splines c - Bearing surface of top cover b - Bearing surface of driveshaft housing CLUTCH AND GEAR ASSEMBLY CLEANING AND FINAL INSPECTION 1 Clean all parts in nontoxic solvent; then dry them with compressed air. Inspect gears for pitting, chipped or broken teeth, and excessive or uneven wear. Inspect the large needle bearing in the gear for pitting, spalling or uneven wear. Replace the gear if any of these conditions exist. 2 The condition of bearing surfaces in the driveshaft housing and the top cover are an indication of the condition of the bearings in the gears. Inspect the bearing surface for pitting, grooves, scoring, discoloration from overheating, uneven wear, and embedded foreign metal particles. If any of these conditions exist, replace the gear and bearing assembly and the bearing sleeve and upper driveshaft needle bearings. 3 Inspect socket of gear for particles adhering the surface of the clutch, and for discoloration. If particles and/or discoloration are present, replace the gear. Page 3B-7 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ CLUTCH AND GEAR ASSEMBLY REASSEMBLY 1. Place the upper driveshaft on the clutch assembly stand. 2. Apply lubricant to the splines of the driveshaft. a b 15055 a - Clutch and gear assembly b - Clutch assembly stand Clutch Assembly Stand 91-17301T1 Tube Ref No. Description Where Used Part No. High Performance Gear 87 Splines 92-802854A1 Lubricant 3. Install the bottom gear on shaft and allow it to rest on the thrust collar. b a 15234 a - Bottom gear b - Thrust collar 90-865612020 FEBRUARY 2006 Page 3B-7 Driveshaft Housing Disassembly, Repair, and Reassembl\ 4. Lightly lubricate and install the thrust bearing with the silver side of the thrust bearing facing the garter spring. a 14859 a - Thrust bearing (silver side facing the garter spring) Tube Ref No. Description High Performance Gear Lubricant 5. Lightly lubricate and install the garter spring. Where Used Thrust bearing Part No. 92-802854A1 87 a 21016 a - Garter spring Tube Ref No. Description Where Used Part No. 87 High Performance Gear Garter spring 92-802854A1 Lubricant NOTE: Place the clutch on top of the driveshaft and release. The clutch should free-fall down the driveshaft. Page 3B-74 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 6. Install the clutch by allowing it to free-fall, turning CLOCKWISE down the shaft until it rest on the garter spring. a 14856 a - Clutch 7. Lightly lubricate and install the garter spring. a 14857 a - Garter spring Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Garter spring 92-802854A1 90-865612020 FEBRUARY 2006 Page 3B-7 Driveshaft Housing Disassembly, Repair, and Reassembl\ 8. Lightly lubricate and install the thrust bearing with the silver side of the thrust bearing facing the garter spring. a 14854 a - Thrust bearing (silver side facing the garter spring) 9. Tube Ref No. Description 87 High Performance Gear Lubricant Place the top gear over the shaft. Where Used Thrust bearing Part No. 92-802854A1 a 14853 a - Top gear Page 3B-76 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 10. Place the thrust collar over the shaft with the small tapper of the thrust collar positioned upward. a b 15056 a - Thrust collar b - Small tapper 11. Install the keepers. a. Press down on the clutch-and-gear assembly and turn CLOCKWISE so that the groove of the driveshaft is completely exposed. a b 15057 a - Down b - Clockwise 90-865612020 FEBRUARY 2006 Page 3B-7 Driveshaft Housing Disassembly, Repair, and Reassembl\ b. Place the keepers in the groove 21021 a a - Keeper (2) c. d. Release pressure from gear. Ensure that the top of the keepers are level with top of thrust collar at position shown. 15753 a b a - Keepers level with thrust collar b - Thrust collar U-joint, Pinion Gear and Bearing Assembly Teardown Inspection and Repair ! CAUTION Avoid injury during disassembly. Heavy sterndrive components may come apart suddenly and forcefully. Properly support the U-joint-yoke assembly while removing the pinion gear nut. 1 Disassemble U-joint from pinion gear and bearing assembly: a. Mount the retainer nut wrench tool in a vise to support the U-joint assembly. Bearing retainer wrench 91-17256 b. Position the U-joint assembly with shaft pointing straight down. c. Use a long screwdriver to secure the U-joint so that it will not rotate while loosening the nut. Page 3B-7 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ d Remove the screwdriver. e The U-joint will fall when nut is removed. Hold the U-joint and remove the nut and washer. e f c b d b d a d - U-joint shaft e - Vise f - Screwdriver b d 15754 a - Nut and washer b - U-joint pinion gear and bearing assembly c - Retainer nut wrench tool 2. Remove remaining components from the fixture. a b c d e f g h i 15755 Standard Bravo U-joint assembly a - Nut f - Thrust washer b - Washer g - Oil seal and oil seal carrier c - Pinion gear and bearing assembly h - Retainer nut d - Sealing ring i - U-joint e - O-ring 90-865612020 FEBRUARY 200 Page 3B-7 Driveshaft Housing Disassembly, Repair, and Reassembl\ a b c d f 15756 e Bravo X series U-joint assembly a - Nut d - Thrust washer b - Washer e - O-ring, oil seal, oil seal carrier, and c - Pinion gear and bearing assembly retainer nut f - U-joint a b c d e f 15757 Bravo XR U-joint assembly a - Nut b - Washer c - Pinion gear and bearing assembly d - Thrust washer e - O-ring, oil seal, oil seal carrier, and retainer nut f - U-joint 3. Inspect and clean the threads of retainer nut. Replace if you detect damage. NOTE: Bravo X Series, inspect threads of oil seal carrier. a b c 15759 a - Standard Bravo retainer nut c - Bravo XR retainer nut b - Bravo X Series retainer nut Page 3B-80 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 4. Inspect washer for cracks, damage or excessive wear. Replace if you detect damage a b 15760 a - Washer for Bravo X series and XR b - Washer for Standard Bravo 5 Inspect the large O-ring around the oil seal carrier for damage or excessive compression. Replace if you detect damage. a 15761 a - O-ring 6 Inspect the oil seal and oil seal carrier for damage or excessive wear. If the carrier is damaged replace the carrier and the oil seal as a unit. If only the oil seal is defective, replace separately. NOTE: Bravo X Series, inspect the threads of the oil seal carrier. a b d d c d 15762 a - Standard Bravo oil seal carrier c - Bravo XR oil seal carrier b - Bravo X series oil seal carrier d - Oil seal 7 Inspect the U-joint pinion gear for pitting, chipped or broken teeth and excessive or uneven wear. If any of these conditions exist, it will be necessary to replace all gears and bearing assemblies of the driveshaft housing. 90-865612020 FEBRUARY 200 Page 3B-8 Driveshaft Housing Disassembly, Repair, and Reassembl\ 8 Rotate the U-joint pinion gear roller bearings by hand, in opposite directions, The bearing rotation should be smooth. Replace the bearings if you detect a rough, uneven movement or a loose condition. a b c 15763 U-joint pinion gear and bearing assemblieX a - U-joint pinion gear c - Bottom roller bearing and flanged b - Top roller bearing and bearing cup bearing cup U-joint Oil Seal Replacement STANDARD BRAVO NOTE: If the carrier is damaged, replace the carrier and the oil seal as a unit. If only the oil seal is defective, replace separately. 1 If the U-joint oil seal is defective and the carrier is reused, press out the seal with a special tool or a suitable mandrel. c a b c - Pressa - Seal in carrier b - Special tool 15764 Pilot washer 91-36571T Page 3B-8 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2. Install the oil seal to the seal driver tool. Position the oil seal so that the seal lip will face the pinion gear when reassembled. a b 15768 a - Seal driver tool b - Oil seal Seal driver 91-813653T 3. Press the oil seal with the seal lips facing into carrier until the tool contacts the carrier. c d a b a - Oil seal carrier b - Oil seal 15766 c - Seal driver tool d - Press 4. Lubricate the lip of oil seal. a 15767 a - Oil seal lip Tube Ref No. Description Where Used Part No, 34 Special Lubricant 101 Lip of oil seal 92-802865A1 90-865612020 FEBRUARY 2006 Page 3B-8 Driveshaft Housing Disassembly, Repair, and Reassembl\ BRAVO X SERIES NOTE: The U-joint seal is located in the bearing retainer nut on Bravo X series. NOTE: If the retainer nut is damaged, replace the retainer nut and the oil seal as a unit. If only the oil seal is defective, replace it separately. 1 If the U-joint oil seal is defective and the retainer nut is reused, press out the seal with a special tool or a suitable mandrel. c a b 15768 a - Seal in carrier c - Press b - Pilot washer tool Pilot washer 91-36571T 2 Install the oil seal to the seal driver tool. Position the oil seal so that the seal lip will face the pinion gear when reassembled. a b 15768 a - Seal driver tool b - Oil seal Seal driver 91-813653T Page 3B-8 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 3. Press the oil seal with the seal lips facing the retainer nut until the tool contacts the retainer nut. d c a b a - Oil seal carrier b - Oil seal 15770 c - Seal driver tool d - Press 4. Lubricate the lip of the oil seal. a 18255 a - Oil seal lip Tube Ref No. Description Where Used Part No. 34 Special Lubricant 10 Lip of oil seal 92-802865A1 BRAVO XR NOTE: The U-joint seal is located in the bearing retainer nut on Bravo XR. NOTE: If the retainer nut is damaged, replace the retainer nut and the oil seal as a unit. If only the oil seal is defective, replace it separately. 1 If the U-joint oil seal is defective and retainer nut is reused, press out seal with seal driver tool or a suitable mandrel. 90-865612020 FEBRUARY 200 Page 3B-8 Driveshaft Housing Disassembly, Repair, and Reassembl\ IMPORTANT: To prevent damage to the retainer nut, position the nut as shown when removing the oil seal. c a b 15772 a - Seal in carrier c - Press b - Oil seal tool Seal driver tool 91-865050 2 Install the oil seal to the seal driver tool. Position the oil seal so that the seal lip will face the pinion gear when reassembled. a b 15773 a - Seal driver tool b - Oil seal Seal driver 91-813653T IMPORTANT: To prevent damage to the retainer nut, positioned the nut as shown when installing the oil seal. 3 Reposition the retainer nut so the oil seal is pressed in from the side opposite the one from which it was removed, (i.e. the inside of the retainer nut). Page 3B-8 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 4. Press the oil seal into the carrier until the seal bottoms out c b d a a - Oil seal carrier b - Oil seal 15774 c - Seal driver tool d - Press 5. Lubricate the lip of the oil seal. a 18257 a - Oil seal lip Tube Ref No. 34 Description Special Lubricant 101 Where Used Lip of oil seal Part No. 92-802865A1 U-joint Pinion Gear and Bearing Repair NOTE: Disassembly of the drive gear and bearing assembly is for replacement of components only. IMPORTANT: Roller bearings are damaged when removed from the pinion gear and must be replaced. 1 If the U-joint bearings are in need of replacement and the pinion gear is in good condition, remove the bearings from the pinion gear using a puller plate and arbor press. a Place the universal puller plate tool between the pinion gear and the flanged bearing cup with the tapered side of the plate toward the pinion gear. NOTE: Ensure that the universal puller plate tool is supporting the flanged bearing cup only, and not the bottom roller bearing. The bottom roller bearing will remain on the pinion gear. 90-865612020 FEBRUARY 200 Page 3B-8 Driveshaft Housing Disassembly, Repair, and Reassembl\ b Using a suitable mandrel and the universal puller plate tool to support the flanged bearing cup, press the gear until the top roller bearing, bearing cup, and the flanged bearing cup are free from the gear. d e f c a g b 15776 a - Universal puller plate tool e - Bottom roller bearing b - Mandrel on pinion gear f - Pinion gear c - Top roller bearing and bearing cup g - Block d - Flanged bearing cup Universal puller plate 91-37241 c. Place the universal puller plate tool between the pinion gear and the roller bearing with the tapered side of the plate toward the roller bearing. d. Press on the sides of the plate until it seats on the pinion gear. a d b c 15777 a - Universal puller plate tool c - Roller bearing b - Pinion gear d - Press on universal puller plate tool Page 3B-8 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ e. Using a suitable mandrel and the universal puller plate tool to support the roller bearing, press the gear from the bearing e d c a b 15778 a - Universal puller plate tool d - Mandrel on pinion gear b - Pinion gear e - Press on mandrel c - Roller bearing Universal puller plate 91-37241 NOTE: Discard the roller bearings and bearing cups after removal from pinion gear. Pinion gear may be reused if not damaged. Obtain new roller bearing assemblies to press on the pinion gear. abcde 15782 Pinion gear and bearing assembly separated a - Pinion gear d - Bearing cup (larger O.D.) b - Roller bearing (smaller O.D.) e - Roller bearing (larger O.D.) c - Flanged bearing cup 2 To reassemble, if the tapered roller bearings were removed from pinion gear, replace as follows: 90-865612020 FEBRUARY 200 Page 3B-8 Driveshaft Housing Disassembly, Repair, and Reassembl\ a. Install the smaller O.D. roller bearing on pinion gear. Using suitable mandrel, press on the inside diameter of roller bearing. a b c 15779 a - Suitable mandrel c - Pinion gear b - Roller bearing (smaller O.D.) b. Place the flanged bearing cup over the roller bearing. a 18423 a - Bearing spacer cup c. Install larger O.D. bearing cup. a 18424 a - Large O.D. bearing cup Page 3B-90 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ d Install larger O.D. roller bearing a 15781 a - Large O.D. roller bearings NOTE: The flanged bearing cup must be free to move. Damage to both bearings could occur if over pressed. e Using a suitable mandrel, press on the outside diameter of the roller bearing. Press bearing to the point where bearing rollers initially make contact with the tapered bearing cup. d c a b 15783 a - Roller bearing with larger O.D. c - Flanged bearing cup (must move b - Larger outside diameter bearing freely) cup d - Suitable mandrel (must push on inner bearing race) 90-865612020 FEBRUARY 200 Page 3B-9 Driveshaft Housing Disassembly, Repair, and Reassembl\ 3. Slightly rotate the flanged bearing cup and press until a slight drag is felt c a b 15784 a - Flanged bearing cup c - Press on suitable mandrel b - Hand rotating flanged bearing cup 4. If a slight over press condition occurs (bearing cup does not move freely), release the pinion gear and bearing assembly preload: a. Place the universal puller plate tool under the shoulder of the flanged bearing cup. b. Press end of pinion gear with a suitable mandrel just till the bearing cups rotate easily. Failure to do this can result in premature bearing failure. f e bd a c 15785 a - Universal puller plate tool d - Pinion gear b - Flanged bearing cup shoulder e - Mandrel on pinion gear c - Top roller bearing and bearing cup f - Press on mandrel Universal puller plate 91-37241 U-Joint Cross Bearing Replacement�Standard Bravo U-JOINT CROSS AND BEARING REMOVAL 1 If inspection determines that the U-joint cross and bearings should be replaced, proceed as follows. 2 Loosen and remove the pinion nut and washer from U-joint shaft. 3 Remove the drive gear and bearings as an assembly. Remove remaining components. Page 3B-9 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ ! WARNING While installing or removing circlips, avoid eye injury; wear eye protection. 4. Release the snap-rings on the double yoke: a. Use a snap-ring driver and tap the snap-ring to break the paint bond between the yoke and the snap-ring. a a 4947 a - Snap-ring driver Snap-Ring Driver 91-866107 b. Remove all snap-rings on the cross bearings being replaced. a a - Snap-ring a 4948 90-865612020 FEBRUARY 2006 Page 3B-9 Driveshaft Housing Disassembly, Repair, and Reassembl\ 5. Press one bearing cap out of the yoke by using a table vise, cross-bearing press and suitable mandrels. a b c d 4996 a - Table vise b - Cross bearing press c - Bearing mandrel on bearing cap d - Bearing mandrel on yoke NOTE: Mandrels from the kit 91-866107A01 are used for the standard Bravo U-joint. Cross bearing press 91-866109 a Press on bearing cross until the opposite bearing cap is pressed out into the adapter. a b 5042 b b 4997 With cross bearing press Cross bearing press removel a - Cross bearing press b - Bearing cap Page 3B-9 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ b. Use the vise to hold the bearing secure and tap the U-joint assembly to remove the bearing cap, cap seal, and cross end spacer. a b c d e 5048 b - Bearing cap on cross d - Bearing cap e - Cap seal 5041 a - Table vise c - Cross end spacer c. Turn the U-joint assembly 180� and press on bearing cross to remove second bearing cap. a b c d 4996 a - Table vise b - Cross bearing press c - Suitable mandrel on bearing cap d - Suitable mandrel on yoke 90-865612020 FEBRUARY 2006 Page 3B-9 Driveshaft Housing Disassembly, Repair, and Reassembl\ d. Use the vise to hold the bearing secure and tap the U-joint assembly to remove the second bearing cap, cap seal, and cross end spacer. a b 5041 c d e 5048 a - Table vise b - Bearing cap d - Bearing cap e - Cap seal c - Cross end spacer e. Remove the U-joint yoke a b 5043 a - Cross member b - Yoke f. Remove each pair of bearings in this manner. U-JOINT CROSS AND BEARING REASSEMBLY 1 Install the cross bearings: a. Insert the cross end spacer into the end of the cross member. b. Place the U-joint yoke over the cross. a b c 5044 a - Cross end spacer c - Yoke b - Cross end spacer in position c. Install the cap seal on the bearing cap. Page 3B-9 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ d. Place the bearing caps in yoke and start them on the cross members 5019 a a a - Bearing cap and cap seal e Press one bearing cap in and passed the snap-ring groove by using a table vise, Cross bearing press and suitable mandrels. a a b c d e 5020 a - Bearing cap d - Suitable mandrel on bearing cap b - Table vise e - Suitable mandrel on yoke c - Cross bearing press f The circlips are different thickness to allow for little or no play. Quantity 1 3 4 2 1 ThicknesX 1.40 mm (0.055 in.) 1.45 mm (0.057 in.) 1.50 mm (0.059 in.) 1.55 mm (0.061 in.) 1.60 mm (0.063 in.) Color Code Lt. Blue Pink Green Red White 90-865612020 FEBRUARY 200 Page 3B-9 Driveshaft Housing Disassembly, Repair, and Reassembl\ g. Install a green retaining snap-ring with the sharp edge positioned away from the bearing cap. Ensure that the snap-ring is fully seated into the groove a a - Bearing cap b - Snap-ring a b a c 5021 c - Snap-ring in position h. Turn the U-joint assembly 180 degrees and press on bearing cap to install second bearing cap. a b c d 4996 a - Table vise b - Cross bearing press c - Suitable mandrel on bearing cap d - Suitable mandrel on yoke i Install a green 1.50 mm (0.059 in.) retaining snap-ring with the sharp edge positioned away from the bearing cap. Ensure that the snap-ring is fully seated into the groove. a a - Bearing cap b - Snap-ring a b a c 5021 c - Snap-ring in position 2 Observe the play between the bearing caps and and the cross. If the bearing is too tight, replace one or both snap-rings with a thinner clip. If it is too loose, replace one or both snap-rings with a thicker snap-ring. The correct snap-rings are in place when the joint moves freely, but does not flop around loosely. Page 3B-9 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 3. Install each pair of bearing caps in this manner. 4. Inspect the U-joint assembly to ensure that the joint moves smoothly with little friction. U-Joint Cross Bearing

Replacement�Bravo X Sreries and Bravo XR U-JOINT CROSS BEARING REMOVAL 1. If inspection determines that the U-joint cross bearings should be replaced, proceed as follows. 2. Loosen and remove the pinion nut and washer from U-joint shaft. 3. Remove the drive gear and bearings as an assembly. Remove remaining components. ! WARNING While installing or removing circlips, avoid eye injury; wear eye protection. 4 Release circlips on the double yoke: a. Drive off universal joint bearing circlip, using a punch and hammer. a a a 2115 21152 Bravo X and XR U-JoinY a - Circlip 5 Press one bearing cap out of the yoke by using a table vise, universal joint tool and suitable mandrels. c - Suitable mandrel on bearing cap d - Suitable mandrel on yoke Cross Bearing Press 91-866109 dc b a 21225 a - Table vise b - Universal joint tool Cross Bearing Mandrels 91-866108 90-865612020 FEBRUARY 200 Page 3B-9 c b a Driveshaft Housing Disassembly, Repair, and Reassembl\ a. Press on bearing cross until the opposite bearing cap is pressed out into the adapter. a b 21569 b b 21227 With universal joint tool Universal joint tool removed a - Universal joint tool b - Bearing cap b The universal joint is too short to allow the bearing cap to be pressed completely out. Use the vise to hold the bearing cap secure and tap the U-joint assembly to remove the bearing cap, cap seal, and cross end spacer. 21229 a - Table vise b - Bearing cap on cross c - U-joint assembly c Turn the U-joint assembly 180 degrees and press on bearing cross to remove second bearing cap. 21230 d e d - Cap seal e - Bearing cap dc b a 21225 a - Table vise b - Universal joint tool c - Suitable mandrel on bearing cap d - Suitable mandrel on yoke Page 3B-10 90-865612020 FEBRUARY 200 c b a Driveshaft Housing Disassembly, Repair, and Reassembl\ d. Use the vise to hold the bearing secure and tap the U-joint assembly to remove the second bearing cap, cap seal, and cross end spacer. 21229 a - Table vise c - U-joint assembly b - Bearing cap e. Remove the U-joint yoke. a b 21233 a - Bearing cross member b - Yoke f. Remove each pair of bearings in this manner. U-JOINT CROSS BEARING REASSEMBLY 1 Install the cross bearings: a. Place the U-joint yoke over the bearing cross member. a b 21233 a - Bearing cross member b - Yoke b. Install the cap seal on the bearing cap. 90-865612020 FEBRUARY 200 Page 3B-10 Driveshaft Housing Disassembly, Repair, and Reassembl\ c. Place the bearing caps in yoke and start them on the cross members 21235a a a - Bearing cap and cap seal d Press one bearing cap in and past the circlip groove by using a table vise, universal joint tool and suitable mandrels. dc b a 21225 a - Table vise b - Universal joint tool d - Suitable mandrel on yoke c - Suitable mandrel on bearing cap e. The circlips are different thickness to allow for little or no play. Quantity 3 4 2 Thickness 1.90mm (0.075 in.) 1.50 (0.077 in.) 2.00 mm (0.079 in.) Color Code Green Plain Yellow f. Position the 1.95 mm (0.077 in.) (plain color code) retaining circlip, with the sharp edge positioned away from the bearing cap. a b 21153 a - Groove in bearing cap b - Circlip Page 3B-10 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ g. Install the circlip with a punch and hammer 21154 a a - Circlip h. Ensure that the circlip is fully seated into the groove. a 21155 a - Circlip in position i Turn the U-joint assembly 180 degrees and press on bearing cap to install second bearing cap. dc b a 21225 a - Table vise b - Universal joint tool c - Suitable mandrel on bearing cap d - Suitable mandrel on yoke 90-865612020 FEBRUARY 200 Page 3B-10 Driveshaft Housing Disassembly, Repair, and Reassembl\ j Position the 1.95 mm (0.077 in.) (plain color code) retaining circlip with the sharp edge positioned away from the bearing cap. If the plain cross bearing clip is loose or tight in the groove, use either the green or yellow as appropriate. a b 21153 a - Groove in bearing cap b - Circlip k. Install the circlip with a punch and hammer. 21154 a a - Circlip l. Ensure that the circlip is fully seated into the groove. a 21155 a - Circlip in position 2. Install each pair of bearing caps in this manner. 3. Inspect the U-joint assembly to ensure that the joint moves smoothly, with little friction. 4. Install U-joint shaft. Refer to Bravo Sterndrive Service Manual. Page 3B-10 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ U-joint, Pinion Gear and Bearing Assembly Reassembl\ ! CAUTION Improper reassembly of the U-joint and pinion gear assembly can cause damage or failure of the sterndrive. Reassemble the U-joint and pinion gear as specified. a b c d e f g h i 15755 Standard Bravo U-joint assembly a - Pinion nut f - Thrust washer b - Washer g - Oil seal and oil seal carrier c - Pinion gear and bearing assembly h - Retainer nut d - Sealing ring i - U-joint e - O-ring a b c d f 15756 e Bravo X series U-joint assembly a - Pinion nut d - Thrust washer b - Washer e - O-ring, oil seal, oil seal carrier, and c - Pinion gear and bearing assembly retainer nut f - U-joint 90-865612020 FEBRUARY 2006 Page 3B-10 Driveshaft Housing Disassembly, Repair, and Reassembl\ a b c d e f 15757 Bravo XR U-joint assembly a - Pinion nut d - Thrust washer b - Washer e - O-ring, oil seal, oil seal carrier, and c - Pinion gear and bearing assembly retainer nut f U-joint The stacking procedure below can be followed for the assembly of all Bravo U-joint assemblies. However, the Bravo X series and the Bravo XR models must refer to specified U-joint exploded view for the parts order and orientation of U-joint reassembly. 1 Stacking procedure for reassembling a Standard Bravo U-joint, pinion gear and bearing assembly. NOTE: Bravo X series and the Bravo XR models must refer to specified U-joint exploded view for the parts order and orientation of U-joint reassembly. a. Place bearing retainer wrench tool in a vise and add the retainer nut b. Stack the oil seal and oil seal carrier on the retainer nut c. Install the O-ring to oil seal carrier a b c d 16399 Standard Bravo model shown Bravo X series and Bravo XR models are similar. a - Bearing retainer wrench tool c - Oil seal and oil seal carrier b - Retainer nut d - O-ring Bearing retainer wrench 91-17256 d. Stack the sealing ring on the oil seal carrier. e. Place the thrust washer, flat side up, on the oil seal carrier. Page 3B-10 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ f. Stack the pinion gear and bearing assembly on the thrust washer and sealing ring a b c 16400 Standard Bravo model shown Bravo X series and Bravo XR models are similar. a - Sealing ring c - Pinion gear and bearing assembly b - Thrust washer g. Apply lubricant to the washer and threads of retainer nut. Tube Ref No. Description Where Used Part No. High Performance Gear U-joint pinion gear washer and 87 92-802854A1 Lubricant retainer nut h. Install the U-joint from the bottom of the stacked assembly. i. Place the washer over the U-joint stub and hand-start the pinion nut. c - Pinion nut j. Use a screwdriver to secure the U-joint. a b a - U-jointb - Washer c 16401 90-865612020 FEBRUARY 2006 Page 3B-10 Driveshaft Housing Disassembly, Repair, and Reassembl\ k. Tighten the pinion nut until the washer contacts the gear. Do not overtighten the nut before setting the preload. b a 16402 a - Screwdriver b - Ratchet and socket NOTE: Complete the U-joint and pinion gear preload procedure before installing the assembly to the driveshaft housing. U-joint Pinion Gear and Bearing Assembly Preload Follow only one of the procedures: Setting Preload Using a Vise, Setting Preload In The Driveshaft Housing. SETTING PRELOAD USING A VISE 1 Set the preload on bearing package as follows: a. Mount the retainer nut wrench tool in a vise to support the U-joint assembly. b. Position the U-joint assembly with its shaft facing down as shown. b d e a c 16407 Standard Bravo a - U-joint pinion gear and bearing d - Vise assembly e - Screwdriver b - Bearing retainer wrench c - U-joint shaft (facing down) Page 3B-10 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ Bearing retainer wrench 91-17256 d e b a c 16408 Bravo X series a - U-joint pinion gear and bearing assembly b - Bearing retainer wrench c - U-joint shaft (facing down) d - Vise e - Screwdriver Spanner wrench for L-18 U-joint bearing 91-862219A1 retainer c. Apply a light coat of lubricant to bearings. Tube Ref No. Description Where Used Part No. High Performance Gear 87 Bearings 92-802854A1 Lubricant d. Set preload by tightening the nut 1/16 of a turn at a time. e. Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and a dial torque wrench lb. in. until you reach the specified torque. ! CAUTION Avoid premature bearing failure. Do not overtighten the U-joint pinion gear nut, a 16409 Standard Bravo shown Bravo X series similar a - Dial type torque wrench (lb. in.) 90-865612020 FEBRUARY 2006 Page 3B-10 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: Bearings are used if spun once under load Description New Used U-joint bearing preload 0.7�1.0 Nm (6�10 lb. in.) 0.3�0.8 Nm (3�7 lb. in.) Torque wrench, lb. in. 91-66274 2. If the nut becomes overtightened (causing excessive preload), release the pinion gear and bearing assembly preload. a. Remove the pinion gear and the bearing assembly from the U-joint. b. Place the universal puller plate under the shoulder of the flanged bearing cup. c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure. g f d ec a b 16412 a - Universal puller plate tool e - Pinion gear b - Flanged bearing cup shoulder f - Mandrel on pinion gear c - Flanged bearing cup g - Press on mandrel d - Top roller bearing and bearing cup Universal puller plate 91-37241 d. Reassemble the components of the U-joint and repeat the preload procedures. SETTING PRELOAD IN THE DRIVESHAFT HOUSING 1 Set the preload on a U-joint pinion gear-and-bearing assembly as follows: a. Apply a light coat of lubricant to bearings. Tube Ref No. DescriptioS Where Used Part No. High Performance Gear 8 Bearings 92-802854A1 Lubricant Page 3B-11 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembly 90-865612020 FEBRUARY 2006 Page 3B-111 b. Install the U-joint and pinion gear assembly into the driveshaft housing. a b 16414 Standard Bravo shown Bravo X series similar a - U-joint and pinion gear assembly b - Retaining nut c. Position the driveshaft housing so that the U-joint coupling shaft is pointing straight down. d. Set the preload by tightening the nut 1/16 of a turn at a time. Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and dial torque wrench until you reach an acceptable torque. ! CAUTION Premature bearing failure can result if U-joint pinion gear nut becomes overtightened (causing excessive preload). a b 16415 Standard Bravo shown Bravo X series similar a - Dial torque wrench (lb. in.) b - Driveshaft housing (U-joint shaft facing down) NOTE: Bearings are used if spun once under load Description New Used U-joint bearing preload 0.7�1.0 Nm (6�10 lb. in.) 0.3�0.8 Nm (3�7 lb. in.) Driveshaft Housing Disassembly, Repair, and Reassembl\ Torque wrench, lb. in. 91-66274 2. Remove U-joint and pinion gear assembly from driveshaft housing. 3. If nut becomes overtightened (causing excessive preload), release the pinion gear and bearing assembly preload: a. Remove the pinion gear and bearing assembly from the U-joint. b. Place the universal puller plate under the shoulder of the flanged bearing cup. c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure. g f d ec a b 16412 a - Universal puller plate tool e - Pinion gear b - Flanged bearing cup shoulder f - Mandrel on pinion gear c - Flanged bearing cup g - Press on mandrel d - Top roller bearing and bearing cup Universal puller plate 91-37241 d. Reassemble components to the U-joint and repeat preload procedures. Driveshaft Housing Shimming Preparation For Assembly U-joint Pinion Gear Shimming ! CAUTION Avoid injury. Heavy sterndrive components may come apart suddenly and forcefully, possibly resulting in injury. Properly support the U-joint yoke assembly while removing the pinion gear nut. 1. Ensure that the U-joint pinion gear and bearing assembly preload is set and ready to install. 2. Disassemble U-joint from pinion gear and bearing assembly: a. Mount the retainer nut wrench tool in a vise to support the U-joint assembly. b. Position the U-joint assembly with shaft pointing straight down. c. Use a long screwdriver to secure the U-joint so that it will not rotate while loosing the nut. d. Remove screwdriver. Page 3B-112 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ e. The U-joint will fall when nut is removed. Hold the U-joint and remove the nut and washer. e f c b d b d a d - U-joint shaft e - Vise f - Screwdriver b d 15754 a - Retainer nut and washer b - U-joint pinion gear and bearing assembly c - Bearing retainer wrench tool Bearing retainer wrench 91-17256 3 Insert the stub shaft tool from the bottom of the the pinion gear and bearing assembly, and the remaining components. NOTE: Do not overtighten the nut. 4 Install the washer and nut; tighten nut until the washer and nut just seat against the pinion gear and the complete assembly is firmly seated to the stub shaft tool. a b d c 15811 Standard Bravo U-joint assembly shown a - Tool c - Pinion gear and bearing assembly b - Stub shaft tool d - Socket on nut Stub shaft for Standard Bravo 91-865084 Stub shaft for Bravo X Series 91-865083 90-865612020 FEBRUARY 200 Page 3B-11 Driveshaft Housing Disassembly, Repair, and Reassembl\ 5 Position the shim on the shoulder of the flanged bearing cup. Use the starting shim specification chart or the original shim thickness that came out of the drive as a starting point. Starting shim specificatioS mm in. U-joint pinion gear shim 0.09 0.035 a b c 15812 a - Shim c - Stub shaft tool b - Shoulder of bearing spacer cup 6 Carefully install the pinion gear and bearing assembly with the stub shaft tool into the driveshaft housing bore so not to damage the shim. c ab 15813 c b a 16139 Standard Bravo Bravo X7 a - Driveshaft housing c - Retainer nut b - Stub shaft tool complete assembly 7 Apply lubricant to the threads of the retainer nut. Tube Ref No. DescriptioS Where Used Part No. 34 Special Lubricant 101 Threads of retainer nut 92-802865A1 IMPORTANT: Ensure that the retainer nut is not cross-threaded by turning the retainer nuY COUNTERCLOCKWISE until thread engagement is felt; then, turn retainer nut clockwise, Page 3B-11 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 8. Install the U-joint retainer nut to driveshaft housing and torque a a - U-joint retainer nut b - Bearing retainer wrench b c 15814 c - Torque wrench 9 Use the specified torque chart and torque wrench as outlined in this section under Torque Conversion Chart For U-joint Retainer Nut Tool. a b 16143 Typical Bravo retainer nut tool shown a - Torque wrench length b - U-joint retainer nut tool measurement, 30.5 cm (12 in.) Bearing retainer wrench 91-17256 NOTE: For Bravo X Series and Bravo XR, use the bearing retainer wrench tool to loosen and remove the retainer nut from the driveshaft housing. Spanner wrench for L-18 U-joint bearing 91-862219A1 retainer IMPORTANT: Ensure that the number of driven gear teeth match the drive gear ratio. NOTE: Diesel sterndrives are listed as Bravo X series. 90-865612020 FEBRUARY 200 Page 3B-11 Driveshaft Housing Disassembly, Repair, and Reassembl\ Driveshaft Housing� Gear Ratio and Gear Tooth Count Sterndrive model Standard Bravo Three and Bravo Three X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo Two and Bravo Two X series Standard Bravo One and Bravo One X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Standard Bravo Two and Bravo Two X series Standard Bravo Three and Bravo Three X series Standard Bravo One and Bravo One X series Bravo One XR Bravo Three XR Ratio 2.43:1 2.20:1 2.00:1 1.81:1 1.65:1 1.50:1 1.36:1 1.50:1 1.35:1 1.26:1 2.00:1 Pinion (drive) gear teeth 23 23 27 27 27 23 27 27 27 16 27 Driven gear teeth 30 30 32 29 32 30 32 29 29 19 32 Page 3B-116 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 10. Insert the pinion gear shimming tool in the top of the driveshaft housing. Position the matching gear teeth count access hole to the pinion gear. a b c 15815 a - Pinion gear shimming tool b - Access holes for gear tooth counts 27/32, 23/30, 16/19 c - Access holes for gear tooth counts 27/29 Pinion gear shimming tool 91-865114 NOTE: Refer to Feeler Gauge Measurement for further assistance. 11. Insert the feeler gauge and measure the clearance of the pinion gear shimming tool to the pinion gear teeth. a c b a b c d a c b 15816 a - Feeler gauge c - Pinion gear shimming tool b - Access hole d - Pinion gear Specification mm in. Pinion gear location 0.64 0.025 12. If the pinion gear location is within specification: a. Remove the pinion shimming tool from the driveshaft housing. b. Remove the the stub shaft tool complete assembly from the driveshaft housing. c. Proceed to Measuring Driven Gear Lash in this section. 13. If the pinion gear does not meet the specification: 90-865612020 FEBRUARY 2006 Page 3B-11 Driveshaft Housing Disassembly, Repair, and Reassembl\ a Calculate the difference of the existing pinion gear location measurement and the specified pinion gear measurement by using the shimming charts below. For example, if the gear is too far away from shimming tool: The shim assembled with the upper driven gear measures 0.89 mm (0.035 in.) thick and the existing pinion gear location measurement is 0.71 mm (0.028 in.). NOTE: Add shim thickness to move the pinion gear away from tool. Remove shim thickness to move the pinion gear closer to tool. The shim thickness should be decreased by 0.08 mm (0.003 in.). Replace the shim with a 0.81 mm (0.032 in.) thick shim. Repeat the measurement process and check your work. IMPORTANT: The shimming process must be repeated until the pinion gear location specifications are met. Shimming Charts Description Existing pinion gear location (feeler gauge thickness) Specification Remove shim measurement (difference) Shim thicknesX 0.711 mm (0.028 in.) 0.635 mm (0.025 in.) 0.076 mm (0.003 in.) For example, if the gear is too close to the shimming tool: The shim assembled with the upper driven gear measures 0.89 mm (0.035 in.) thick and the existing pinion gear location measurement is 0.56 mm (0.022 in.). NOTE: Add shim thickness to move pinion gear away from tool. Remove shim thickness to move pinion gear closer to tool. The shim thickness should be increased by 0.08 mm (0.003 in.). Replace the shim with a 0.81 mm (0.032 in.) thick shim. Repeat the measurement process and check your work. IMPORTANT: The shimming process must be repeated until the pinion gear location specifications are met. Shimming Charts Description Specification Existing pinion gear location (feeler gauge thickness) Add shim measurement (difference) Shim thicknesX 0.64 mm (0.025 in.) 0.56 mm (0.022 in.) 0.08 mm (0.003 in.) NOTE: A reference chart of the U-joint pinion gear shims follows Page 3B-11 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ U-joint pinion gear shim 15-888927-028 15-888927-029 15-888927-030 15-888927-031 15-888927-032 15-888927-033 15-888927-034 15-888927-035 15-888927-036 15-888927-037 15-888927-038 15-888927-039 15-888927-040 FEELER GAUGE MEASUREMENT 1 To properly check gear location: mm in. 0.71 0.028 0.74 0.029 0.76 0.030 0.79 0.031 0.81 0.032 0.83 0.033 0.86 0.034 0.89 0.035 0.91 0.036 0.97 0.037 0.97 0.038 0.99 0.039 1.02 0.040 a Position the gear with at least 2 full teeth centered on the gauging surface. One full tooth must be on each side of the gauging surface center line. Insert a 0.64 mm (0.025 in.) feeler gauge between a tooth and the gauging surface. b Slightly rotate the shimming tool until one side of the gauging surface contacts the feeler gauge and a slight drag is felt on the feeler gauge. c Without moving the shimming tool, remove the feeler gauge and re-insert it between the other tooth and the gauging surface. 16419 2 If the feeler gauge can be inserted with only a slight drag, the shimming is correct. 3 If the feeler gauge inserts with no drag, repeat Steps 1., a., b., and c. with progressively thicker feeler gauges until the feeler gauge can be inserted with only a slight drag. 4 If the feeler gauge cannot be inserted, repeat Steps 1., a., b., and c. with progressively thinner feeler gauges until the feeler gauge can be inserted with only a slight drag. Measuring Driven Gear Lash IMPORTANT: Repeat the shimming process, Measuring Driven Gear Lash, until the gear lash measurement is within specifications. 90-865612020 FEBRUARY 200 Page 3B-11 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 Ensure that the U-joint pinion gear has completed the shimming procedure and is removed from the driveshaft housing. 2 Measure the upper and lower thrust race. Record this measurement. 3 If not using the original thrust race, use a thrust race with the specified thickness as a starting point or the same thickness as the original thrust race. a b 15380 a - Micrometer b - Thrust race Starting thrust race specification mm in. Driven gear thrust race 1.63 0.064 4. Lightly lubricate the lower thrust race. Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Lower thrust race 92-802854A1 NOTE: If using the original thrust race, race should be installed so that the side of original contact area is in the same position as removed. 5 Position the lower thrust race in the center of the driveshaft housing. a a - Lower thrust race 15384 6. Lightly lubricate the lower thrust bearing. Tube Ref No. Description High Performance Gear Lubricant Where Used Lower thrust bearing Part No. 92-802854A1 87 Page 3B-12 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembly 90-865612020 FEBRUARY 2006 Page 3B-121 NOTE: The thrust bearing is always positioned to the gear, and the thrust race (shim) is positioned to the driveshaft housing. 7. Position the lower thrust bearing on top of the lower thrust race in the center of the driveshaft housing. a 15383 a - Lower thrust bearing NOTE: The clutch and gear assembly and the top cover assembly can not be properly installed if the lower thrust race and lower thrust bearing are positioned incorrectly. b a 16444 Positioned correctly Positioned incorrectly a - Driveshaft housing b - Lower thrust bearing ! CAUTION Mistiming of the clutch and gear assembly will cause the sterndrive not to shift out of gear properly and can cause damage and failure of the gear assembly. Always time the assembly as specified. IMPORTANT: Do not align two positive (+) marks or two negative (�) marks. NOTE: Timing marks on gears must be aligned in one of two ways. The positive (+) mark over the negative (�) or the negative (�) mark over the positive (+). Never align two positive (+) marks or two negative (�) marks. Driveshaft Housing Disassembly, Repair, and Reassembl\ 8. Position the clutch and gear assembly timing marks on gears a+ - b 18178 a - Upper driven gear to the positive (+) mark b - Lower driven Gear to negative (�) mark 9. Lightly lubricate clutch and gear assembly. a + - 18179 a - Clutch and gear assembly Tube Ref No. 87 Description High Performance Gear Lubricant Where Used Clutch and gear assembly Part No. 92-802854A1 Page 3B-122 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 10. Install the clutch and gear assembly into the driveshaft housing so that the timing marks on gears are easily visible through the back of the driveshaft housing. a b a 15793 a - Clutch and gear assembly b - Bottom face of lower gear 11. Position the clutch and gear assembly timing marks on the gears. NOTE: The timing marks on the gears must be aligned in one of two ways. The positive (+) mark over the negative (�) or the negative (�) mark over the positive (+). Never align two positive (+) marks or two negative (�) marks. _ + a b 16557 Clutch and gear assembly properly installed in the driveshaft housing a - Upper gear (+) positive timing b - Lower gear (�) negative timing mark mark 90-865612020 FEBRUARY 2006 Page 3B-12 Driveshaft Housing Disassembly, Repair, and Reassembl\ 12. Align the timing index marks of the clutch and gear assembly with the index marks on driveshaft housing as close as possible. _ + b a a b 18180 Clutch and gear assembly properly installed in the driveshaft housing a - Index marks on driven gears b - Index marks on driveshaft housing 13. Ensure that the clutch and gear assembly is positioned below the top of the driveshaft housing. 14. If the clutch and gear assembly is above the driveshaft housing, reposition the lower thrust race and lower thrust bearing. a b ba 15794 15795 Positioned correctly Positioned incorrectly a - Clutch and gear assembly b - Driveshaft housing 15. Lightly lubricate thrust bearing. Tube Ref No. Description Where Used Part No. 87 High Performance Gear Thrust bearing 92-802854A1 Lubricant NOTE: The thrust bearing is always aligned to the gear, and the thrust race (shim) is aligned to the driveshaft housing. Page 3B-124 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 16. Position the upper thrust bearing on top of the clutch and gear assembly a 15381 a - Thrust bearing 17. Lightly lubricate the thrust race. Tube Ref No. Description Where Used Part No. High Performance Gear 87 Thrust race 92-802854A1 Lubricant NOTE: If using the original thrust race, install the race so the side of original contact area is in the same position as the one removed. 18. Position the upper thrust race on top of upper thrust bearing. a 15379 a - Thrust race NOTE: Ensure that the shim is positioned on the shoulder of the flanged bearing cup . 90-865612020 FEBRUARY 2006 Page 3B-12 Driveshaft Housing Disassembly, Repair, and Reassembl\ 19. Carefully install the stub shaft tool complete assembly into the driveshaft housing bore so not to damage the shim. c ab 15813 a - Driveshaft housing c - Retainer nut b - Stub Shaft tool complete assembly 20. Apply lubricant to the threads of the retaining nut. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Threads of retainer nut 92-802865A1 IMPORTANT: Ensure that the retainer nut is not cross-threaded by turning the retainer nut COUNTERCLOCKWISE until you feel the threads engage and then turn the retainer nut clockwise. 21. Install the U-joint retainer nut to driveshaft housing. c b a 16139 a 18183 Standard Bravo shown a - U-joint retainer nut Page 3B-126 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 22. Torque the retainer nut a b 18182 Standard Bravo showS a - Bearing retainer wrench tool b - Torque wrench 23. Use the specified torque chart and torque wrench as outlined in this section under Torque Conversion Chart For U-joint Retainer Nut Tool. a b 16143 Typical Bravo retainer nut tool shown a - Torque wrench length b - U-joint retainer nut tool measurement, 30.5 cm (12 in.) Bearing retainer wrench 91-17256 NOTE: For Bravo XZ, XR and Diesel Bravo drives use the bearing retainer wrench for Bravo X series tool to loosen and remove the retainer nut from the driveshaft housing. Spanner wrench for L-18 U-joint bearing 91-862219A1 retainer 24. NOTE: The shift shaft upper seal must be installed on the driveshaft housing before you can install the top cover. 90-865612020 FEBRUARY 2006 Page 3B-12 Driveshaft Housing Disassembly, Repair, and Reassembl\ 25. Insert the shift shaft seal into the driveshaft housing a 15330 a - Shift shaft seal NOTE: Ensure that the top cover O-ring is positioned correctly. 26. Apply lubricant to the top cover O-ring and install to the top cover. a 15328 a a - Top cover O-ring Tube Ref No. Description 87 High Performance Gear Lubricant 27. Install the top cover and torque the screws. Where Used Top cover O-ring Part No. 92-802854A1 a b 16430 a - Top cover b - Bolts Description Nm lb. in. lb. ft. Driveshaft housing top cover screws 27 20 Page 3B-128 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 28. Install the adapter rod tool in the top stud hole of the driveshaft housing and tighten the nut. a b 15797 a - Adapter rod tool b - Nut Adaptor rod tool 91- 865086 29. Install the gear lash flag onto the stub shaft tool. Ensure that the drive tooth count matches the numbers on the flag. 30. Align the indicator mark of the gear lash flag toward the stub shaft tool. b a 15798 a - Stub shaft tool b - Gear lash flag Gear lash flag 27/32 91-865080 Gear lash flag 27/29 91-865081 Gear lash flag 23/30 91-865082 Gear lash flag 16/19 91-865116 90-865612020 FEBRUARY 2006 Page 3B-12 Driveshaft Housing Disassembly, Repair, and Reassembl\ 31. Install the clamp block and handle tool on the end of the stub shaft tool. Tighten just to snug up to shaft. c a b 15799 a - Clamp block and handle tool c - Gear lash flag b - Stub shaft tool Clamp block and handle tool 91-865085 32. Install the dial indicator holding block to the adapter rod and nut tool. b a 15800 a - Dial indicator holding block b - Adapter rod and nut tool Dial indicator holding block 91-865097 NOTE: Use the short extension tip for the dial indicator. 33. Install the dial indicator to the holding block using the correct drive gear ratio access hole. Dial indicator 91-58222A1 34. Position the dial indicator holding block to align the dial indicator tip 90� parallel to the gear lash flag indicator mark. Page 3B-130 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 35. Final alignment can be made to ensure that the gear lash flag is positioned vertically on the stub shaft tool. b a f ad e c b a f g c d 15802 15803 Standard Bravo Bravo X Series a - Gear lash flag e - Adapter rod tool b - Dial indicator tip f - Clamp block and handle tool c - Dial indicator g - Stub shaft tool d - Dial indicator holding block 36. Reposition the clutch for the clamp tool installation by carefully pushing the clutch up with a screwdriver to gain access to the upper driven gear. d c b a 15804 a - Clutch c - Upper driven gear torus ring b - Lower driven gear torus ring d - Screwdriver NOTE: The clutch and gear assembly timing marks "+" and "�" must remain aligned while measuring gearlash. 90-865612020 FEBRUARY 2006 Page 3B-13 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: The driven gear clamping tool clamps to the torus ring a b 16440 a - Driven gear torus ring b - Driven gear clamping tool 37. Install the driven gear clamping tool to the upper driven gear of the clutch and gear assembly. Position the tool so you can hold the clamping tool while reading the dial indicator. a c b 15805 a - Upper driven gear torus ring c - Clutch b - Driven gear clamping tool Driven gear clamping tool 91-865115 38. Make final adjustments enabling holding the driven gear clamping tool with one hand and the handle tool with the other hand while reading the dial indicator. Tighten the clamp block and handle tool to the stub shaft tool. Page 3B-132 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 39. Hold the driven gear in locked position with the driven gear clamping tool. Slightly rotate the clamp block and handle tool back and forth to move the U-joint pinion gear, to feel the gear lash. a c b c b a 15807 a - Clamp block and handle tool c - Dial indicator b - Driven gear clamping tool 40. Observe the dial gauge while rotating the pinion gear back and forth to feel the gear lash. Record this measurement as an upper driven gear measurement. 41. Remove the driven gear clamping tool from the upper driven gear. 42. Reposition the clutch, carefully pushing the clutch down with a screwdriver to gain access to the lower driven gear. b d a c 15806 a - Clutch c - Lower driven gear b - Upper driven gear d - Screwdriver 43. Install the driven gear clamping tool to the lower driven gear of the clutch and gear assembly. 90-865612020 FEBRUARY 2006 Page 3B-13 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: The driven gear clamping tool clamps to the lower torus ring bc a 15817 a - Lower gear torus ring c - Clutch b - Driven gear clamping tool Driven gear clamping tool 91-865115 44. Hold the driven gear in locked position with the driven gear clamping tool. Slightly rotate the clamp block and handle tool back and forth to move the U-joint pinion gear, to feel the gear lash. a c b a - Clamp block and handle tool b - Driven gear clamping tool c b a 15807 c - Dial indicator 45. Observe the dial gauge while rotating the pinion gear back and forth to feel the gear lash. Record measurement as a lower driven gear measurement. NOTE: The upper driven gear and lower driven gear have the same gear lash specification. Drive gear tooth 27 27 23 16 Driven gear tooth 32 29 30 19 Gear lash specification 0.279 mm�0.406 mm [(0.011 in.)�(0.016 in.)] 0.330 mm�0.457 mm [(0.013 in.)�(0.018 in.)] 0.279 mm�0.406 mm [(0.011 in.)�(0.016 in.)] 0.229 mm�0.381 mm [(0.009 in.)�(0.015 in.)] Page 3B-134 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 46. If the gear lash measurement of the upper driven gear and the lower driven gear are within specification: a. Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover from the driveshaft housing. b. Remove all components from the stub shaft tool. c The upper thrust race and upper thrust bearing, clutch and gear assembly, and the lower thrust bearing and lower thrust race remain in the driveshaft housing for complete reassembly of the driveshaft housing. d Proceed to Drive Reassembly. NOTE: Refer to Calculation Method For Specified Gear Lash in this section. 47. If the gear lash measurement of the upper driven gear is incorrect and the lower driven gear is within the specified measurement: a. Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover and the upper thrust race from the driveshaft housing. b. Replace only the upper thrust race. c. Repeat the measurement process. 48. If the gear lash measurement of the lower driven gear is incorrect and the upper driven gear is within the specified measurement: a Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover, upper thrust race and upper thrust bearing, clutch and gear assembly, and the lower thrust bearing and lower thrust race from the driveshaft housing. b Replace only the lower thrust race. c Repeat the measurement process. 49. If the gear lash measurement of the upper driven gear and the lower driven gear are incorrect: a. Carefully remove the measuring tools, stub shaft tool, and assembly. Remove the top cover, upper thrust race and thrust bearing, clutch and gear assembly, and the lower thrust bearing and thrust race from the driveshaft housing. b. Replace the upper thrust race and the lower thrust race. c. Repeat the measurement process. IMPORTANT: The shimming process must be repeated until gear lash is within specifications. CALCULATION METHOD FOR SPECIFIED GEAR LASH ! CAUTION Using multiple thrust races to obtain the specified gear lash can cause drive damage and failure. Always use the correct race. 1. If the gear lash is not within specification: a. Calculate the difference of the existing gear lash measurement and the specified gear lash measurement by using the gear lash charts below. b. Make the gear lash measurement changes by removing or adding thrust race thickness. For example, if the gear lash measurement is too high: The thrust race assembled with the driven gear measures 1.55 mm (0.061 in.) thick and the gear lash measurement is 0.43 mm (0.017 in.). 90-865612020 FEBRUARY 200 Page 3B-13 Driveshaft Housing Disassembly, Repair, and Reassembl\ NOTE: Use the midpoint of the specified gear lash. If the specified gear lash is 0.28�0.41 mm (0.011�0.016 in.), use the midpoint of 0.36 mm (0.014 in.). The thrust race thickness should be increased by 0.08 mm (0.003 in.). Replace the thrust race with a 1.63 mm (0.064 in.) thick thrust race. Repeat the measurement process and check your work. Gear lash chart Description Existing gear lash measurement Specification Add thrust race measurement (difference) Thrust race thicknesX 0.432 mm (0.017 in.) 0.356 mm (0.014 in.) 0.076 mm (0.003 in.) For example, If the gear lash measurement is too low: The thrust race assembled with the driven gear measures 1.55 mm (0.061 in.) thick and the gear lash measurement is 0.30 mm (0.012 in.). NOTE: NOTE: Use the midpoint of the specified gear lash; if the specified gear lash is 0.28�0.41 mm (0.011�0.016 in.), use the mid point of 0.36 mm (0.014 in.). The thrust race thickness should be decreased by 0.05 mm (0.002 in.). Replace the thrust race with a 1.50 mm (0.059 in.) thick thrust race. Repeat the measurement process and check your work. Gear lash chart Description Specification Existing gear lash measurement Remove thrust race measurement (difference) Thrust race thickness 0.356 mm (0.014 in.) 0.305 mm (0.012 in.) 0.051 mm (0.002 in.) Adding thrust race thickness positions the driven gear closer to the pinion gear, reducing gear lash. Removing thrust race thickness positions the driven gear farther away from the pinion gear, increasing gear lash. Thrust bearing race 23-864596-058 23-864596-059 23-864596-060 23-864596-061 23-864596-062 23-864596-063 23-864596-064 23-864596-065 23-864596-066 23-864596-067 Thickness Color code 1.47 mm (0.058 in.) Brown 1.50 mm (0.059 in.) White 1.52 mm (0.060 in.) Orange 1.55 mm (0.061 in.) Green 1.57 mm (0.062 in.) Yellow 1.60 mm (0.063 in.) Red 1.63 mm (0.064 in.) Light Blue 1.65 mm (0.065 in.) Black 1.68 mm (0.066 in.) Pink 1.70 mm (0.067 in.) Purple Driveshaft Housing Reassembly Reset U-joint Pinion Gear and Bearing Preload IMPORTANT: Reset the U-joint pinion gear and bearing assembly preload after the shimming procedure and before it is reinstalled into the driveshaft housing. Page 3B-136 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 1 Carefully remove the shim from the pinion gear and bearing assembly. 2 Release the pinion gear and bearing assembly preload: a. Place the universal puller plate tool under the shoulder of the flanged bearing cup. b. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure. g f d ec a b 16412 a - Universal puller plate tool e - Pinion gear b - Flanged bearing cup shoulder f - Mandrel on pinion gear c - Flanged bearing cup g - Press on mandrel d - Top roller bearing and bearing cup Universal puller plate 91-37241 U-joint, Pinion Gear and Bearing Assembly Reassembl\ ! CAUTION Improper reassembly of the U-joint and pinion gear assembly can cause damage or failure of the sterndrive. Reassemble the U-joint and pinion gear as specified. a b c d e f g h i 15755 Standard Bravo U-joint assembl\ a - Pinion nut f - Thrust washer b - Washer g - Oil seal and oil seal carrier c - Pinion gear and bearing assembly h - Retainer nut d - Sealing ring i - U-joint e - O-ring 90-865612020 FEBRUARY 200 Page 3B-13 Driveshaft Housing Disassembly, Repair, and Reassembl\ a b c d f 15756 e Bravo X series U-joint assembly a - Pinion nut d - Thrust washer b - Washer e - O-ring, oil seal, oil seal carrier, and c - Pinion gear and bearing assembly retainer nut f U-joint d - Thrust washer e - O-ring, oil seal, oil seal carrier, and retainer nut f - U-joint a b c d e f 15757 Bravo XR U-joint assembly a - Pinion nut b - Washer c - Pinion gear and bearing assembly The stacking procedure below can be followed for the assembly of all Bravo U-joint assemblies. However, the Bravo X series and the Bravo XR models must refer to specified U-joint exploded view for the parts order and orientation of U-joint reassembly. 1 Stacking procedure for reassembling a Standard Bravo U-joint, pinion gear and bearing assembly. NOTE: Bravo X series and the Bravo XR models must refer to specified U-joint exploded view for the parts order and orientation of U-joint reassembly. a. Place bearing retainer wrench tool in a vise and add the retainer nut b. Stack the oil seal and oil seal carrier on the retainer nut Page 3B-13 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ c. Install the O-ring to oil seal carrier a b c d 16399 Standard Bravo model shown Bravo X series and Bravo XR models are similar. a - Bearing retainer wrench tool c - Oil seal and oil seal carrier b - Retainer nut d - O-ring Bearing retainer wrench 91-17256 d. Stack the sealing ring on the oil seal carrier. e. Place the thrust washer, flat side up, on the oil seal carrier. f. Stack the pinion gear and bearing assembly on the thrust washer and sealing ring. a b c 16400 Standard Bravo model shown Bravo X series and Bravo XR models are similar. a - Sealing ring c - Pinion gear and bearing assembly b - Thrust washer g. Apply lubricant to the washer and threads of retainer nut. Tube Ref No. Description Where Used Part No. High Performance Gear U-joint pinion gear washer and 87 92-802854A1 Lubricant retainer nut h. Install the U-joint from the bottom of the stacked assembly 90-865612020 FEBRUARY 2006 Page 3B-13 Driveshaft Housing Disassembly, Repair, and Reassembl\ i. Place the washer over the U-joint stub and hand-start the pinion nut a b a - U-jointb - Washer c 16401 c - Pinion nut j Use a screwdriver to secure the U-joint. k Tighten the pinion nut until the washer contacts the gear. Do not overtighten the nut before setting the preload. b a 16402 a - Screwdriver b - Ratchet and socket NOTE: Complete the U-joint and pinion gear preload procedure before installing the assembly to the driveshaft housing. U-joint Pinion Gear and Bearing Assembly Preload Follow only one of the procedures: Setting Preload Using a Vise, Setting Preload In The Driveshaft Housing. SETTING PRELOAD USING A VISE 1 Set the preload on bearing package as follows: a. Mount the retainer nut wrench tool in a vise to support the U-joint assembly. Page 3B-14 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ b. Position the U-joint assembly with its shaft facing down as shown b d e a c 16407 Standard Bravo a - U-joint pinion gear and bearing assembly b - Bearing retainer wrench c - U-joint shaft (facing down) d - Vise e - Screwdriver Bearing retainer wrench 91-17256 d e b a c 16408 Bravo X series a - U-joint pinion gear and bearing assembly b - Bearing retainer wrench c - U-joint shaft (facing down) d - Vise e - Screwdriver Spanner wrench for L-18 U-joint bearing 91-862219A1 retainer c. Apply a light coat of lubricant to bearings. Tube Ref No. Description Where Used Part No. 87 High Performance Gear Bearings 92-802854A1 Lubricant d. Set preload by tightening the nut 1/16 of a turn at a time 90-865612020 FEBRUARY 2006 Page 3B-14 Driveshaft Housing Disassembly, Repair, and Reassembl\ e Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and a dial torque wrench lb. in. until you reach the specified torque. ! CAUTION Avoid premature bearing failure. Do not overtighten the U-joint pinion gear nut, a 16409 Standard Bravo shown Bravo X series similar a - Dial type torque wrench (lb. in.) NOTE: Bearings are used if spun once under load. Description New Used U-joint bearing preload 0.7�1.0 Nm (6�10 lb. in.) 0.3�0.8 Nm (3�7 lb. in.) Torque wrench, lb. in. 91-66274 2. If the nut becomes overtightened (causing excessive preload), release the pinion gear and bearing assembly preload. a. Remove the pinion gear and the bearing assembly from the U-joint. b. Place the universal puller plate under the shoulder of the flanged bearing cup. Page 3B-14 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure. g f d ec a b 16412 a - Universal puller plate tool e - Pinion gear b - Flanged bearing cup shoulder f - Mandrel on pinion gear c - Flanged bearing cup g - Press on mandrel d - Top roller bearing and bearing cup Universal puller plate 91-37241 d. Reassemble the components of the U-joint and repeat the preload procedures. SETTING PRELOAD IN THE DRIVESHAFT HOUSING 1 Set the preload on a U-joint pinion gear-and-bearing assembly as follows: a. Apply a light coat of lubricant to bearings. Tube Ref No. DescriptioS Where Used Part No. High Performance Gear 8 Bearings 92-802854A1 Lubricant b. Install the U-joint and pinion gear assembly into the driveshaft housing. a b 16414 Standard Bravo shown Bravo X series similaU a - U-joint and pinion gear assembly b - Retaining nut c Position the driveshaft housing so that the U-joint coupling shaft is pointing straight down. 90-865612020 FEBRUARY 200 Page 3B-14 Driveshaft Housing Disassembly, Repair, and Reassembl\ d Set the preload by tightening the nut 1/16 of a turn at a time. Check for proper preload by turning the pinion gear, using an extension, appropriate socket, and dial torque wrench until you reach an acceptable torque. ! CAUTION Premature bearing failure can result if U-joint pinion gear nut becomes overtightened (causing excessive preload). a b 16415 Standard Bravo shown Bravo X series similar a - Dial torque wrench (lb. in.) b - Driveshaft housing (U-joint shaft facing down) NOTE: Bearings are used if spun once under load Description New Used U-joint bearing preload 0.7�1.0 Nm (6�10 lb. in.) 0.3�0.8 Nm (3�7 lb. in.) Torque wrench, lb. in. 91-66274 2 Remove U-joint and pinion gear assembly from driveshaft housing. 3 If nut becomes overtightened (causing excessive preload), release the pinion gear and bearing assembly preload: a. Remove the pinion gear and bearing assembly from the U-joint. b. Place the universal puller plate under the shoulder of the flanged bearing cup. Page 3B-14 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ c. Press end of pinion gear with a suitable mandrel just until the bearing cups rotate easily. Failure to do this can result in premature bearing failure. g f d ec a b 16412 a - Universal puller plate tool e - Pinion gear b - Flanged bearing cup shoulder f - Mandrel on pinion gear c - Flanged bearing cup g - Press on mandrel d - Top roller bearing and bearing cup Universal puller plate 91-37241 d. Reassemble components to the U-joint and repeat preload procedures. Clutch and Gear Assembly Installation ! WARNING Sterndrive failure will result if the shimming process is not followed. The clutch and gear assembly was installed during the shimming process. If the clutch and gear assembly is not installed, refer to the Measuring Driven Gear Lash section and properly complete the shimming process before assembling the drive. U-joint Pinion Gear and Bearing Assembly Installation 1. Ensure that the shim is positioned on the flanged bearing cup shoulder of the U-joint pinion gear and bearing assembly. 2. Carefully install the U-joint assembly into the driveshaft housing bore to prevent damage to the shim. a 15367 a - Driveshaft housing and U-joint assembly aligned 3. Apply lubricant to the threads of the retaining nut. 90-865612020 FEBRUARY 2006 Page 3B-14 Driveshaft Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Threads of retainer nut 92-802865A1 IMPORTANT: Ensure that the retainer nut is not cross-threaded by turning the retainer nut COUNTERCLOCKWISE until you feel thread engagement and then turn the retainer nut clockwise. 4. Install the U-joint retainer nut to driveshaft housing. NOTE: On Bravo X series, the retainer nut must be started using retainer nut spanner wrench. a b c b 15344 16445 Standard Bravo Bravo X serieX a - Bearing retainer wrench tool c - Tool b - U-joint 5. Torque the retainer nut. b 16713 a Standard Bravo a - Torque wrench b - Retainer nut wrench tool Page 3B-146 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 16710 b a Bravo X serieX a - Retainer Nut Wrench tool b - Torque wrench 6 Use the specified torque chart and torque wrench as outlined in this section under Torque Conversion Chart For U-joint Retainer Nut Tool. a b 16143 Typical Bravo retainer nut tool shown a - Torque wrench length b - U-joint retainer nut tool measurement, 30.5 cm (12 in) Bearing retainer wrench 91-17256 Spanner wrench for L-18 U-joint bearing 91-862219A1 retainer 7 Ensure that timing marks are still properly aligned (by turning U-joint, if necessary). If marks have moved, remove U-joint assembly and repeat the process of setting the timing marks and installing the U-joint. + _ b b a c 16428 a - Timing marks c - Index marks on driven gears b - Index marks on driveshaft housing 90-865612020 FEBRUARY 200 Page 3B-14 Driveshaft Housing Disassembly, Repair, and Reassembl\ Shift Shaft, Shift Lever, and Shift Cam and Yoke Assemblies Installation 1 Push the shift lever assembly into place. If the assembly binds, move it gently from side to side while pushing. aa aa 16562 a - Shift lever assembly 2. Turn shift lever assembly 1/4 turn COUNTERCLOCKWISE and position as shown. 16564a a - Shift lever assembly 3 Install shift cam and yoke assembly into shifter cavity in driveshaft housing with the shift cam nuts facing the bottom of the driveshaft housing. a 15336 Shift cam and yoke assembly a - Shift cam and yoke assembly 4 Screw the shift handle tool into the shifter shaft. Page 3B-14 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 5. Push the shift handle tool and shift shaft into the driveshaft housing. Install the shift shaft through the cam and yoke assembly and through the shift lever assembly. a b 15334 a - Shift handle tool b - Shifter shaft Shift handle tool 91-17302 6. Move shifter shaft back and forth as necessary to align lower hole in shift cam assembly with threaded hole in shifter shaft. 7. If you are reusing the shift cam and yoke cthreads of the screw before installing. ap screw, apply adhesive to the first 2 or 3 Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Cap screws 92-809819 NOTE: New cap screws have preapplied adhesive and do not require additional adhesive. 8. Install a cap screw to secure the cam-and-yoke assembly to the shift shaft. Torque. a b c 16565 c - Hex wrench a - Shift cam and yoke assembly b - Cap Screw DescriptioS Nm lb. in. lb. ft. Shift cam and yoke assembly screw 12�13 100�120 9 If you are reusing the shift lever cap screw, apply adhesive to the first 2 or 3 threads of screw before installing. 90-865612020 FEBRUARY 200 Page 3B-14 Driveshaft Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Cap screws 92-809819 NOTE: New cap screws have preapplied adhesive and do not require additional adhesive. 10. Install a cap screw to secure the shift lever assembly to the shift shaft and torque. b a c 15333 a - Shift lever assembly b - Cap screw c - Hex wrench Description Shift linkage cap screw Nm 12�13 lb. in. 100�120 lb. ft. 11. Move shift linkage to the NEUTRAL detent position. Apply liberal amount of lubricant to inner diameter of screw recess. a a - Screw recess 16566 34 Tube Ref No. Description Special Lubricant 101 O-Rings and Seals Installation Inner diWhere Used ameter of screw recess Part No. 92-802865A1 1. Ensure that all O-rings and seals are installed properly and replaced as needed. NOTE: Replacement of all O-rings and seals helps ensure proper sealing from contamination. Page 3B-150 90-865612020 FEBRUARY 200

Driveshaft Housing Disassembly, Repair, and Reassembl\ a. O-rings in the driveshaft housing: Apply adhesive to the shift linkage O-ring groove of the driveshaft housing before installation. a a 15676 a - Shift linkage O-ring b Apply adhesive to the water passage O-ring groove of the driveshaft housing before installation. 15561 a a a - Water passage seal Tube Ref No. Description Where Used Part No, 27 Bellows Adhesive O-rings 92-86166Q1 90-865612020 FEBRUARY 200 Page 3B-15 Driveshaft Housing Disassembly, Repair, and Reassembl\ c. Back cover assembly: apply lubricant in the groove of back cover housing before installing O-ring. a 15323 b a - Back cover sealTube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Back cover O-ring grooves 92-802865A1 d. Top cover assembly: apply lubricant to the O-ring before installing. a 15328 a a - Top cover O-ring Tube Ref No. Description Where Used Part No. High Performance Gear Lubricant Top cover O-ring 92-802854A1 87 Page 3B-152 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ e. Insert shift shaft seal into driveshaft housing a 15330 a - Shift shaft seal Top Cover Assembly Installation 1. Install driveshaft housing top cover. a b a 15679 a - Driveshaft housing top cover b - Screws NOTE: Bravo X series use the ribbed top cover with special bolts and washers. b a 15326 b c a - Bravo X series top cover c - Washers b - Bolts 90-865612020 FEBRUARY 2006 Page 3B-15 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2. Torque bolts a 15911 Standard Bravo shown a - Torque wrench Description Nm All Bravo models driveshaft housing top cover bolts 27 Back Cover Assembly Installation 1. Install driveshaft housing back cover and hand start bolts. lb. in. lb. ft. 20 a 15322 a - Back cover Page 3B-154 90-865612020 FEBRUARY 200 Driveshaft Housing Disassembly, Repair, and Reassembl\ 2. Tighten bolts in an even pattern until cover is flush against the driveshaft housing a b 15321 a - Back cover b - Bolts 3. Torque the bolts. NOTE: To avoid damage to the cover, tighten bolts evenly until the cover is flush against the driveshaft housing before finally tightening the screws. a a - Torque wrench 15912 Description All Bravo models driveshaft housing back cover bolts Nm 27 lb. in. lb. ft. 20 90-865612020 FEBRUARY 2006 Page 3B-15 Driveshaft Housing Disassembly, Repair, and Reassembl\ Notes8 Page 3B-156 90-865612020 FEBRUARY 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Bravo Sterndrive Section 3C - Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Table of Contents Bravo Sterndrive Propeller Removal..............3C-2 Bravo One Models...................................3C-2 Bravo Two Models..................................3C-4 Bravo Three Models................................3C-5 Drain Gearlube From Sterndrive.....................3C-7 Inspect seal...3C-8 Bravo Sterndrive Removal From Boat............3C-8 Bravo One Driveshaft Housing and Gear Housing Separation..3C-12 Inspection...3C-13 Bravo Two Driveshaft Housing and Gear Housing Separation..3C-13 Inspection...3C-14 Bravo Three Driveshaft Housing and Gear Housing Separation..3C-14 Inspection...3C-15 Cleaning the Gear Lube Monitor System.......3C-15 3 C 90-865612031 AUGUST 2007 Page 3C- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Lubricant, Sealant, Adhesives Tube Ref No. 87 Description High Performance Gear Lubricant Where Used Gear lube monitor Part No. 92-858064K01 Special Tools Propeller Nut Tool 91-805457T 1 10677 Aids in the removal and installation of the front propeller nut. Bravo Sterndrive Propeller Removal ! WARNING Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting ! WARNING Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Bravo One Models NOTE:Bravo One XR models do not use the tab washer. 1. If Equipped, straighten the bent tabs of the tab washer on the propeller shaft. ecdba4750 a - Prop d - Tab bent down b - Tab washer e - Propeller nut c - Drive sleeve adapter Page 3C-2 90-865612031 AUGUST 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 2 Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. abc4826 a - Wood block c - Propeller nut under socket b - Propeller 3. Turn the propeller shaft nut counterclockwise and remove the nut. 4. Slide the propeller and the attaching hardware from the propeller shaft. abcdefg5301 Bravo One models a - Propeller shaft splines e - Drive sleeve adapter b - Forward thrust hub f - Tab washer c - Flo-Torque II drive hub g - Propeller nut d - Propeller 90-865612031 AUGUST 200 Page 3C- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation abcdefg19816e - Washer f - Washer g - Propeller nut Bravo One XR models a - Propeller shaft b - Propeller hub insert with snubbers c - Propeller d - Thrust washer Bravo Two Models 1. Straighten the bent tabs of the tab washer on the propeller shaft. ecdba4750 a - Prop d - Tab bent down b - Tab washer e - Propeller nut c - Drive sleeve adapter Page 3C-4 90-865612031 AUGUST 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 2 Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. abc4826 a - Wood block c - Propeller nut under socket b - Propeller 3. Turn propeller shaft nut counterclockwise to remove nut. 4. Slide the propeller and attaching hardware from the propeller shaft. 8566abcfde Bravo Two a - Propeller shaft splines d - Spline washer b - Forward thrust hub e - Tab washer c - Propeller f - Propeller nut Bravo Three Models 1 Place a block of wood between the propeller blade and the sterndrives anti-ventilation plate. 2 Remove the bolt and washers securing the propeller shaft anode. 90-865612031 AUGUST 200 Page 3C- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Page 3C-6 90-865612031 AUGUST 2007 3. Remove the propeller shaft anode. b d c e f 19058 a a - Propeller b - Propeller shaft nut c - Propeller shaft anode d - Propeller shaft anode screw e - Flat washer f - Star washer 4. Turn aft propeller shaft nut counterclockwise to remove nut. 5. Slide propeller and thrust hub off propeller shaft. 6. Use the Propeller Nut Tool, turn the front propeller shaft nut counterclockwise and remove the nut. Propeller Nut Tool 91-805457T 1 7. Slide the propeller and the thrust hub off the propeller shaft. e f a b c d 5304 g h i j Bravo Three a - Aft propeller nut b - Aft propeller c - Aft propeller thrust hub d - Front propeller nut e - Front propeller f - Front propeller thrust hub g - Propeller shaft anode screw h - Flat washer i - Star washer j - Propeller shaft anode Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation Drain Gearlube From Sterndrive NOTICE Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required. 1. Bravo One: Trim the sterndrive to the full DOWN/IN position. 2. Remove the fill and drain plug. 14620a b Bravo One model a - Fill and drain plug b - Sealing washer 3. Bravo Two and Bravo Three: Trim the sterndrive to the full UP/OUT position. 4. Remove the fill and drain plug. a b 14621a b 19777 Bravo Two model Bravo Three model a - Fill and drain plug b - Sealing washer 90-865612031 AUGUST 2007 Page 3C- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 5. Remove the oil vent screw and seal ba19066 a - Oil vent screw b - Seal Inspect seal 1. 2. Inspect the seals for nicks,tears and flattness, replace if damaged. Inspect the gearlube for water. Bravo Sterndrive Removal From Boat IMPORTANT: In the following procedure, the shift cables are connected to the sterndrive shift plate and the remote control box. 1. Move the remote control handle to neutral gear position. ! CAUTION Avoid injury during sterndrive disassembly and assembly. Heavy sterndrive components may separate suddenly and forcefully. Properly support the U-joint-yoke assembly while removing and installing the pinion gear nut. ! CAUTION Heavy sterndrive components may come apart suddenly and forcefully, resulting in possible injury. Properly support the power package during disassembly. Remove the outer propeller shaft and the inner propeller shaft separately. ! CAUTION Improperly removing or installing the sterndrive can result in injury. Use a hoist, or other approved lifting device, to properly secure and guide the sterndrive. IMPORTANT: Disconnect the speedometer hose fitting from the driveshaft housing prior to removing the sterndrive to prevent damage to the fitting. 2. Press the sterndrive trailer button on the control handle to raise the sterndrive to trailer (full-up) position. Page 3C-8 90-865612031 AUGUST 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 3 Locate the area between the gimbal housing and the sterndrive on top of the transom end of the anti-ventilation plate. a b c 31769 a - Sterndrive at trailer (full-up) c - Gimbal housing position b - Speedometer hose 4 Rotate the speedometer connector counter clockwise and lift upward to remove. a a 5300 a - Speedometer connector handle 5 Press the sterndrive trim switch on the control handle to lower the sterndrive to in/down position. Do not allow the sterndrive skeg to contact the ground. ! WARNING Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components. 7. Remove the sterndrive propeller. Refer to Bravo Propeller Removal. 8. Remove the trim cylinders: 90-865612031 AUGUST 200 Page 3C- Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation a. Remove the aft power trim cylinder mounting hardware abcc a - Anchor pin b - Flat washer (2) large I.D c - Bushing (4) d - Locknuts (2) b. Remove the front power trim cylinder mounting hardware and the trim clyinders. cgfde10432e - Plastic caps (2) f - Flat washer (2) small I.D. g - Trim cylinder acb bed31772f a - Flat washer (2) small I.D. b - Locknut (2) c - Trim cylinder d - Anchor pin e - Bushing (4) f - Continuity wire c. Retain the hardware for reassembly. ! CAUTION Improperly removing or installing the sterndrive can result in injury. Use a hoist, or other approved lifting device, to properly secure and guide the sterndrive. 9. Remove the sterndrive fasteners: a. Secure the sterndrive with a suitable lifting device. Page 3C-10 90-865612031 AUGUST 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation b. Remove the locknuts and washers holding the sterndrive to the transom assembly. 31770aaaaaa a - Locknuts NOTE:Toeaseremoval,slightlyraisethesterndrivesoitisnotrestingonthegimbal housing studs and pull straight out of gimbal housing. NOTE:Ifthesterndriveseemsstuck,tothegimbalhousing,holdtheaftendofthe sterndrive and slightly rock the sterndrive in a up-and-down motion. c. Carefully pull the sterndrive from the gimbal housing by holding the aft end of the sterndrive and pull the sterndrive straight out. Make sure the shift cable linkage jaws open and release the shift cable end as you pull the sterndrive from the bell housing. abb cd 31766 31767 a - Shift cable end (released from c - Sterndrive jaws) d - Transom Assembly b - Shift linkage jaws (open) IMPORTANT: Do not use a sharp object to pry the sterndrive from the bell housing; doing so can damage the mating surface of the bell housing and sterndrive. 90-865612031 AUGUST 2007 Page 3C-1 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation ravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation d. If a bell housing stud backs out with the nut, retain and reinstall after sterndrive is removed. Bravo One Driveshaft Housing and Gear Housing Separation 1. Install the sterndrive to a stand and properly secure. 2. Remove the rubber plug. ab20664a -Rubber plug b - Anode plate 3. Loosen the screw of the anode plate. ab18946 a -Socket on a 1/2 in.bolt b -Anode plate Page 3C-12 90-865612031 AUGUST 2007 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 4. Remove the anode plate a21202 a - Anode plate 5. Remove the six nuts and washers. 6. Remove the bolt from anodic cavity. a20662bc a - Nuts and washers (3 each side) b - Bolt (1) (located in the anode cavity) c - Screw for anode plate 7. Remove the gear case from driveshaft housing by pulling the driveshaft housing straight up. Inspection 1. 2. 3. 4. Inspect the rubber plug, replace if damaged. Inspect the anodic plate, replace if required. Inspect all studs, bolts and washers, replace if damaged. Inspect nuts, replace if damaged. Bravo Two Driveshaft Housing and Gear Housing Separation 1. Install the sterndrive to a stand and properly secure. 90-865612031 AUGUST 2007 Page 3C-1 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 2. Remove the bolt aft of the anode plate. ba21426 a - Anode plate b - Bolt removed 3. Remove the six nuts and washers. abc21424 a - Nuts and washers (3 each side) c - Screw for anode plate b - Bolt and washer (1) 4 Remove gear case from driveshaft housing by pulling the driveshaft housing straight up. Inspection 1. Inspect the rubber plug, replace if damaged. 2. Inspect the anodic plate, replace if required. 3. Inspect all studs, bolts and washers, replace if damaged. 4. Inspect nuts, replace if damaged. Bravo Three Driveshaft Housing and Gear Housing Separation 1. Install the sterndrive to a stand and properly secure. 2. Remove the rubber plug. Page 3C-1 90-865612031 AUGUST 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 3 Remove the front anode plate ab 21551 a - Rubber plug b - Front anode plate 4 Remove the bolt from the front anodic cavity. 5 Remove the six nuts and washers. 6 Remove the gear case from the driveshaft housing by pulling the driveshaft housing straight up. 21548abc a - Nuts and washers (3 each side) c - Screw for anode plate b - Bolt (1) (located in the anode cavity) Inspection 1. Inspect the anode plates, replace if required. 2. Inspect all studs, bolts and washers, replace if damaged. 3. Inspect nuts, replace if damaged. Cleaning the Gear Lube Monitor System NOTICE Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required. 1. To prevent contamination, clean the gear lube monitoring system if : � Water is visible at the bottom of the gear lube monitor. � Gear lube oil appears discolored. � Metal particles are visible in the gear lube. 90-865612031 AUGUST 200 Page 3C-1 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 2. Remove the retaining strap and the gear lube monitor from the bracket . a. Remove the cap and tip the monitor upside down over a suitable container until all remaining gear lube drains from the monitor. abcb31322 Gear lube monitor in bracket a - Gear lube monitor c - Retaining strap b - Bracket b. Install the monitor in the bracket. 31323 Gear lube monitor in bracket 3. Press the dribble valve until all remaining gear lube drains from the system. a 21440 a - Dribble valve Page 3C-16 90-865612031 AUGUST 200 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 4 Fill the gear lube monitor with specified gear lube to the "OPERATING RANGE" mark. Do not overfill. ba a - Gear lube b - Gear lube monitor 31771c c "OPERATING RANGE" mark Tube Ref No. Description Where Used Part No. High Performance Gear 87 Gear lube monitor 92-858064K01 Lubricant 5. To purge air from the system depress the dribble valve until the gear lube appears. a 21440 a - Dribble valve 6. If the gear lube monitor is below the "OPERATING RANGE" mark, fill the gear lube monitor to the "OPERATING RANGE" mark with specified gear lube. Do not overfill. 7. Install the gear lube monitor cap. Ensure that the rubber gasket is inside the monitor cap. Do not overtighten. 90-865612031 AUGUST 200 Page 3C-1 Bravo Sterndrive Removal, Pre-Disassembly Inspection, and Driveshaft Housing and Gear Housing Separation 8. 31765acb a - Gear lube b - "OPERATING RANGE" line c - "ADD" line Tube Ref No. 87 Description High Performance Gear Lubricant Where Used Gear lube monitor Part No. 92-858064K01 Page 3C-18 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Bravo Sterndrive Section 3D - Bravo One Gear Housing Disassembly, Repair, and Reassembly Table of Contents Specifications...3D-6 Bearing Preloads......................................3D-6 Gear Backlash ....3D-6 Pinion Gear Clearance............................3D-6 Bravo One Gear Housing�Drive Gear Ratio (Teeth Per Gear)....................................3D-6 Torque Specifications.............................3D-6 Feeler Gauge Measurement.....................3D-7 Bravo One Gear Housing Exploded View........3D-8 Gear Housing 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Removal........3D-27 Gear Housing and Assemblies Teardown Inspection and Repair...................................3D-29 Gear Housing Inspection and Cleaning ....3D-29 Gear Housing Repair Painting Procedure ....3D-30 Driveshaft Assembly Repair ....3D-31 Propeller Shaft Inspection.....................3D-34 Propeller Shaft Bearing Replacement....3D-35 Pinion Bearing Removal........................3D-35 Pinion Bearing Installation.....................3D-36 Front Driven Gear and Bearing Repair...3D-38 Front Driven Gear Bearing Cup Installation ....3D-39 Bearing Carrier Repair...........................3D-41 Bearing Carrier Repair�XR Models......3D-45 Gear Housing Shimming and Reassembly....3D-45 Final Checklist.......................................3D-45 Driveshaft Lower Bearing Cup and Shims Installation..3D-46 Front Driven Gear and Bearing Installation ....3D-47 Driveshaft and Pinion Gear Installation ....3D-47 Driveshaft Upper Bearing Preload Cup and Tab Washer Installation...............................3D-49 Driveshaft Bearing Preload Measurement ....3D-50 Pinion Gear Height Measurement..........3D-52 Load Ring, Thrust Washer, and O-ring Installation...3D-55 Propeller Shaft Assembly Installation.....3D-56 Bearing Carrier Installation....................3D-56 Bearing Carrier Installation�XR Models ....3D-57 Tab Washer and Bearing Carrier Retainer Nut Installation...3D-59 Tab Washer and Bearing Carrier Retainer Nut Installation�XR Models........................3D-60 Driven Gear Backlash Measurement and Shimming...3D-61 Final Assembly and Overall Gear Housing Preload...3D-63 Oil Passage Quad Ring and Water Passage O-ring Installation.................................3D-65 Bravo One Gear Housing�Driveshaft Housing Installation...3D-65 3 D 90-865612031 AUGUST 2007 Page 3D- Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Lubricant, Sealant, AdhesiveX 4 7 Tube Ref No. Description Needle Bearing Assembly Lubricant Loctite 271 Threadlocker 19 Perfect Seal 27 Bellows Adhesive 34 Special Lubricant 101 87 High Performance Gear Lubricant Special Tools 95 Clamp plate 2-4-C with Teflon Where Used Part No. Pinion bearing roller needle bearings 92-802868A1 O.D. of the outer oil seal for the bearing carrier O.D. of the inner oil seal for the bearing 92-809819 carrier Threads of pinion screw Bearing carrier mating surfaces 92-34227-1 Bearing carrier mating surface O.D. of seal Gear housing groove for the water passage O-ring 92-86166Q1 Gear housing groove for the oil passagX quad rinZ Bearing carrier retaining nut threadX 92-802865Q02 Bearing carrier retaining nuY I.D. of the bearing racX I.D. of small tapered roller bearinZ I.D. of large tapered roller bearinZ I.D. of the tapered roll bearing. 92-858064K01 Pinion bearing race outer diameter I.D. of new bearing Bearing cuU Bearing carrier seaO Bearing carrier seals and spaces 92-802859A1 between seals 91-43559T Installs onto the gear housing while separated from the driveshaft housing and holds a preload while checking the the gear backlash and bearing preload. 10486 Dial indicator adapter 91-83155 Attaches the dial indicator to the gearcase when checking backlash. 2999 Dial indicator 91-58222A1 Measures gear backlash and pinion gear location. 9479 Page 3D-2 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Bearing carrier retainer nut wrench 91-61069T 29487 Installs and removes the bearing carrier retainer nuts. Bearing carrier retainer nut wrench 91-840393 Installs the bearing carrier retainer nut on heavy duty propeller shafts. 9449 Puller Bar 91-90338A1 1045791-90339 Aids in the removal of the bearing carrier. Propeller shaft/driveshaft adapter 91-61077T 10805 Provides a wrench surface to turn the propeller shaft or the driveshaft. Slide hammer 91-34569A 1 Aids in the removal of various engine components. Use with puller jaws. 6761 Universal puller plate 91-37241 8505 Removes bearings from gears and the driveshaft. Driver rod 91-37323 Used in pinion gear and pinion bearing installation. 25431 Bearing driver 91-63638 1 Removes and installs the lower driveshaft pinion bearing. 10477 90-865612031 AUGUST 2007 Page 3D- Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Pilot washer 91-36571T Used in pinion gear and pinion bearing installation. 29490 Bearing driver 91-89867T 10478 Aids in the installation of the driveshaft needle bearings. Seal driver 91-813653T 10852 Installs the U-joint oil seal into the bearing carrier. Also used to pilot the puller rod for the installation of the gear housing needle bearing. Bearing Removal and Installation kit 91-31229A7 Installs and removes the bearings in all gearcases. 91-31229A7 tool assembly includes the following components: 11-24156 Hex nut 12-34961 Washer 91-15755T Bearing carrier 91-29310 Plate 91-29610 Pilot plate 91-30366T1 Mandrel 91-31229 Puller shaft 91-32325T Driver head 91-32336 Driver needle bearing 91-36379 Puller/Head gear 91-36569T Driver head 91-36571T Pilot washer 91-37292 Roller bearing 91-37311 Driver head 91-37312 -Driver head 91-37323 Driver head rod 91-37324 Pilot washer 91-38628T Puller/Driver head 91-52393 Driver needle bearing 91-52394 Head pull rod Bearing cup driver 91-31106T 2966 Installs the driven gear bearing cup. 8882 Page 3D-4 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Guide insert tool 91-805473 Inserts into the Bearing cup driver (91-31106T) when installing the front driven gear bearing cup. 20864 Guide plate 91-816243 4481 Centers the rod used to drive in the forward gear bearing on a standard rotation gearcase, and the reverse gear bearing on a counter rotation gearcase. Bearing seal and cup driver 91-89865 Aids in the installation of the bearing carrier seals and bearing cup. Bearing Carrier Oil Seal Installer 91-840385 10467 Installs the needle bearing and oil seals into the bearing carrier. 10698 Bearing cup driver 91-67443T Installs the driveshaft bearing cup into the gear housing, and the bearing cup into the bearing carrier. 10838 Torque wrench, lb. in. 91-66274 Dial type torque wrench that sets torque from 9 to 150 lb. in.; 3/8 in. drive. 10829 Driveshaft Pinion Gear Shimming Tool 91-42840T Assists in determining the driveshaft pinion gear shims. 10586 90-865612031 AUGUST 2007 Page 3D- Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Bearing Carrier Installation Tool 91-840388 9518 Installs the bearing carrier on heavy duty propeller shafts. Backlash indicator rod 91-53459 Aids in checking gear backlash. 10452 Specifications Bearing Preloads NOTE:DOES NOT include 0.3�0.6 Nm (3�5 lb. in.) on the driveshaft. A bearing is used if spun once under load. DescriptioS Driveshaft bearinZ Propeller shaft bearingX Checked at propeller shaft (new bearings) Propeller shaft bearingX Checked at propeller shaft (used bearings) Gear Backlash Description Gear backlash Pinion Gear Clearance DescriptioS Pinion gear clearancX Bravo One Gear Housing�Drive Gear Ratio (Teeth Per Gear) Bravo One Gear Housing Standard Bravo One and Bravo One X series Bravo One XR Torque Specifications Drive Gear RatiR 1.36: 1.50: 1.65: 1.26: 1.35: 1.50: Drive Gear Teeth 15 15 15 17 15 15 Nm lb. in. 0.3�0.5 3�5 0.9�1.14 8�12 0.6�0.9 5�8 mm in 0.304� 0.012. 0.381 0.01 mm in 0.635 0.02 Driven Gear Teet[1 1 1 1 1 1 NOTE:Securely tighten all fasteners not listed below Page 3D-6 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Description Pinion screw Clamp plate Rolling preload of driveshaft Gear housing to driveshaft housing nuts and bolts Anode plate bolt Propeller locknut Feeler Gauge Measurement 1. To properly check gear location: NR 6 4 0.3�0. 4 2 7 lb. in. lb. ft. 45 35 3�5 35 20 55 a Position the gear with at least two full teeth centered on the gauging surface. One full tooth must be on each side of the gauging surface center line. Insert a 0.64 mm (0.025 in.) feeler gauge between a tooth and the gauging surface. b Slightly rotate the shimming tool until one side of the gauging surface contacts the feeler gauge and a slight drag is felt on the feeler gauge. c Without moving the shimming tool, remove the feeler gauge and re-insert it between the other tooth and the gauging surface. 31301c baa bb a - Feeler Gauge b - Shimming tool c - Gear teeth centered on gauging surface 2 If the feeler gauge can be inserted with only a slight drag, the shimming is correct. 3 If the feeler gauge inserts with no drag, repeat Steps 1., a., b., and c. with progressively thicker feeler gauges until the feeler gauge can be inserted with only a slight drag. 4 If the feeler gauge cannot be inserted, repeat Steps 1., a., b., and c. with progressively thinner feeler gauges until the feeler gauge can be inserted with only a slight drag. 90-865612031 AUGUST 200 Page 3D- Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Bravo One Gear Housing Exploded VieZ 1234567884591011121346471414151617181920212223242526272829303132333435363738394041424344213014849 Page 3D-8 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 1 - Gear housing assembly 2 - Stud 3 - Water passage O-ring 4 - Oil quad ring seal 5 - Speedometer passage seal 6 - Roller bearing 7 - Anodic plate 8 - Lockwasher 9 - Screw 10 - Shim 11 - Bearing cup and tappered roller bearing 12 - Driveshaft assembly 13 - Bearing race 14 - Tappered roller bearing and bearing cup 15 - Tab washer 16 - Shim 17 - Spacer 18 - O-ring 19 - Coupling assembly 20 - Retaining ring 21 - Driven gear 22 - Washer 23 - Screw 24 - Shim 25 - Bearing cup and tappered roller bearing Gear Housing Disassembly Gear Housing Preparation 26 - Propeller shaft 27 - Washer 28 - Tappered roller bearing and bearing cup 29 - Load ring 30 - Thrust washer 31 - Bearing carrier assembly 32 - O-ring 33 - Inner oil seal and outer oil seal 34 - Fill and drain plug 35 - Seal 36 - Anode assembly 37 - Screw 38 - Lockwasher 39 - Tab washer 40 - Retaining nut 41 - Drive sleeve 42 - AFT adaptor 43 - Tab washer 44 - Propeller nut 45 - Screw 46 - Washer 47 -Nut 48 - Thrust hub 49 - Pinion gear For complete disassembly of the gear case: Secure the gear case tightly so that it will not move when loosing a torque of 271 Nm (200 lb. ft.). 1. Install the gear housing in a fixture or stand. 2. Properly secure the gear housing. 90-865612031 AUGUST 2007 Page 3D- Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Oil Passage Quad Ring and Water Passage O-ring RemovaO 1. Remove the oil passage quad ring a 16057 a - Oil passage quad ring 2. Remove the water passage O-ring. a 18357 a - Water passage O-ring WATER PASSAGE O-RING AND OIL PASSAGE QUAD RING INSPECTION 1. Inspect the oil passage quad ring for nicks or cuts. Replace if you detect damage. 2. Inspect the water passage O-ring for flatness cuts or nicks. Replace if you detect damage. Clamp Plate Tool Installation IMPORTANT: Failure to use appropriate tools when installing or removing components can result in product damage. Always use the correct tools in the specified manner when performing these procedures. IMPORTANT: The clamp plate tool maintains the position of the driveshaft and the bearings, preventing damage to the internal components when disassembling the sterndrive. 1. Install the clamp plate tool on the gear housing. Page 3D-10 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2. Place two (2) washers and one (1) nut on each stud. Tighten securely a a - Clamp plate b - Nuts abc18377 c - Washers (4) NOTE:The clamp plate tool must sit flat against the gear housing to be correctly positioned. aab 15996 16000 Correctly positioned Incorrectly positioned a - Clamp plate b - Incorrect gap Clamp plate 91-43559T Propeller Shaft Runout Test NOTE:Do not damage the painted surface of the sterndrive. 1. Perform the propeller shaft runout test on the propeller shaft. 90-865612031 AUGUST 2007 Page 3D-1 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ a. Position the dial indicator tool on the gear housing with the dial indicator tip touching the propeller shaft. abc21164 Set up for the propeller shaft runout test a - Propeller shaft c - Dial indicator adapter kit tool b - Dial indicator tool Dial indicator adapteU 91-83155 Dial indicatoU 91-58222A1 b Rotate the propeller shaft while observing the dial indicator. c If the runout is more than the maximum specification, a bent propeller shaft is indicated. Replace the propeller shaft. Propeller Shaft Runout Bravo One Models Maximum Specification Propeller shaft 0.178 mm 0.007 in. Anode Assembly Removal 1. Loosen and remove the anode screws and washers abc 18810 Bravo XR model shown, other Bravo models are similar a - Anode screw and washer c - Propeller shaft b - Anode Page 3D-1 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2. Remove the anode from the gear housing. Retain the anode and the attaching hardware. a 18811 Bravo XR model shown, other Bravo models are similar a - Anode INSPECTION 1. Inspect the condition of the anode for deterioration. 2. Replace the anode if it has deteriorated more than fifty percent. 3. Inspect the screws and lockwashers for damage. Replace as needed. Bearing Carrier Retainer Nut and Tab Washer Removal 1. Using a screwdriver, bend the tabs of the tab washer away from the retainer nut. ab 18812 a - ScrewdriveU b - Tab washer 2 Use the bearing carrier retainer nut wrench tool and a breaker bar to loosen the retainer nut. ab 18813 a - Bearing carrier retainer nut wrench b - Breaker bar tool 90-865612031 AUGUST 200 Page 3D-1 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Bearing carrier retainer nut wrench 91-61069T 3. Remove the bearing carrier retainer nut. a 18814 a - Bearing carrier retainer nut 4. Remove the tab washer. a 18815 a - Tab washer BEARING CARRIER RETAINER NUT AND TAB WASHER INSPECTION IMPORTANT: Protect the gear housing. Using a retainer nut with thread damage can cause damage to the gear housing threads. 1. Inspect the bearing carrier retainer nut threads. 2. Replace the bearing carrier retainer nut if you detect thread damage. 3. Inspect the tab washer for damage. Replace as needed. Page 3D-14 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Bearing Carrier Retainer Nut and Tab Washer Removal�XR Models 1. Using a screwdriver, bend the tabs of the tab washer away from the bearing carrier retainer nut. ab 18816 a - ScrewdriveU b - Tab washer 2 Use the bearing carrier retainer nut wrench tool and a breaker bar to loosen the bearing carrier retainer nut. ab 18817 a - Bearing carrier retainer nut wrench tool Bearing carrier retainer nut wrench 91-840393 3. Remove the bearing carrier retainer nut. a 18818 a - Bearing carrier retainer nut 90-865612031 AUGUST 200 Page 3D-1 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 4. Remove the tab washer a 18819 a - Tab washer BEARING CARRIER RETAINER NUT AND TAB WASHER INSPECTION IMPORTANT: Protect the gear housing. Using a retainer nut with thread damage can cause damage to the gear housing threads. 1. Inspect the bearing carrier retainer nut threads. 2. Replace the bearing carrier retainer nut if you detect thread damage. 3. Inspect the tab washer for damage. Replace as needed. Bearing Carrier Removal 1. Position the puller bar tool to hold the bearing carrier. Attach the first notch of the puller bar to the puller bar handle. Position the puller bar handle on the end of the propeller shaft. 2. Pull the puller bar handle back to move the bearing carrier up and out of gear housing. 3. Reposition the puller bar using different notches as the bearing carrier moves up. acbd18822 a - Puller bar handle c - Propeller shaft b - Puller bar tool d - Bearing carrier Puller Bar 91-90338A1 Page 3D-16 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 4 Remove the bearing carrier ab 18823 a - Bearing Carrier BEARING CARRIER INSPECTION 1. Check the bearing carrier for signs of corrosion, especially on the gear housing to bearing carrier mating surfaces. 2. Replace the bearing carrier if you detect corrosion. 3. The condition of the propeller shaft tapered roller bearing cup is an indication of the condition of a tapered roller bearing on the propeller shaft. Replace the bearing and cup if the cup is pitted, grooved, scored, worn, uneven, discolored from overheating, or has embedded metal particles. Bearing Carrier Removal � XR Models 1. Modify the puller bar tool to hold the bearing carrier. a20614b Puller bar shown before and after modificatioS a - Puller bar modified for XR models b - Puller bar handlX 2 Position the puller bar tool to hold the bearing carrier. Attach the first notch of the puller bar to the puller bar handle. Position the puller bar handle on the end of the propeller shaft. 3 Pull the puller bar handle back to move the bearing carrier up and out of gear housing. 90-865612031 AUGUST 200 Page 3D-1 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 4. Reposition the puller bar using different notches as the bearing carrier moves up acbd 18824 a - Puller bar handle c - Propeller shaft b - Puller bar tool d - Bearing carrier Puller Bar 91-90338A1 5. Remove the bearing carrier. a 18825 a - Bearing carrier BEARING CARRIER INSPECTION 1. Check the bearing carrier for signs of corrosion, especially on the gear housing to bearing carrier mating surfaces. 2. Replace the bearing carrier if you detect corrosion. 3. The condition of the propeller shaft tapered roller bearing cup is an indication of the condition of tapered roller bearing on propeller shaft. Replace the bearing and the cup if cup is pitted, grooved, scored, worn, uneven, discolored from overheating, or has embedded metal particles. Page 3D-18 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Propeller Shaft Assembly Removal 1. Pull the propeller shaft assembly straight up to remove from gear housing. ab cd 18826 Bravo Standard and X series model Bravo XR model a - Propeller shaft c - Propeller shaft (XR model) b - Tapered roller bearing d - Tapered roller bearing (XR model) PROPELLER SHAFT ASSEMBLY INSPECTION 1. Inspect for damaged or twisted splines. 2 Inspect the surface of the shaft where the bearing carrier oil seal lips contact the shaft. Oil seals will have to be replaced if you detect any grooves. 3 Inspect the tapered roller bearing for pitting, chipped or broken gear teeth, and excessive or uneven wear. abca18827a - Propeller splines b - Tapered roller bearing c - Contact surface for bearing carrier oil seals O-Ring, Thrust Washer, and Load Ring Removal 1. Remove the O-ring from the gear housing. a 18872 a - O-ring 90-865612031 AUGUST 200 Page 3D-1 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2. Remove the thrust washer from the gear housing a 18873 a - Thrust washer 3. Remove the load ring from the gear housing. a 18874 a - Load ring O-RING, THRUST WASHER, AND LOAD RING INSPECTION 1. Inspect the O-ring for damage including flatness, tears, and nicks. 2. Check the thrust washer for damage. Normally the thrust washer will not be damaged. 3. Replace all damaged parts. 4. Retain the load ring to use when checking the preassemble specification. The load ring is not reused for final reassembly 5. Use a new load ring for final assembly Page 3D-20 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Pinion Gear Screw Removal 1. Temporarily reinstall the bearing carrier retainer nut in the gear housing to protect the housing threads. a18831 a - Bearing carrier retainer nut 2 Remove driveshaft pinion screw and washer. a. Place a breaker bar and socket or place a wrench on the pinion screw. abc 18832 a - Pinion gear c - Driven gear b - Pinion screw b. Install the driveshaft adapter tool to the driveshaft 90-865612031 AUGUST 200 Page 3D-2 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ c. Place a breaker bar and socket on the driveshaft adapter tool. Turn COUNTERCLOCKWISE to loosen the pinion screw. dcba 18833 a - Breaker bar and socket c - Driveshaft b - Driveshaft adapter tool d - Tool on the pinion screw Propeller shaft/driveshaft adapter 91-61077T PINION SCREW AND WASHER INSPECTION 1. Inspect the pinion screw and washer for damage. Replace as needed. Clamp Plate Tool Removal 1. Remove the nuts, washers, and clamp plate from the gear housing. abc a - Clamp plate b - Nuts (2) a 16010 c - Washers (4) Clamp plate 91-43559T Page 3D-22 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Driveshaft Preload Spacer Removal 1. Remove the O-ring and the spacer. a b 19473 a - O-ring b - Spacer 2. 3. 4. Remove the shims and the tab washer. Measure the shim thickness. Record the shim thickness. ab 19472 a - Shims b - Tab washer DRIVESHAFT PRELOAD SPACER INSPECTION 1. Inspect O-ring for cuts and nicks. Replace if damaged. 2. Inspect the spacer, shims, and the tab washer for damage. Replace damaged parts. Driveshaft and Pinion Gear Removal 1. Support the pinion gear while pulling the driveshaft straight up from the gear housing. NOTE:Be careful not to lose the rollers from the driveshaft pinion bearing if they should drop during driveshaft removal. aca18870b a - Driveshaft c - Preload bearing cup b - Driveshaft pinion gear 90-865612031 AUGUST 2007 Page 3D-2 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2 Remove the pinion gear a 18869 a - Pinion gear DRIVESHAFT AND PINION GEAR INSPECTION AND CLEANING ! WARNING Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air. 1 Inspect the pinion gear for pitting, chipped or broken teeth and excessive or uneven wear. 2 The condition of the tapered bearing cups in the driveshaft is an indication of the condition of the tapered roller bearings on the driveshaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn uneven, discolored from overheating, or has embedded metal particles. 3 The condition of the bearing surface on the driveshaft where it meets the needle bearing is an indication of the condition of needle bearings. Replace the needle bearing and sleeve if pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or has embedded metal particles. 4 Inspect splines for worn or twisted condition. Replace the driveshaft if either condition exists. 5 Clean all parts that are to be reused with solvent. Dry the parts completely using compressed air, being careful not to spin the bearings. Page 3D-2 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ NOTE:Roller needle bearings has been removed from the bearing race for clarity d - Tapered roller bearings e - Bearing surface f - Splines afbcefd15980a - Roller needle bearings (19) b - Driveshaft assembly c - Preload bearing cup PINION GEAR BEARING NOTE:The needle bearings must be in the pinion bearing race if the pinion bearing is removed. Now that the driveshaft is removed the roller needle bearings can easily fall from the bearing race. � A cardboard piece can be inserted to keep all 19 roller needle bearings positioned in bearing race, and can easily be removed just before driveshaft is installed. � Needle bearings can be removed from pinion bearing race, and reinstalled later during reassembly of the gear housing. 16014cbbdaa - Cardboard piece b - Roller needle bearings c - Front driven gear d - Pinion bearing Driveshaft Lower Bearing Cup and Shims Removal 1. Position the slide hammer puller tool so that the jaws are holding the edge of the bearing cup and are not touching the gear housing. 2. Pull the bearing cup from the gear housing. 90-865612031 AUGUST 200 Page 3D-2 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 3. Remove the shims ab c 15981 a - Slide hammer puller c - Shims b - Bearing cup Slide hammer 91-34569A 1 4. Measure the shims and record the measurement for later reassembly. a20993 a - Micrometer DRIVESHAFT LOWER BEARING CUP AND SHIMS INSPECTION 1. Inspect the bearing cup for pitting, grooves, scoring, uneven wear, discoloration from overheating, spalling, or from metal particles embedded in the cups. Replace the tapered roller bearings and the cups if you detect damage. 2. Shims become damaged during removal of the bearing cup and therefore may not be reused. Measure the thickness of the shims and record for later reassembly. Discard the shims. Page 3D-26 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Driven Gear and Bearing Removal 1. Remove the front driven gear and the bearing from the gear housing. ba 18876 a - Front driven gear b - Bearing DRIVEN GEAR AND BEARING INSPECTION 1. Inspect driven gear for pitting, chipped or broken teeth, and excessive or uneven wear. If any of these conditions exist, replace both the gear-and-bearing assembly and the driveshaft pinion gear. NOTE:Inspect the bearing cup of the tapered roller bearing inside the gear housing. 2. Replace the tapered roller bearing and the bearing cup if the tapered roller bearing is pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or has metal particles embedded in the cup. Driven Gear Bearing Cup Removal NOTE: Pulling the bearing cup with the slide hammer puller tool will damage the shims. Do not reuse the shims. 1. Remove the bearing cup and the shims using the slide hammer puller. a 18891 a - Slide hammer puller tool Slide hammer 91-34569A 1 90-865612031 AUGUST 2007 Page 3D-2 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2. Remove the driven gear bearing cup a 18892 a - Driven gear bearing cup 3. Remove the shims. a18894 a - Shims 4. Measure the shims and record the measurement for later reassembly. DRIVEN GEAR BEARING CUP INSPECTION 1. Inspect the bearing cup for pitting, grooves, scoring, uneven wear, discoloration from overheating, spalling, or for metal particles embedded in the cups. Replace the driven tapered roller bearing and cup if you detect damage. a18895 a - Driven gear bearing cup 2 Shims become damaged during removal of the bearing cup and therefore may not be reused. Measure the thickness of the shims for later reassembly and then discard the shims. Page 3D-2 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Gear Housing and Assemblies Teardown Inspection and Repair Gear Housing Inspection and Cleaning SPEEDOMETER WATER PASSAGE INSPECTION AND CLEANING 1. Inspect the pitot tube opening on the leading edge of the gear housing for any obstruction. 2. Clean the opening with a short piece of wire, if necessary. 3. If you remove the obstruction with wire, carefully reopen the tube using a 2 mm (5/64 inches) diameter drill bit. Do not drill beyond a depth of 62 mm (2�7/16 inches) . a 19358 a - Pitot tube opening SPEEDOMETER WATER PASSAGE SEAL REMOVAL 1. Pry off the speedometer water passage seal with a suitable tool. a 16837 a - Speedometer water passage seal 2. Inspect the speedometer water passage seal for nicks, cuts, or distortion. Replace if necessary. SPEEDOMETER WATER PASSAGE SEAL INSTALLATION 1. Apply adhesive to the outer diameter of the seal and install the seal in the speedometer water passage bore. 90-865612031 AUGUST 2007 Page 3D-2 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2. Ensure that the top edge of the seal is flush with the surface of the gear housing a a - Seal 16838 Tube Ref No. Description 27 Bellows Adhesive Where Used O.D. of seal Part No. 92-86166Q1 Gear Housing Repair Painting Procedure Complete the following procedure when refinishing the gear housing and the driveshaft housings. This procedure provides the most durable paint system available in the field. The materials we recommend are of high quality and approximate marine requirements. If you follow this procedure closely, the new painting job will compare favorably with a properly applied factory paint finish. We recommend materials available at a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each listed is sufficient to refinish several gear housings or driveshaft housings. 1. Wash the gear housing with a muriatic acid base cleaner to remove any type of marine growth and rinse with water. 2. Wash the gear housing with soap and water, and then rinse. 3. Sand the blistered area with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather all broken paint edges. 4. Clean the gear housing thoroughly with wax and grease remover (DX-330). 5. Where bare metal is exposed, spot repair surfaces with alodine treatment (DX-503) . IMPORTANT: Do not use any type of aerosol spray paints: the paint will not properly adhere to the surface nor will the coating be sufficiently thick to resist future blistering. 6 Mix epoxy chromate primer (DP-40) with an equal part catalyst (DP-401) according to the manufacturer's instructions, allowing a proper induction period for permeation of the epoxy primer and catalyst. 7 Allow a minimum of one hour drying time and no more than one week before top-coating the assemblies. ! WARNING Continuous exposure to airborne particles such as chemical vapors, dust, or spray can cause serious injury or death. Ensure that the work area is properly ventilated and wear protective eyeware, clothing, and respirators. 8 Use Ditzler Urethane DU9000 for Mercury Black and Ditzler Urethane DU33414M for Sea Ray White. Catalyze all three colors with Ditzler DU5 catalyst mixed in a 1:1 ratio. Reduce with solvents according to the instructions on the Ditzler label. 9. The type of spray gun being used will determine the proper reduction ratio of the paint. IMPORTANT: Do not paint the sacrificial trim tabs or anodes. 10. Using a spray gun, apply 1/2�1 ml. film thickness evenly. Allow five minutes for dying then apply another even coat of 1/2�1 ml. thickness. Page 3D-3 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ NOTE:This urethane paint dries to touch in a matter of hours, but remains susceptible toscratches and abrasions for days. Driveshaft Assembly Repair PRELOAD BEARING REMOVAL NOTE:You must replace the bearing assembly if you remove it from the driveshaft. Remove damaged tapered roller bearings. 1 Press the preload tapered roller bearing from the driveshaft using a universal puller plate tool to support the bearing. dbca abc15985 a - Tapered roller bearing c - Universal puller plate tool b - Driveshaft d - Press Universal puller platX 91-37241 PINION HEIGHT BEARING REMOVAL 1. Press the pinion height tapered roller bearing from the driveshaft using the universal puller plate tool to support the bearing. dbca abc15986 a - Pinion height roller bearing c - Universal puller plate b - Driveshaft d - Press Universal puller platX 91-37241 90-865612031 AUGUST 200 Page 3D-3 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ BEARING RACE REMOVAL 1. Press the bearing race from the driveshaft using the universal puller plate tool to support the bearing. deacbdeca15987 a - Bearing race d - Press b - Driveshaft e - Mandrel c - Universal puller plate tool Universal puller plate 91-37241 BEARING RACE REASSEMBLE NOTE:You can use an old bearing race or inner race as a suitable mandrel for installing bearings. 1. Lubricate the I.D. of the bearing race. Tube Ref No. Description Where Used Part No. 87 High Performance Gear I.D. of the bearing race 92-858064K01 Lubricant Page 3D-32 90-865612031 AUGUST 200 Bravo One Gear Housing

Disassembly, Repair, and Reassembl\ 2. Press a new bearing race to the driveshaft using a suitable mandrel acb 15992 a - Bearing race c - Suitable mandrel b - Driveshaft PINION HEIGHT BEARING REASSEMBLE 1. Lubricate the inner diameter of the small tapered roller bearing. Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant I.D. of small tapered roller bearing 92-858064K01 2 Position the pinion height of the roller bearing so that the smaller outer diameter faces the pinion end of driveshaft. 3 Press the pinion height roller bearing onto the driveshaft to the shoulder of driveshaft. acbde 15990 a - Pinion height roller bearing d - Suitable mandrel b - Driveshaft e - Press c - Shoulder of driveshaft PRELOAD BEARING REASSEMBLE 1. Lubricate the inner diameter of the large tapered roller bearing. 90-865612031 AUGUST 200 Page 3D-3 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant I.D. of large tapered roller bearing 92-858064K01 2. Press the large tapered roller bearing onto the driveshaft using a suitable mandrel. Ensure that the larger O.D. faces the pinion end of the shaft. a b e c d e a 15991 a - Large tapered roller bearing d - Press b - Driveshaft e - Small tapered roller bearing c - Suitable mandrel Propeller Shaft Inspection Check the propeller shaft for straightness using the lathe or the V-block method: 1. LATHE AND DIAL INDICATOR METHOD: a. Position the propeller shaft centers in the lathe. b. Mount the dial indicator at the front edge of the propeller shaft. c. Rotate the shaft and observe the dial indicator. Movement of more than 0.178 mm (0.007 in.) is reason for replacement. d. Inspect the shaft for bent or twisted splines. e. Inspect the surface of the shaft where the lips of the bearing carrier oil seal contact the shaft. You will need to replace the bearing carrier oil seals if you detect any grooves. 2. V-BLOCKS AND DIAL INDICATOR METHOD: a. Position the propeller shaft bearing surfaces on the V-blocks. b. Mount a dial indicator at the front edge of the propeller shaft. c. Rotate the shaft and observe the dial indicator. Movement of more than 0.178 mm (0.007 in.) is reason for replacement. d. Inspect the shaft for bent or twisted splines. e Inspect the surface of shaft where the lips of the bearing carrier oil seal contact the shaft. You will need to replace the bearing carrier oil seals if you detect any grooves. Page 3D-3 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Propeller Shaft Bearing Replacement BEARING REMOVAL 1. Press the bearing from the propeller shaft using the universal puller plate. abcda - Press b - Propeller shaft bcd 19490 c - Tapered roller bearing d - Universal puller plate Universal puller plate 91-37241 BEARING INSTALLATION 1. Apply lubricant to the I.D. of a new tapered roller bearing. 2. Install the bearing to the propeller shaft using a old bearing race as a mandrel to support the bearing on its inner race. 3. Press the bearing into place. eabcd abcd 19491 d - Old bearing race e - Press a - Propeller shaft b - Propeller shaft shoulder c - Tapered roller bearing Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant I.D. of the tapered roll bearing. 92-858064K01 Pinion Bearing Removal IMPORTANT: All needle bearings must be in place inside the bearing casing while driving the pinion bearing from the gear housing. Otherwise the bearing casing will bend or break and become difficult to remove. 1. Remove the pinion bearing. 90-865612031 AUGUST 2007 Page 3D-3 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ a. Assemble the driver rod tool to the bearing driver tool. b. Insert the driver rod and bearing driver tool assembly into the gear housing so the bearing driver tool rest on the pinion bearing. NOTE:The pilot washer prevents the bearing from becoming cocked during removal. c. Place the pilot washer tool over the driver rod tool and inside the gear housing. d. Using a hammer, strike the driver rod tool to drive the pinion bearing from the gear housing. e. Using a hammer, strike the driver rod tool to drive the pinion bearing from the gear housing. abc d 16631 a - Driver rod c - Pilot washer b - Bearing driver d - Hammer NOTE:The driver Head rod 91-37323 is included in the Bearing Removal and InstallationTool Assembly 91-31229A7. Driver rod 91-37323 Bearing driver 91-63638 1 Pilot washer 91-36571T Pinion Bearing Installation 1. Assemble the pinion bearing: a. Apply lubricant to the roller needle bearings. Tube Ref No. Description Where Used Part No. 4 Needle Bearing Assembly Lubricant Pinion bearing roller needle bearings 92-802868A1 b. Install the roller needle bearings in the bearing race. c. Use additional lubricant to help keep the roller needle bearings in place. 2. Install the pinion bearing: a. Position the pinion bearing over the bearing driver tool with the number on the bearing race facing up. Page 3D-36 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ b. Lubricate the outer diameter of the pinion bearing race b31708ca a - Pinion bearing c - Pinion bearing race outer diameter b - Bearing driver tool Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Pinion bearing race outer diameter 92-858064K01 Bearing driver 91-89867T c. Install the seal driver tool, the nut, and the washer onto the puller shaft tool. d. Place the puller shaft tool assembly on the gear housing as shown. NOTE:Ensure that the number on the bearing race is facing to the driveshaft wheninstalled. e. Position the pinion bearing and bearing driver tool through the gear housing torpedo and into the driveshaft cavity and align with the puller shaft tool. f. Thread the puller shaft tool into the bearing driver tool. g. Turn the nut CLOCKWISE to pull the pinion bearing completely into the driveshaft cavity until seated. 31709cdefab a - Pinion bearing d - Seal driver b - Bearing driver e - Nut c - Puller shaft f - Washer 90-865612031 AUGUST 2007 Page 3D-3 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ NOTE:The puller shaft 91-31229 is included in the Bearing Removal and Installation TooO Assembly 91-31229A7. Seal driver 91-813653T Bearing Removal and Installation kit h. Remove the tools. Front Driven Gear and Bearing Repair 91-31229A7 1 If you determine that bearings are in need of replacement and the gear is still in good condition, remove the bearing from the gear using a universal puller plate and a suitable mandrel. (Bearings are damaged in removal and should not be reused.). cadeb 16376 a - Driven gear d - PresX b - Universal puller plate e - Suitable mandreO c - Tapered roller bearinZ Universal puller platX 91-37241 2 Lubricate the I.D. of the new bearing. 3 Place a suitable mandrel (old bearing race) against the inner bearing race. 4 Place another mandrel on the face of the gear and press the gear and bearing together. decba 16377 a - Driven gear d - Suitable mandrel b - Roller bearing e - Suitable mandrel (old bearing race) c - Press Page 3D-3 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. High Performance Gear I.D. of new bearing 92-858064K01 87 Lubricant Front Driven Gear Bearing Cup Installation 1. For proper installation of the bearing cup use the special tools. abedca - Hammer b - Driver handle tool c - Guide plate tool cdeb19148 d - Guide insert tool e - Bering cup driver tool 2. Install new shims of the exact measurement as the shims previously removed. 3. If you cannot determine the original thickness of the shims, install a 0.38 mm (0.015 in.) shim for a starting point. a 31051 a - Shims 90-865612031 AUGUST 2007 Page 3D-3 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 4. Lubricate the O.D. of the bearing cup and place in the gear housing with the tapered end towards the prop. a a - Bearing cup 31052 5. Tube Ref No. Description Where Used 87 High Performance Gear Lubricant Bearing cup Install bearing cup driver tool on top of the bearing cup. Part No. 92-858064K01 a 31053 a - Bearing cup driver tool Bearing cup driver 91-31106T Page 3D-40 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 6. Place the driver rod and guide insert tool into the gear housing so that the guide insert is in the bearing cup driver tool. ab31054 a - Driver rod tool b - Guide insert tool Driver rod 91-37323 Guide insert tool 91-805473 7. Place the guide plate tool in position and hold it against the gear housing. Drive the bearing cup until seated. aab 31055 a - Guide plate tool b - Hammer Guide plate 91-816243 Bearing Carrier Repair NOTE:Use the following procedures for Bravo One and Bravo One XR bearing carriers. The special tool 91-840385 is used on the XR model seals and bearing cup installation. NOTE:If you detect heavy corrosion on the bearing carrier, replace the bearing carrier. BEARING CUP AND OIL SEALS REMOVAL NOTE:Use the following procedure for Bravo One and Bravo One XR bearing carriers. 90-865612031 AUGUST 2007 Page 3D-4 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 1. Remove the bearing cup using a slide hammer puller a b 21166 Bearing cup removal a - Bearing cup b - Slide hammer puller Slide hammer 91-34569A 1 2. Remove oil seals from bearing carrier using a hammer and punch. ab 21167 Oil seals removal a - Oil seals b - Punch BEARING CUP AND OIL SEALS REPLACEMENT NOTE:Use the following procedure for Bravo One and Bravo One XR bearing carriers. The special tool 91-840385 is used on the XR model seals and bearing cup installation. 1. With the oil seal lip facing down, place the outer oil seal on the bearing carrier seal and bearing cup driver tool 2. Coat the O.D. of the oil seal with threadlocker Page 3D-42 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 3. Install the outer oil seal with lip facing down, using the bearing carrier seal and bearing cup driver and a press. ab c 21168 Outer oil seal installatioS a - Outer oil seal c - PresX b - Bearing carrier seal and bearinZ cup driver tool Bearing seal and cup driver 91-89865 NOTE:The XR model bearing carrier requires the special tool 91-840385 to install the outeroil seal. Bearing Carrier Oil Seal Installer 91-840385 Tube Ref No. Description Where Used Part No. 7 O.D. of the outer oil seal for the Loctite 271 Threadlocker 92-809819 bearing carrier 4. With the oil seal lip facing up, place the inner oil seal on the bearing carrier seal and bearing cup driver tool. 5. Coat the O.D. of oil seal with threadlocker. 90-865612031 AUGUST 2007 Page 3D-4 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 6. Install the inner oil seal with lip facing up, using the bearing carrier seal and bearing cup driver tool and a press. ab Inner oil seal installation a - Outer oil seal b - Bearing carrier seal and bearing cup driver tool c 21169 c - Press Bearing seal and cup driver 91-89865 NOTE:The XR model bearing carrier requires the special tool 91-840385 to install the inneroil seal. Bearing Carrier Oil Seal Installer 91-840385 Tube Ref No. Description Where Used Part No. O.D. of the inner oil seal for the 7 Loctite 271 Threadlocker 92-809819 bearing carrier Page 3D-44 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 7. Install the bearing cup with the bearing surface facing inward, using the bearing carrier seal and bearing cup driver. a b c 21170 Bearing cup installation a - Bearing cup c - Press b - Bearing carrier seal and bearing cup driver tool Bearing carrier seal and bearing cup driver 91-89865 NOTE:The XR model bearing carrier requires the special tool 91-840385 to install thebearing cup. Bearing Carrier Oil Seal Installer 91-840385 Bearing Carrier Repair�XR Models See Bearing Carrier Repair. Gear Housing Shimming and Reassembly Final Checklist 1. Ensure that the gear housing is clean. 2. Verify that the bearing cup is installed in the gear housing for the front driven gear and bearing placement. a 19345 a - Front driven gear bearing cup 90-865612031 AUGUST 2007 Page 3D-4 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 3. Verify that the driveshaft needle bearing case is installed in the gear housing and that all 19 needle bearings are positioned inside. a 19346 a - Driveshaft roller needle bearings and cardboard case Driveshaft Lower Bearing Cup and Shims Installation 1. Install shims of the original thickness for lowering the bearing cup into the gear housing. 2. If the shims were lost or ruined (i.e. the original thickness cannot be determined), install a 1.27 mm (0.050 in.) shim pack as a starting point. a 16347 a - Shims Page 3D-46 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 3. Install the lower bearing cup of the driveshaft using the bearing cup driver tool abcde 16349 a - Bearing cup d - Driven handle tool b - Bearing cup driver tool e - Guide insert tool c - Hammer Bearing cup driver 91-67443T Front Driven Gear and Bearing Installation 1. Install the driven gear and bearing assembly. ba 18876 a - Front driven gear b - Bearing Driveshaft and Pinion Gear Installation NOTE:Be careful not to lose the rollers from the driveshaft pinion bearing if they drop duringdriveshaft installation. 90-865612031 AUGUST 2007 Page 3D-4 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 1. Install the driveshaft into the gear housing 31063a a - Driveshaft 2. Install the pinion gear onto the driveshaft splines. cab 31062 a - Pinion gear c - Driveshaft b - Splines to driveshaft splines 3. Install pinion washer and pinion screw. abcdab 31067 Outside the gear housing Inside the gear housing a - Washer c - Pinion gear b - Pinion screw d - Front driven gear Page 3D-48 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 4. Place a breaker bar and socket on the pinion screw. Torque the pinion screw ac31073bc Side view Front view a - Breaker bar c - Torque wrench b - Driveshaft adapter tool Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Threads of pinion screw 92-809819 Description Nm lb. in. lb. ft. Pinion screw 61 45 Driveshaft Upper Bearing Preload Cup and Tab Washer Installation 1. Install the upper bearing preload cup. aab 19350 a - Upper bearing preload cup b - Wooden hammer handle 2. Install the tab washer. ab b 16353 a - Tab washer b - Tab placemenY 90-865612031 AUGUST 2007 Page 3D-4 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Driveshaft Bearing Preload Measurement 1. Determine the thickness of the shim required of the driveshaft bearing preload. a. Measure the distance between top of the gear housing and the tab washer using a 0�2.54 cm (0�1 inch) depth micrometer. a 16354 a - 0�2.54 cm (0�1 inch) depth micrometer b Measure the thickness of the spacer from the top machined surface to the bottom machined surface using a 0�2.54 cm (0�1 inch) outside micrometer. a c b 16355 a - 0�2.54 cm (0�1 inch) outside micrometer b - Spacer c - Thickness to measure Driveshaft Bearing Preload Measurement Help Chart Order of Measurements mm in. Distance of gear housing to tab washer � (minus) Spacer thickness + (plus) Add measurement of 0.051 0.002 = (equals) Shim thickness to install to the gear housing Page 3D-5 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2. Install shims having the original thickness, spacer, and a new O-ring a a - Shimsb - Spacer b c 19340 c - O-ring 3. Install the clamp plate tool on the gear housing. 4. Place two washers and one nut on each stud. Torque the nuts. a a - Clamp plate b - Nuts abc18377 c - Washers (4) Description Nm lb. in. lb. ft Nuts on clamp plate tool 47 3 NOTE:The clamp plate tool must sit flat against the gear housing to be correctly positioned. aab 1599616000 Correctly positioned Incorrectly positioned a - Clamp plate b - Incorrect gap Clamp plate 91-43559T 90-865612031 AUGUST 2007 Page 3D-5 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 5 Using a dial lb. in. torque wrench, check the rolling preload by turning the driveshaft with a slow, steady motion. If necessary, add or subtract shims beneath the spacer to bring the preload into the specified range. 31707ab a - Driveshaft adapteU b - Dial lb. in. torque wrenc[Description Rolling preload of driveshaft Nm 0.3�0.6 lb. in. 3�5 lb. ft. Torque wrench, lb. in. 91-66274 Propeller shaft/driveshaft adapter 91-61077T Pinion Gear Height Measurement 1 Ensure that the clamp plate has been reinstalled after adjusting the preload in the previous step. The clamp plate tool must be in place for checking pinion height in the following procedure. 2 Ensure that the number of driven gear teeth match the drive gear ratio. Bravo One Gear Housing Standard Bravo One and Bravo One X series Bravo One XR Drive Gear RatiR 1.65: 1.50: 1.36: 1.35: 1.26: Drive Gear Teeth 15 15 15 15 17 Driven Gear Teeth 19 19 19 17 18 3. Match the shimming tool access hole to the correct gear teeth count 31299aa Bravo One shimming tool a - Access holes with the gear teeth count Page 3D-5 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Driveshaft Pinion Gear Shimming Tool 91-42840T 4. Check the pinion height as follows: a. Insert the shimming tool into the gear housing. b. Position the matching gear teeth count access hole to the pinion gear. a b c 31300 a - Shimming tool c - DriveshafY b - Clamp platX NOTE:Refer toFeeler Gauge Measurement for further assistance. c. Insert the feeler gauge and measure the clearance of the shimming tool to the pinion gear teeth. d. Take measurements at three locations on the pinion gear, 120� apart. 31301c baa bb a - Feeler Gauge b - Shimming tool c - Gear teeth centered on gauging surface Description mm in. Pinion gear clearance 0.635 0.025 e. If clearance is within specification: i. Recheck the rolling preload to ensure that it is within specification. ii. When the rolling preload and the pinion height are within specification, proceed to the reassembly process described in "Back Driven Gear Shim Installation." f. If clearance is less than specified: NOTE:Anythicknessaddedheremustbesubtractedtotheshimthicknessattheupperbearing. 90-865612031 AUGUST 2007 Page 3D-5 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ i Add an appropriate thickness of shims under the lower tapered roller bearing cup. Refer to "Driveshaft Lower Bearing Cup and Shims Removal" and "Driveshaft Lower Bearing Cup and Shims Installation." a b 19337 a - ShimX b - Bearing cup ii. Subtract the appropriate thickness of shims from the upper bearing. Refer to "Driveshaft Preload Spacer Removal" and "Driveshaft Preload Spacer Installation." a b 19338 a - ShimX b - Spacer g. If clearance is more than specified: NOTE:Any thickness subtracted here must be added to the shim thickness at the upperbearing. i. Subtract an appropriate thickness of shims from under the lower tapered roller bearing cup. Refer to "Driveshaft Lower Bearing Cup and Shims Removal" and "Driveshaft Lower Bearing Cup and Shims Installation." a b 19337 a - ShimX b - Bearing cuU Page 3D-5 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ ii. Add an appropriate thickness of shims from the upper bearing. Refer to "Driveshaft Preload Spacer Removal" and "Driveshaft Preload Spacer Installation." ab a - Shims 19338 b - Spacer h. i. Recheck the pinion gear clearance. Recheck the rolling preload. 5 When the rolling preload and the pinion height are within specification proceed to the reassembly process as described in "Back Driven Gear Shim Installation." Load Ring, Thrust Washer, and O-ring Installation NOTE:Do not use a new load ring at his time, always use the original load ring topreassemble the gearcase. 1. Install the original load ring into the gear housing. a 18874 a - Load ring 2. Install the thrust washer into the gear housing. a 18873 a - Thrust washer 90-865612031 AUGUST 200 Page 3D-5 Bravo One Gear Housing Disassembly, Repair, and Reassembly ravo One Gear Housing Disassembly, Repair, and Reassembly 3. Install the O-ring into the gear housing. a 18872 a -O-ring Propeller Shaft Assembly Installation 1. Install the propeller shaft assembly into the gear housing and driven gear, rotating the propeller slightly to engage the propeller shaft splines and the driven gear splines. cd 18826 ab Bravo ..R modelBravo Standard and .. series modela -Propeller shaft c - Propeller shaft (..R model) b -Tapered roller bearing d -Tapered roller bearing (..R model) Bearing Carrier Installation 1. Lubricate the bearing carrier seals and the space between the seals. a20627 Typical cutaway view of a bearing carrier a -Seal location Page 3D-56 90-865612031 AUGUST 2007 Bravo One Gear Housing Disassembly, Repair, and Reassembly 90-865612031 AUGUST 2007 Page 3D-57 Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Bearing carrier seal 92-802859A1 2. Coat the bearing carrier mating surfaces with sealant. 3. Slide the bearing carrier into the gear housing. a 18823 b Bravo Standard and .. series a - Bearing carrier b - Mating surface Tube Ref No. Description Where Used Part No. 19 Perfect Seal Bearing carrier mating surfaces 92-34227-1 Bearing Carrier Installation�..R Models 1. Lubricate the bearing carrier seals and the space between the seals. a 20627 Typical cutaway view of a bearing carrier a - Seal location Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Bearing carrier seal 92-802859A1 Bravo One Gear Housing Disassembly, Repair, and Reassembly ravo One Gear Housing Disassembly, Repair, and Reassembly 2. Coat the bearing carrier mating surfaces with sealant. a 20628 a -Mating surfaces Tube Ref No. Description Where Used Part No. 19Perfect Seal Bearing carrier mating surfaces 92-34227-1 3. Position the bearing carrier installation tool onto the propeller shaft. Bearing Carrier Installation Tool 91-840388 4. Slide the bearing carrier over the installation tool and into the gear housing. abc a 20626 18825 a -Bearing carrier c - Propshaft b -Installation tool Page 3D-58 90-865612031 AUGUST 2007 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Tab Washer and Bearing Carrier Retainer Nut Installation 1. Install the tab washer, place the outer diameter tab into the notch inside the gear housing. a 18815 a - Outer diameter tab of the tab washer IMPORTANT: Threads on the outer propeller shaft bearing retainer nut must be lubricated to prevent corrosion and cracking in the gear housing. 2. Lubricate the threads on the bearing carrier retaining nut. Tube Ref No. Description Where Used Part No. Bearing carrier retaining nut 34 Special Lubricant 10 92-802865Q02 threads 3. Install the bearing carrier retainer nut into the gear housing. 4. Using your hands, turn the retainer nut COUNTERCLOCKWISE until you feel the threads engage and then turn CLOCKWISE to hand-tighten. a 18814 a - Bearing carrier retainer nut 5 Install the bearing carrier retainer tool: slightly rotate the tool until the teeth are placed between the retainer nut teeth. 90-865612031 AUGUST 200 Page 3D-5 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 6. Tighten the bearing carrier retaining nut until the propeller shaft rotation has very heavy resistance and you can not rotate the propeller shaft by hand. ab 18813 a - Breaker bar b - Bearing carrier retainer nut wrench tool Bearing carrier retainer nut wrench 91-61069T Tab Washer and Bearing Carrier Retainer Nut Installation�XR Models 1. Install the tab washer, place the outer diameter tab into the notch inside the gear housing. a 18819 a - Outer diameter tab on tab washer IMPORTANT: Threads on the outer propeller shaft bearing retainer nut must be lubricated to prevent corrosion and cracking in the gear housing. 2. Lubricate the threads on the bearing carrier retaining nut. Tube Ref No. Description Where Used Part No. Bearing carrier retaining nut 34 Special Lubricant 101 92-802865Q02 threads 3. Install the bearing carrier retainer nut into the gear housing. Page 3D-60 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 4. Using your hands, turn the retainer nut COUNTERCLOCKWISE until you feel the threads engage and then turn CLOCKWISE to hand-tighten. a 18818 a - Bearing carrier retainer nut 5 Install the bearing carrier retainer tool: slightly rotate the tool until the teeth are placed between the retainer nut teeth. 6 Tighten the bearing carrier retaining nut until the propeller shaft rotation has very heavy resistance and you can not rotate the propeller shaft by hand. ab 18817 a - Bearing carrier retainer nut wrench b - Ratchet tool Bearing carrier retainer nut wrenc[91-840393 Driven Gear Backlash Measurement and Shimming NOTE:The dial indicator adapter tool must be modified to fit over the stud of the gearhousing. 1. Install the dial indicator adapter, backlash indicator rod, and dial indicator. Ensure that the dial rod is aligned with "II" on the indicator rod. 90-865612031 AUGUST 200 Page 3D-6 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 2. Check gear backlash by lightly rotating the drive shaft back and forth. Do not allow the propeller shaft to turn. Observe the dial indicator. b c a 21165 Set-up used to measure the driven gear backlas[a - Dial indicator adapter c - Dial indicatoU b - Backlash indicator roW Dial indicator adapter 91-83155 Backlash indicator rod 91-53459 Dial indicator 91-58222A1 Specification mm in. Gear backlash 0.305�0.381 0.012�0.015 3. If the gear backlash is within specification: Proceed to "Final Assembly and Overall Gear Housing Preload." NOTE: Refer to "Driven Bearing Cup Removal" and "Driven Bearing Cup Installation." 4. If backlash is more than specified: Add shims under the driven gear bearing cup. 5. Recheck the backlash reading after reassembly. a b 19509 a - Driven bearing cup b - Shims NOTE:Refer to"Driven Bering Cup Removal" and"Driven Bearing Cup Installation." 6. If backlash is less than specified: remove shims under the driven gear bearing cup. Page 3D-62 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 7. Recheck the backlash reading after reassembly a b 19509 a - Driven bearing cup b - Shims Final Assembly and Overall Gear Housing Preload 1. Remove the bearing carrier, refer to "Bearing Carrier removal". 2. Remove the propeller shaft assembly, refer to "Propeller Shaft Assembly Removal". 3. Remove the O-ring, thrust washer, and load ring, refer to "O-Ring, Thrust Washer, and Load Ring Removal". 4. Reassemble using a new load ring. IMPORTANT: The bearing carrier and the threads on the retainer must be lubricated to prevent corrosion and cracking in the gear housing. Use lubricant on the retainer and coat the O.D. on the carrier rounds with sealant. 5. Lubricate the bearing carrier seals and coat the carrier mating surfaces with sealant. Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Bearing carrier seals and spaces between seals 92-802859A1 Tube Ref No. Description Where Used Part No. 19 Perfect Seal Bearing carrier mating surface 92-34227-1 6. Install the bearing carrier and the tab washer in the gear housing. 7. Lubricate the threads on the bearing carrier retaining nut. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Bearing carrier retaining nut 92-802865Q02 8. Install and tighten the bearing carrier retainer nut until you can feel the resistance to the propeller shaft rotation (to preload bearings). OVERALL GEAR HOUSING PRELOAD 1. Add the drive shaft bearing preload (previously recorded) to the propeller shaft bearing preload as outlined in the example below. IMPORTANT: The overall preload includes both the drive shaft preload and the gear case preload. NOTE:A bearing is considered used if spun under load even once ("under load" meaning: with power applied). NOTE:Plus drive shaft preload of 0.3�0.6 Nm (3�5 lb. in.) 90-865612031 AUGUST 2007 Page 3D-6 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Example: Drive shaft bearing preload 0.3�0.6 Nm (3-5 lb. in.) Preload Checked at Propeller Shaft (New Bearings) 0.9�1.14 Nm (8�12 lb. in.) Overall Gear Case Preload Checked at Propeller Shaft 0.6�0.9 Nm (5�8 lb. in.) Used bearings +0.3�0.6 Nm (3�5 lb. in.) 2. Tighten the retainer in small increments using bearing carrier retainer tool. a 20835 a - Bearing retainer nut wrench tool Bearing carrier retainer nut wrench 91-61069T 3. Check the bearing preload of the overall gear housing: a. Hand tighten a propeller nut on the propeller shaft. b. Place an lb. in. torque wrench with a socket on the propeller nut. c. Rotate the propeller shaft in the normal direction with a slow, steady motion while watching the dial indicator. ab 20836 a - Socket on a propeller nut b - Torque wrench, lb. in. tool Torque Wrench, lb. in. 91-66274 4. When the propeller shaft preload is correct: a. Bend one tab of the tab washer into the retaining nut b. Bend the remaining tabs of the tab washer down into the gear housing. Cushion the gear housing to avoid chipping or scratching the paint. Page 3D-64 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ Oil Passage Quad Ring and Water Passage O-ring Installation 1. Apply adhesive to the gear housing groove for the water passage O-ring. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Gear housing groove for the water passage O-ring 92-86166Q1 2. Install the water passage O-ring. ab 19475 a - Water passage O-ring b - Gear housing groove for the water passage O-ring 3. Apply adhesive to the gear housing groove for the oil passage quad ring. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Gear housing groove for the oil passage quad ring 92-86166Q1 4. Install the oil passage quad ring. ab 19476 a - Oil passage quad ring b - Gear housing groove for the oil passage quad ring Bravo One Gear Housing�Driveshaft Housing Installation NOTE:Before reassembling the gear housing to the driveshaft housing: ensure that allO-rings and seals are installed, and the gear housing and the driveshaft housing arecompletely assembled and free from defects. 90-865612031 AUGUST 2007 Page 3D-6 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 1. Place the star washer and screw in the gear housing. The screw will be used later to secure the anode plate. ab21211 a - Screw b - Star washer 2. Align the studs to the holes and place the drive shaft housing on the gear housing. 3. Install a washer and a nut on each stud and tighten. 4. Install the bolt into the anode cavity using the bolt hole with the ground plate. 5. Torque the six nuts and one bolt. a20662bc a - Nuts and washers (3 each side) c - Screw for anode plate b - Bolt (1) (located in the anode cavity) Description Nm lb. in. lb. ft. Gear housing to driveshaft housing nuts and bolts 47 35 Page 3D-66 90-865612031 AUGUST 200 Bravo One Gear Housing Disassembly, Repair, and Reassembly ravo One Gear Housing Disassembly, Repair, and Reassembly 6. Use the screw and star washer (installed earlier) to secure the anode plate to the gear housing. a 21202 a -Anode plate 7. Torque the screw. a b 18946 a -Socket on a Screw b -Anode plate Description Nm lb. in. lb. ft. Anode plate screw 27 20 8. Install the rubber plug. a b 20664a -Rubber plug b -Anode plate 9. Fill the sterndrive with gear lube. Refer to Section ..B .. Maintenance. 90-865612031 AUGUST 2007 Page 3D-67 Bravo One Gear Housing Disassembly, Repair, and Reassembl\ 10. Reinstall the sterndrive to the boat. Refer to Section 2A � Installation and Adjustments. Page 3D-68 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Bravo Sterndrive Section 3E - Bravo Two Gear Housing Disassembly, Repair, and Reassembly Table of Contents Specifications..3E-6 Bearing Preloads......................................3E-6 Gear Backlash..3E-6 Pinion Gear Clearance.............................3E-6 Bravo Two Gear Housing�Drive Gear Ratio (Teeth Per Gear).......................................3E-6 Torque Specifications..............................3E-6 Feeler Gauge Measurement.....................3E-7 Bravo Two Gear Housing Exploded View........3E-8 Bravo Two Gear Housing Disassembly..........3E-9 Gear Housing Preparation........................3E-9 Oil Passage Quad Ring and Water Passage O-ring Removal..3E-9 Clamp Plate Tool Installation.................3E-10 Propeller Shaft Runout Test..................3E-11 Bearing Carrier Retainer Nut and Tab Washer Removal...3E-12 Bearing Carrier Removal.......................3E-13 Propeller Shaft Assembly Removal........3E-14 O-Ring, Thrust Washer, and Load Ring Removal...3E-15 Pinion Gear Screw Removal..................3E-16 Clamp Plate Tool Removal.....................3E-17 Driveshaft Preload Spacer Removal.......3E-18 Driveshaft and Pinion Gear Removal.....3E-18 Driveshaft Lower Bearing Cup and Shims Removal...3E-20 Driven Gear and Bearing Removal.........3E-22 Driven Gear Bearing Cup Removal........3E-22 Gear Housing and Assemblies Teardown Inspection and Repair...................................3E-25 Gear Housing Inspection and Cleaning ....3E-25 Gear Housing Repair Painting Procedure ....3E-26 Driveshaft Assembly Repair ....3E-27 Propeller Shaft Inspection......................3E-30 Propeller Shaft Bearing Replacement....3E-31 Pinion Bearing Removal........................3E-32 Pinion Bearing Installation.....................3E-32 Front Driven Gear and Bearing Repair...3E-34 Front Driven Gear Bearing Cup Installation ....3E-35 Bearing Carrier Repair...........................3E-38 Gear Housing Shimming and Reassembly....3E-43 Final Checklist.......................................3E-43 Driveshaft Lower Bearing Cup and Shims Installation...3E-44 Front Driven Gear and Bearing Installation ....3E-45 Driveshaft and Pinion Gear Installation ....3E-45 Driveshaft Upper Bearing Preload Cup and Tab Washer Installation...............................3E-47 Driveshaft Bearing Preload Measurement ....3E-47 Pinion Gear Height Measurement..........3E-50 Load Ring, Thrust Washer, and O-ring Installation...3E-54 Propeller Shaft Assembly Installation.....3E-55 Bearing Carrier Installation....................3E-55 Tab Washer and Bearing Carrier Retainer Nut Installation...3E-56 Driven Gear Backlash Measurement and Shimming...3E-57 Final Assembly and Overall Gear Housing Preload...3E-59 Oil Passage Quad Ring and Water Passage O-ring Installation..................................3E-61 Bravo Two Gear Housing�Driveshaft Housing Installation...3E-61 3 E 90-865612031 AUGUST 2007 Page 3E- Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Installs onto the gear housing while separated from the driveshaft housing and holds a preload while checking the the gear backlash and bearing preload. 10486 Dial indicator adapter 91-83155 Attaches the dial indicator to the gearcase when checking backlash. 2999 Dial indicator 91-58222A1 Measures gear backlash and pinion gear location. 9479 Bearing carrier retainer tool 91-17257 Lubricant, Sealant, AdhesiveX 4 7 19 Tube Ref No. Description Needle Bearing Assembly Lubricant Loctite 271 Threadlocker Perfect Seal 27 Bellows Adhesive 34 Special Lubricant 101 87 High Performance Gear Lubricant Special Tools 95 Clamp plate 2-4-C with Teflon Where Used Part No. Pinion bearing roller needle bearings 92-802868A1 O.D. of oil seal 92-809819 Threads of pinion screw Bearing carrier mating surface 92-34227-1 O.D. of seal Gear housing groove for the water passage O-ring 92-86166Q1 Gear housing groove for the oil passagX quad rinZ Bearing carrier retaining nut threadX 92-802865Q02 Bearing carrier retaining nuY I.D. of the bearing racX I.D. of small tapered roller bearinZ I.D. of large tapered roller bearing 92-858064K01 Pinion bearing race outer diameter I.D. of new bearing Bearing cup Between the oil seals of bearing carrier. Bearing carrier seals and spaces 92-802859A1 between seals 91-43559T Loosens and tightens the bearing carrier retainer nut. 10465 Page 3E-2 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Puller jaws assembly 91-46086A1 Puller bolt 91-85716 9514 Removes bearing carrier and bearing races. Slide hammer 91-34569A 1 Aids in the removal of various engine components. Use with puller jaws. 6761 Propeller shaft/driveshaft adapter 91-61077T 10805 Provides a wrench surface to turn the propeller shaft or the driveshaft. Universal puller plate 91-37241 8505 Removes bearings from gears and the driveshaft. Driver rod 91-37323 Used in pinion gear and pinion bearing installation. 25431 Bearing driver 91-63638 1 10477 Removes and installs the lower driveshaft pinion bearing. Pilot washer 91-36571T Used in pinion gear and pinion bearing installation. 29490 90-865612031 AUGUST 2007 Page 3E- Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Bearing driver 91-89867T 10478 Aids in the installation of the driveshaft needle bearings. Seal driver 91-813653T 10852 Installs the U-joint oil seal into the bearing carrier. Also used to pilot the puller rod for the installation of the gear housing needle bearing. Bearing Removal and Installation kit 91-31229A7 Installs and removes the bearings in all gearcases. 91-31229A7 tool assembly includes the following components: 11-24156 Hex nut 12-34961 Washer 91-15755T Bearing carrier 91-29310 Plate 91-29610 Pilot plate 91-30366T1 Mandrel 91-31229 Puller shaft 91-32325T Driver head 91-32336 Driver needle bearing 91-36379 Puller/Head gear 91-36569T Driver head 91-36571T Pilot washer 91-37292 Roller bearing 91-37311 Driver head 91-37312 -Driver head 91-37323 Driver head rod 91-37324 Pilot washer 91-38628T Puller/Driver head 91-52393 Driver needle bearing 91-52394 Head pull rod Bearing cup driver 91-31106T 2966 Installs the driven gear bearing cup. 8882 Guide insert tool 91-805473 Inserts into the bearing cup driver (91-31106T) when installing the front driven gear bearing cup. 20864 Page 3E-4 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Guide plate 91-816243 Centers the rod used to drive in the forward gear bearing on a standard rotation gearcase, and the reverse gear bearing on a counter rotation gearcase. 4481 Bearing cup driver 91-63626 Installs the bearing cup into the bearing carrier. 10473 Bearing driver 91-55918 10476 Aids in the removal and installation of the bearing carrier needle bearings. Driver handle 91-805454 Use with Front Bearing Guide (91-805470) for installation of the front bearing. Oil seal driver 91-55916 Installs the bearing carrier oil seals. 10848 Bearing cup driver 91-67443T Installs the driveshaft bearing cup into the gear housing, and the bearing cup into the bearing carrier. 10838 Torque wrench, lb. in. 91-66274 Dial type torque wrench that sets torque from 9 to 150 lb. in.; 3/8 in. drive. Gearcase Pinion Shimming Tool 91-96512 10590 10829 10670 Aids in measuring the gearcase pinion height. 90-865612031 AUGUST 2007 Page 3E- Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Backlash indicator rod 91-53459 Aids in checking gear backlash. 10452 Specifications Bearing Preloads NOTE:DOES NOT include 0.3�0.6 Nm (3�5 lb. in.) on the driveshaft. A bearing is used if spun once under load. DescriptioS Driveshaft bearinZ Propeller shaft bearingX Checked at propeller shaft (new bearings) Propeller shaft bearingX Checked at propeller shaft (used bearings) Gear Backlash Description Gear backlash Pinion Gear Clearance DescriptioS Pinion gear clearancX Bravo Two Gear Housing�Drive Gear Ratio (Teeth Per Gear) Bravo Two Gear Housing Standard Bravo Two and Bravo Two X series Torque Specifications Drive Gear RatiR 1.65: 1.50: 1.81: 2.00: 2.20: Drive Gear Teeth 18 18 16 16 16 NOTE:Securely tighten all fasteners not listed below. Description Pinion screw Clamp plate Rolling preload of driveshaft Gear housing to driveshaft housing nuts and bolts Anode plate bolt Propeller locknut NR 6 4 0.3�0. 4 2 7 Nm lb. in. 0.3�0.5 3�5 0.9�1.14 8�12 0.6�0.9 5�8 mm in. 0.304� 0.012� 0.381 0.015 mm in. 0.635 0.025 Driven Gear Teeth 25 25 27 27 27 lb. in. lb. ft. 45 35 3�5 35 20 55 Page 3E-6 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Feeler Gauge Measurement 1. To properly check gear location: a. Position the gear with at least 2 full teeth centered on the gauging surface. One full tooth must be on each side of the gauging surface center line. Insert a 0.64 mm (0.025 in.) feeler gauge between a tooth and the gauging surface. b. Slightly rotate the shimming tool until one side of the gauging surface contacts the feeler gauge and a slight drag is felt on the feeler gauge. c. Without moving the shimming tool, remove the feeler gauge and re-insert it between the other tooth and the gauging surface. 31302abbb c a a - Feeler Gauge c - Gear teeth centered on gauging b - Shimming tool surface 2 If the feeler gauge can be inserted with only a slight drag, the shimming is correct. 3 If the feeler gauge inserts with no drag, repeat Steps 1., a., b., and c. with progressively thicker feeler gauges until the feeler gauge can be inserted with only a slight drag. 4 If the feeler gauge cannot be inserted, repeat Steps 1., a., b., and c. with progressively thinner feeler gauges until the feeler gauge can be inserted with only a slight drag. 90-865612031 AUGUST 200 Page 3E- Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Bravo Two Gear Housing Exploded VieZ 424344454619079 Page 3E-8 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 1 - Gear housing assembly 2 - Stud 3 - Water passage O-ring 4 - Oil quad ring seal 5 - Speedometer passage seal 6 - Roller bearing 7 - Fill and drain plug 8 - Seal 9 - Anodic plate 10 - Lockwasher 11 - Screw 12 - Washer 13 - Speedometer pick-up 14 - Shim 15 - Bearing cup and tappered roller bearing 16 - Driveshaft assembly 17 - Bearing race 18 - Tappered roller bearing and bearing cup 19 - Tab washer 20 - Shim 21 - Spacer 22 - O-ring 23 - Coupling assembly Bravo Two Gear Housing Disassembly Gear Housing Preparation 24 - Retaining ring 25 - Pinion gear 26 - Washer 27 - Screw 28 - Shim 29 - Bearing cup and tappered roller bearing 30 - Propeller shaft 31 - Tappered roller bearing and bearing cup 32 - Drive Gear 33 - Thrust washer 34 - Load ring 35 - O-ring 36 - Bearing carrier assembly 37 - Roller bearing 38 - Inner oil seal and outer oil seal 39 - Key (of the bearing carrier) 40 - Tab washer 41 - Retaining nut 42 - Propeller nut 43 - Lock washer 44 - Screw 45 - Washer 46 -Nut For complete disassembly of the gear case: Secure the gear case tightly so that it will not move when loosing a torque of 271 Nm (200 lb. ft.). 1. Install the gear housing in a fixture or stand. 2. Properly secure the gear housing. Oil Passage Quad Ring and Water Passage O-ring Removal 1. Remove the oil passage quad ring. a 16057 a - Oil passage quad ring 90-865612031 AUGUST 2007 Page 3E- Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 2. Remove the water passage O-ring a 18357 a - Water passage O-ring WATER PASSAGE O-RING AND OIL PASSAGE QUAD RING INSPECTION 1. Inspect the oil passage quad ring for nicks or cuts. Replace if you detect damage. 2. Inspect the water passage O-ring for flatness cuts or nicks. Replace if you detect damaged. Clamp Plate Tool Installation IMPORTANT: Failure to use appropriate tools when installing or removing components can result in product damage. Always use the correct tools in the specified manner when performing these procedures. IMPORTANT: The clamp plate tool maintains the position of the driveshaft and the bearings, preventing damage to the internal components when disassembling the sterndrive. 1. Install the clamp plate tool on the gear housing. 2. Place two (2) washers and one (1) nut on each stud. Tighten securely. a a - Clamp plate b - Nuts abc18377 c - Washers (4) Page 3E-10 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ NOTE:The clamp plate tool must sit flat against the gear housing to be correctly positioned aab 15996 16000 Correctly positioned Incorrectly positioned a - Clamp plate b - Incorrect gap Clamp platX 91-43559T Propeller Shaft Runout Test 1. Perform the propeller shaft runout test on the propeller shaft. NOTE:Do not damage the painted surface of the sterndrive. a Position the dial indicator tool on the gear housing with the dial indicator tip touching the propeller shaft. abc 21364 Set up for the propeller shaft runout test a - Propeller shaft c - Dial indicator adapter kit tool b - Dial Indicator tool Dial indicator adapteU 91-83155 Dial indicatoU 91-58222A1 b. Rotate the propeller shaft while observing the dial indicator. c. A runout of more than the maximum specification indicates a bent propeller shaft. Propeller Shaft Runout Bravo Two Models Maximum Specification Propeller shaft 0.178 mm 0.007 in. 90-865612031 AUGUST 200 Page 3E-1 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Bearing Carrier Retainer Nut and Tab Washer Removal 1. Using a screwdriver, bend the tabs of the tab washer away from the retainer nut. ab 18884 a - Tab washeU b - Bearing carrier retainer nut 2 Use the bearing carrier retainer nut wrench tool and a breaker bar to loosen the retainer nut. ba 18888 a - Breaker bar b - Bearing carrier retainer nut wrench tool Bearing carrier retainer tool 91-17257 3. Remove the bearing carrier retainer nut. a 18889 a - Bearing carrier retainer nut Page 3E-1 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembly 90-865612031 AUGUST 2007 Page 3E-13 4. Remove the tab washer. a 18890 a - Tab washer BEARING CARRIER RETAINER NUT AND TAB WASHER INSPECTION IMPORTANT: Protect the gear housing, using a retainer nut with thread damage can cause damage to the gear housing threads. 1. Inspect the threads of bearing carrier retainer nut. 2. Replace the bearing carrier retainer nut if you detect thread damage. 3. Inspect the tab washer for damage. Replace as needed. Bearing Carrier Removal 1. Position the puller jaws to hold the bearing carrier. Attach the slide hammer puller to the puller jaws. 10763 c b a a - Puller jaws tool b - Bearing carrier c - Slide hammer puller tool Puller jaws assembly Puller bolt 91-46086A1 91-85716 Slide hammer 91-34569A 1 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 2. Remove the bearing carrier ab 18920 a - Propeller shaft b - Bearing carrier BEARING CARRIER INSPECTION 1. Check the bearing carrier for signs of corrosion, especially on the gear housing to bearing carrier mating surfaces. 2. Replace the bearing carrier If you detect corrosion. 3. The condition of the tapered roller bearing cup of the propeller shaft is an indication of the condition of the tapered roller bearing on the propeller shaft. Replace the bearing and cup if the cup is pitted, grooved, scored, worn, uneven, discolored from overheating, or has embedded metal particles. Propeller Shaft Assembly Removal 1. Pull the propeller shaft assembly straight up to remove from the gear housing. ab 18921 a - Propeller shaft b - Tapered roller bearing PROPELLER SHAFT ASSEMBLY INSPECTION 1. Inspect for damaged or twisted splines. 2. Inspect the surface of the shaft where the lips of the oil seal in the bearing carrier contact the shaft. If any grooves are detected, replace the oil seals. If deep grooves are detected, replace the oil seals and the propeller shaft. 3. Inspect the tapered roller bearing for excessive or uneven wear. Page 3E-14 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 4. If any gear teeth are found chipped or broken, inspect the tapered roller bearing for pitting. abc18922a a - Propeller splines c - Contact surface for bearing carrier b - Tapered roller bearing oil seals O-Ring, Thrust Washer, and Load Ring Removal 1. Remove the O-ring from the gear housing. a 18923 a - O-ring 2. Remove the thrust washer from the gear housing. a 18925 a - Thrust washer 3. Remove the load ring from the gear housing. a 18924 a - Load ring O-RING, THRUST WASHER, AND LOAD RING INSPECTION 1. Inspect the O-ring for damage, including flatness, tears, and nicks. 2. Check the thrust washer for damage. Normally the thrust washer will not be damaged. 90-865612031 AUGUST 2007 Page 3E-1 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. Replace all damaged parts. 4. Retain the load ring to use when checking preassemble specification. The load ring is not reused for final reassembly. 5. Use a new load ring for final assembly. Pinion Gear Screw Removal 1. Temporarily reinstall the bearing carrier retainer nut in the gear housing to protect the housing threads. a18831 a - Bearing carrier retainer nut 2 Remove the driveshaft pinion screw and washer. a. Hold the pinion screw stationary using a wrench, or a socket and a breaker bar. 18929abc a - Driven gear c - Pinion gear b - Pinion screw b. Install the driveshaft adapter tool on the driveshaft Page 3E-1 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ c. Place a breaker bar and socket on the driveshaft adapter tool. Turn COUNTERCLOCKWISE to loosen pinion screw. 18928abcda - Tool on the pinion screw b - Breaker bar and socket c - Driveshaft adapter tool d - Driveshaft Propeller shaft/driveshaft adapter 91-61077T PINION SCREW AND WASHER INSPECTION 1. Inspect the pinion screw and washer for damage. Replace as needed. Clamp Plate Tool Removal 1. Remove the nuts, washers, and clamp plate from the gear housing. abc a - Clamp plate b - Nuts (2) a 16010 c - Washers (4) Clamp plate 91-43559T 90-865612031 AUGUST 2007 Page 3E-1 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Driveshaft Preload Spacer Removal 1. Remove the O-ring and the spacer. a b 19473 a - O-ring b - Spacer 2. 3. 4. Remove the shims and the tab washer. Measure the shim thickness. Record the shim thickness. ab 19472 a - Shims b - Tab washer DRIVESHAFT PRELOAD SPACER INSPECTION 1. Inspect O-ring for cuts and nicks. Replace if damaged. 2. Inspect the spacer, shims, and the tab washer for damage. Replace damaged parts. Driveshaft and Pinion Gear Removal 1. Support the pinion gear while pulling the driveshaft straight up from the gear housing. NOTE:Be careful not to lose the rollers from the driveshaft pinion bearing if they drop during removal of the driveshaft. acabb10826 a - Driveshaft c - Preload bearing cup b - Driveshaft pinion gear Page 3E-18 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 2 Remove the pinion gear 18931a a - Pinion geaU DRIVESHAFT AND PINION GEAR INSPECTION AND CLEANING ! WARNING Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air. 1 Inspect the pinion gear for pitting, chipped or broken teeth and excessive or uneven wear. 2 The condition of the driveshaft tapered bearing cups is an indication of the condition of the tapered roller bearings on the driveshaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn uneven, discolored from overheating, or has embedded metal particles. 3 The condition of the bearing surface of the driveshaft at the needle bearing location is an indication of the condition of needle bearings. Replace the needle bearing and the drive shaft needle bearing race if it is pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or has embedded metal particles. 4 Inspect splines for worn or twisted condition. Replace the driveshaft if either condition exists. 5 Clean all parts that are to be reused with solvent. Dry the parts completely using compressed air, being careful not to spin bearings. 90-865612031 AUGUST 200 Page 3E-1 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ NOTE:The roller needle bearings have been removed from the bearing race for clarity d - Tapered roller bearings e - Bearing surface f - Splines afbcefd15980a - Roller needle bearings (19) b - Driveshaft assembly c - Preload bearing cup PINION GEAR BEARING NOTE:Theneedlebearingsmustbeinthepinionbearingraceif the pinion bearing is removed. Once the driveshaft is removed the roller needle bearings can easily fall from bearing race. � A cardboard piece can be inserted to keep all 19 roller needle bearings positioned in bearing race, and can easily be removed just before driveshaft is installed. � Needle bearings can be removed from pinion bearing race, and reinstalled later during reassembly of the gear housing. NOTE:The cardboard piece shown was retained from a new bearing. 18927abcaa - Cardboard piece b - Roller needle bearings c Front driven gear Driveshaft Lower Bearing Cup and Shims Removal 1. Position the slide hammer puller tool so that the jaws are holding the edge of the bearing cup and are not touching the gear housing. 2. Pull the bearing cup from the gear housing. Page 3E-2 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. Remove the shims ab c 15981 a - Slide hammer puller c - Shims b - Bearing cup Slide hammer 91-34569A 1 4. Measure the shims and record the measurement for later reassembly. a20993 a - Micrometer DRIVESHAFT LOWER BEARING CUP AND SHIMS INSPECTION 1. Inspect the bearing cup for pitting, grooves, scoring, uneven wear, discoloration from overheating, spalling, or from metal particles embedded in the cups. Replace the tapered roller bearings and the cups if you detect damage. 2. Shims become damaged during removal of the bearing cup and therefore may not be reused. Measure the thickness of the shims and record for later reassembly. Discard the shims. 90-865612031 AUGUST 2007 Page 3E-2 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Driven Gear and Bearing Removal 1. Remove the front driven gear and the bearing from the gear housing. a 18932 a - Driven gear and bearing DRIVEN GEAR AND BEARING INSPECTION 1. Inspect the driven gear for pitting, chipped or broken teeth, and excessive or uneven wear. If any of these conditions exist, replace both the gear and the bearing assembly-and-driveshaft pinion gear. NOTE:Inspect the bearing cup of the tapered roller bearing inside the gear housing. 2. Replace the tapered roller bearing and the bearing cup if the tapered roller bearing is pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or has metal particles embedded in the cup. 18933aba - Driven gear b - Tapered roller bearing Driven Gear Bearing Cup Removal NOTE:Pulling the bearing cup with the slide hammer puller tool will damage the shims. Do not reuse. Page 3E-22 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 1. Position the slide hammer puller tool so that the jaws are holding the edge of the bearing cup and are not touching the gear housing. a 19102 a - Slide hammer puller tool Slide hammer 91-34569A 1 2. Remove the driven gear bearing cup. a a - Driven gear bearing cup 20989 90-865612031 AUGUST 2007 Page 3E-2 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3 Remove the shims a20988 a - Shims 4. Measure the thickness of the shims and record the measurement for later reassembly. a20993 a - Micrometer DRIVEN GEAR BEARING CUP INSPECTION 1. Inspect bearing cup for pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or metal particles embedded in the cups. Replace the driven tapered roller bearing and the cup if damage is found. a18895 a - Driven gear bearing cup 2 Shims are damaged during the bearing cup removal and may not be reused. Measure the thickness of the shims for reassembly and discard the shims. Page 3E-2 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Gear Housing and Assemblies Teardown Inspection and Repair Gear Housing Inspection and Cleaning SPEEDOMETER WATER PASSAGE INSPECTION AND CLEANING 1. Inspect the pitot tube opening on the leading edge of the gear housing for any obstruction. 2. Clean the opening with a short piece of wire, if necessary. 3. If you remove the obstruction with wire, carefully reopen the tube using a 2 mm (5/64 inches) diameter drill bit. Do not drill beyond a depth of 62 mm (2�7/16 inches) . a 19358 a - Pitot tube opening SPEEDOMETER WATER PASSAGE SEAL REMOVAL 1. Pry off the speedometer water passage seal with a suitable tool. a 16837 a - Speedometer water passage seal 2. Inspect the speedometer water passage seal for nicks, cuts, or distortion. Replace if necessary. SPEEDOMETER WATER PASSAGE SEAL INSTALLATION 1. Apply adhesive to the outer diameter of the seal and install the seal in the speedometer water passage bore. 90-865612031 AUGUST 2007 Page 3E-2 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 2. Ensure that the top edge of the seal is flush with the surface of the gear housing a a - Seal 16838 Tube Ref No. Description 27 Bellows Adhesive Where Used O.D. of seal Part No. 92-86166Q1 Gear Housing Repair Painting Procedure Complete the following procedure when refinishing the gear housing and the driveshaft housings. This procedure provides the most durable paint system available in the field. The materials we recommend are of high quality and approximate marine requirements. If you follow this procedure closely, the new painting job will compare favorably with a properly applied factory paint finish. We recommend materials available at a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each listed is sufficient to refinish several gear housings or driveshaft housings. 1. Wash the gear housing with a muriatic acid base cleaner to remove any type of marine growth and rinse with water. 2. Wash the gear housing with soap and water, and then rinse. 3. Sand the blistered area with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather all broken paint edges. 4. Clean the gear housing thoroughly with wax and grease remover (DX-330). 5. Where bare metal is exposed, spot repair surfaces with alodine treatment (DX-503) . IMPORTANT: Do not use any type of aerosol spray paints: the paint will not properly adhere to the surface nor will the coating be sufficiently thick to resist future blistering. 6 Mix epoxy chromate primer (DP-40) with an equal part catalyst (DP-401) according to the manufacturer's instructions, allowing a proper induction period for permeation of the epoxy primer and catalyst. 7 Allow a minimum of one hour drying time and no more than one week before top-coating the assemblies. ! WARNING Continuous exposure to airborne particles such as chemical vapors, dust, or spray can cause serious injury or death. Ensure that the work area is properly ventilated and wear protective eyeware, clothing, and respirators. 8 Use Ditzler Urethane DU9000 for Mercury Black and Ditzler Urethane DU33414M for Sea Ray White. Catalyze all three colors with Ditzler DU5 catalyst mixed in a 1:1 ratio. Reduce with solvents according to the instructions on the Ditzler label. 9. The type of spray gun being used will determine the proper reduction ratio of the paint. IMPORTANT: Do not paint the sacrificial trim tabs or anodes. 10. Using a spray gun, apply 1/2�1 ml. film thickness evenly. Allow five minutes for dying then apply another even coat of 1/2�1 ml. thickness. Page 3E-2 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ NOTE:This urethane paint dries to touch in a matter of hours, but remains susceptible toscratches and abrasions for days. Driveshaft Assembly Repair PRELOAD BEARING REMOVAL NOTE:You must replace the bearing assembly if you remove it from the driveshaft. Remove damaged tapered roller bearings. 1 Press the preload tapered roller bearing from the driveshaft using a universal puller plate tool to support the bearing. dbca abc15985 a - Tapered roller bearing c - Universal puller plate tool b - Driveshaft d - Press Universal puller platX 91-37241 PINION HEIGHT BEARING REMOVAL 1. Press the pinion height tapered roller bearing from the driveshaft using the universal puller plate tool to support the bearing. dbca abc15986 a - Pinion height roller bearing c - Universal puller plate b - Driveshaft d - Press Universal puller platX 91-37241 90-865612031 AUGUST 200 Page 3E-2 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ BEARING RACE REMOVAL 1. Press the bearing race from the driveshaft using the universal puller plate tool to support the bearing. deacbdeca15987 a - Bearing race d - Press b - Driveshaft e - Mandrel c - Universal puller plate tool Universal puller plate 91-37241 BEARING RACE REASSEMBLE NOTE:You can use an old bearing race or inner race as a suitable mandrel for installing bearings. 1. Lubricate the I.D. of the bearing race. Tube Ref No. Description Where Used Part No. 87 High Performance Gear I.D. of the bearing race 92-858064K01 Lubricant Page 3E-28 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 2. Press a new bearing race to the driveshaft using a suitable mandrel acb 15992 a - Bearing race c - Suitable mandrel b - Driveshaft PINION HEIGHT BEARING REASSEMBLE 1. Lubricate the inner diameter of the small tapered roller bearing. Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant I.D. of small tapered roller bearing 92-858064K01 2 Position the pinion height of the roller bearing so that the smaller outer diameter faces the pinion end of driveshaft. 3 Press the pinion height roller bearing onto the driveshaft to the shoulder of driveshaft. acbde 15990 a - Pinion height roller bearing d - Suitable mandrel b - Driveshaft e - Press c - Shoulder of driveshaft PRELOAD BEARING REASSEMBLE 1. Lubricate the inner diameter of the large tapered roller bearing. 90-865612031 AUGUST 200 Page 3E-2 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant I.D. of large tapered roller bearing 92-858064K01 2. Press the large tapered roller bearing onto the driveshaft using a suitable mandrel. Ensure that the larger O.D. faces the pinion end of the shaft. a b e c d e a 15991 a - Large tapered roller bearing d - Press b - Driveshaft e - Small tapered roller bearing c - Suitable mandrel Propeller Shaft Inspection Check the propeller shaft for straightness using the lathe or the V-block method: 1. LATHE AND DIAL INDICATOR METHOD: a. Position the propeller shaft centers in the lathe. b. Mount the dial indicator at the front edge of the propeller shaft. c. Rotate the shaft and observe the dial indicator. Movement of more than 0.178 mm (0.007 in.) is reason for replacement. d. Inspect the shaft for bent or twisted splines. e. Inspect the surface of the shaft where the lips of the bearing carrier oil seal contact the shaft. You will need to replace the bearing carrier oil seals if you detect any grooves. 2. V-BLOCKS AND DIAL INDICATOR METHOD: a. Position the propeller shaft bearing surfaces on the V-blocks. b. Mount a dial indicator at the front edge of the propeller shaft. c. Rotate the shaft and observe the dial indicator. Movement of more than 0.178 mm (0.007 in.) is reason for replacement. d. Inspect the shaft for bent or twisted splines. e Inspect the surface of shaft where the lips of the bearing carrier oil seal contact the shaft. You will need to replace the bearing carrier oil seals if you detect any grooves. Page 3E-3 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Propeller Shaft Bearing Replacement BEARING REMOVAL 1. Press the bearing from the propeller shaft using the universal puller plate. abcd bcd 19489 a - Press c - Tapered roller bearing b - Propeller shaft d - Universal puller plate Universal puller plate 91-37241 BEARING INSTALLATION 1 Apply lubricant to the inside diameter of a new tapered roller bearing. 2 Install the bearing to the propeller shaft using an old bearing race as a mandrel to support the bearing on its inner race. 3 Press the bearing into place. eadcb 18934abcd a - Press d - Old bearing race b - Propeller shaft e - Propeller shaft shoulder c - Tapered roller bearing Tube Ref No. Description Where Used Part No. High Performance Gear 87 92-858064K01 Lubricant 90-865612031 AUGUST 200 Page 3E-3 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Pinion Bearing Removal IMPORTANT: All needle bearings must be in place inside bearing casing while driving pinion bearing from gear housing. Otherwise the bearing casing will bend or break and become difficult to remove. 1. Remove the pinion bearing. a. Assemble the driver rod tool to the bearing driver tool. b. Insert the driver rod and bearing driver tool assembly into the gear housing so the bearing driver tool rest on the pinion bearing. NOTE:The pilot washer prevents the bearing from becoming cocked during removal. c. Place the pilot washer tool over the driver rod tool and inside the gear housing. d. Using a hammer, strike the driver rod tool to drive the pinion bearing from the gear housing. e. Using a hammer, strike the driver rod tool to drive the pinion bearing from the gear housing. dabc 16631 a - Driver rod c - Pilot washer b - Bearing driver d - Hammer NOTE:The driver Head rod 91-37323 is included in the Bearing Removal and InstallationTool Assembly 91-31229A7. Driver rod 91-37323 Bearing driver 91-63638 1 Pilot washer 91-36571T Pinion Bearing Installation 1. Assemble the pinion bearing: a. Apply lubricant to the roller needle bearings. Tube Ref No. Description Where Used Part No. 4 Needle Bearing Assembly Lubricant Pinion bearing roller needle bearings 92-802868A1 b. Install the roller needle bearings in the bearing race Page 3E-32 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ c. Use additional lubricant to help keep the roller needle bearings in place. 2. Install the pinion bearing: a. Position the pinion bearing over the bearing driver tool with the number on the bearing race facing up. b. Lubricate the outer diameter of the pinion bearing race. b31708ca a - Pinion bearing c - Pinion bearing race outer diameter b - Bearing driver tool Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Pinion bearing race outer diameter 92-858064K01 Bearing driver 91-89867T c. Install the seal driver tool, the nut, and the washer onto the puller shaft tool. d. Place the puller shaft tool assembly on the gear housing as shown. NOTE:Ensure that the number on the bearing race is facing to the driveshaft wheninstalled. e. Position the pinion bearing and bearing driver tool through the gear housing torpedo and into the driveshaft cavity and align with the puller shaft tool. f. Thread the puller shaft tool into the bearing driver tool. 90-865612031 AUGUST 2007 Page 3E-3 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ g. Turn the nut CLOCKWISE to pull the pinion bearing completely into the driveshaft cavity until seated. 31325cdefab a - Pinion bearing d - Seal driver b - Bearing driver e - Nut c - Puller shaft f - Washer NOTE:The puller shaft 91-31229 is included in the Bearing Removal and Installation ToolAssembly 91-31229A7. Seal driver 91-813653T Bearing Removal and Installation kit 91-31229A7 h. Remove the tools. Front Driven Gear and Bearing Repair 1. If you determine that bearings are in need of replacement and the gear is still in good condition, remove the bearing from the gear using a universal puller plate and a suitable mandrel. (Bearings are damaged in removal and should not be reused.). cadeb 16376 a - Driven gear d - Press b - Universal puller plate e - Suitable mandrel c - Tapered roller bearing Universal puller plate 91-37241 2. Lubricate the I.D. of the new bearing. Page 3E-34 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. Place a suitable mandrel (old bearing race) against the inner bearing race. 4. Place another mandrel on the face of the gear and press the gear and bearing together. decba 16377 a - Driven gear d - Suitable mandrel b - Roller bearing e - Suitable mandrel (old bearing race) c - Press Tube Ref No. Description Where Used Part No. High Performance Gear 87 I.D. of new bearing 92-858064K01 Lubricant Front Driven Gear Bearing Cup Installation 1. For proper installation of the bearing cup use the special tools. abedccdeb 19148 a - Hammer d - Guide insert tool b - Driver rod tool e - Bering cup driver tool c - Guide plate tool 2. Install new shims of the exact measurement as the shims previously removed. 90-865612031 AUGUST 2007 Page 3E-3 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. If you cannot determine the thickness of the original shims, install a 0.38 mm (0.015 inch) shim for a starting point. a20988 a - Shims 4 Lubricate the O.D. of the bearing cup and place it in the gear housing with the tapered end towards the propeller. a20989 a - Bearing cup Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Bearing cup 92-858064K01 Page 3E-3 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 5. Install the bearing cup driver tool on top of the bearing cup a 20986 a - Bearing cup driver tool Bearing cup driver 91-31106T 6. Place the driver rod and guide insert tool into the gear housing so that the guide insert is in the bearing cup driver tool. a20984b a - Driver rod tool b - Guide insert tool Driver rod 91-37323 Guide insert tool 91-805473 90-865612031 AUGUST 2007 Page 3E-3 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 7. Place the guide plate tool in position 20987a a - Guide plate tool Guide plate 91-816243 8. Hold the guide plate tool against the gear housing. Drive the bearing cup until seated. a 20985 a - Hammer Bearing Carrier Repair If you detect corrosion on the bearing carrier, replace the bearing carrier. NEEDLE BEARING, OIL SEALS AND BEARING CUP REMOVAL 1. Perform Method "A" or "B," following: a. Method A: If replacing the propeller shaft needle bearing, press the needle bearing and oil seals from the carrier. NOTE:You will need to replace the needle bearing if you remove it. Page 3E-38 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ b. Method B: If propeller shaft needle bearing replacement is not required, pry the oil seals from the carrier. 18936abcd a - Oil seals (2) c - Pry bar or screwdriver b - Bearing carrier d - Vise 2. Remove the bearing cup using the slide hammer puller tool. 18937abc a - Bearing carrier c - Slide hammer puller tool b - Bearing cup Slide hammer 91-34569A 1 NEEDLE BEARING, OIL SEALS AND BEARING CUP INSTALLATION 1. Place the bearing cup in the bearing carrier. a 18938 a - Bearing cup 90-865612031 AUGUST 2007 Page 3E-3 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 2. Press the bearing cup into the bearing carrier using the bearing cup driver tool abc a - Bearing cup driver b - Bearing cup cad 18939 c - Press Bearing cup driver 91-63626 3. Position the needle bearing in the bearing carrier. 4. Assemble the bearing driver tool to the driver rod tool and place on the needle bearing. acba 19482 a - Needle bearing b - Bearing driver tool c - Driver rod tool Bearing driver 91-55918 Driver handle 91-805454 Page 3E-40 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 5. Press the needle bearing in place cba 19483 a - Needle bearing c - Press b - Driver rod tool NOTE:Needle bearing properly installed. ab 19484 a - Needle bearing b - Position for oil seals 6. Install the oil seals: NOTE:Two oil seals are installed back to back. The open face (inner) oil seal is installedjust above the needle bearing with the seal lip facing the bearing. The metal face (outer) oil seal is installed with the metal face toward the propeller. a. Position the inner oil seal on the oil seal driver tool. b. Coat the outside diameter of the oil seal with threadlocker. ab19486 a - Oil seal driver tool b - Oil seaO Oil seal driver 91-55916 90-865612031 AUGUST 2007 Page 3E-4 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker O.D. of oil seal 92-809819 c. Install the inner oil seal with the seal lip facing the needle bearing ab a - Press 19485 b - Oil seal driver tool d. e. Position the outer oil seal on the oil seal driver tool. Coat the O.D. of the oil seal with threadlocker. 19487ab a - Oil seal driver tool b - Oil seal Oil seal driver 91-55916 Tube Ref No. Description Where Used Loctite 271 Threadlocker O.D. of oil seal f. Install the outer oil seal with the seal lip facing the propeller. Part No. 92-809819 7 21015ab a - Press b - Oil seal driver tooO Page 3E-42 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ g. Fill the area between the oil seals with lubricant ab19488c a - Needle bearing c - Metal face of the outer oil seal b - Oil seals Tube Ref No. Description Where Used Part No. Between the oil seals of bearing 95 2-4-C with Teflon 92-802859A1 carrier. Gear Housing Shimming and Reassembly Final Checklist 1. The housing is clean. 2. The bearing cup is installed in gear housing for the front driven gear and bearing placement. a 19345 a - Front driven gear bearing cup 90-865612031 AUGUST 2007 Page 3E-4 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. The driveshaft needle bearing is installed in the gear housing and all 19 needle bearings are positioned inside. a 19346 a - Driveshaft roller needle bearing b - Driveshaft roller needle bearings Driveshaft Lower Bearing Cup and Shims Installation 1. Install shims of the original thickness for lowering the bearing cup into the gear housing. 2. If the shims were lost or ruined (i.e. the original thickness cannot be determined), install a 1.27 mm (0.050 in.) shim pack as a starting point. a 16347 a - Shims Page 3E-44 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. Install the lower bearing cup of the driveshaft using the bearing cup driver tool abcde 16349 a - Bearing cup d - Driven handle tool b - Bearing cup driver tool e - Guide insert tool c - Hammer Bearing cup driver 91-67443T Front Driven Gear and Bearing Installation 1. Install front driven gear-and-bearing assembly and shims having the same original thickness into the gear housing. 18932a a - Front driven gear and bearing assembly Driveshaft and Pinion Gear Installation 1. Install the driveshaft into the gear housing. 90-865612031 AUGUST 2007 Page 3E-4 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ NOTE:Be careful not to lose the rollers from the driveshaft pinion bearing in case they dropduring installation of the driveshaft. ab a 19347 a - Driveshaft b - Pinion gear 2. Install the pinion washer and pinion screw. a ba 19348 a - Pinion screw and washer b - Front driven geaU 3. Place a breaker bar and socket on the pinion screw. Torque the pinion screw abcca19349 a - Breaker bar or wrench c - Torque wrench b - Driveshaft adapter tool Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Threads of pinion screw 92-809819 Page 3E-46 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Description Pinion screw Nm 61 lb. in. lb. ft. 45 Driveshaft Upper Bearing Preload Cup and Tab Washer Installation 1. Install the upper bearing preload cup. aab 19350 a - Upper bearing preload cup b - Wooden hammer handle 2. Install the tab washer. ab b 16353 a - Tab washer b - Tab placement Driveshaft Bearing Preload Measurement 1. Determine the shim thickness required for driveshaft bearing preload. a. Measure the distance between the top of the gear housing and the tab washer using a 0�2.54 cm (0�1 inch) depth micrometer. a 16354 a - 0�2.54 cm (0�1 inch) depth micrometer 90-865612031 AUGUST 2007 Page 3E-4 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ b. Measure thickness of the spacer from the top machined surface to the bottoR machined surface using a 0�2.54 cm (0�1 inch) outside micrometer. a c b 16355 a - 0�2.54 cm (0�1 inch)outside micrometer b - Spacer c - Area to measure Driveshaft Bearing Preload Measurement Help Chart Order of Measurements mm in. Distance of gear housing to tab washer � (minus) Spacer thickness + (plus) Add measurement of 0.051 0.002 = (equals) Shim thickness to install to the gear housing 2. Install original thickness shims, spacer, and new O-ring. a a - Shimsb - Spacer b c 19340 c - O-ring 3. Install the clamp plate tool on the gear housing. Page 3E-48 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 4. Place 2 washers and 1 nut on each stud. Torque the nuts a a - Clamp plate b - Nuts abc18377 c - Washers (4) Description Nm lb. in. lb. ft Nuts on clamp plate tool 47 3 NOTE:The clamp plate tool must sit flat against the gear housing to be correctly positioned. aab 1599616000 Correctly positioned Incorrectly positioned a - Clamp plate b - Incorrect gap Clamp plate 91-43559T 90-865612031 AUGUST 2007 Page 3E-4 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 5 Using a dial lb-in. torque wrench, check the rolling preload by turning the driveshaft with a slow, steady motion. If necessary, add or subtract shims from beneath the spacer to bring the preload into the specified range. ba 19344 a - Driveshaft adapteU b - Dial lb-in. torque wrench Description Nm lb. in. lb. ft. Rolling preload of driveshaft 0.3-0.6 3-5 Torque wrench, lb. in 91-66274 Propeller shaft/driveshaft adapteU 91-61077T Pinion Gear Height Measurement 1. Ensure that the clamp plate has been reinstalled after adjusting preload in the previous step. The clamp plate tool must be in place for checking pinion height in the following procedure. 2. Ensure that the number of driven gear teeth match the drive gear ratio. Bravo Two Gear Housing Standard Bravo Two and Bravo Two X series Drive Gear RatiR 1.65: 1.50: 1.81: 2.00: 2.20: Drive Gear Teeth 18 18 16 16 16 Driven Gear Teeth 25 25 27 27 27 Page 3E-5 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. Match the shimming tool access hole to the correct gear teeth count 31298aa Bravo Two shimming toola - Access holes with the gear teeth count Gearcase Pinion Shimming Tool 91-96512 4. Check the pinion height as follows: a. Insert the shimming tool into the gear housing. b. Position the matching gear teeth count access hole to the pinion gear. abc 19343 a - Shimming tool c - DriveshafY b - Clamp platX NOTE:Refer toFeeler Gauge Measurement for further assistance. c. Insert the feeler gauge and measure the clearance of the shimming tool to the pinion gear teeth. 90-865612031 AUGUST 2007 Page 3E-5 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ d. Take measurements at three locations on the pinion gear, 120� apart 31302abbb c a a - Feeler Gauge b - Shimming tool c - Gear teeth centered on gauging surface Description Pinion gear clearance e. If clearance is within specification: mm 0.635 in. 0.025 i. Recheck the rolling preload to ensure that it is within specification. ii. When the rolling preload and the pinion height are within specification, you may continue the reassembly process, "Back Driven Gear Shim Installation." f. If clearance is less than specified: NOTE:Anythicknessaddedheremustbesubtractedtoshimthicknessattheupperbearing. i. Add appropriate thickness of shims under the lower tapered roller bearing cup. Refer to "Driveshaft Lower Bearing Cup and Shims Removal" and "Driveshaft Lower Bearing Cup and Shims Installation." a b 19337 a - Shims b - Bearing cuU Page 3E-52 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ ii. Subtract the appropriate thickness of shims from the upper bearing. Refer to "Driveshaft Preload Spacer Removal" and "Driveshaft Preload Spacer Installation." a b 19338 a - Shims b - Spacer g. If the clearance is more than specified: NOTE:Any thickness subtracted here must be added to shim thickness at upper bearing. i. Subtract the appropriate thickness of shims from under the lower tapered roller bearing cup. Refer to "Driveshaft Lower Bearing Cup And Shims Removal" and "Driveshaft Lower Bearing Cup and Shims Installation." a b 19337 a - Shims b - Bearing cup ii. Add the appropriate thickness of shims from the upper bearing. Refer to "Driveshaft Preload Spacer Removal" and "Driveshaft Preload Spacer Installation." a b 19338 a - Shims b - Spacer h. Recheck the pinion gear clearance. i. Recheck the rolling preload. 5. When the rolling preload and the pinion height are within specification, advance to continuing the reassembly process "Back Driven Gear Shim Installation." 90-865612031 AUGUST 2007 Page 3E-5 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Load Ring, Thrust Washer, and O-ring Installation NOTE:Do not use a new load ring at his time. Always use the original load ring topreassemble the gearcase. 1. Install the original load ring into the gear housing. a 18924 a - Load ring 2. Install the thrust washer into the gear housing. a 18925 a - Thrust washer 3. Install the O-ring into the gear housing. a 18923 a - O-ring Page 3E-54 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Propeller Shaft Assembly Installation 1. Install the propeller shaft assembly into the gear housing and the driven gear. Rotate the propeller slightly to engage the propeller shaft splines and the driven gear splines. ab 18921 a - Propeller shaft b - Tapered roller bearing Bearing Carrier Installation 1. Align the groove in the bearing carrier to the groove in the gear housing. 2. Install the bearing carrier over the propeller shaft and into the gear case with the grooves aligned. abc a - Propeller shaftb - Bearing carrier c 20999 c - Grooves aligneW 90-865612031 AUGUST 2007 Page 3E-5 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 3. Install the key in the groove and push the bearing carrier and the key into the gearcase. Ensure the key is flush with the bearing carrier. a b 21000 a - Key inserted in the groove b - Key flush with the bearing carrier Tab Washer and Bearing Carrier Retainer Nut Installation 1. Install the tab washer with the tab in the V-notch recess of the bearing carrier. a a - Tab washer b - Tab bc 21001 c - V-notch IMPORTANT: You must lubricate the bearing retainer nut of the outer propeller shaft to prevent corrosion and cracking in the gear housing. 2. Lubricate the threads on the bearing carrier retaining nut. Tube Ref No. Description Where Used Part No. Bearing carrier retaining nut 34 Special Lubricant 101 92-802865Q02 threads 3. Install the bearing carrier retainer nut into the gear housing. Page 3E-56 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ 4. Using your hands, turn the retainer nut COUNTERCLOCKWISE until you feel the thread engage and then turn CLOCKWISE to hand-tighten. a 18889 a - Bearing carrier retainer nut 5 Install the bearing carrier retainer tool. Rotate it slightly until the tool teeth are placed between the teeth of the retainer nut. 6 Tighten the bearing carrier retaining nut until the propeller shaft rotation has very heavy resistance and you can not rotate the propeller shaft by hand. ba 18888 a - Breaker bar b - Bearing carrier retainer nut wrench tool Bearing Carrier Retainer TooO 91-17257 Driven Gear Backlash Measurement and Shimming NOTE:The dial indicator adapter tool must be modified to fit over the stud of the gearhousing. 1. Install the dial indicator adapter, backlash indicator rod, and dial indicator. Ensure that the dial rod is aligned with "II" on the indicator rod. 90-865612031 AUGUST 200 Page 3E-5 Bravo Two Gear Housing Disassembly, Repair, and Reassembly ravo Two Gear Housing Disassembly, Repair, and Reassembly 2. Check gear backlash by lightly rotating the drive shaft back and forth. Do not allow the propeller shaft to turn. Observe the dial indicator. b c a 21165 Set-up used to measure the driven gear backlash a -Dial indicator adapter b -Backlash indicator rod c -Dial indicator Dial indicator adapter 91-83155 Backlash indicator rod 91-53459 Dial indicator 91-58222A1 Specification mm in. Gear backlash 0.304�0.381 0.012�0.015 NOTE 3. If the gear backlash is within specification.. Proceed to ....inal Assembly and ..verall Gear ..ousing Preload... :Refer to......i..en ..ea.. ..ea..ing ....e..o..al.. and......i..en ..ea.. ..ea..ing ...... Installation... 4. If backlash is more than specified.. Add shims under the driven gear bearing cup. 5. Recheck the backlash reading after reassembly. a b 21108 NOTa -Driven bearing cup b -Shims E:Refer to......i..en ..ea.. ..ea..ing ....e..o..al.. and......i..en ..ea.. ..ea..ing ...... Installation... 6. If backlash is less than specified.. remove shims under the driven gear bearing cup. Page 3E-58 90-865612031 AUGUST 2007 Bravo Two Gear Housing Disassembly, Repair, and Reassembly 90-865612031 AUGUST 2007 Page 3E-59 7. Recheck the backlash reading after reassembly. a b 21108 a - Driven bearing cup b - Shims Final Assembly and Overall Gear Housing Preload 1. Remove the bearing carrier, refer to ..Bearing Carrier removal... 2. Remove the propeller shaft assembly, refer to ..Propeller Shaft Assembly Removal... 3. Remove the O-ring, thrust washer, and load ring, refer to ......Ring.. ..hrust Washer.. and ..oad Ring Removal... 4. Reassemble using a new load ring. IMPORTANT: The bearing carrier and the threads on the retainer must be lubricated to prevent corrosion and cracking in the gear housing. Use lubricant on retainer and coat the outside the diameter on the carrier rounds with sealant. 5. Lubricate the bearing carrier seals and coat the carrier mating surfaces with sealant. Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Bearing carrier seals and spaces between seals 92-802859A1 Tube Ref No. Description Where Used Part No. 19 Perfect Seal Bearing carrier mating surface 92-34227-1 6. Install the bearing carrier and the tab washer in the gear housing. 7. Lubricate the threads on the bearing carrier retaining nut. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Bearing carrier retaining nut 92-802865..02 8. Install and tighten the bearing carrier retainer nut until you can feel the resistance to the propeller shaft rotation (to preload bearings). OVERALL GEAR HOUSING PRELOAD 1. Add the drive shaft bearing preload (previously recorded) to the propeller shaft bearing preload as outlined in the example below. IMPORTANT: The overall preload includes both the drive shaft preload and the gear case preload. NOTE: A bearing is considered used if spun under load even once (..under load.. meaning: with power applied). NOTE: Plus drive shaft preload of 0.3�0.6 Nm (3�5 lb. in.) Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Example: Rolling preload of drive shaft bearing 0.3�0.6 Nm (3-5 b. in.) Preload Checked at Propeller Shaft (New Bearings) 0.9�1.14 Nm (8�12 b. in.) Overall Gear Case Preload Checked at Propeller Shaft 0.6�0.9 Nm (5�8 b. in.) Used bearings +0.3�0.6 Nm (3�5 lb. in.) 2. Tighten the retainer in small increments using bearing carrier retainer tool. ba 18888 a - Ratchet and sockeY b - Bearing retainer nut wrench tool Bearing carrier retainer tooO 91-17257 3. Check the bearing preload of the overall gear housing: a Hand tighten a propeller nut on the propeller shaft. b Place an lb. in. torque wrench with a socket on the propeller nut. c. Rotate the propeller shaft in the normal direction with a slow, steady motion while watching the dial indicator. ab 19474 a - Socket on a propeller nut b - Torque wrench, lb. in. tool To4. rque Wrench, lb. in. When the propeller shaft preload is correct: 91-66274 a Bend one tab of the tab washer into the retaining nut. b Bend the remaining tabs of the tab washer down into the gear housing. Cushion the gear housing to avoid chipping or scratching the paint. Page 3E-6 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Oil Passage Quad Ring and Water Passage O-ring Installation 1. Apply adhesive to the gear housing groove for the water passage O-ring. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Gear housing groove for the water passage O-ring 92-86166Q1 2. Install the water passage O-ring. ab 19475 a - Water passage O-ring b - Gear housing groove for the water passage O-ring 3. Apply adhesive to the gear housing groove for the oil passage quad ring. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Gear housing groove for the oil passage quad ring 92-86166Q1 4. Install the oil passage quad ring. ab 19476 a - Oil passage quad ring b - Gear housing groove for the oil passage quad ring Bravo Two Gear Housing�Driveshaft Housing Installation NOTE:Before reassembling the gear housing to the driveshaft housing: ensure that all O-rings and seals are installed, and the gear housing and the driveshaft housing are completely assembled and free from defects. 1. If the anode was removed: place the star washer and screw in the gear housing. a. Install the anode plate and secure it with the screw. 90-865612031 AUGUST 2007 Page 3E-6 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ b. Torque the screw 21427ba a - Screw and star washer b - Anode plate Description Nm lb. in. lb. ft. Anode plate screw 27 20 2. Align the studs to the holes and place the drive shaft housing on the gear housing 3. Use a washer on the bolt, and install the bolt into the bolt hole aft of the anode plate ba21426 a - Anode plate b - Bolt hole 4. Install a washer and a nut on each stud and tighten. 5. Torque the six nuts and one bolt. abc21424 a - Nuts and washers (3 each side) c - Screw for anode plate b - Bolt and washer (1) 6. Torque fasteners Page 3E-62 90-865612031 AUGUST 200 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Description Nm lb. in. lb. ft. Gear housing to driveshaft housing nuts and bolts 47 35 7. Fill the sterndrive with gear lube. Refer to Section 1B � Maintenance. 8. Reinstall the sterndrive to the boat. Refer to Section 2A � Installation and Adjustments. 90-865612031 AUGUST 2007 Page 3E-6 Bravo Two Gear Housing Disassembly, Repair, and Reassembl\ Notes Page 3E-64 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Bravo Sterndrive Section 3F - Bravo Three Gear Housing Disassembly, Repair, and Reassembly Table of Contents

Page 3F-2 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Lubricant, Sealant, Adhesives 4 7 19 27 Tube Ref No. Description Needle Bearing Assembly Lubricant Loctite 271 Threadlocker Perfect Seal Bellows Adhesive 34 Special Lubricant 101 87 High Performance Gear Lubricant Special Tools Clamp plate Where Used Part No. Pinion bearing roller needle bearings 92-802868A1 O.D. of oil seal Threads of pinion screw 92-809819 Bearing carrier tapered surface 92-34227-1 O.D. of seal Gear housing groove for the water passage O-ring 92-86166Q1 Gear housing groove for the oil passage quad ring Lips of oil seal and fill area between lips of seal Between the seal lips of the outer propeller shaft 92-802865Q02 Threads of the retainer nut of the outer propeller shaft bearing Between the seal lips of the bearing carrier I.D. of the bearing race I.D. of small tapered roller bearing I.D. of large tapered roller bearing Pinion bearing race outer diameter 92-858064K01 I.D. of new bearing Bearing cup O.D. of the roller needle bearing Back driven gear bearing cup 91-43559T Installs onto the gear housing while separated from the driveshaft housing and holds a preload while checking the the gear backlash and bearing preload. 10486 Dial indicator adapter 91-83155 Attaches the dial indicator to the gearcase when checking backlash. 2999 90-865612031 AUGUST 2007 Page 3F- Bravo Three Gear Housing Disassembly, Repair, and Reassembly Bearing Removal and Installation kit 91-31229A7 Installs and removes the bearings in all gearcases. 91-31229A7 tool assembly includes the following components: 11-24156 Hex nut 12-34961 Washer 91-15755T Bearing carrier 91-29310 Plate 91-29610 Pilot plate 91-30366T1 Mandrel 91-31229 Puller shaft 91-32325T Driver head 91-32336 Driver needle bearing 91-36379 Puller/head gear 91-36569T Driver head 91-36571T Pilot washer 91-37292 Roller bearing 91-37311 Driver head 91-37312 -Driver head 91-37323 Driver head rod 91-37324 Pilot washer 91-38628T Puller/driver head 91-52393 Driver needle bearing 91-52394 Head pull rod Dial indicator 91-58222A1 2966 9479 Measures gear backlash and pinion gear location. Bearing carrier tool 91-805374-1 10471 Removes and installs the driveshaft bearing carrier. Bearing retainer tool 91-805382T 10481 Removes and installs the outer propeller shaft bearing retainer. Bearing carrier tool 91-805374 Aids in the removal and installation of the outer propeller shaft bearing carrier. Also used with Bearing Retainer Tool (91-805382T) to remove propeller shaft retainer nut. 10470 Page 3F-4 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Propeller shaft/driveshaft adapter 91-61077T 10805 Provides a wrench surface to turn the propeller shaft or the driveshaft. Slide hammer 91-34569A 1 Aids in the removal of various engine components. Use with 6761 puller jaws. Universal puller plate 91-37241 Removes bearings from gears and the driveshaft. Outer propeller shaft bearing driver 91-805352T 8505 10479 Installs the roller bearing into the outer propeller shaft. Spline backlash tool 91-806192 10692 Measures the propeller shaft to gear spline backlash while on V-blocks. Driver rod 91-37323 Used in pinion gear and pinion bearing installation. 25431 Bearing driver 91-63638 1 Removes and installs the lower driveshaft pinion bearing. 10477 90-865612031 AUGUST 2007 Page 3F- Bravo Three Gear Housing Disassembly, Repair, and Reassembly Pilot washer 91-36571T Used in pinion gear and pinion bearing installation. 29490 Bearing driver 91-89867T 10478 Aids in the installation of the driveshaft needle bearings. Seal driver 91-813653T Installs the U-joint oil seal into the bearing carrier. Also used to pilot the puller rod for the installation of the gear housing needle bearing. 10852 Bearing cup driver 91-31106T Installs the driven gear bearing cup. 8882 Guide insert tool 91-805473 Inserts into the Bearing cup driver (91-31106T) when installing the front driven gear bearing cup. 20864 Guide plate 91-816243 Centers the rod used to drive in the forward gear bearing on a standard rotation gearcase, and the reverse gear bearing on a counter rotation gearcase. 4481 Seal removal tool 91-862064A 1 Aids in the removal of the bearing carrier needle bearing and oil seals. 10685 Page 3F-6 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Bearing carrier tool 91-805356 10469 Aids in the installation of the bearing carrier needle bearing. Bearing carrier seal driver 91-805372 10683 Aids in the installation of seals into the bearing carrier. Bearing cup driver 91-67443T Installs the driveshaft bearing cup into the gear housing, and the bearing cup into the bearing carrier. 10838 Torque wrench, lb. in. 91-66274 Dial type torque wrench that sets torque from 9 to 150 lb. in.; 3/8 in. drive. Shimming tool 91-805462T 10689 Aids in measuring the pinion height. Driveshaft retaining tool 91-863738 10829 Holds the bearings and the lower driveshaft while checking backlash. Backlash indicator rod 91-805481 10843 Indicates the inner propeller shaft backlash. 10453 90-865612031 AUGUST 2007 Page 3F- Bravo Three Gear Housing Disassembly, Repair, and Reassembly Backlash indicator rod 91-805482 Indicates the outer propeller shaft backlash. 10455 Specifications Bearing Preloads NOTE:All measurements include driveshaft preload. NOTE:A bearing is used if spun once under load. Description Driveshaft bearing Overall preload checked at inner propeller shaft (new bearings) Overall gear case preload checked at inner propeller shaft (used bearings) Propeller Shaft Runout Propeller Shaft Deflection Chart Nm lb. in. 0.3�0.6 3�5 0.9�2 8�18 0.6�1.7 5�15 Bravo Three Models Maximum Specification Inner propeller shaft 0.127 mm 0.005 in. Outer propeller shaft 0.254 mm 0.010 in. Gear Backlash Description mm in. Gear backlash 0.3�0.4 0.012� 0.016 Pinion Gear Clearance Description mm in. Pinion gear clearance 0.635 0.025 Back Driven Gear Shim Thickness Description mm in. Back driven gear shim thickness (use as a starting point measurement) 1.3 0.050 Propeller Shaft End Play Description mm in. Propeller shaft end play 0.025� 0.030 0.001� 0.012 Page 3F-8 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Bravo Three Gear Housing�Drive Gear Ratio (Teeth Per Gear) Bravo Three Gear Housing Standard Bravo Three and Bravo Three X series Bravo Three XR Torque Specifications Drive Gear Ratio 1.65:1 1.50:1 1.36:1 1.18:1 2.00:1 2.20:1 2.43:1 2.00:1 Drive Gear Teeth 18 15 15 16 16 16 13 16 NOTE:Securely tighten all fasteners not listed below. Description Pinion screw Clamp plate Rolling preload of driveshaft Gear housing to driveshaft housing nuts and bolts Anode plate bolt Propeller locknut Feeler Gauge Measurement 1. To properly check gear location: Nm 6 4 0.3�0. 4 2 7 Driven Gear Teeth 25 19 19 27 27 27 24 27 lb. in. lb. ft. 45 35 3�5 35 20 55 a Position the gear with at least 2 full teeth centered on the gauging surface. One full tooth must be on each side of the gauging surface center line. Insert a 0.64 mm (0.025 in.) feeler gauge between a tooth and the gauging surface. b Slightly rotate the shimming tool until one side of the gauging surface contacts the feeler gauge and a slight drag is felt on the feeler gauge. c Without moving the shimming tool, remove the feeler gauge and re-insert it between the other tooth and the gauging surface. 16361 2. If the feeler gauge can be inserted with only a slight drag, the shimming is correct 90-865612031 AUGUST 200 Page 3F- Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3 If the feeler gauge inserts with no drag, repeat Steps 1., a., b., and c. with progressively thicker feeler gauges until the feeler gauge can be inserted with only a slight drag. 4 If the feeler gauge cannot be inserted, repeat Steps 1., a., b., and c. with progressively thinner feeler gauges until the feeler gauge can be inserted with only a slight drag. Torque Conversion Chart For Bearing Carrier Length of torque wrench mm 381 406 432 457 483 508 533 559 584 610 635 660 686 711 737 762 787 813 838 864 889 914 in. 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 Reading in lb-ft (Nm) of torque wrench to achieve 150 lb. ft. (203 Nm) Nm 165 167 168 171 172 174 175 175 176 178 179 179 180 180 182 182 183 183 184 184 184 186 lb. ft. 122 123 124 126 127 128 129 129 130 131 132 132 133 133 134 134 135 135 136 136 136 137 a 16135 a - Torque wrench length Page 3F-1 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Torque Conversion Chart For Bearing Retainer Nut Length of torque wrench mm 381 406 432 457 483 508 533 559 584 610 635 660 686 711 737 762 787 813 838 864 889 914 in. 15 16

17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 Reading of torque wrench in lb. ft. (Nm) to achieve 200 lb. ft. (271 Nm) Nm 220 222 225 226 229 230 232 235 236 237 237 239 240 241 241 243 244 244 245 245 247 247 lb. ft. 162 164 166 167 169 170 171 173 174 175 175 176 177 178 178 179 180 180 181 181 182 182 a16135 a - Torque wrench length Outer Prop Shaft Bearing Retainer and Bearing Carrier Torque Procedure Use the following procedure to torque the outer prop shaft bearing retainer and the bearing carrier. 1. On beam-type torque wrenches: measure from the square drive to the fulcrum (pivot) point of handle. 2 On click-stop or dial type torque wrenches: measure from the square drive to the reference mark on the handle (2 bands, etc.). 90-865612031 AUGUST 200 Page 3F-1 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Bravo Three Gear Housing Exploded View 785455505251534755045657 Page 3F-12 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 1 - Gear housing assembly 2 - Stud 3 - Water passage O-ring 4 - Speedometer passage seal 5 - Oil quad ring seal 6 - Screw 7 - Lockwasher 8 - Anodic plate 9 - Roller bearing (of pinion gear) 10 - Fill and drain plug 11 - Seal 12 - Screw 13 - Washer 14 - Pinion Gear 15 - Shim 16 - Bearing cup and tappered roller bearing 17 - Driveshaft assembly 18 - Bearing race 19 - Tappered roller bearing and bearing cup 20 - Tab washer 21 - Shim 22 - Spacer 23 - O-ring 24 - Coupling 25 - Retaining ring 26 - Shim 27 - Bearing cup and tappered roller bearing 28 - Inner propeller shaft 29 - Caged roller bearing Gear Housing Disassembly Gear Housing Preparation 30 - Bushing 31 - Shim 32 - Ring 33 - Shim 34 - Tapered roller bearing and bearing cup 35 - Outer propeller shaft 36 - Roller bearing 37 - Oil Seal 38 - Retainer nut 39 - Bearing carrier 40 - O-ring 41 - Roller bearing 42 - Oil seal 43 - Front thrust hub 44 - Front propeller nut 45 - Rear thrust hub 46 - Rear propeller nut 47 - Screw 48 - Washer 49 -Nut 50 - Propeller shaft anode 51 - Washer 52 - Lockwasher 53 - Screw 54 - Anodic plate 55 - Screw 56 - Front driven gear 57 - Back driven gear For complete disassembly of the gear case: Secure the gear case tightly so that it will not move when loosing a torque of 271 Nm (200 lb. ft.). 1. Install the gear housing in a fixture or stand. 2. Properly secure the gear housing. 90-865612031 AUGUST 2007 Page 3F-1 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Oil Passage Quad Ring and Water Passage O-ring Removal 1. Remove the oil passage quad ring. a 16057 a - Oil passage quad ring 2. Remove the water passage O-ring. a 18357 a - Water passage O-ring WATER PASSAGE O-RING AND OIL PASSAGE QUAD RING INSPECTION 1. Inspect the oil passage quad ring for nicks or cuts. Replace if you detect damage. 2. Inspect the water passage O-ring for flatness cuts or nicks. Replace if you detect damaged. Clamp Plate Tool Installation IMPORTANT: Failure to use appropriate tools when installing or removing components can result in product damage. Always use the correct tools in the specified manner when performing these procedures. IMPORTANT: The clamp plate tool maintains the position of the driveshaft and the bearings, preventing damage to the internal components when disassembling the sterndrive. 1. Install the clamp plate tool on the gear housing. Page 3F-14 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2. Place two (2) washers and one (1) nut on each stud. Tighten securely. a a - Clamp plate b - Nuts abc18377 c - Washers (4) NOTE:The clamp plate tool must sit flat against the gear housing to be correctly positioned. aab Correctly positioned a - Clamp plate 15996 16000 Incorrectly positioned b - Incorrect gap Clamp plate 91-43559T Propeller Shaft Runout Test 1. Perform the propeller shaft runout test on the Inner propeller shaft. a. Assemble the all-thread rod to the dial indicator adapter tool. 19395baa a - All-thread rod b - Dial indicator adapter tool Dial indicator adapter 91-83155 90-865612031 AUGUST 2007 Page 3F-1 Bravo Three Gear Housing Disassembly, Repair, and Reassembly NOTE:The all-thread rod is a component of the Bearing Removal and Installation kit. Bearing Removal and Installation kit 91-31229A7 b. Position the sterndrive with the propeller shafts positioned up. c. Position the dial indicator probe on the inner propeller shaft. d. Rotate the inner propeller shaft while observing the dial indicator. e. Deflection more than the maximum specification indicates a bent inner propeller shaft. ab 19365 a - Inner propeller shaft b - Dial indicator Propeller Shaft Round Deflection Bravo Three Models Maximum Specification Inner propeller shaft 0.127 mm 0.005 in. Dial indicator 91-58222A1 2 Perform the propeller shaft runout test on the outer propeller shaft. a. Position the sterndrive with the propeller shafts in a downward positioned. b. Place the dial indicator probe on the outer propeller shaft. c. Rotate the outer propeller shaft while observing the dial indicator. d. Deflection more than the maximum specification indicates a bent outer propeller shaft. ab 19368 a - Dial indicator b - Outer propeller shaft Page 3F-1 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Propeller Shaft Round Deflection Bravo Three Models Outer propeller shaft 0.254 mm Maximum Specification 0.010 in. Dial indicator adapter 91-83155 Dial indicator 91-58222A1 Propeller Shaft Bearing Carrier Removal NOTE:Bearing carrier has a LEFT HAND THREAD. Remove by turning CLOCKWISE. 1. Install the bearing carrier tool to the bearing carrier. 2. Install a breaker bar to the bearing carrier tool and turn CLOCKWISE to loosen the bearing carrier. You may use a cheater bar if necessary. 3. To ease removal, you can heat the area using a torch lamp where the carrier and housing meet. dca a - Bearing carrier tool b - Bearing carrier cba16001 c - Breaker bar d - Cheater bar (piece of pipe) Bearing carrier tool 91-805374-1 PROPELLER SHAFT BEARING CARRIER INSPECTION 1. Inspect the bearing carrier for signs of corrosion, especially on the gear housing to the bearing carrier mating surfaces. If you detect corrosion, replace bearing carrier. 90-865612031 AUGUST 2007 Page 3F-1 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2 Inspect the needle bearing for pitting, grooves, discoloration, or embedded particles. If any of these conditions exist, you will have to replace the needle bearing. ab16002 a - Bearing carrier b - Needle bearing Propeller Shaft Bearing Retainer Nut Removal 1. Position the bearing retainer tool in the gear case and rotate the tabs of the tool between the tabs of the retainer nut. 2. Install the bearing carrier tool over the bearing retainer tool. 3. Install a breaker bar to the bearing carrier tool and turn CLOCKWISE to loosen the retainer nut. You may use a cheater bar, if necessary. dccab e 16003 a - Bearing retainer tool d - Cheater bar b - Bearing carrier tool e - Bearing retainer c - Breaker bar Bearing retainer tool 91-805382T Bearing carrier tool 91-805374 PROPELLER SHAFT BEARING RETAINER NUT INSPECTION 1. Inspect the nut threads and tabs of the bearing retainer for damage. 2. Replace the bearing retainer nut if you detect any damage. Page 3F-1 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Outer Propeller Shaft, Inner Propeller Shaft and Shim Removal ! CAUTION Heavy sterndrive components may come apart suddenly and forcefully, resulting in possible injury. Properly support the power package during disassembly. Remove the outer propeller shaft and the inner propeller shaft separately. 1 Press down on the inner propeller shaft and pull the outer propeller shaft assembly straight up to remove from the gear housing. ab 16004 a - Inner propeller shaft b - Outer propeller shaft assembly 2 Lift the the inner propeller shaft straight up and remove shaft and thrust bearing from the gear housing. aab 18716 a - Inner propeller shaft b - Thrust bearing 90-865612031 AUGUST 200 Page 3F-1 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3. Remove the outer propeller shaft shims from the gear housing. a 16005 a - Shims OUTER PROPELLER SHAFT, INNER PROPELLER SHAFT AND SHIM INSPECTION 1. Inspect the propeller shafts for damaged or twisted splines. 2. Inspect the surface of the outer propeller shaft where the bearing carrier oil seal lips contact the shaft. Replace the outer propeller shaft and the bearing carrier oil seals if you detect grooves. a15974 a - Contact surface 3 Inspect the needle bearing surface on the outer propeller shaft and the bearing surface of the inner propeller shaft for pitting, grooves, discoloration, or embedded particles. If any of these conditions exist, replace the shaft. ab a - Needle bearing surface b - Outer propeller shaft cd15976 c - Bearing surface d - Inner propeller shaft Page 3F-2 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4 The condition of the bearing surfaces on the outer propeller shaft and on the inner propeller shaft is an indication of the condition of the bearings in the bearing carrier and the outer propeller shaft. Inspect the bearing rollers for pitting, grooves, discoloration, or embedded particles. If any of these conditions exist, replace bearings and shaft. 15978ba a - Roller bearing (inside) b - Bearing surface 5 Inspect the outer propeller shaft tapered bearing and bearing cup. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or has embedded metal particles. abc15979 a - Outer propeller shaft c - Bearing cup b - Tapered bearing 90-865612031 AUGUST 200 Page 3F-2 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Pinion Screw and Washer Removal 1. Remove the driveshaft pinion screw and washer: abccbd16009a - Pinion gear b - Washer c - Pinion screw d - Front driven gear a. Place a breaker bar and socket or place a wrench on the pinion screw. a bc 16006 a - Breaker bar and socket on pinion c - Pinion gear screw b - Wrench on pinion screw b. Install the driveshaft adapter tool to the driveshaft. Page 3F-22 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly c Place a breaker bar and socket on the driveshaft adapter tool. Turn COUNTERCLOCKWISE to loosen pinion screw. ab 16008 a - Driveshaft adapter tool b - Breaker bar and socket Propeller shaft/driveshaft adapter 91-61077T d. Remove the pinion screw and washer. PINION SCREW AND WASHER INSPECTION 1. Inspect the pinion screw and washer for damage. Replace as needed. Clamp Plate Tool Removal 1. Remove the nuts, washers, and clamp plate from the gear housing. abc a - Clamp plate b - Nuts (2) a 16010 c - Washers (4) Clamp plate 91-43559T 90-865612031 AUGUST 200 Page 3F-2 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Driveshaft Preload Spacer Removal 1. Remove the O-ring and the spacer. a b 19473 a - O-ring b - Spacer 2. 3. 4. Remove the shims and the tab washer. Measure the shim thickness. Record the shim thickness. ab 19472 a - Shims b - Tab washer DRIVESHAFT PRELOAD SPACER INSPECTION 1. Inspect O-ring for cuts and nicks. Replace if damaged. 2. Inspect the spacer, shims, and the tab washer for damage. Replace damaged parts. Driveshaft and Pinion Gear Removal 1. Support the pinion gear while pulling the driveshaft straight up from the gear housing. 2. Remove the pinion gear. Page 3F-24 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly NOTE:Be careful not to lose rollers from driveshaft pinion bearing should they drop duringdriveshaft removal. 16013cbaa - Driveshaft b - Driveshaft pinion gear c Preload bearing cup DRIVESHAFT AND PINION GEAR INSPECTION AND CLEANING ! WARNING Spin-drying bearings with compressed air can cause serious injury or death. The bearings can explode, even if spun at very slow speeds. Do not allow the bearings to spin when drying with compressed air. 1 Inspect the pinion gear for pitting, chipped or broken teeth and excessive or uneven wear. 2 The condition of the driveshaft tapered bearing cups is an indication of the condition of the tapered roller bearings on the driveshaft. Replace bearing and bearing cup if the cup is pitted, grooved, scored, worn uneven, discolored from overheating, or has embedded metal particles. 3 The condition of the bearing surface on the driveshaft at the needle bearing is an indication of the condition of the needle bearings. Replace the needle bearing and race if the bearing or race are pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or has embedded metal particles. 4 Inspect the splines for worn or twisted condition. Replace driveshaft if either condition exists. 5 Clean all parts that are to be reused with solvent. Dry the parts completely using compressed air, being careful not to spin the bearings. 90-865612031 AUGUST 200 Page 3F-2 Bravo Three Gear Housing Disassembly, Repair, and Reassembly NOTE:Bearing rollers are removed from the bearing race for clarity. d - Tapered roller bearings e - Bearing surface f - Splines afbcefd15980a - Bearing rollers (19) b - Driveshaft assembly c - Preload bearing cup PINION GEAR BEARING NOTE:The bearing rollers must be in the pinion bearing race if the pinion bearing is removed. When the driveshaft is removed the bearing rollers can easily fall from bearing race. NOTE:The cardboard piece shown was obtained from the packaging of a new pinion gearbearing purchase. � You can insert a cardboard piece to keep all 19 bearing rollers positioned in the bearing race, and can easily be removed just before driveshaft is installed. � You can remove bearing rollers from the pinion bearing race and reinstall them later during reassembly of the gear housing. 16014cbbdaa - Cardboard piece b - Bearing rollers c - Front driven gear d - Pinion bearing Driveshaft Lower Bearing Cup and Shims Removal 1. Position the slide hammer puller tool so that the jaws are holding the edge of the bearing cup and are not touching the gear housing. 2. Pull the bearing cup from the gear housing. Page 3F-2 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3. Remove the shims. ab c 15981 a - Slide hammer puller c - Shims b - Bearing cup Slide hammer 91-34569A 1 4. Measure the shims and record the measurement for later reassembly. a20993 a - Micrometer DRIVESHAFT LOWER BEARING CUP AND SHIMS INSPECTION 1. Inspect the bearing cup for pitting, grooves, scoring, uneven wear, discoloration from overheating, spalling, or from metal particles embedded in the cups. Replace the tapered roller bearings and the cups if you detect damage. 2. Shims become damaged during removal of the bearing cup and therefore may not be reused. Measure the thickness of the shims and record for later reassembly. Discard the shims. 90-865612031 AUGUST 2007 Page 3F-2 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Front Driven Gear and Bearing Removal 1. Remove the front driven gear and the bearing from the gear housing. aa 18727 a - Front driven gear and bearing assembly FRONT DRIVEN GEAR AND BEARING INSPECTION 1. Inspect the front driven gear for pitting, chipped or broken teeth, and excessive or uneven wear. If any of these conditions exist, replace both gear and bearing assembly and the driveshaft pinion gear. NOTE:Inspect the bearing cup of the tapered roller bearing inside the gear housing. 2. Replace the tapered roller bearing and the bearing cup if the tapered roller bearing is pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or have metal particles embedded in the cup. ab15982 a - Front driven gear b - Tapered roller bearing Front Driven Gear Bearing Cup Removal 1. Position the slide hammer puller tool so that the jaws are holding the edge of the bearing cup and are not touching the gear housing. 2. Pull the bearing cup from the gear housing. 3. Remove the shims. 4. Measure the thickness of the shims and record the measurement for later reassembly. Page 3F-28 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly NOTE: Pulling the bearing cup with the slide hammer puller tool will damage the shims. Do not reuse. ab c 15984 a - Slide hammer puller c - Shims b - Bearing cup Slide Hammer 91-34569A 1 FRONT DRIVEN GEAR BEARING CUP INSPECTION 1. Inspect the bearing cup for pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or metal particles embedded in the cup. Replace the front driven tapered roller bearing and the cup if damage is found. 2. Shims are damaged during the bearing cup removal and may not be reused. Measure the thickness of the shims for reassembly and discard the shims. Gear Housing and Assembly Teardown Inspection and Repair Gear Housing Inspection and Cleaning SPEEDOMETER WATER PASSAGE INSPECTION AND CLEANING 1. Inspect the pitot tube opening on the leading edge of the gear housing for any obstruction. 2. Clean the opening with a short piece of wire, if necessary. 3. If you remove the obstruction with wire, carefully reopen the tube using a 2 mm (5/64 inches) diameter drill bit. Do not drill beyond a depth of 62 mm (2�7/16 inches) . a 19358 a - Pitot tube opening 90-865612031 AUGUST 2007 Page 3F-2 Bravo Three Gear Housing Disassembly, Repair, and Reassembly SPEEDOMETER WATER PASSAGE SEAL REMOVAL 1. Pry off the speedometer water passage seal with a suitable tool. a 16837 a - Speedometer water passage seal 2. Inspect the speedometer water passage seal for nicks, cuts, or distortion. Replace if necessary. SPEEDOMETER WATER PASSAGE SEAL INSTALLATION 1. Apply adhesive to the outer diameter of the seal and install the seal in the speedometer water passage bore. 2. Ensure that the top edge of the seal is flush with the surface of the gear housing. a a - Seal 16838 Tube Ref No. Description 27 Bellows Adhesive Where Used O.D. of seal Part No. 92-86166Q1 Gear Housing Repair Painting Procedure Complete the following procedure when refinishing the gear housing and the driveshaft housings. This procedure provides the most durable paint system available in the field. The materials we recommend are of high quality and approximate marine requirements. If you follow this procedure closely, the new painting job will compare favorably with a properly applied factory paint finish. We recommend materials available at a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each listed is sufficient to refinish several gear housings or driveshaft housings. 1. Wash the gear housing with a muriatic acid base cleaner to remove any type of marine growth and rinse with water. 2. Wash the gear housing with soap and water, and then rinse. Page 3F-30 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3. Sand the blistered area with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather all broken paint edges. 4. Clean the gear housing thoroughly with wax and grease remover (DX-330). 5. Where bare metal is exposed, spot repair surfaces with alodine treatment (DX-503) . IMPORTANT: Do not use any type of aerosol spray paints: the paint will not properly adhere to the surface nor will the coating be sufficiently thick to resist future blistering. 6 Mix epoxy chromate primer (DP-40) with an equal part catalyst (DP-401) according to the manufacturer's instructions, allowing a proper induction period for permeation of the epoxy primer and catalyst. 7 Allow a minimum of one hour drying time and no more than one week before top-coating the assemblies. ! WARNING Continuous exposure to airborne particles such as chemical vapors, dust, or spray can cause serious injury or death. Ensure that the work area is properly ventilated and wear protective eyeware, clothing, and respirators. 8 Use Ditzler Urethane DU9000 for Mercury Black and Ditzler Urethane DU33414M for Sea Ray White. Catalyze all three colors with Ditzler DU5 catalyst mixed in a 1:1 ratio. Reduce with solvents according to the instructions on the Ditzler label. 9. The type of spray gun being used will determine the proper reduction ratio of the paint. IMPORTANT: Do not paint the sacrificial trim tabs or anodes. 10. Using a spray gun, apply 1/2�1 ml. film thickness evenly. Allow five minutes for dying then apply another even coat of 1/2�1 ml. thickness. NOTE:This urethane paint dries to touch in a matter of hours, but remains susceptible to scratches and abrasions for days. Driveshaft Assembly Repair PRELOAD BEARING REMOVAL NOTE:You must replace the bearing assembly if you remove it from the driveshaft. Remove damaged tapered roller bearings. 1. Press the preload tapered roller bearing from the driveshaft using a universal puller plate tool to support the bearing. dbca abc15985 a - Tapered roller bearing c - Universal puller plate tool b - Driveshaft d - Press Universal puller plate 91-37241 90-865612031 AUGUST 200 Page 3F-3 Bravo Three Gear Housing Disassembly, Repair, and Reassembly PINION HEIGHT BEARING REMOVAL 1. Press the pinion height tapered roller bearing from the driveshaft using the universal puller plate tool to support the bearing. dbca abc15986 a - Pinion height roller bearing c - Universal puller plate b - Driveshaft d - Press Universal puller plate 91-37241 BEARING RACE REMOVAL 1. Press the bearing race from the driveshaft using the universal puller plate tool to support the bearing. deacbdeca15987 a - Bearing race d - Press b - Driveshaft e - Mandrel c - Universal puller plate tool Universal puller plate 91-37241 Page 3F-32 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly BEARING RACE REASSEMBLE NOTE:You can use an old bearing race or inner race as a suitable mandrel for installingbearings. 1. Lubricate the I.D. of the bearing race. Tube Ref No. Description Where Used Part No. 87 High Performance Gear I.D. of the bearing race 92-858064K01 Lubricant 2. Press a new bearing race to the driveshaft using a suitable mandrel acb 15992 a - Bearing race c - Suitable mandrel b - Driveshaft PINION HEIGHT BEARING REASSEMBLE 1. Lubricate the inner diameter of the small tapered roller bearing. Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant I.D. of small tapered roller bearing 92-858064K01 2. Position the pinion height of the roller bearing so that the smaller outer diameter faces the pinion end of driveshaft. 90-865612031 AUGUST 2007 Page 3F-3 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3. Press the pinion height roller bearing onto the driveshaft to the shoulder of driveshaft. acbde 15990 a - Pinion height roller bearing d - Suitable mandrel b - Driveshaft e - Press c - Shoulder of driveshaft PRELOAD BEARING REASSEMBLE 1. Lubricate the inner diameter of the large tapered roller bearing. Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant I.D. of large tapered roller bearing 92-858064K01 2. Press the large tapered roller bearing onto the driveshaft using a suitable mandrel. Ensure that the larger O.D. faces the pinion end of the shaft. abecd ea 15991 a - Large tapered roller bearing d - Press b - Driveshaft e - Small tapered roller bearing c - Suitable mandrel Page 3F-34 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Outer Propeller Shaft Disassembly and Inspection 1. Remove the bearing cup from outer propeller shaft. abc15979 a - Outer propeller shaft c - Bearing cup b - Tappered bearing 2 Remove the thrust cap and shims using a punch and hammer. Align the punch with the opening in the snap ring. cba a - Thrust cap b - Punch c - Hammer edf16365a d - Shims e - Snap ring f -Back driven gear-and-bearing assembly 90-865612031 AUGUST 200 Page 3F-3 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3 Remove the snap ring and the back driven gear-and-bearing assembly from the outer propeller shaft. abc16366 a - Snap ring c - Outer propeller shaft b - Back driven gear and bearing assembly OUTER PROPELLER SHAFT INSPECTION 1. Inspect the back driven gear for pitting, chipped or broken teeth, and excessive or uneven wear. If any of these conditions exsist replace the gear and tapered roller bearing assembly. 2. Replace the tapered roller bearing and the bearing cup if the tapered roller bearing is pitted, grooved, scored, worn uneven, discolored from overheating, spalling, or have metal particles embedded in the cup. 3. Inspect the oil seal inside the propeller shaft. Replace the oil seal if any damage is found. 4. Inspect the roller bearing inside the propeller shaft. Replace the roller bearing if any damage is found. Propeller Shaft End Play Adjustment 1. Remove the thrust cap and shims using a punch and hammer. Align the punch with the opening in the snap ring. cba edf16365a d - Shims e - Snap ring f -Back driven gear-and-bearing assembly a - Thrust cap b - Punch c - Hammer Page 3F-3 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2. Remove or add shim thickness to adjust the propeller shaft end play. 3. Place the shims in the thrust cap. 4. Place the thrust cap on the propeller shaft 5. Use a suitable mandrel to cover the thrust cap. 6. Drive the thrust cap on the outer propeller shaft. a a - Thrust cap b - Hammer bc16368 c - Mandrel Outer Propeller Shaft�Roller Bearing and Oil Seal Repair Inspect the oil seal and the roller bearing inside the propeller shaft. The oil seal may need replaced but the bearing is ok...or they may both need replaced, determine then continue the disassembly...when the roller bearing is removed the oil seal is damaged and must be replaced. IMPORTANT: Removing the roller bearing damages the oil seal. 1. Remove the damaged roller bearing and the oil seal from outer propeller shaft using the slide hammer puller tool with the three-jaw puller. abb 16369 a - Slide hammer puller b - Outer propeller shaft Slide hammer 91-34569A 1 90-865612031 AUGUST 2007 Page 3F-3 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2. Install the roller bearing using bearing driver. ab 16370 a - Bearing driver b - Outer propeller shaft Outer propeller shaft bearing driver 91-805352T 3. Lubricate outer diameter of oil seal. 4. Press oil seal into outer propeller shaft using seal driver until tool seats against shaft. 5. Lubricate lips of oil seal and fill area between lips of seal. Back Driven Gear and Bearing Repair 1. If you determine that bearings are in need of replacement and the gear is still in good condition, remove bearing from gear using universal puller plate and a suitable mandrel. (Bearings are damaged in removal and should not be reused.). cadeb 16376 Typical a - Driven gear d - Press b - Universal puller plate e - Suitable mandrel c - Tapered roller bearing Universal puller plate 91-37241 2. Lubricate the inner diameter of the new bearing. 3. Place a suitable mandrel (old bearing race) against the inner bearing race. Page 3F-38 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4. Place another mandrel on the face of the gear and press the gear and bearing together. decba 16377 Typical a - Driven gear d - Suitable mandrel b - Roller bearing e - Suitable mandrel c - Press Outer Propeller Shaft Reassembly 1. Install the driven gear and bearing assembly onto the outer propeller shaft. 2. Secure with snap ring. abc16366 a - Snap ring c - Outer propeller shaft b - Driven gear and bearing assembly 90-865612031 AUGUST 2007 Page 3F-3 Bravo Three Gear Housing Disassembly, Repair, and Reassembly NOTE:The shim to be installed in the following step regulates the end play of theprop-shaft. Use the existing shim as a starting point only if the shafts, gears, or bearingswere not replaced. If any of the components were replaced, use a .020 in. shim as a startingpoint. This shim may need to be adjusted if the end play is not within specifications. acdeb16367 a - Outer propeller shaft d - Shims b - Driven gear e - Thrust cap c - Snap ring 3 Install thrust cap and an appropriately sized shim on the outer propeller shaft. Ensure that the cap is straight while pressing into place. a a - Thrust cap b - Hammer bc16368 c - Mandrel Outer Propeller Shaft Spline Lash Check IMPORTANT: Record the spline lash reading, you will use this reading to determine true backlash between the pinion and the driven gear. 1. Place propeller shaft on 2 V-blocks. Page 3F-4 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2. Install the spline backlash tool. cab16374 a - Propeller shaft c - Spline backlash tool b - V-blocks 3 Mount the dial indicator to gear and position so that indicator probe aligns with mark on the spline backlash tool. df edabc16371 a - Dial indicator tool d - Dial indicator adapter b - Indicator probe tool e - Hose clamp c - Spline backlash tool f - Washer Dial indicator 91-58222A1 Dial Indicator Adapter 91-83155 Spline backlash tool 91-806192 90-865612031 AUGUST 200 Page 3F-4 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4 Rotate the gear back and forth while observing the dial indicator. Record the spline lash reading (for use later in this section). You will use this reading to determine true backlash between pinion and driven gear. acb 16372 a - Dial indicator c - Mark stamped on the spline b - Dial indicator adapter backlash tool Inner Propeller Shaft and Thrust Bearing Disassembly 1. Remove the inner propeller shaft and the thrust bearing from the assembly. ab 16358 a - Inner propeller shaft b - Thrust bearing INNER PROPELLER SHAFT INSPECTION Inspect the needle bearing surface on the inner propeller shaft for pitting, groves, discoloration, or embedded particles. If any of these conditions exist, replace the shaft. Inner Propeller Shaft Spline Lash Check IMPORTANT: Record the spline lash reading, you will use it to determine true backlash between the pinion and the driven gear. 1. Place propeller shaft on 2 V-blocks. 2. Install spline backlash tool on inner propeller shaft just behind shaft spline. Page 3F-4 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3. Slide the front driven gear assembly on the splines of inner propeller shaft. cadcabb16364Inner propeller shaft a - Propeller shaft b - V-blocks c - Spline backlash tool d - Front driven gear assembly 4. Mount the dial indicator onto the gear and position so that the indicator probe aligns with the mark on spline backlash tool. NOTE:Using a flat washer between the gear and tool will stabilize the tool set up. adbecf 16362 Inner propeller shaft shown. The outer propeller shaft is similar a - Dial indicator tool d - Dial indicator adapter b - Indicator probe tool e - Hose clamp c - Spline backlash tool f - Flat washer Dial indicator 91-58222A1 Dial Indicator Adapter 91-83155 Spline backlash tool 91-806192 5 Ensure that the inner propeller shaft and assembly are correctly supported by the V-blocks so that the assembly will not touch the table top. 90-865612031 AUGUST 200 Page 3F-4 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 6 Rotate the gear back and forth while observing the dial indicator. Record the spline lash reading (for use later in this section). You will use this reading to determine true backlash between pinion and driven gear. abc16363 Outer propeller shaft shown. The inner propeller shaft is similar a - Dial indicator c - Mark stamped on the spline b - Dial Indicator Adapter backlash tool Pinion Bearing Removal IMPORTANT: All needle bearings must be in place inside bearing casing while driving pinion bearing from gear housing. Otherwise the bearing casing will bend or break and become difficult to remove. 1 Remove the pinion bearing. a. Assemble the driver rod tool to the bearing driver tool. b. Insert the driver rod and bearing driver tool assembly into the gear housing so the bearing driver tool rest on the pinion bearing. NOTE:The pilot washer prevents the bearing from becoming cocked during removal. c. Place the pilot washer tool over the driver rod tool and inside the gear housing. d. Using a hammer, strike the driver rod tool to drive the pinion bearing from the gear housing. e. Using a hammer, strike the driver rod tool to drive the pinion bearing from the gear housing. abc d 16631 a - Driver rod c - Pilot washer b - Bearing driver d - Hammer Page 3F-44 90-865612031 AUGUST 2007 Bravo Three Gear Housing Disassembly, Repair, and Reassembly NOTE:The driver Head rod 91-37323 is included in the Bearing Removal and InstallationTool Assembly 91-31229A7. Driver rod 91-37323 Bearing driver 91-63638 1 Pilot washer 91-36571T Pinion Bearing Installation 1. Assemble the pinion bearing: a. Apply lubricant to the roller needle bearings. Tube Ref No. Description Where Used Part No. 4 Needle Bearing Assembly Lubricant Pinion bearing roller needle bearings 92-802868A1 b. Install the roller needle bearings in the bearing race. c. Use additional lubricant to help keep the roller needle bearings in place. 2. Install the pinion bearing: a. Position the pinion bearing over the bearing driver tool with the number on the bearing race facing up. b. Lubricate the outer diameter of the pinion bearing race. a a - Pinion bearing b - Bearing driver tool bc 16356 c - Pinion bearing race outer diameter Tube Ref No. Description Where Used Part No. 87 High Performance Gear Lubricant Pinion bearing race outer diameter 92-858064K01 Bearing driver 91-89867T c. Install the seal driver tool, the nut, and the washer onto the puller shaft tool. d. Place the puller shaft tool assembly on the gear housing as shown. NOTE:Ensure that the number on the bearing race is facing to the driveshaft wheninstalled. e. Position the pinion bearing and bearing driver tool through the gear housing torpedo and into the driveshaft cavity and align with the puller shaft tool. 90-865612031 AUGUST 2007 Page 3F-4 Bravo Three Gear Housing Disassembly, Repair, and Reassembly f Thread the puller shaft tool into the bearing driver tool. g Turn the nut CLOCKWISE to pull the pinion bearing completely into the driveshaft cavity until seated. ab a - Pinion bearing b - Bearing driver c - Puller shaft c 16357def d - Seal driver e - Nut f - Washer NOTE:The puller shaft 91-31229 is included in the Bearing Removal and Installation Tool Assembly 91-31229A7. Seal driver 91-813653T Bearing Removal and Installation kit h. Remove the tools. Front Driven Gear and Bearing Repair 91-31229A7 1 If you determine that bearings are in need of replacement and the gear is still in good condition, remove the bearing from the gear using a universal puller plate and a suitable mandrel. (Bearings are damaged in removal and should not be reused.). cadeb 16376 a - Driven gear d - Press b - Universal puller plate e - Suitable mandrel c - Tapered roller bearing Page 3F-4 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Universal puller plate 91-37241 2. Lubricate the I.D. of the new bearing. 3. Place a suitable mandrel (old bearing race) against the inner bearing race. 4. Place another mandrel on the face of the gear and press the gear and bearing together. decba 16377 a - Driven gear d - Suitable mandrel b - Roller bearing e - Suitable mandrel (old bearing race) c - Press Tube Ref No. Description Where Used Part No. High Performance Gear 87 I.D. of new bearing 92-858064K01 Lubricant Front Driven Gear Bearing Cup Installation 1. For proper installation of the bearing cup use the special tools. abedca - Hammer b - Driver handle tool c - Guide plate tool cdeb19148 d - Guide insert tool e - Bering cup driver tool 2. Install new shims of the exact measurement as the shims previously removed. 90-865612031 AUGUST 2007 Page 3F-4 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3 If you cannot determine the original thickness of the shims, install a 0.38 mm (0.015 in.) shim for a starting point. a 16378 a - Shims 4 Lubricate the O.D. of the bearing cup and place in the gear housing with the tapered end towards the prop. a a - Bearing cup 16379 5. Tube Ref No. Description Where Used 87 High Performance Gear Lubricant Bearing cup Install bearing cup driver tool on top of the bearing cup. Part No. 92-858064K01 a 16380 a - Bearing cup driver tool Page 3F-4 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Bearing cup driver 91-31106T 6 Place the driver rod and guide insert tool into the gear housing so that the guide insert is in the bearing cup driver tool. ab 16381 a - Driver rod tool b - Guide insert tool Driver rod 91-37323 Guide insert tool 91-805473 7. Place the guide plate tool in position it and hold against the gear housing. Drive the bearing cup until seated. a - Guide plate tool b - Hammer Guide plate 91-816243 a b 16382 90-865612031 AUGUST 200 Page 3F-4 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Bearing Carrier Seal and Bearing Replacement ravo Three Gear Housing Disassembly, Repair, and Reassembly Bearing Carrier Seal and Bearing Replacement Bearing carrier cba19149 a -Bearing carrier c - Bearing carrier seal b -Needle bearing 1. Press the seal from bearing carrier using the seal removal tool. baa16338a -Seal removal tool b -Bearing carrier Seal removal tool 91-862064A 1 2. Remove the needle bearing using a three-jaw puller and the slide hammer tool. ab19150 a -Slide hammer b -Bearing carrier Page 3F-50 90-865612031 AUGUST 2007 Bravo Three Gear Housing Disassembly, Repair, and Reassembly BEARING CARRIER SEAL AND BEARING INSTALLATION 1. Lubricate the O.D. of the roller needle bearing. abc21509 a - Bearing carrier tool c - Bearing carrier b - Roller needle bearing Tube Ref No. Description Where Used Part No. High Performance Gear 87 O.D. of the roller needle bearing 92-858064K01 Lubricant 2. Install the roller needle bearing to the bearing carrier tool. 3. Press the roller needle bearing in the bearing carrier. abc a - Needle bearing b - Bearing carrier tool 21510 c - Press Bearing carrier tool 91-805356 90-865612031 AUGUST 2007 Page 3F-5 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4. Apply sealant to the outer diameter of the oil seal. abc21512 a - Bearing carrier seal driver b - Oil seal c - Bearing carrier Tube R7 ef No. Description Loctite 271 Threadlocker Where Used O.D. of oil seal Part No. 92-809819 5. Press the oil seal into the bearing carrier using a bearing carrier seal driver until the tool seats against the housing. abc a - Oil seal b - Bearing carrier seal driver 21491 c - Press Bearing carrier seal driver 91-805372 Page 3F-52 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 6. Lubricate lips of oil seal and the area between the lips of the seal. c19151ab a - Bearing carrier c - Bearing carrier seal b - Needle bearing Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Lips of oil seal and fill area between lips of seal 92-802865Q02 Gear Housing Shimming And Reassembly Final Checklist 1. The housing is clean. 2. The bearing cup is installed in the gear housing for the front driven gear and in the bearing placement. a 19345 a - Front driven gear bearing cup 90-865612031 AUGUST 2007 Page 3F-5 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3 The driveshaft needle bearing case is installed in the gear housing and all 19 needle bearings are positioned inside. a 19346 a - Driveshaft roller needle bearing case Driveshaft Lower Bearing Cup and Shims Installation 1. Install shims of the original thickness for lowering the bearing cup into the gear housing. 2. If the shims were lost or ruined (i.e. the original thickness cannot be determined), install a 1.27 mm (0.050 in.) shim pack as a starting point. a 16347 a - Shims Page 3F-5 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3. Install the lower bearing cup of the driveshaft using the bearing cup driver tool. abcde 16349 a - Bearing cup d - Driven handle tool b - Bearing cup driver tool e - Guide insert tool c - Hammer Bearing cup driver 91-67443T Front Driven Gear and Bearing Installation 1. Install the front driven gear and bearing assembly and shims of the original thickness into the gear housing. aa19376 a - Front driven gear and bearing assembly Driveshaft And Pinion Gear Installation 1. Install the driveshaft into the gear housing. 90-865612031 AUGUST 2007 Page 3F-5 Bravo Three Gear Housing Disassembly, Repair, and Reassembly NOTE:Be careful not to lose rollers from the driveshaft pinion bearing in case they dropduring installation of the driveshaft . ab a16350 a - Driveshaft b - Pinion gear 2. Install the pinion washer and pinion screw. abcd16825a - Washer b - Pinion screw c - Pinion gear d - Front driven gear 3. Place the breaker bar and socket onto the pinion screw. Torque the pinion screw. abc a - Breaker bar b - Driveshaft adapter tool c16351 c - Torque wrench Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Threads of pinion screw 92-809819 Page 3F-56 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Description Pinion screw Nm 61 lb. in. lb. ft. 45 Driveshaft Upper Bearing Preload Cup and Tab Washer Installation 1. Install the upper bearing preload cup. aab 19350 a - Upper bearing preload cup b - Wooden hammer handle 2. Install the tab washer. ab b 16353 a - Tab washer b - Tab placement Driveshaft Bearing Preload Measurement 1. Determine the thickness of the shim required of the driveshaft bearing preload. a. Measure the distance between top of the gear housing and the tab washer using a 0�2.54 cm (0�1 inch) depth micrometer. a 16354 a - 0�2.54 cm (0�1 inch) depth micrometer 90-865612031 AUGUST 2007 Page 3F-5 Bravo Three Gear Housing Disassembly, Repair, and Reassembly b Measure the thickness of the spacer from the top machined surface to the bottom machined surface using a 0�2.54 cm (0�1 inch) outside micrometer. a c b 16355 a - 0�2.54 cm (0�1 inch) outside micrometer b - Spacer c - Thickness to measure Driveshaft Bearing Preload Measurement Help Chart Order of Measurements mm in. Distance of gear housing to tab washer � (minus) Spacer thickness + (plus) Add measurement of 0.051 0.002 = (equals) Shim thickness to install to the gear housing 2. Install shims having the original thickness, spacer, and a new O-ring. a a - Shimsb - Spacer b c 19340 c - O-ring 3. Install the clamp plate tool on the gear housing. Page 3F-5 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4. Place two washers and one nut on each stud. Torque the nuts a a - Clamp plate b - Nuts abc18377 c Washers (4) Description Nm lb. in. lb. ft Nuts on clamp plate tool 47 3 NOTE:The clamp plate tool must sit flat against the gear housing to be correctly positioned. aab 15996 16000 Correctly positioned Incorrectly positioned a - Clamp plate b - Incorrect gap Clamp plate 91-43559T 5 Using a dial lb. in. torque wrench, check the rolling preload by turning the driveshaft with a slow, steady motion. If necessary, add or subtract shims beneath the spacer to bring the preload into the specified range. 31707ab a - Driveshaft adapter b - Dial lb. in. torque wrench 90-865612031 AUGUST 200 Page 3F-5 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Description Rolling preload of driveshaft Nm 0.3�0.6 lb. in. 3�5 lb. ft. Torque wrench, lb. in. 91-66274 Propeller shaft/driveshaft adapter 91-61077T Pinion Gear Height Measurement 1 Ensure that the clamp plate has been reinstalled after adjusting the preload in the previous step. The clamp plate tool must be in place for checking pinion height in the following procedure. 2. Ensure that the number of driven gear teeth match the drive gear ratio Bravo Three Gear Housing Standard Bravo Three and Bravo Three X series Bravo Three XR Drive Gear Ratio 1.65: 1.50: 1.36: 1.18: 2.00: 2.20: 2.43: 2.00: Drive Gear Teeth 18 15 15 16 16 16 13 16 Driven Gear Teeth 25 19 19 27 27 27 24 27 3. Match the shimming tool access hole to the correct gear teeth count a20612 Shimming tool a - Access holes with the gear teeth count 4 Check the pinion height as follows: a. Insert the shimming tool into the gear housing. Page 3F-6 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly b. Position the matching gear teeth count access hole to the pinion gear a b c 16360 a - Shimming tool c - Driveshaft b - Clamp plate NOTE:Refer toFeeler Gauge Measurement for further assistance. c. Insert the feeler gauge and measure the clearance of the shimming tool to the pinion gear teeth. d. Take measurements at three locations on the pinion gear, 120� apart. 16361 Shimming tool 91-805462T Description mm in. Pinion gear clearance 0.635 0.025 e. If clearance is within specification: i. Recheck the rolling preload to ensure that it is within specification. ii. When the rolling preload and the pinion height are within specification, proceed to the reassembly process described in "Back Driven Gear Shim Installation." f. If clearance is less than specified: NOTE:Any thickness added here must be subtracted to the shim thickness at the upperbearing. 90-865612031 AUGUST 2007 Page 3F-6 Bravo Three Gear Housing Disassembly, Repair, and Reassembly i Add an appropriate thickness of shims under the lower tapered roller bearing cup. Refer to "Driveshaft Lower Bearing Cup and Shims Removal" and "Driveshaft Lower Bearing Cup and Shims Installation." a b 19337 a - Shims b - Bearing cup ii. Subtract the appropriate thickness of shims from the upper bearing. Refer to "Driveshaft Preload Spacer Removal" and "Driveshaft Preload Spacer Installation." a b 19338 a - Shims b - Spacer g. If clearance is more than specified: NOTE:Any thickness subtracted here must be added to the shim thickness at the upperbearing. i. Subtract an appropriate thickness of shims from under the lower tapered roller bearing cup. Refer to "Driveshaft Lower Bearing Cup and Shims Removal" and "Driveshaft Lower Bearing Cup and Shims Installation." a b 19337 a - Shims b - Bearing cup Page 3F-6 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly ii. Add an appropriate thickness of shims from the upper bearing. Refer to "Driveshaft Preload Spacer Removal" and "Driveshaft Preload Spacer Installation." ab a - Shims 19338 b - Spacer h. i. Recheck the pinion gear clearance. Recheck the rolling preload. 5 When the rolling preload and the pinion height are within specification proceed to the reassembly process as described in "Back Driven Gear Shim Installation." Back Driven Gear Shim Installation 1. Install a new shim pack into the gear housing of the same thickness as the originals that were removed. 2. If the shims were lost or ruined (i.e. the original shim thickness cannot be determined), install the specified back driven gear shim thickness for a starting point. Description mm in. Back driven gear shim thickness (use as a starting point measurement) 1.3 0.050 a 16005 a - Back driven gear shim Inner Propeller Shaft and Thrust Bearing Installation 1. Place the thrust bearing on the inner propeller shaft. 2 Install the inner propeller shaft and thrust bearing into the gear housing. 90-865612031 AUGUST 200 Page 3F-6 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3. Position the shaft splines inside of the front driven gear assembly. ab 16389 a - Inner propeller shaft b - Thrust bearing Outer Propeller Shaft Assembly Installation 1. Locate the seal in the outer propeller shaft. Lubricate the area between the seal lips. Tube Ref No. Description Where Used Part No. Between the seal lips of the 34 Special Lubricant 10 92-802865Q02 outer propeller shaft 2 Install the outer propeller shaft assembly into the gear housing with the back driven gear inserted first. 3 Slightly rotate the outer propeller shaft to allow the back driven gear teeth to engage the teeth of the driveshaft pinion gear. a 19403 a - Outer propeller shaft Back Driven Gear Bearing Cup Installation 1. Lubricate the back driven gear bearing cup. Tube Ref No. Description Where Used Part No. High Performance Gear 87 Back driven gear bearing cup 92-858064K01 Lubricant Page 3F-6 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2. Install bearing cup into gear housing. a 19404 a - Back driven gear bearing cup Outer Propeller Shaft Bearing Retainer Nut Installation IMPORTANT: The outer propeller shaft bearing retainer is a left-hand-threaded component. Install counter-clockwise. IMPORTANT: Threads on the outer propeller shaft bearing retainer nut must be lubricated to prevent galling in the gear housing. NOTE:To ensure proper thread engagement, start the retainer nut by hand. Turn the retainer nut CLOCKWISE until you feel thread engagement is felt and then turnCOUNTERCLOCKWISE. 1. Lubricate the threads of the retainer nut of the outer propeller shaft bearing. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Threads of the retainer nut of the outer propeller shaft bearing 92-802865Q02 NOTE:Installation of the outer propeller shaft bearing retainer nut seats the back drivengear shim pack and the back driven gear bearing cup. 2. Install the retainer nut of the outer propeller shaft bearing into the gear housing. 90-865612031 AUGUST 2007 Page 3F-6 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3 Using your hands, turn the retainer nut CLOCKWISE until you feel thread engagement and then turn COUNTERCLOCKWISE to hand tighten. a 19401 a - Retainer nut 4 Install the bearing retainer tool, slightly rotating until the tool teeth fit between the retainer nut teeth. 5 Install the bearing carrier tool and a ratchet or breaker bar to tighten. cab 19402 a - Bearing retainer tool c - Breaker bar b - Bearing carrier tool Bearing retainer tool 91-805382T Bearing carrier tool 91-805374 Page 3F-6 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 6. Use a torque wrench and torque the retainer nut to specification. cba a - Bearing retainer tool b - Bearing carrier tool c - Torque wrench Description Outer propeller shaft bearing retainer nut Nm 271 lb. in. lb. ft. 200 Bearing Carrier Installation IMPORTANT: Thecounter-clockwise. bearing carrier is a left-hand-threaded component. Install c 16387 IMPORTANT: Bearing carrier threads must be lubricated to prevent corrosion and cracking in the gear housing. NOTE:To ensure proper thread engagement, start the bearing carrier by hand. Turn thebearing carrier CLOCKWISE until you feel thread engagement and then turnCOUNTERCLOCKWISE. 1. Lubricate the bearing carrier threads, and the O-ring surface area of bearing carrier. 2. Install the O-ring on the bearing carrier. 3. Locate the bearing carrier seal and fill the area between the seal lips with lubricant. Tube Ref No. Description Where Used Part No. Between the seal lips of the 34 Special Lubricant 101 92-802865Q02 bearing carrier 4. Apply sealant to the tapered surface of the bearing carrier. Tube Ref No. Description Where Used Part No. 19 Perfect Seal Bearing carrier tapered surface 92-34227-1 5. Install the bearing carrier into the gear housing. 6. Using your hands, turn the bearing carrier CLOCKWISE until thread engagement is felt, then turn COUNTERCLOCKWISE to hand tighten. 7. Install the bearing carrier tool and a ratchet to tighten. 90-865612031 AUGUST 2007 Page 3F-6 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 8. Torque the bearing carrier to specification. abc c 16388 a - Bearing carrier tool b - Bearing carrier c - Torque wrench Description Bearing carrier Nm lb. in. 203 lb. ft. 150 Bearing carrier tool 91-805374-1 Checking Gear Backlash and Propeller Shaft End Play NOTE:Using the recorded measurements of the backlash of the front driven gear, the backdriven gear, and the end play of propeller shaft you can determine the correct shimadjustments and make all corrections within one disassembly. Follow the procedures asdirected and refer to the Help Charts for quick reference. PREPARATION FOR MEASUREMENT NOTE:Measure the front driven gear lash, the back driven gear lash, and

the propellershaft end play before adding or removing shims. 1. Remove the nuts, washers, and clamp plate from the gear housing. abc a - Clamp plate b - Nuts (2) a 16010 c - Washers (4) Clamp plate 91-43559T Page 3F-68 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2. Remove the O-ring, preload spacer, and shims. abc 19339 a - O-ring c - Shims b - Spacer 3. Place driveshaft retaining tool on tab washer. Do not tighten the locking bolt at this time. abab 16383 a - Driveshaft retaining tool b - Locking bolt Driveshaft retaining tool 91-863738 4. Position the gear housing so that the propeller shafts are facing upward. Rotate the propeller shafts several times to seal the bearings before making checks. a 19398 a - Propeller shafts 90-865612031 AUGUST 2007 Page 3F-6 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 5 Lightly press down on the driveshaft retaining tool while simultaneously turning the shaft. Rotate several times to ensure bearings are seated in bearing cups, then tighten locking bolt to retain driveshaft. abc a - Driveshaft retaining tool c - Driveshaft b - Locking bolt GEAR LASH MEASUREMENT OF THE FRONT DRIVEN GEAR 1. Assemble the dial indicator adapter on a 203mm (8 in.) long piece of all-thread rod. 19395baa a - Threaded rod b - Dial indicator adapter 2. Install the backlash indicator rod onto the inner propeller shaft. 3. Mount the dial indicator adapter and all-thread rod onto the bearing carrier. Page 3F-7 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4 Install the dial indicator and position the dial indicator probe on the mark stamped in the backlash indicator rod. e b f c d a b 21505 a - Backlash indicator rod d - Dial indicator adaptor tool b - Inner propeller shaft e - All-thread rod c - Dial indicator f - Hose clamp Dial indicator adapter 91-83155 Dial indicator 91-58222A1 Backlash indicator rod 91-805481 5. Check the gear lash by lightly rotating the inner propeller shaft back and forth. Observe the dial indicator tool and record the measurement of movement. 6. Obtain the measurement of the shaft spline of the inner propeller lash. Refer to Propeller Shaft Spline Lash Check. 7. Subtract the spline lash measurement from the gear lash measurement; the difference equals the actual gear backlash. Example: Gear lash measurement 0.75 mm (0.030 in.) Spline lash measurement - Spline Lash Check 0.4 mm (0.016 in.) Gear backlash 0.35 mm (0.014 in.) 8. Record the gear backlash. 9. The gear backlash must be within specification. Description mm in. Gear backlash specification 0.3�0.4 0.012� 0.016 NOTE:The example shows that the front driven gear backlash is within specification. Theback driven gear backlash and the propeller shaft end play must also be within specificationbefore you can reassemble the gear housing. 10. Complete the next procedure, Gear lash Measurement Of The Back Driven Gear, before making any shim adjustments. 90-865612031 AUGUST 200 Page 3F-7 Bravo Three Gear Housing Disassembly, Repair, and Reassembly GEAR LASH MEASUREMENT OF THE BACK DRIVEN GEAR 1. Position the gear housing so that the propeller shafts are facing downward. 2. Assemble the dial indicator adapter on a 152mm (6 in.) long piece of all-thread rod. 19380b a a a - Threaded rod b - Dial indicator adapter 3 Install the backlash indicator rod onto the outer propeller shaft. 4 Mount the dial indicator adapter and all-thread rod onto the bearing carrier. 5 Install the dial indicator and position the dial indicator probe on the mark stamped on the backlash indicator rod. a b d c b e f 21506 a - Backlash indicator rod d - Dial indicator adaptor tool b - Outer propeller shaft e - All-thread rod c - Dial indicator f - Hose clamp Dial indicator adapter 91-83155 Dial indicator 91-58222A1 Backlash indicator rod 91-805482 6 Check the gear lash by lightly rotating the outer propeller shaft back and forth. Observe the dial indicator tool and record the measurement of movement. 7 Obtain the measurement of the shaft spline lash of the outer propeller checked earlier. Refer to Propeller Shaft Spline Lash Check. 8 Subtract the spline lash measurement from the gear lash measurement; the sum equals the actual gear backlash. Page 3F-7 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Example: Gear lash measurement 0.75 mm (0.030 in.) Spline lash measurement - Spline Lash Check 0.4 mm (0.016 in.) Gear backlash 0.35 mm (0.014 in.) 9. Record the gear backlash. 10. The gear backlash must be within specification. Description mm in. Gear backlash specification 0.3�0.4 0.012� 0.016 NOTE:The example shows that the back driven gear backlash is within specification. Thepropeller shaft end play must also be within specification before you can reassemble thegear housing. 11. Complete the following procedure, Propeller Shaft End Play Measurement, before making any shim adjustments. PROPELLER SHAFT END PLAY MEASUREMENT 1. Position the gear housing so that the propeller shafts are facing upward. 2. Assemble the dial indicator adapter on a 305mm (12 in.) long piece of all-thread rod. b a 19400 a - Dial indicator adapter b - Threaded rod 90-865612031 AUGUST 2007 Page 3F-7 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 3 Mount the dial indicator adapter and all-thread rod onto the bearing carrier. Install the dial indicator and position the dial indicator probe on the end of the inner propeller shaft as shown. d g e b c a f 21507 Checking propeller shaft end play set-up a - Inner propeller shaft e - Hose clamp b - Dial indicator tool f - Dial indicator adapter kit tool c - Dial indicator probe g - Outer propeller shaft d - All-thread rod Dial indicator adapter 91-83155 Dial indicator 91-58222A1 4. Move the inner propeller shaft up and ensure that the outer propeller shaft is also being lifted by the inner propeller shaft. 5. Check the propeller shaft end play by moving the inner shaft up and down. Observe the dial indicator tool and record the measurement of movement. 6. The propeller shaft end play must be within specification. Description mm in. Propeller shaft end play specification 0.025�0.30 0.001� 0.012 NOTE:The front driven gear backlash, the back driven gear backlash, and the propellershaft end play must be within specification before you can reassemble the gear housing. 7. If all specifications are met: proceed to the Gear Housing Final Assembly procedure. 8. If all specifications are not met: refer to the Shim Adjustments procedure and the Help Charts later in this section. SHIM ADJUSTMENTS NOTE:Refer to the Gear Backlash Help Chart and the Propeller Shaft End Play Help Chartfor quick reference. IMPORTANT: The pinion gear screw threads must have locking sealant applied at the final installation 1. Front Driven Gear Lash Measurements: Page 3F-7 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly a. If backlash is more than specified, add shims behind the front driven gear bearing cup. b. If backlash is less than specified, remove shims behind the front driven gear bearing cup. c. Recheck the backlash measurement after reassembly. 2. Back Driven Gear Lash Measurement: a. If backlash is more than specified, remove shims in front of rear driven gear bearing cup. b. If backlash is less than specified, add shims in front of rear driven gear bearing cup. c. Recheck the backlash measurement after reassembly. 3. Propeller Shaft End Play Measurement: a. If the end play of the propeller shaft is more than specified, add shims behind the outer propeller shaft thrust race. b. If the propeller shaft end play is less than specified, remove shims behind the outer propeller shaft thrust race. c. Recheck the end play measurement of the propeller shaft after reassembly. HELP CHARTS Measurement The front driven gear measurement is good. The back driven gear measurement is good. Measurement The front driven gear measurement is incorrect Requires a shim change. The back driven gear measurement is good. Gear Backlash Help Chart Shim Changes No change needed No change needed Action Remove the: � bearing carrier. � retainer nut. � prop shafts. Reassemble the gear housing using Loctite on the pinion screw threads. Both gear backlash measurements are within specification. Gear Backlash Help Chart Shim Changes Action Above specification: Remove the: add shims behind � bearing carrier. the front driven gear � retainer nut. bearing cup. � prop shafts. � shim. � pinion gear. � front driven gear and bearing assembly. Below specification: remove shims � front bearing cup. behind the front Add or subtract shims. driven gear bearing Reassemble the gear housing using Loctite on the pinion screw cup. threads. Repeat the Checking Backlash procedure to ensure that the backlash measurement is within specification. No change needed. No action needed. 90-865612031 AUGUST 2007 Page 3F-7 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Gear Backlash Help Chart Measurement Shim Changes Action The front driven gear measurement is No change needed. No action needed. good. Above specification: remove shims in front of the back The back driven driven gear bearing gear measurement cup. is incorrect. Requires a shim Below specification: change add shims in front of the back driven gear bearing cup. Remove the: � bearing carrier. � retainer nut. � prop shafts. Add or subtract shims. Reassemble the gear housing using Loctite on the pinion screw threads. Repeat the Checking Backlash procedure to ensure that the backlash measurement is within specification. Propeller Shaft End Play Help Chart Measurement Shim Changes Action Propeller shaft end play measurement is incorrect. Requires shim change. Above specification: add shims behind the outer propeller Remove the outer propeller shaft thrust race. shaft thrust race. Add or subtract shims. Below specification: Reinstall the outer propeller shaft shims and thrust cap to the remove shims outer propeller shaft. behind the outer propeller shaft thrust race. Propeller shaft end play measurement is No change needed. No action needed. good. GEAR HOUSING FINAL ASSEMBLY 1. Remove the driveshaft retaining tool. a b a b 16383 a - Driveshaft retaining tool b - Locking bolt Page 3F-7 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 2. Install the shims, preload spacer, and O-ring. ab c 19340 a - Shims c - O-ring b - Preload spacer Oil Passage Quad Ring and Water Passage O-ring Installation 1. Apply adhesive to the gear housing groove for the water passage O-ring. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Gear housing groove for the water passage O-ring 92-86166Q1 2. Install the water passage O-ring. ab 19475 a - Water passage O-ring b - Gear housing groove for the water passage O-ring 3. Apply adhesive to the gear housing groove for the oil passage quad ring. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Gear housing groove for the oil passage quad ring 92-86166Q1 90-865612031 AUGUST 2007 Page 3F-7 Bravo Three Gear Housing Disassembly, Repair, and Reassembly 4. Install the oil passage quad ring. ab 19476 a - Oil passage quad ring b - Gear housing groove for the oil passage quad ring Bravo Three Gear Housing�Driveshaft Housing Installation NOTE:Before reassembling the gear housing to the driveshaft housing: ensure that all O-rings and seals are installed, and the gear housing and the driveshaft housing are completely assembled and free from defects. 1. Place the star washer and screw in the gear housing. The screw will be used later to secure a anode plate. ab21549 a - Screw b - Star washer 2. Align the studs to the holes and place the drive shaft housing on the gear housing. 3. Install a washer and a nut on each stud and tighten. 4. Install the bolt into the anode cavity using the bolt hole with the ground plate. 5. Torque the six nuts and one bolt. 21548abc a - Nuts and washers (3 each side) c - Screw for anode plate b - Bolt (1) (located in the anode cavity) Page 3F-78 90-865612031 AUGUST 200 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Description Nm lb. in. lb. ft. Gear housing to driveshaft housing nuts and bolts 47 35 6 If the aft anode plate was removed: Install the aft anode plate and secure with a screw and star washer. 7 Use the screw and star washer (installed earlier) to secure the front anode plate to the gear housing. ba a a - Anode plate 21547 b - Screw and star washer 8. Torque the anode plate screws. Description Anode plate screw 9. Install the rubber plug. Nm 27 lb. in. lb. ft. 20 a b b 21550 a - Rubber plug b - Anode plate 10. Fill the sterndrive with gear lube. Refer to Section 1B � Maintenance. 11. Reinstall the sterndrive to the boat. Refer to Section 2A � Installation and Adjustments. 90-865612031 AUGUST 200 Page 3F-7 Bravo Three Gear Housing Disassembly, Repair, and Reassembly Notes: Page 3F-80 90-865612031 AUGUST 200 Transom Removal and Service ProcedureV Transom Assembly Section 4A - Transom Removal and Service Procedures Table of Contents Gimbal Bearing Replacement.........................4A-3 Gimbal Bearing Installation......................4A-5 Gimbal Bearing Inspection.......................4A-4 Transom Removal From Boat.........................4A-7 Gimbal Bearing Removal.........................4A-4 4 A 90-865612040 FEBRUARY 2006 Page 4A- Transom Removal and Service ProcedureV Special Tools Bearing Removal and Installation kit 91-31229A7 Installs and removes the bearings in all gearcases. 91-31229A7 tool assembly includes the following components: 11-24156 Hex nut 12-34961 Washer 91-15755T Bearing carrier 91-29310 Plate 91-29610 Pilot plate 91-30366T1 Mandrel 91-31229 Puller shaft 91-32325T Driver head 91-32336 Driver needle bearing 91-36379 Puller/head gear 91-36569T Driver head 91-36571T Pilot washer 91-37292 Roller bearing 91-37311 Driver head 91-37312 -Driver head 91-37323 Driver head rod 91-37324 Pilot washer 91-38628T Puller/driver head 91-52393 Driver needle bearing 91-52394 Head pull rod 2966 Slide hammer 91-34569A 1 Aids in the removal of various engine components. Use with puller jaws. 6761 Collar #3 Bearing Installation Tool 91-30366T1 10777 Use with Plate Puller (91-29310), Driver Rod (91-37323) and Bearing Head (91-32335T) to install the gimbal bearing. Puller rod head 91-32325T Installs the gimbal bearing into the transom gimbal housing; use with gimbal bearing installation collar number 3 (91-30366T1) and driver rod (91-37323). Driver rod 91-37323 Used in pinion gear and pinion bearing installation. ob01623 Puller plate 91-29310 Aids in the removal and installation of the gimbal bearing, as well as various bearings in the gear housing. Also included in the Bearing Removal and Installation kit (91-31229A 7). 18600 10474 Page 4A-2 90-865612040 FEBRUARY 200 Transom Removal and Service ProcedureV Gimbal Bearing Replacement The gimbal bearing and carrier should only be removed if damaged. The transom assembly can remain attached to the boat to ease the removal and installation of the gimbal bearing and carrier. IMPORTANT: The gimbal bearing and carrier are a matched set and must be replaced as an assembly. The tolerance ring must be replaced any time the gimbal bearing is removed. NOTE: The thickness of the gimbal bearing inner race has changed to accommodate the larger U-joint used in the Bravo X series and the Bravo XR models. If a Bravo X series or Bravo XR model is installed on a transom with the thicker gimbal bearing, the U-joint and bearing will interference with one another. One or both components will fail. The new gimbal bearing can be identified by a red dot. NOTE: The thickness of the retention sleeve has changed to accommodate the larger U-joint used in the Bravo X series and Bravo XR models. The new retention sleeve can be identified by measurement. a b c a -Red dot on the gimbal bearing b -Retention sleeve measurement 9.47 cm (3.73 in.) 16243 c -Retention sleeve measurement 2.05 cm (0.81 in.) IMPORTANT: Gimbal bearing and carrier are a matched set and must be replaced as an assembly. Tolerance ring must be replaced any time gimbal bearing is removed. e a b d c 16244 Complete gimbal bearing assemblu a -Gimbal bearing d -Red dot b -Gimbal bearing carrier e -Grease hole c -Tolerance ring 90-865612040 FEBRUARY 2006 Page 4A- Transom Removal and Service ProcedureV Gimbal Bearing Inspection 1 Remove the sterndrive: a. Reach through the bell housing. Rotate the gimbal bearing and check for rough spots. b. Pull and push on the inner race to check for side wear. c. Any excessive movement or roughness is cause for replacement. Gimbal Bearing Removal ! CAUTION Do not remove the gimbal bearing unless replacement is necessary; damage to the bearing may occur during removal. 1 Remove the gimbal bearing assembly. e -Slide hammer puller f -Gimbal bearing inner race g -Gimbal bearing carrier e f gc a b d 16245 a -Puller shaft b -Nut c -Washer d -Plates (3) NOTE: Plate puller included in Bearing Removal and Installation Tool Assembly part number 91-31339A7. Bearing Removal and Installation kit 91-31229A7 Slide hammer 91-34569A 1 2. Remove grease seal using a slide hammer puller. a b 16247 a -Gimbal housing b -Grease seal Page 4A- 90-865612040 FEBRUARY 200 Transom Removal and Service ProcedureV Slide hammer 91-34569A 1 Gimbal Bearing Installation 1. Install the grease seal using a suitable mandrel. NOTE: The seal should be installed with the open face of the seal towards the gimbal bearing. a b 16247 a -Gimbal housing b -Grease seal 2. Install and position new tolerance ring. e a b d c 16244 a -Gimbal bearing b -Gimbal bearing carrier c -Tolerance ring d -Red dot e -Grease hole 3. Assemble tools. a b c 16255 a -Mandrel tool c -Drive rod tool b -Puller/driver head tool Collar #3 Bearing Installation Tool 91-30366T1 90-865612040 FEBRUARY 2006 Page 4A- Transom Removal and Service ProcedureV Puller rod head 91-32325T Driver rod 91-37323 4 Align the opening in the tolerance ring with the grease hole in the gimbal bearing cartridge. IMPORTANT: The red dot on gimbal bearing must be positioned at 10 o'clock. IMPORTANT: Ensure that notched edge of the bearing carrier faces inward in bore. 5 Align the gimbal bearing carrier grease hole and the tolerance ring opening with grease cavity hole in gimbal housing. a b d c 16254 a -Showing alignment of the gimbal c -Tolerance ring opening bearing carrier grease hole and d -Bearing carrier notchthe gimbal housing grease insert b -Gimbal bearing carrier grease hole 6 Install the gimbal bearing with the red dot facing the drive end using a brass hammer and the tools shown. Ensure that the gimbal bearing carrier contacts the gimbal housing. a b a -Drive rod b -Puller plate c -Puller/driver head a b e f c d 16256 d -Mandrel e -Gimbal bearing assembly (red dot facing out) f -Chamfer Puller plate 91-29310 Page 4A- 90-865612040 FEBRUARY 200 Transom Removal and Service ProcedureV Transom Removal From Boat NOTE: If replacing the Gimbal bearing: The transom assembly can remain attached to the boat to ease the removal and installation of the gimbal bearing and carrier. Refer to Gimbal Bearing Replacement. 1 The sterndrive has previously been removed from the transom. Refer to Section 3A, Bravo Sterndrive Removal From Boat. 2 Remove the hydraulic lines from the power steering control valve. a b a b a a 16225 a -Hydraulic lines b -Power steering control valve 3. Connect the hydraulic lines quick-connect fittings to each other. a 19304 a -Hydraulic lines quick-connect fittings 90-865612040 FEBRUARY 200 Page 4A- Transom Removal and Service ProcedureV 4. Disconnect the intermediate shift cable from the engine shift plate a b 21682 a -Shift plate b -Intermediate shift cable 5 If the engine is equipped with a water hose, remove the hose fitting from the transom. Use a screwdriver to release the quick-connect fitting. a b 16226 a -Inlet water hose b -Quick-connect fitting 6 Remove the transom ground wire from the engine stud. Follow the transom ground wire to the engine stud. Remove the ground wire from the engine stud. a 16227 a -Ground wire at transom Page 4A- 90-865612040 FEBRUARY 200 Transom Removal and Service ProcedureV 7. Disconnect the sterndrive gear lube reservoir oil line from the transom connection a a -Gear lube reservoir oil line quick-connect fitting 16228 8. 9. Disconnect the trim limit wires at the trim pump connection. Disconnect the trim sender wires from the engine connection. a b 16229 a -Trim limit wires b -Trim sender wires 10. Disconnect the MerCathode assembly wire connection from the engine harness. a b 19303 a -MerCathode transom connection b -MerCathode engine connection 11. Remove the engine. Refer to the MerCruiser Installation Manual specific to this manual. 90-865612040 FEBRUARY 2006 Page 4A- Transom Removal and Service ProcedureV 12. If the engine is equipped with the water inlet hose fitting, remove the fitting from the transom. a 18979 a -Water inlet hose fitting 13. If equipped, remove the engine exhaust bulhorn from transom. a 16231 a -Engine exhaust bulhorn 14. If equipped, remove the engine exhaust from transom. a 18976 a -Engine exhaust 15. If equipped, remove the engine exhaust block off-plate from transom a 18977 a -Engine exhaust block-off plate 16. Remove the steering cable from the power steering assembly. a. Remove the cotter pin Page 4A-10 90-865612040 FEBRUARY 200 Transom Removal and Service ProcedureV b. Remove the clevis pin a b 16233 a -Cotter pin b -Clevis pin c. Loosen the nut and pull the cable from the power steering assembly a 18978 a -Nut 17. Remove the steering clevis from the steering lever. a. Remove the cotter pin. b. Remove the clevis pin. c b a a c b 16234 a -Cotter pin c -Steering lever b -Clevis pin 18. Inspect the steering clevis and steering lever parts for wear. The cotter pin should be replaced for reassembly. 19. Remove the complete steering assembly: a. Bend the tabs on the tab washers. 90-865612040 FEBRUARY 2006 Page 4A-1 Transom Removal and Service ProcedureV b. Loosen the upper and lower pivot bolts enough to release the steering assembly. c. Remove the power steering cylinder. b a c a c 16235 a -Upper bolt c -Lower bolt b -Power steering cylinder 20. Remove the continuity wire from the steering lever. a b c 16236 a -Steering lever c -Continuity wire b -Torque screw 21. Inspect the continuity wire for frayed areas or loose ends. Replace if damaged. 22. Remove the quick-connect hydraulic lines from the trim pump and link together. a 19305 a -Hydraulic lines quick-connect fittings 23. Inspect the transom continuity wire for frayed areas or loose ends. Page 4A-12 90-865612040 FEBRUARY 200 Transom Removal and Service ProcedureV 24. Remove the locknuts and washers securing the gimbal housing to the transom plate. 25. Carefully pull the transom plate from the gimbal housing, taking care not to damage the gimbal studs. 16239 a a a a b a -Locknuts and washers b -Transom continuity wire 26. Remove the gimbal housing from the boat transom. 90-865612040 FEBRUARY 2006 Page 4A-1 Transom Removal and Service ProcedureV Notes: Page 4A-14 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Transom Assembly Section 4B - Transom Disassembly, Repair, and Reassembly Table of Contents Specifications...4B-6 Torque Specifications.............................4B-6 Exploded Views...4B-8 Bravo Inner Transom Plate Assembly......4B-8 Bell Housing Assembly.........................4B-10 Gimbal Ring Assembly..........................4B-12 Gimbal Housing Assembly.....................4B-14 Bravo Transom Disassembly........................4B-15 Hydraulic Manifold, MerCathode, and Trim Cylinder Assemblies Removal...............4B-15 Gear Lube Monitor Fitting Removal........4B-18 Speedometer Fitting�Bell Housing Removal ....4B-19 Tapered Insert Removal........................4B-19 Shift Cable�Bell Housing Removal........4B-21 Dribble Valve Removal..........................4B-21 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shift cable retaining nut Shift cable bellows Exhaust bellows/tube mounting surface 92-86166Q1 U-joint bellows Exhaust bellows mounting surface Brass area of shift cable end 92-802865A1 High Performance hinge pin High performance hinge pin screw threads 92-809821 Dribble valve O-ring 92-802854A1 Hose inner diameter 92-802859A1 Hinge pin bushing 92-65150-1 Lower swivel pin 91-43579 Removes and installs the tapered insert retainer into the water inlet hose. 9197 Retention sleeve removal tool 91-862546 Removes the aluminum sleeve from the U-joint bellows of all the Bravo and Blackhawk drive units, Serial Number 0L999999 and below. 10851 Puller plate 91-29310 Aids in the removal and installation of the gimbal bearing, as well as various bearings in the gear housing. Also included in the Bearing Removal and Installation Kit (91-31229A 7). 18600 90-865612040 FEBRUARY 2006 Page 4B- Transom Disassembly, Repair, and Reassembly Washer 12-34961 Use on the threaded puller rod between the nut and plate when removing bearings. 10834 Puller Shaft 91-31229 A 5/8 in. x 18 in. (15.875 mm) long threaded rod which aids in the removal and installation of various engine components. Also included in the Bearing Removal and Installation Kit (91-31229A 7). Hex Nut 11-24156 18604 18650 A 5/8 in. x 18 in. hex nut which aids in the removal and installation of various engine components. May use with Puller Shaft (91-31229); also included in the Bearing Removal and Installation Kit (91-31229A 7). Hinge pin tool 91-78310 10672 Removes and installs the hinge pins. Puller head 91-63616T 10678 Removes the upper swivel shaft on gimbal rings. Slide hammer 91-34569A 1 Aids in the removal of various engine components. Use with puller jaws. 6761 Bushing/bearing/seal driver 91-43578A1 10484 Installs the transom assembly bushings, bearings, and seals. Expanding Rod Snap-On CG45-4 17771 Aids in the removal of the upper swivel shaft lower bearing in the gimbal housing. Use with Snap-On Collet (CG45-15). Page 4B-4 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Collet Snap-On CG45-15 Aids in the removal of the upper swivel shaft lower bearing in the gimbal housing. Use with Snap-On Expanding Rod 10774 (CG-45-4). Collet Snap-On CG40A-6 Aids in the removal of gears or bearings; use with expanding rod. Expanding rod Snap-On CG40-4 Aids in the removal of gears and bearings; use with collet. Bellows expander tool 91-45497A1 Aids in the removal and installation of the exhaust bellows. Sleeve installation tool 91-818162 12534 12538 10483 10823 Installs the aluminum sleeve into the U-joint bellows. Bearing driver 91-63638 1 Removes and installs the lower driveshaft pinion bearing. Driver handle 91-805454 Use with Front Bearing Guide (91-805470) for installation of the front bearing. Shift cable anchor adjustment tool 91-17262A1 91-17263 10687 Use to set the shift cable adjustments after shift cable installation. Includes the following components: 91-17262A1 Core wire locating tool 91-17263 Shift cable anchor adjustment tool 10477 10590 91-17262 90-865612040 FEBRUARY 2006 Page 4B- Transom Disassembly, Repair, and Reassembly Specifications Description Specification Clearance between lower swivel pin washer and gimbal housing mount 0.05�0.25 mm (0.002�0.010 in.) Trim limit dimension Torque Specifications Description Gimbal housing stud Trim wire retainer screw Gimbal ring locknuts for 3/8 in. U-bolt Gimbal ring locknuts for 7/16 in. U-bolt Shift cable bellows hose clamp Exhaust bellows/tube hose clamp Speedometer quick-connect fitting to gimbal housing U-joint bellows hose clamp Standard Bravo hinge pin High performance hinge pin screws (2) early style High performance hinge pin screws (4) later style Exhaust bellows hose clamp Hydralic manifold locknuts MerCathode screws Nm 31 11 72 95 4 4 12 4 197 40 12.4 4 11 9 552 mm (21�� in.) lb. in. lb. ft. 23 95 53 70 35 35 110 35 145 35 110 35 95 80 Page 4B-6 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Notes: 90-865612040 FEBRUARY 2006 Page 4B- ..ransom Disassembly.. Repair.. and Reassembly ..xploded ..iews Bravo Inner ..ransom Plate Assembly .. .. .. 2 2 .. .. 4 5 .. .. 8 .. ..0 .... ..2 .... ..4 ..5 ....8 .... 20 19420 ..a......4....8 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly 1 - Transom plate assembly 11 - Locknut 2 - Pivot bolts 12 - Shift cable casing 3 - Tab washers 13 - Core wire anchor 4 - Rear engine mounting bolt 14 - Set screws (2) 5 - Washer 15 - End guide 6 - Spacer 16 - Nylon tube 7 - Washer-fiber 17 - Nylon wrapping 8 - Spacer (optional alignment) 18 - Core wire 9 - Locknut 19 - Sealing washer 10 - Washer 20 - Nut 90-865612040 FEBRUARY 2006 Page 4B- ..ransom Disassembly.. Repair.. and Reassembly Bell ..ousing Assembly .... .. 2 .. 4 5 .. .. 8 .. ..0 ....2 ....4 ..5 ....8 .... 20 2.. 22 2.. 24 25 2.. 19426 ..a......4....10 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly 1 - Bell housing 2 - Stud 3 - Washer 4 - Locknut 5 - O-ring 6 - Gear lube valve 7 - O-rings 8 - Hinge pin washer 9 - Bellows clamp 10 - U-joint bellows 11 - Grounding clip 12 - Sleeve 13 - Bellows clamp 14 - Exhaust bellows 15 - Exhaust tube (some models) 16 - Lube monitor hose 17 - Hose clamp 18 - Bayonet fitting 19 - Bushing (High Performance transom) 20 - Indentations in bell housing 21 - Speedometer female quick-connect fitting 22 - Speedometer male quick-connect fitting 23 - Speedometer hose 24 - Speedometer adaptor fitting 25 - Clamp on stay strap 26 - Retention clip 90-865612040 FEBRUARY 2006 Page 4B-1 ..ransom Disassembly.. Repair.. and Reassembly Gimbal Ring Assembly .. .. 2 .. 4 5 .. .. 8 .. .. 8 .. ..0 ..0 .... ..2 .... ..4 ..5 ....8 .... 20 2.. 22 2.. 2425 2.. 2.. 28 ..02.. 19428 ..a......4....12 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly 1 - Gimbal ring 2 - Bushing 3 - Bushing 4 - Flat washer 5 - Hinge pin 6 - Trim position sender 7 - Flat washer 8 - Lockwasher 9 - Screw 10 - Clip 11 - U-bolt 12 - Plate 13 - Locknuts 14 - Swivel shaft 15 - Flat washer (smaller ID) 16 - Flat washer (larger ID) 17 - Clamp screw 18 - Locknut 19 - Nut 20 - Screw 21 - Clamp plate 22 - High Performance hinge pin assembly (early style) (2 screws) 23 - High Performance hinge pin assembly (later style) (4 screws) 24 - Magnum and High Performance gimbal ring identification (filled area) 25 - Standard gimbal ring identification (2 ribs) 26 - Steering lever 27 - Trim limit switch 28 - Trim sender (SmartCraft) 29 - TPA 30 - Connector 90-865612040 FEBRUARY 2006 Page 4B-1 ..ransom Disassembly.. Repair.. and Reassembly Gimbal ..ousing Assembly .... 2 .. 4 5 .. .. 8 .. ..0 .... ..2 .... ..4 ..5 ....8 .... 20 2.. 22 2.. 24 25 2.. 2.. 2..2..28 ..0 .... ..2 .... ..4 ..5 ....8 19429 .... 40 ..a......4....14 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly 1 - Gimbal housing 2 - Stud 3 - Swivel shaft bushing (lower) 4 - Swivel shaft seal 5 - Swivel shaft bushing (upper) 6 - Clamp 7 - Lube monitor hose 8 - Quick disconnect fitting 9 - E-clip 10 - Gear lube fitting 11 - Water bypass plug 12 - Flat washer 13 - Locknut 14 - Seal 15 - Gimbal bearing 16 - Tolerance ring 17 - Crimp clamp 18 - Shift cable bellows 19 - Bellows clamp 20 - Washer Bravo Transom Disassembly 21 - Lower swivel pin 22 - Cotter pin 23 - Stud 24 - Gasket 25 - Hydraulic manifold 26 - Washer 27 - Locknut 28 - Exhaust passage seal 29 - Water hose insert 30 - Water hose 31 - Water fitting gasket 32 - Water fitting 33 - Lockwasher 34 - Screw 35 - Gimbal housing seal 36 - Large O-rings 37 - Snap ring groove 38 - Small O-ring 39 - Grease fitting 40 - Lubricap Hydraulic Manifold, MerCathode, and Trim Cylinder Assemblies Removal This procedure presumes that the transom assembly has been removed from the boat, placed on a service stand, and secured for complete disassembly. 1. Remove the Torx screw holding 3 ground wires from the trim cylinders. Retain the screw and grounding wires for later reassembly. a b b b a b b b 16477 a - Torx screw b - Continuity wire 90-865612040 FEBRUARY 2006 Page 4B-1 Transom Disassembly, Repair, and Reassembly 2. Remove nuts from anchor pin. a b 17854 a - Wrench on nut b - Ratchet socket on nut 3. Remove flat washers, bushings, and trim cylinders from the anchor pin. a c d 16480 b a - Flat washer (2) c - Trim cylinder (2) b - Bushing (4) d - Anchor pin 4. Remove E-clips, flat washers, and anchor pin. a b c 16481 a - E-clip (2) c - Anchor pin b - Flat washer (2) 5. Remove the two screws and lockwashers that attach the MerCathode to the hydraulic manifold. Page 4B-16 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 6. Pull the MerCathode away from the hydraulic manifold. a b 16482 MerCathode assembly on a Bravo transom a - Screw b - Washers 7. 8. Remove two locknuts and continuity washers from the hydraulic manifold. Work the hydraulic manifold assembly out by pulling and moving side by side to release the manifold hoses with 90� fittings and the MerCathode wire connection from the gimbal housing. a b c a - Locknuts b - Continuity washer c - Hydraulic manifold d e 16483 d - MerCathode wire connection e - Manifold hoses 9. Remove and scrape gasket debris from the manifold and the gimbal housing. INSPECTION 1. If bare metal is present, use recommended touch-up paint before reassembly. 2. Inspect the ground wires for frayed areas and loose connectors. 3. Check the anode of each trim cylinder. 4. Inspect the hydraulic hoses for damage. 5. Inspect the reference wire of the MerCathode for damage. 90-865612040 FEBRUARY 2006 Page 4B-1 Transom Disassembly, Repair, and Reassembly Gear Lube Monitor Fitting Removal 1. Remove the E-clip from the quick-connect gear lube monitor fitting. a b c a b 16484 a - E-clip c - Screwdriver b - Gear lube monitor fitting 2. Push the gear lube monitor fitting through the gimbal housing toward the bell housing. a 17855 a - Gear lube monitor fitting pushed toward the bell housing INSPECTION 1. Check the E-clip for damage. Page 4B-18 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Speedometer Fitting�Bell Housing Removal 1. Remove the retaining clip from the bell housing. a 17856 a - Retaining clip 2. Cut the stay strap and remove the quick-connect speedometer fitting from the hose. a b c 16485 a - Quick-connect speedometer fitting c - Stay strap b - Hose INSPECTION 1. Inspect the speedometer fitting and hose for damage. Replace as needed. 2. Replace the retaining clip and the stay strap. Tapered Insert Removal 1. Remove the tapered insert from the water inlet hose at the bell housing. a. Attach the tapered insert tool to a ratchet extension. b. Insert the tapered insert tool into the insert of the inlet water hose. 90-865612040 FEBRUARY 2006 Page 4B-1 Transom Disassembly, Repair, and Reassembly c. Turn counter clockwise to remove the insert. a b Bell housing a - Tapered insert location in the bell housing b - Ratchet and extension d c 16486 c - Tapered insert d - Tapered insert tool Tapered insert tool 91-43579 2. Remove the tapered insert from the water inlet hose at the gimbal housing. a. Attach the tapered insert tool to a ratchet extension. b. Insert the tapered insert tool into the insert of the inlet water hose. c. Turn counterclockwise to remove the insert. 17857 c d b a Gimbal housing a - Tapered insert location in the c - Tapered insert gimbal housing d - Tapered insert tool b - Ratchet and extension Tapered insert tool 91-43579 INSPECTION 1. Inspect each tapered insert for thread damage and cracks. Replace as needed. Page 4B-20 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Shift Cable�Bell Housing Removal 1 On the bell housing, loosen and remove the flanged nut that attaches the intermediate shift cable assembly to bell housing. Retain the flanged nut. a b a - Intermediate shift cable b - Flanged nut c 16490 c - Deep socket 2. Push the cable back toward the gimbal housing. Dribble Valve Removal 1 Remove the dribble valve by pulling straight out. 16492 a b a - Dribble valve b - O-ring in the bell housing INSPECTION 1. 2. 3. 4. 5. Check the O-ring on the dribble valve for nicks and cuts. Ensure that the end of the dribble valve is not damaged. Check the O-ring in the bell housing for nicks and cuts. Inspect the bell housing for corrosion at the hole of the dribble valve. Replace damaged parts. Retention Sleeve Removal Pull the retention sleeve from the bell housing using the retention sleeve removal tool, threaded rod, washer, nut, and puller plate. 1. Place the retention sleeve removal tool inside the U-joint bellows and position the retention sleeve removal tool against the retention sleeve. 90-865612040 FEBRUARY 200 Page 4B-2 Transom Disassembly, Repair, and Reassembly NOTE: Install the retention sleeve removal tool. With the flat side vertical, insert the tool in the bellows and then turn it into the correct position. a b 17858 a - Retention sleeve removal tool b - Retention sleeve Retention sleeve removal tool 91-862546 2. Thread the nut onto the threaded rod and snug nut up to the washer and the puller plate tool. 3. Install the washer over the threaded rod and place it against the puller plate tool. 4. Install the puller plate tool over the threaded rod and place the tool against the bell housing, just under the top two studs. 5. Thread the threaded rod into the retention sleeve removal tool. 6. While holding the threaded rod in place, tighten the nut until the retention sleeve pulls away from the bell housing. a b c 16521 a - Puller plate tool c - Nut and flat washer b - Threaded rod (puller shaft) d - Retention sleeve removed Puller plate 91-29310 Washer 12-34961 Puller Shaft 91-31229 Page 4B-22 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Hex Nut 11-24156 7. Retention sleeve removed. a 17859 a - Retention sleeve removed RETENTION SLEEVE INSPECTION 1. The retention sleeve should always be replaced if damage is visable. IMPORTANT: The edge of the U-joint bellows acts as a seal between the bell housing and the driveshaft housing. Ensure that the seal lip is not damaged 2. If reusing the retention sleeve: The seal lip of the retention sleeve must not be damaged. 16522 b a a - Retention sleeve b - Sealing lip 90-865612040 FEBRUARY 2006 Page 4B-2 Transom Disassembly, Repair, and Reassembly Water Inlet Hose�Bell Housing Removal 1 Push the water inlet hose completely out of the bell housing and into the gimbal housing. a 16523 Bell housing a - Water inlet hose Trim Limit Switch�Gimbal Ring Removal 1 Remove trim limit switch hardware and allow the trim limit switch to temporarily dangle from the gimbal ring. Retain the hardware. a 16524 a - Attaching hardware Page 4B-2 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Trim Position Sender�Gimbal Ring Removal 1 Remove trim position sender hardware and allow the trim position sender to temporarily dangle from the gimbal ring. Retain the hardware. a 16525 a - Attaching hardware Ground Strap�Bell Housing Removal 1. Lift the bell housing to locate the ground strap that attaches to the gimbal ring. 2. Remove the ground strap at the bell housing connection. Retain the hardware. a b 16526 a - Ground strap b - Torx screw GROUND STRAP INSPECTION 1. Inspect the ground strap for frayed wire and loose end connectors. U-Joint Bellows�Bell Housing Removal NOTE: Ensure that the retainer sleeve has been removed. Refer to Retainer Sleeve Removal. 1 Pull up on the bell housing and pull the U-joint bellow from the bell housing. Exhaust Bellows�Bell Housing Removal NOTE: Exhaust bellows are glued in place. Bellows must be replaced when removed. 1. Lift the bell housing to gain access to the exhaust bellows. 2. Remove the hose clamp at bell housing end only. 90-865612040 FEBRUARY 200 Page 4B-2 Transom Disassembly, Repair, and Reassembly 3 Remove exhaust bellows from the bell housing. Use care not to scratch the painted surface of the bell housing. a b 16527 a - Hose clamp b - Exhaust bellows EXHAUST BELLOWS INSPECTION 1 Exhaust bellows are not to be reused. Discard. Hinge Pin Removal 1 Using the hinge pin tool, loosen and remove the hinge pin on the starboard side and the port side of the gimbal ring. c a c b 16528 a - Hinge pin on starboard side c - Hinge pin tool b - Hinge pin on port side Hinge pin tool 91-78310 2 High Performance Transom: Use the following procedure to remove the starboard side and the port side hinge pin: Page 4B-2 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly a. Remove Torx head screws from the hinge pin. b b a 16529 a - Hinge pin b - Torx head screw b. Thread the puller head tool into the hinge pin. c. Thread the slide hammer puller tool into the puller head tool. d. Operate the slide hammer puller tool until the hinge pin is removed. c a b 16530 a b c a - Hinge pin c - Slide hammer puller tool b - Puller head tool Puller head 91-63616T Slide hammer 91-34569A 1 HINGE PIN INSPECTION 1. Inspect the hinge pin for corrosion, debris, or damage. 2. Replace hinge pin if you detect damage. 90-865612040 FEBRUARY 2006 Page 4B-2 Transom Disassembly, Repair, and Reassembly Bell Housing Removal 1. Hold the bell housing securely and pull the bell housing from the gimbal ring cb a d 16531 a - Bell housing c - Gimbal housing b - Gimbal ring d - Hinge pin backing washer 2 Remove the gear lube hose assembly from the bell housing if you suspect damage or malfunction. Refer to Gear Lube Hose Assembly�Bell Housing Replacement. c b a 16532 a - Gear lube fitting to the gimbal c - Gear lube barb fitting to the bell housing housing b - Gear lube hose BELL HOUSING INSPECTION 1 Inspect the painted surface of the bell housing for damaged paint. If bare metal is exposed repaint before reassembly. 2 Check the bell housing studs for thread damage and ensure they are tight in the bell housing. Replace any damaged stud. Refer to Gimbal Housing or Bell Housing Stud Replacement. Page 4B-2 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 3. Ensure that the bell housing mating surfaces for all bellows are not damaged. a b 16533 a - Bellows mating surface b - Bell housing studs Shift Cable�Gimbal Housing Removal 1. Locate the shift cable end guide that was removed from the engine shift plate. 2. Loosen both set screws. 3. Pull the shift cable end guide from the shift cable. a bb c a da b 16487 a - Shift cable end guide c - Control cable b - Set screws d - Anchor 4. Loosen and remove the shift cable extension from the shift cable. b a a c a 16488 a - Shift cable extension c - Control cable b - Shift cable 90-865612040 FEBRUARY 2006 Page 4B-2 Transom Disassembly, Repair, and Reassembly 5 Remove the shift cable wrapping. a b 16489 a - Shift cable wrapping b - Shift cable 6. Loosen the crimp clamp on the shift bellow. b a 16491 a - Crimp clamp b - Shift cable bellows 7. Lubricate the brass area of the cable end and pull the shift cable through the bellows. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Brass area of shift cable end 92-802865A1 INSPECTION 1. Inspect the shift cable for chafing, kinks, and bends. 2. The shift cable should not be loose at the crimped area of the brass fittings . 3. The control cable should not be damaged, the control cable must move freely inside the shift cable. 4 The control cable end to the sterndrive must not be bent or distorted, thus preventing the shift cable jaws from closing. U-joint Bellows � Gimbal Housing Removal 1 Loosen the hose clamp securing the U-joint bellows to the gimbal housing. Page 4B-3 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 2 Pull the U-joint bellows from the gimbal housing. a b a 16539 a - U-joint bellows b - Hose clamp U-JOINT BELLOWS INSPECTION 1. Inspect the U-joint bellows for tears, holes, and wear damage. 2. Replace the U-joint bellows if you detect damage. Retention Clips and Inlet Water Hose � Gimbal Housing Removal 1 For ease of reassembly, note the position of the inlet water hose, retention clips, the speedometer hose, and the trim limit switch. 2 Remove the retention clips. 3 Pull the inlet water hose from the gimbal housing. a b 16535 a - Retention clip b - Inlet water hose RETENTION CLIP AND WATER INLET HOSE INSPECTION 1. Retention clips must be replaced if you detect damage. 2. Inlet water hose must be replaced if damaged. Exhaust Bellows, Exhaust Tube � Gimbal Housing Removal 1 Position a long screwdriver through the access hole on the port side of the in gimbal housing. 90-865612040 FEBRUARY 200 Page 4B-3 Transom Disassembly, Repair, and Reassembly 2. Loosen the hose clamp securing the exhaust bellows (or tube) to the gimbal housing. a b c 16534 a - Screw driver c - Access hole in gimbal housing b - Hose clamp 3. Remove the exhaust bellows (or tube) from the gimbal housing. a b 16536 a - Exhaust bellows b - Exhaust tube EXHAUST BELLOWS, EXHAUST TUBE INSPECTION 1. Exhaust bellows can not be reused. Discard. 2. Exhaust tube can not be reused. Discard. Shift Cable Bellows � Gimbal Housing Removal 1. Loosen and remove the hose clamp from the shift cable bellows. 2. Remove the shift cable bellows from the gimbal housing. Page 4B-32 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly NOTE: The shift cable bellows was installed with adhesive applied to the bellows flange. If you plan to reuse the bellows, use care not to damage them during removal. a b c a b 16537 a - Hose clamp c - Swivel socket and extension b - Shift cable bellows SHIFT CABLE BELLOWS INSPECTION 1. Inspect the shift cable bellow for tears. 2. Replace damaged shift cable bellows. Gimbal Ring Assembly Removal 1. Loosen the U-bolt nuts. a 16575 a - U-bolt nuts 90-865612040 FEBRUARY 2006 Page 4B-3 Transom Disassembly, Repair, and Reassembly 2. Loosen clamping bolt and nut on the steering lever. a b 13576 Engine and transom assembly removed a - Wrench on clamping bolt b - Wrench on nut. 3. Remove the upper swivel shaft locking nut. a b 16577 a - Upper swivel shaft locking nut. b - Wrench 4. Remove the cotter pin. a a - Cotter pin a 16578 Page 4B-34 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 5 Remove the lower swivel pin. a 16579 a - Lower swivel pin 6. Remove the washer. a 16580 a - Washer 7 Remove the upper swivel shaft from the gimbal ring using the slide hammer puller and puller head tools. 16581 a b bc c a a a - Slide hammer puller c - Puller head tool b - Upper swivel shaft Puller head 91-63616T 90-865612040 FEBRUARY 200 Page 4B-3 Transom Disassembly, Repair, and Reassembly Slide Hammer 91-34569A 1 8. Remove the large ID washer, steering lever, small ID washer, and locknut. d c b a 17907 a - Locknut c - Steering lever b - Small ID washer d - Washer 9. Remove the gimbal ring. GIMBAL RING ASSEMBLY INSPECTION 1. Inspect the painted surfaces and bushings on the gimbal ring. 2. Inspect the upper swivel shaft threads for damage, corrosion and rust. 3. Inspect the lower swivel pin for nicks. 4. Replace the cotter pin. Analog Trim Limit Switch and Trim Position Sender � Gimbal Housing Removal NOTE: To ease in reassembly, note the position of the two grommet halves. The flat mating edges are vertically aligned and seated lightly in the hole under the clamp plate. 1. Remove and the screw securing the clamp plate to the gimbal housing. a c b d 16572 a - Screw c - Trim position sender (starboard) b - Clamp plate d - Trim limit switch (port) Page 4B-36 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 2. Pull the complete assembly from the gimbal housing. Retain the hardware. 16573 a c b a - Clamp plate b - Trim limit switch (port) c - Trim position sender (starboard) TRIM LIMIT SWITCH AND TRIM POSITION SENDER INSPECTION 1. Inspect the bullet connections. 2. Check the wire for any frayed, nicked, or melted areas. 3. Ensure that the grommets are secured to the wire. 4. All connections are tight. 16574 d b c a Analog Trim sender switch and Trim position sender complete assemblies a - Grommet c - Trim sender switch b - Bullet connections d - Trim position sender Speedometer Hose and Fitting At Gimbal Housing Removal NOTE: This note presumes that the speedometer retention clip and quick-connect fitting at the bell housing have been removed. 1. Loosen the speedometer quick-connect fitting at the gimbal housing. 2. Pull the speedometer quick-connect fitting and the hose assembly from the gimbal housing. INSPECTION 1. Replace the speedometer assembly if the hose feels brittle, or if you find holes or wear damage. 2. Check the quick-connect fitting for damage at the threads and at the connection points. 90-865612040 FEBRUARY 2006 Page 4B-3 Transom Disassembly, Repair, and Reassembly Bravo Transom Repair Gimbal Housing or Bell Housing Stud Replacement NOTE: This procedure may be used to replace the studs in the bell housing. Description Nm lb. in. lb. ft. Bell housing stud 20 15 NOTE: The gimbal housing coarse threads screw into the gimbal housing. 1 If applicable, clean the old sealant residue from the gimbal housing and the gimbal housing stud. 2 Apply sealant to the first three coarse threads of the gimbal housing stud. Tube Ref No. Description Where Used Part No. Studs of the gimbal housing or 7 Loctite 271 Threadlocker 92-809819 bell housing 3. Hand-start the gimbal housing stud into the gimbal housing. NOTE: You may use a stud driver to tighten and torque the gimbal housing studs. Do not damage the threads. 4 To tighten the gimbal housing stud: a. Thread two nuts onto the gimbal housing stud. a ab 16585 Gimbal housing a - Bottom nut b - Top nut Page 4B-3 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly b. Tighten both nuts to each other a b 16587 Gimbal housing a - Wrench on top nut b - Wrench on bottom nut c. Using a wrench on the top nut, tighten the gimbal housing stud. b a 17893 Gimbal housing a - Top nut b - Gimbal housing stud d. Torque the gimbal housing stud. b ca 17894 Gimbal housing a - Torque wrench on top nut c - Gimbal housing stud b - Bottom nut 90-865612040 FEBRUARY 2006 Page 4B-3 Transom Disassembly, Repair, and Reassembly Description Nm lb. in. lb. ft. Gimbal housing stud 31 23 e. Loosen and remove both nuts from the stud. Do not loosen the stud. Gimbal Ring Hinge Pin Bushing Replacement IMPORTANT: Ensure the mandrel will not damage the gimbal ring bore when removing the bushing. The following procedure pertains to replacement of the port, starboard hinge pin bushing. 1. Place a suitable mandrel on the gimbal ring hinge pin bushing. 2. Use a hammer to tap on the mandrel until the bushing is completely removed. a b c 16606 a - Hammer c - Gimbal ring b - Suitable mandrel 3. Inspect the bore for cleanliness and damage before installing the hinge pin bushing. 4. Replace the gimbal ring if the bore is damaged. 5. Install a new hinge pin bushing: a. Thread the hinge pin into the bushing/bearing/seal driver tool. a b 16608 a - Hinge pin b - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Apply sealer to the outside surface of the hinge pin bushing. Tube Ref No. Description Where Used Part No. 130 Sealer Kit, Two Part Epoxy Hinge pin bushing 92-65150-1 c. Place the hinge pin bushing over the hinge pin. NOTE: Use only one of the following procedures: Page 4B-40 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly d. Press the hinge pin bushing in gimbal ring. a b c 16619 a - Gimbal ring c - Bushing/bearing/seal driver tool b - Press e. Drive the hinge pin bushing in the gimbal ring using a hammer. c a b d 16609 a - Gimbal ring c - Bushing/bearing/seal driver tool b - Hammer d - Bushing Gimbal Ring Lower Swivel Pin Bushing Replacement IMPORTANT: Be careful not to damage the gimbal ring bore with the mandrel when removing the bushing. 1. Place a suitable mandrel on the lower swivel pin bushing of the gimbal ring. 90-865612040 FEBRUARY 2006 Page 4B-4 Transom Disassembly, Repair, and Reassembly 2. Use a hammer to tap on the mandrel until the bushing is completely removed. 17905 d a b c a - Hammer b - Suitable mandrel c - Gimbal ring 3. 4. 5. Inspect the bore for cleanliness and damage before installing the bushing of the lower swivel pin. Replace the gimbal ring if the bore is damaged. Install a new bushing on the lower swivel pin: a. Thread the hinge pin tool into the bushing/bearing/seal driver tool. a b 16608 a - Hinge pin b - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Apply sealer to the outside surface of the bushing onto the lower swivel pin. Tube Ref No. Description Where Used Part No. 130 Sealer Kit, Two Part Epoxy Lower swivel pin 92-65150-1 c. Place the lower swivel pin bushing over the hinge pin tool. NOTE: Use only one of the following procedures: Page 4B-42 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly d. Press the bushing of the lower swivel pin into gimbal ring. a b c a - Press b - Bushing/bearing/seal driver d 16610 c - Bushing d - Bushing installed e. Drive the lower swivel pin bushing into the gimbal ring using a hammer. a b c 17906 a - Hammer c - Bushing b - Bushing/bearing/seal driver Gimbal Housing Swivel Shaft Bushing And Seal Replacement 1 Remove the swivel shaft seal and the lower swivel shaft bushing from the gimbal housing using the bushing removal tool with the slide hammer tool. a a 17895 a - Bushing removal tool (expanding rod and collet) Expanding Rod Snap-On CG45- Collet Snap-On CG45-1 90-865612040 FEBRUARY 200 Page 4B-4 Transom Disassembly, Repair, and Reassembly Slide hammer 91-34569A 1 2 Remove the upper swivel shaft bushing from the gimbal housing using the bushing removal tool. a a 17895 a - Bushing removal tool (expanding rod and collet) Collet Snap-On CG40A-6 Expanding rod Snap-On CG40-4 3. Install new swivel shaft bushings and seal: a b c 16615 Swivel shaft bushing and seal replacement parts a - Swivel shaft seal c - Upper swivel shaft bushing b - Lower swivel shaft bushing 4 Install the upper swivel shaft bushing: a. Place the upper swivel shaft bushing on the bushing/bearing/seal driver tool. 16616 a b a - Upper swivel shaft bushing b - Bushing/bearing/seal driver tool Page 4B-4 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly Bushing/bearing/seal driver 91-43578A1 b. Install upper swivel shaft bushing by tapping it in place with a hammer. a b 16617 a - Bushing/bearing/seal driver tool b - Hammer 5 Install the lower swivel shaft bushing: a. Place the lower swivel shaft bushing on the bushing/bearing/seal driver tool a b 16618 a - Lower swivel shaft bushing b - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Install lower swivel shaft bushing by tapping it in place with a hammer. a b 16617 a - Bushing/bearing/seal driver tool b - Hammer 6 Install the swivel shaft seal: a. Apply sealant to outside surface of swivel shaft seal. 90-865612040 FEBRUARY 200 Page 4B-4 Transom Disassembly, Repair, and Reassembly Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Swivel shaft seal 92-809819 b. Place seal on bushing/bearing/seal driver tool with lip facing the end of the tool with the smaller diameter. 16620 a b c a - Swivel shaft seal b - Seal lip c - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 c. Install the swivel shaft seal by tapping it in place with a hammer. a b 16617 a - Bushing/bearing/seal driver tool b - Hammer Gimbal Ring Phenolic Washer Replacement 1. Peel the damaged phenolic washer from the gimbal ring. Page 4B-46 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 2. Carefully remove glue residue from gimbal ring surface. Do not scratch or remove paint. a b 16568 a - Phenolic washer locations b - Gimbal ring 3. To install a new phenolic washer: a. Temporarily place a hinge pin in the gimbal ring. b. Peel the backing off the phenolic washer. c. Place the new phenolic washer onto the gimbal ring using the hinge pin for alignment. a a b 16569 a - Phenolic washer b - Hinge pin 90-865612040 FEBRUARY 2006 Page 4B-4 Transom Disassembly, Repair, and Reassembly Gimbal Ring U-bolt Replacement 1 Remove the nuts, plate, and U-bolt. a - U-bolt c - Plate b - Nuts a b c b 2 Install U-bolt assembly: a. Insert the U-bolt through the gimbal ring. b. Install the plate. c. Install the nuts. NOTE: U-bolt will not be torqued until assembled with the gimbal housing. a c b 16570 a c b b a c 16571 a - U-bolt c - Plate b - Nuts Gear Lube Hose � Bell Housing Replacement 1. Remove the gear lube monitor hose assembly from the bell housing. a. Release the clamp from the barb fitting at the bell housing. Page 4B-4 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly b. Pull the gear lube hose from the barb fitting c b a 16532 a - Gear lube bulkhead fitting to the gimbal housing b - Gear lube hose c - Gear lube barb fitting to the bell housing 2. 3. Replace the damaged component. Ensure that all O-rings are in good condition. a b c d ef 18133 a - Quick-connect bulkhead fitting to d - Clamp the gimbal housing e - Stay strap b - Gear lube hose f - O-ring c - Gear lube barb fitting to the bell housing 4 If it was previously removed, install the barb fitting onto the bell housing using sealant on threads. Tube Ref No. Description Where Used Part No. 19 Perfect Seal Threads 92-34227-1 5. Push the gear lube hose onto the barb fitting. 6. Install the clamp to secure the gear lube hose to the barb fitting. 7. Push the gear lube hose onto the bulkhead fitting. 8. Install the stay strap to secure the gear lube hose to the bulkhead fitting. 90-865612040 FEBRUARY 200 Page 4B-4 ..ransom Disassembly.. Repair.. and Reassembly Gimbal ..ousing Gasket Replacement 1 ....a.............ac.............a.....................3....a.....................ac.............a.............a....a...............S ....ba................. Bell ..ousing Check ..alve and Drive Shaft ..ousing Check Ball Replacement ......E.. Unless damaged during disassembly or by heat.. these check valves should last the life of the sterndrive unit. The bell housing check valve is replaced as an assembly with the check ball in the Bravo drive shaft housing. a b 19447 Bell housing check valve ..dribble valve a .. ..c......a........a........b..\ b .. ..V b a c 19448 Bravo sterndrive check ball assembly a .. ....a....c..S c .. ..J b .. ..c....ba..O 1 Bell housing check valve ..dribble valve..c....c......a.................b.....O .... 16492a b a .. ..c......a...............bb........a...... b .. ..b...................J 2 ....c....c......a........a........b.... a ....b....ca........................... ..a......4....50 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly Tube Ref No. Description Where Used Part No. High Performance Gear 8 Dribble valve O-ring 92-802854A1 Lubricant b. Insert the check valve into the seal cup. c. Using pliers, push check valve into the casting until the shoulder surface is flush with the casting surface. a b 21703 Bell housing check valve (dribble valve) a - Shoulder surface b - Casting surface 3 Bravo sterndrive check ball assembly: Remove the seal cup, check ball, and spring by inserting a screwdriver into the the center of the seal cup and prying it out while using a second screwdriver as a fulcrum. aaa a 19543 Bravo sterndrive check ball assembly in the drive shaft housing a - Check ball 4 To reinsert the check ball assembly: a. Insert a new spring, check ball, and seal cup into the drive shaft housing. b. Press or tap carefully the seal cup until the outer face is flush with the surface of the drive shaft housing c. Do not use sealant 90-865612040 FEBRUARY 200 Page 4B-5 Transom Disassembly, Repair, and Reassembly 5. a a a a 19542 Bravo sterndrive check ball assembly in the drive shaft housing a - Check ball Bravo Transom Reassembly Analog Trim Limit Switch and Trim Position Sender � Gimbal Housing Installation 1 Ensure that the trim limit switch and the trim position sender assemblies are not damaged. 16574 d b c a Analog Trim limit switch and Trim position sender complete assemblies a - Grommet c - Trim limit switch b - Bullet connectors d - Trim position sender 2 Install the trim limit wire and the trim position wire connectors through the access hole in the gimbal housing. a b 16229 a - Trim limit switch bullet connectors b - Trim position sender bullet connectors Page 4B-5 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 3. Position the trim limit switch wire to the port side of the gimbal housing. 4. Position the trim position sender wire to the starboard side of the gimbal housing. 5. Position the flat side of each grommet together. 6. Attach the clamp plate. 7. Pull the wires taut until the grommets rest in the access hole of the gimbal housing trim and the clamp plate is flush to the gimbal housing. a c b d 17975 a - Clamp plate b - Trim limit switch (port) c - Trim position sender (starboard) d - Access hole of the gimbal housing 8. 9. Ensure that the trim limit wire is positioned to the port side and that the trim position wire is positioned to the starboard side of the gimbal housing. Install and torque the retainer screw securing the clamp plate to gimbal housing. a c b d 16572 a - Retainer screw c - Trim position sender (starboard) b - Clamp plate d - Trim limit switch (port) Description Nm lb. in. lb. ft. Trim wire retainer screw 11 95 Gimbal Ring Assembly Installation and Alignment 1. Align the gimbal ring hole in the lower swivel shaft with the hole in the gimbal housing. 2. Install the washer between the gimbal ring and the gimbal housing as shown. 90-865612040 FEBRUARY 2006 Page 4B-5 Transom Disassembly, Repair, and Reassembly 3. Install the lower swivel pin. Align the lower swivel pin slot to face foreword and aft. a a b c d a - Gimbal housing b - Gimbal ring 17982 c - Lower swivel pin d - Washer 4. 5. Install the cotter pin through the gimbal housing and the lower swivel pin. Bend the open end of the cotter pin in opposite directions to secure. NOTE: The cotter pin must be slightly bent to clear the gimbal ring ears a ba 17981 a - Cotter pin b - Cotter pin ends bent Page 4B-54 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 6 In order place the washer with the large inner diameter, the steering lever, the washer with the small inner diameter, and locknut into the cavity in the gimbal housing. d c b a a b c d 17985 a - Locknut c - Steering lever b - Small inner diameter washer d - Large inner diameter washer 7 Install the upper swivel shaft through the gimbal ring and up through the washers, steering lever, and locknut. a 17983 a - Upper swivel shaft 90-865612040 FEBRUARY 200 Page 4B-5 Transom Disassembly, Repair, and Reassembly 8. Hand-start the locknut on the upper swivel shaft threads. a b 17984 a - Hand starting nut b - Upper swivel shaft 9. Overtighten the locknut to pull the swivel shaft completely in the gimbal ring a b 16577 a - Locknut b - Wrench 10. Evenly tighten and torque the gimbal ring U-bolt locknuts. a a - Torque wrench 17987 Description Gimbal ring locknuts for 3/8 in. U-bolt Gimbal ring locknuts for 7/16 in. U-bolt Nm 72 95 lb. in. lb. ft. 53 70 Page 4B-56 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 11. Back off the locknut on the upper swivel shaft. a b 16577 a - Locknut b - Wrench 12. Strike down on the gimbal ring side supports using a synthane hammer. 13. Strike the gimbal ring side supports using a synthane hammer. IMPORTANT: You must reposition the gimbal ring by using a plastic hammer after each locknut adjustment to ensure proper measurement. 17989 Locations to strike when adjusting gimbal ring for alignment 14. Measure the clearance between the gimbal ring and the gimbal housing using a feeler gauge. a bc 17988 a - Lower swivel pin c - Washer b - Feeler gauge 90-865612040 FEBRUARY 2006 Page 4B-5 Transom Disassembly, Repair, and Reassembly Description Specification Clearance between lower swivel pin washer and gimbal housing mount 0.05�0.25 mm (0.002�0.010 in.) 15. If measurement is not within specification: Repeat the procedure steps as listed until you obtain the proper measurement. a. Back off or tighten the locknut on the upper swivel shaft as necessary to achieve the specified clearance. b. Strike down on the gimbal ring side supports. c. Strike the gimbal ring side supports using a plastic hammer. d. Measure the clearance between the gimbal ring and the gimbal housing using a feeler gauge. Shift Cable Bellows � Gimbal Housing Installation 1. Ensure that the shift cable bellows are not damaged. 2. If applicable, remove the old adhesive from the shift cable bellows using lacquer thinner. Tube Ref No. Description Where Used Part No. Lacquer thinner Shift Cable Bellows Obtain Locally 3. Clean the mounting flange of the shift cable bellows on gimbal housing using lacquer thinner. Tube Ref No. Description Where Used Part No. Lacquer thinner Gimbal housing shift cable bellows mounting flange Obtain Locally ! WARNING Avoid injury. Read and follow package label directions before applying adhesive to the bellows. 4. Apply adhesive to shift cable bellows. Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive Shift cable bellows 92-86166Q1 5. Allow the adhesive to dry until no longer tacky (approximately 10 minutes). 6. Install the shift bellows onto the flange of the gimbal housing. 7. Position the hose clamp on the shift bellows as shown. Page 4B-58 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 8 Tighten and torque the hose clamp. a b a - Shift cable bellows b - Hose clamp c a b 18040 c - Swivel socket and extension Description Nm lb. in. lb. ft. Shift cable bellows hose clamp 4 35 Exhaust Bellows, Exhaust Tube � Gimbal Housing Installation 1 Clean the exhaust bellows/tube mounting flange on gimbal housing. Use sandpaper to remove hard adhesive residue and wipe clean with lacquer thinner. Do not remove paint. If paint has been removed, repaint before installing bellows/tube. ! WARNING Avoid injury. Read and follow package label directions before applying adhesive to the bellows. ! CAUTION Avoid corrosion damage to the hose clamp. Install the ground clip onto the exhaust bellows or the exhaust tube. Tube Ref No. Description Where Used Part No. Gimbal housing mounting Lacquer thinner Obtain Locally flange for exhaust bellows/tube 2. Position grounding clips on bellows/tube. 3. Apply adhesive to exhaust bellows/tube mounting surface. 4. Allow bellows adhesive to dry until no longer tacky (approximately 10 minutes). Tube Ref No. Description Where Used Part No. 27 Exhaust bellows/tube mounting Bellows Adhesive 92-86166Q1 surface 5. Install the exhaust bellows/tube on the flange of the gimbal housing. 90-865612040 FEBRUARY 200 Page 4B-5 Transom Disassembly, Repair, and Reassembly 6. Position hose clamp as shown and torque. a b c 16534 a - Tool c - Access hole in gimbal housing b - Hose clamp Description Nm lb. in. lb. ft. Exhaust bellows/tube hose clamp 4 35 Speedometer Hose and Fitting At Gimbal Housing Installation 1. Apply sealant to the quick-connect fitting threads. Tube Ref No. Description Where Used Part No. 9 Loctite 567 PST Pipe Sealant Speedometer fitting threads 92-809822 2. Install the speedometer hose through the threaded hole of the gimbal housing. 3. Hand-start the quick-connect fitting into the gimbal housing. 4. Tighten and torque the quick-connect fitting. Description Nm lb. in. lb. ft. Speedometer quick-connect fitting to gimbal housing 12 110 Inlet Water Hose, Tapered Insert, and Retainer Clips � Gimbal Housing Installation 1. Install the inlet water hose to the gimbal housing. a b 18138 Gimbal housing a - Water inlet hose b - Water inlet through hole 2. Install the tapered insert to secure the inlet water hose to the gimbal housing. Page 4B-60 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly a. b. Position the water hose so that approximately 3 mm (1/8 in.) protrudes from edge of the opening of the gimbal housing. Apply a small amount of lubricant to the ID of the hose. Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Hose inner diameter 92-802859A1 c. Install tapered inserts using the tapered insert tool b a c d 18135 a - Tapered insert location in gimbal housing b - Ratchet and extension c - Tapered insert d - Tapered insert tool Tapered insert tool 91-43579 3. Install the retaining clips to the inlet water hose. a. Install the top retaining clip to hold the trim limit switch wire in position. a b 18136 a - Trim limit switch wire b - Retaining clip 90-865612040 FEBRUARY 2006 Page 4B-6 Transom Disassembly, Repair, and Reassembly b Install the bottom retaining clip to hold the speedometer hose in position. a b 18137 a - Retaining clip b - Speedometer hose c Push the inlet water hose back into position in the gimbal housing, taking care not to pinch the trim limit wire and the speedometer hose. a b 19599 a - Retain clip b - Inlet water hose Shift Cable � Gimbal Housing Installation 1 If applicable, install the shift cable housing insert into the gimbal housing and snap it into place. NOTE: The shift cable housing insert must be installed from transom side. a b 18101 a - Shift cable housing insert b - Gimbal housing Page 4B-6 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 2 Locate the shift cable end without fittings. Insert the shift cable into the small end of the shift cable bellows and through the gimbal housing. a b 18102 a - Shift cable b - Shift cable bellows 3 Pull the shift cable through the gimbal housing until the shift cable with brass end fittings contacts the small end of the bellows. NOTE: Allow the shift cable end with fittings to remain loose at the shift cable bellows until the bell housing is installed. 18106 b a a a - Shift cable b - Control cable U-joint Bellows � Gimbal Housing Installation 1 If reusing the U-joint bellows, remove the old adhesive from the U-joint bellows using lacquer thinner. Tube Ref No. Description Where Used Part No. Lacquer thinner U-joint bellows Obtain Locally 2 Clean the U-joint bellows mounting flange on the gimbal housing with sandpaper and wipe clean with lacquer thinner. Do not harm the paint. If paint has been removed, repaint before installing bellows. Tube Ref No. Description Where Used Part No. U-joint bellows mounting flange Lacquer thinner Obtain Locally on the gimbal housing 90-865612040 FEBRUARY 200 Page 4B-6 Transom Disassembly, Repair, and Reassembly ! WARNING Avoid injury. Read and follow package label directions before applying adhesive to the bellows. ! CAUTION Avoid corrosion damage to the hose clamp. The ground clip must be installed to the U-joint bellows. 3. 4. 5. Install the ground clip on the U-joint bellows close to the "TOP" mark on bellows. Apply adhesive to the inside diameter side of the U-joint bellows to be attached to the gimbal housing. Allow adhesive to dry until no longer tacky (approximately 10 minutes). Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive U-joint bellows 92-86166Q1 6. Position the hose clamp on the U-joint bellows so that the hose clamp fitting is facing downward on the starboard side when the U-joint bellows are installed. IMPORTANT: The "TOP" mark on the U-joint bellows must be facing upward when installing onto the gimbal housing. 7. Position the U-joint bellows "TOP" mark facing upwards. 8. Push the U-joint bellows onto the gimbal housing flange until the bead on the inner matting surface of the U-joint bellows is in the grove of the gimbal housing flange. a b 18087 a - U-joint bellows b - Hose clamp IMPORTANT: Ensure that the U-joint bellows is correctly positioned in the groove of the gimbal housing flange. Page 4B-64 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 9. Tighten and torque the hose clamp of the U-joint bellows b a 18086 a - Hose clamp b - Swivel socket with extension Description Nm lb. in. lb. ft. U-joint bellows hose clamp 4 35 Bell Housing and Gear Lube Monitor Installation 1 Arrange the trim limit switch and the trim position sender assemblies so that they will not be damaged when installing the bell housing . 2 Ensure that the gear lube hose assembly is installed to the bell housing. c b a 16532 Bell housing with the gear lube hose assembly installed a - Gear lube fitting to gimbal housing c - Gear lube barb fitting to bell housing b - Gear lube hose 3 Hold the bell housing close to the gimbal ring, as if to install. 90-865612040 FEBRUARY 200 Page 4B-6 b a c b a c ..ransom Disassembly.. Repair.. and Reassembly 4 ....a........b.............a........b...........c....c.......c..ba...............J ....a..b..a............. 19446 c .. ..b..........a...............J 5 ....a.................c.........................a........b.............a........b......b..........a................. a .. ....a........b.......................... b .. ....a..........a..............c..a.... a b 18134 ..or clarity the ....clip shown is not completely installed a .. ....c....S b .. ..a................J 6 ....b.............................a..b.....................a........b...............a...................H ....ba.............................. ..a......4....66 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly NOTE: Standard Bravo uses hinge pin backing washers. 16531 cb a d a - Bell housing c - Gimbal housing b - Gimbal ring d - Hinge pin backing washer 7. Use one of the following procedures to secure the bell housing to the gimbal ring: � "Standard Bravo Transom Hinge Pin Installation" � "High Performance Transom Hinge Pin Installation" Hinge Pin Installation 1. Standard Bravo transom hinge pin Installation: NOTE: The Standard Bravo hinge pin bushings are located in the gimbal ring. 2. Ensure that the hinge pin bushings are in position and are not damaged. 3. Ensure that the bell housing hinge pin backing washers are in place. 4. Use the following procedure to install the port and starboard hinge pins. a. Apply Loctite to the hinge pin threads. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Hinge pin threads 92-809819 b. Position the hinge pin through the gimbal ring and into the bell housing. c. Using the hinge pin tool, start the hinge pin threads into the bell housing. d. Tighten the port and starboard hinge pins evenly. c a c b 16528 a - Hinge pin on starboard side c - Hinge pin tool b - Hinge pin on port side 90-865612040 FEBRUARY 2006 Page 4B-6 Transom Disassembly, Repair, and Reassembly Hinge pin tool 91-78310 e. Torque the port and starboard hinge pins. a 19559 a - Torque wrench Description Standard Bravo hinge pin 5. High Performance transom hinge pin installation: Nm 197 lb. in. lb. ft. 145 NOTE: High Performance gimbal ring has no bushings. The hinge pin bushings are located in the High Performance bell housing. 6. Ensure that the hinge pin bushings are in position and are not damaged. 7. Use the following procedure to install the port and starboard hinge pins. a. Thread the puller head tool into the hinge pin. Puller head 91-63616T b. Lubricate the hinge pin. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 High Performance hinge pin 92-802865A1 c. Slide the hinge pin through the gimbal ring and the bell housing. d. Align the screw holes in the hinge pin with the screw holes in the gimbal ring. Page 4B-68 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly e. Lightly tap the hinge pin into place using the slide hammer tool if required. a b c a - Hinge pin b - Puller head tool c a b 19557 c - Slide hammer tool Slide hammer 91-34569A 1 f. Apply sealant to the threads of the hinge pin screw. g. Install the screws to the hinge pin. Tube Ref No. Description Where Used Part No. High performance hinge pin 66 Loctite 242 Threadlocker 92-809821 screw threads h. Torque the hinge pin screws b b a c a - Hinge pin b - Hinge pin screw 19558 c - Torque wrench Description High performance hinge pin screws (2) early style High performance hinge pin screws (4) later style Nm 40 12.4 lb. in. 35 110 lb. ft. Exhaust Bellows � Bell Housing Installation 1 Clean the exhaust bellows mounting flange on the bell housing. Use sandpaper to remove hard adhesive residue and wipe clean with lacquer thinner. Do not damage the paint. 90-865612040 FEBRUARY 200 Page 4B-6 ..ransom Disassembly.. Repair.. and Reassembly ..ube Ref ..o. Description Where ..sed Part ..o. ..ac...a............. ......a........b.............b..a..........ca...... 2 ....c.....................b............ !....A.......... Avoid injury. Read and follow package label directions before applying bellows adhesive. !....A.......... Avoid corrosion damage to the hose clamp. ..he ground clip must be installed to the ....joint bellows. ..ube Ref ..o. Description Where ..sed Part ..o. 27................A...................a........b............................ ....ac..92..86166..1 3 A..........a...ac........................a........b............ 4 A.................b.............a..ac........a.............a..........10................ 5 ....ac......................c..a......................b................... 6 ....ac............b...................a..b.........................c................... 7 ....c.....................................a.....................b..........................A...........b.........V ....a..a.................a........................ a cd b 19595c .. ..a........b............ d .. ..c..a.... a .. ..a.................. b .. ..a...... ....a.................91..45497A1 8 ....b.............c................... 9 ....b...............................b..........................a...... ..a......4....70 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly 10. Install the cross pin in the bellows expander tool. a b 19508 a - Cross pin b - Bellows expander tool 11. Tighten the hose clamp and torque. 12. Remove the bellows expander tool. a b c 19596 a - Exhaust bellows b - Bell housing flange c - Hose clamp Description Exhaust bellows hose clamp U-joint Bellows � Bell Housing Installation 1. Pull the U-joint bellows into the bell housing. Nm 4 lb. in. 35 lb. ft. 90-865612040 FEBRUARY 2006 Page 4B-7 ..ransom Disassembly.. Repair.. and Reassembly 2 ....a...........b...........................a..c..H b........... a a 19449a .. ..a...... Retention Sleeve Installation 1 ....b....ca.............................a...a........a..........................c....a...... 16522b a a .. ..a...Q b .. ....a.......................b...................H ....H ..a......4....72 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly 2. Assemble the sleeve installation tool, puller plate tool, and the driving rod tool. a b c d 19470 a - Sleeve installation tool c - Driver handle tool b - Bearing driver tool d - Puller plate tool Sleeve installation tool 91-818162 Bearing driver 91-63638 1 Driver handle 91-805454 Puller plate 91-29310 3. Position the retention sleeve on the sleeve installation tool as shown. a b c d e 19468 a - Retention sleeve b - Sleeve installation tool c - Bearing driver tool d - Puller plate tool e - Driver handle tool 4. Attach the sleeve installation tool and a suitable driving rod 90-865612040 FEBRUARY 2006 Page 4B-7 ..ransom Disassembly.. Repair.. and Reassembly 5 ....a....a...ac.. a b 19469 a .. ..a......U b .. ..a............O Shift Cable .. Bell ..ousing Installation 1 A.............a..a..cab...........a................. ..ube Ref ..o. Description Where ..sed Part ..o. 19..........c........a..........a................................cab.... ......a.................92..34227..1 2 ....c.....................cab............b..................... bc a 19437 Shift cable secured to bell housing a .. ..cab...........a...............W c .. ....a.............W b .. ....a.......a......U !....A.......... Prevent water leakage. Do not flatten the end of the shift bellows when crimping the shift bellows clamp during installation. 3 ....a.........................cab......b.............c..........c..a.... ..a......4....74 90..865612040................A........2006 ..ransom Disassembly.. Repair.. and Reassembly IMP..R..A...... Do not compress the crimp clamp with pliers. b a 16491 ..ool shown is not for compressing the crimp clamp a .. ..c..a..S b .. ..cab......b.........V 4 ....cab......b.............c..........c..a..........a......a............a..13..............................U ....a.......... 5 ....a............c..a............c....................................a......a......a................a....b.....................b..........V a........................cab.......................a.................b.......................a........ Plans ..or Making a Crimp Clamp ..ool ......E.. The crimp clamp tool is used to compress the shift cable bellows crimp clamp.. maintaining a .... mm (.. in.) outer diameter. 1 ....a...a...........a....a...........................a................ 2 ..a..........................a........................a..a........................ 3 ....a...............a.....................................a.....c.........a.............................a..............................a..\ .... 4 ....a.....................b...a................................ 5 ....c..a......a......b.. a a a b b c 18122 Crimp Clamp ..ool a .. ..V c .. ..V b .. ..W 90..865612040................A........2006 ..a......4....75 Transom Disassembly, Repair, and Reassembly Tapered Insert � Bell Housing 1. Position the water hose so that approximately 3 mm (1/8 in.) protrudes from the edge of the opening of the bell housing. 2. Apply a small amount of lubricant to the inner diameter of the hose and install tapered inserts using the tapered insert tool. a b d c 16486 a - Tapered insert location in the bell c - Tapered Insert housing d - Tapered Insert tool b - Rachet and extension Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Hose inner diameter 92-802859A1 Tapered insert tool 91-43579 Dribble Valve Installation NOTE: Unless damaged during disassembly or by heat, these check valves should last the life of the sterndrive unit. The bell housing check valve is replaced as an assembly with the check ball in the Bravo drive shaft housing. Refer to Bell Housing Dribble Valve And Drive Shaft Housing Check Ball Replacement.. 1. Ensure that the O-ring in the bell housing is not damaged. 2. Push the dribble valve into the bell housing until both O-rings are inserted. b a 16462 a - Dribble valve b - O-ring in bell housing Speedometer Fitting � Bell Housing Installation 1. Slide the retaining clip onto the speedometer hose. Page 4B-76 90-865612040 FEBRUARY 200 ..ransom Disassembly.. Repair.. and Reassembly 2 ....a..............ba..b.................................c....c........c.. 3 ....a......a......a..........a.............c................c........c........ a b c 16485 a .. ..c.....c........c................J c .. ....a..........aS b .. ..H 4 ....a..a....a...................................ba.............b................................U ....b..................... 5 ....a............c.........................b.................... a 17856 a .. ..a...........c....S ..rim ..imit Switch .. Gimbal Ring Installation 1 ....c..c.........a.......................................a...a.........Q ....b...... a 19438 a .. ..a..N 90..865612040................A........2006 ..a......4....77 ..ransom Disassembly.. Repair.. and Reassembly 2 ....a..c....a.........c.................a....ac...........a......a.... a 16524 a .. A....ac...........a......a..H 3 ....c...c......a.............................a..a......c..c.........................Inlet Water ..ose.. ..apered Insert.. And Retainer Clips ..o Gimbal ..ousing. a b 18136 a .. ..H b .. ..a...........c....S ..rim Position Sender .. Gimbal Ring Installation 1 ....c..a..............................a..............................[..a..................................b...... a 19438 a .. ..a..N ..a......4....78 90..865612040................A........2006 Transom Disassembly, Repair, and Reassembly 2. Install the trim position sender and secure with attaching hardware. a 16525 a - Attaching hardware 3. Secure the trim position sender harness to the gear lube hose with the plastic clip. Hydraulic Manifold, MerCathode, and Trim Cylinder Assemblies Installation 1. Rotate the transom assembly stand so that the bottom of the gimbal housing is on top. 2. Insert the hydraulic manifold hoses with 90� fittings and the MerCathode wire connection in the gimbal housing by pushing and moving side by side. a a c b bc 19533 a - Manifold black hoses b - Manifold grey hoses c - MerCathode wire connection 3. Install the hydraulic manifold gasket, hydraulic manifold assembly, washers and nuts. 90-865612040 FEBRUARY 2006 Page 4B-7 Transom Disassembly, Repair, and Reassembly 4. Torque the nuts. a b c 19534 a - Locknuts c - Hydraulic manifold b - Continuity washer Description Nm lb. in. lb. ft. Hydraulic manifold locknuts 11 95 5. Install the MerCathode to the hydraulic manifold. 6. Install screws and lockwashers. 7. Torque the screws. a b a - Screw 16482 b - Washers Description MerCathode screws 8. Install the anchor pin of the trim cylinder. Nm 9 lb. in. 80 lb. ft. Page 4B-80 90-865612040 FEBRUARY 200 Transom Disassembly, Repair, and Reassembly 9. Install the flat washer and the E-clips. a b c 16481 a - E-clip (2) c - Anchor pin b - Flat washer (2) 10. Install the bushings, trim cylinders, and flat washers to the anchor pin. a c d 16480 b a - Flat washer (2) c - Trim cylinder (2) b - Bushing (4) d - Anchor pin 11. Install the nuts onto the anchor pin and tighten. a b 17854 a - Wrench on nut b - Ratchet socket on nut . 90-865612040 FEBRUARY 2006 Page 4B-8 Transom Disassembly, Repair, and Reassembly 12. Use the Torx screw to secure 3 ground wires from the trim cylinders to the bottom of the gimbal housing. a b b b a b b b 16477 a - Torx screw b - Continuity wire Shift Cable Final Assembly and Adjustment 1 Install the shift cable wrapping approximately 51 mm (2 in.) from the gimbal housing. a b 16489 a - Shift cable wrapping b - Shift cable 2 Locate the brass threaded end of cable and thread the the shift cable extension over the core wire. b a c a 18125 a - Shift cable extension c - Shift cable b - Threads Page 4B-82 90-865612040 FEBRUARY 2006 Transom Disassembly, Repair, and Reassembly 3. Screw the shift cable extension into the shift cable a b c 18132 a - Shift cable extension c - Shift cable b - Jam nut 4. Tighten the connection. a b 18126 a - Shift cable extension b - Shift cable 5. Install the control cable through the shift cable end guide 90-865612040 FEBRUARY 2006 Page 4B-8 Transom Disassembly, Repair, and Reassembly 6. Allow the core wire to enter through the anchor. a b a d c e 18128 a - Set screws d - Core wire b - Anchor e - Shift cable extension c - Shift cable end guide 7. Tighten the set screws on the anchor to secure the core wire. a b 18131 a - Set screws b - Shift cable end guide 8. Pull the control cable end guide to ensure the control cable connection is secure Page 4B-84 90-865612040 FEBRUARY 200 ..ransom Disassembly.. Repair.. and Reassembly S..I.... CAB.... AD....S..M...... 1 ....a.......c......................ca..ac..........b..................... a b 19546 a .. ..J b .. ..ca................O ....cab......a..c........a..........................91..17262A1 2 ....ac.......................cab......a..c........a..cab.... d a cb 19547a .. ..cab......a..c........a.......................... b .. .. c .. ..ba.............ac............... d .. ..cab......a........b.... ....cab......a..c........a..........................91..17262A1 3 ....a.....b..c..a..a..................c..............H ....ca................. a b c 19445a .. .. b .. ..ca................. c .. .. 90..865612040................A........2006 ..a......4....85 Transom Disassembly, Repair, and Reassembly 4. Adjust the cable barrel to align with the hole in the tool. a b 19551 a - Barrel b - Hole in tool Page 4B-86 90-865612040 FEBRUARY 200 Oildyne Trim Pump Power Trim Section 5A - Oildyne Trim Pump Table of Contents Specifications..5A-2 Valve Pressure Specifications.................5A-2 Electrical Specification..............................5A-2 Torque Specification..5A-3 Exploded Views..5A-4 Power Trim Pump.....................................5A-4 Later-Model Trim Pump and Bracket Hardware..5A-6 Maintaining Power Trim Pump Oil Level..........5A-7 Air Bleeding Power Trim System....................5A-8 Bleeding OUT/UP Trim Circuit..................5A-8 Bleeding IN/DOWN Trim Circuit..............5A-8 Testing Power Trim Pump..............................5A-9 Test Gauge..5A-9 Internal Restriction Test.........................5A-11 OUT/UP Pressure Test..........................5A-11 IN/DOWN Pressure Test.......................5A-11 Power Trim Pump Hydraulic System......5A-12 Trim Cylinder Internal Leak Test...................5A-12 Trim Cylinder Shock Piston Test...........5A-14 Motor and Electrical Bench Tests.................5A-15 Power Trim Pump Motor Test (In Boat) ....5A-15 Power Trim Pump Motor Test (Out of Boat) ....5A-16 Solenoid Test (Pump In Boat)................5A-17 Solenoid Test (Pump Out of Boat)..........5A-18 110-Amp Fuse Test (Pump in Boat).......5A-20 110-Amp Fuse Test (Pump Out of Boat) ....5A-21 20-Amp Fuse Test.................................5A-22 Power Trim Pump Removal...........................5A-22 Hydraulic Repair..5A-23 Disassembly..5A-23 Filter Replacement...............................5A-25 UP Pressure Relief Valve Replacement ....5A-25 DOWN Pressure Relief Valve Replacement ....5A-27 Thermal Relief Valve Replacement........5A-28 Pump Replacement...............................5A-28 Adapter Replacement...........................5A-30 Adapter Repair.......................................5A-32 Pump Shaft Oil Seal Replacement.........5A-34 Motor Repair...5A-37 Disassembly..5A-37 Armature Tests...5A-40 Continuity Test..5A-40 Test For A Shorted Circuit....................5A-40 Cleaning Commutator............................5A-41 Field Tests...5A-41 Test for Open Circuit...............................5A-41 Test For A Shorted Circuit.....................5A-42 Thermal Switch Continuity Test.............5A-43 Brush Replacement......................................5A-44 Reassembly...5A-46 Installation ....5A-51 Trim Pump Wiring Diagrams.........................5A-53 Model With Three-Button Trim/Trailer Panel ....5A-53 5 A 90-865612050 FEBRUARY 2006 Page 5A-1 Oildyne Trim Pump Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Screws 92-809819 95 2-4-C Marine Lubricant with Teflon Coupling 92-802859A 1 Trim pump O-ring at base on new valve. O-ring at base on new valve Power Trim and Steering Fluid Lip of adapter seal 92-858074K01 114 Check valve body O-rings Hex plug retainer O-rings O-ring at the base on the new valve Special Tools Plug 922-38609 Aids in bleeding the in/down circuit on the remote trim pump. 8862 Power Trim Test Gauge Kit 91-52915A6 Tests circuit pressures for various trim pumps. 3753 Torque Wrench, lb. in. 91-66274 10829 Dial type torque wrench that sets torque from 9 to 150 lb. in.; 3/8 in. drive. Specifications Valve Pressure Specifications Description kPa PSI Valve UP circuit DOWN circuit 15173-17932 2759-4138 2200-2600 400-600 Electrical Specification Description kPa PSI Pump Amperage Draw 115 amps at: 15173-17932 2200-2600 Page 5A-2 90-865612050 FEBRUARY 2006 Oildyne Trim Pump Torque Specification Description Up pressure relief valve Down pressure relief valve Thermal relief valve Pump to adapter mounting screws Pump screws Adapter to reservoir screws (early model) Trim motor screws Hydraulic hose fittings Hydraulic hose adapter fittings Trim cylinder hoses Nm 7.9 7.9 7.9 7.9 8 3 2.8 9 9 11 lb. in. lb. ft. 70 70 70 70 75 27 25 80 80 100 90-865612050 FEBRUARY 2006 Page 5A-3 Oildyne Trim Pump Page 5A-4 90-865612050 FEBRUARY 2006 Exploded Views Power Trim Pump 1 2 9 9 7 8 12 10 3 4 5 6 11 13 14 15 16 17 16153 Oildyne Trim Pump 1 Pump and motor assembly 10 - Adapter assembly 2 Motor assembly 11 -Coupling 3 Filter 12 -O-ring 4 Screw (4) 13 -Pump assembly 5 Quick-connect fitting 14 -Filter 6 O-ring 15 -O-ring 7 Quick-connect fitting 16 -Reservoir 8 O-ring 17 -Oil reservoir cap 9 Screw (2) NOTE:The circuit board plate in the brush holder kit was added to the later-model trimpump. The hardware and mounting difference are shown. Replacement Relief Valve Identification Codes Down pressure Green Up pressure Blue Thermal Silver 90-865612050 FEBRUARY 2006 Page 5A-5 Oildyne Trim Pump Page 5A-6 90-865612050 FEBRUARY 2006 Later-Model Trim Pump and Bracket Hardware 3 4 5 5 4 3 7 8 8 6 9 10 12 13 14 13 14 15 16 17 1819 23 25 1 21 20 11 22 27 2 24 26 28 16154 29 30 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-7 1 - Trim pump assembly 2 - Pump and motor assembly 3 - Harness assembly 4 - 20-amp fuse 5 - Cover 6 - Solenoid 7 - Retainer 8 - Screw (4) 9 - Nut (4) 10 - Cable assembly 11 - Cable assembly 12 - Link 13 - Lockwasher (4) 14 - Nut (4) 15 - Fuse assembly 16 - Washer 17 - Cable assembly 18 - Lockwasher 19 - Nut 20 - Insulator 21 - Screw 22 - Cable assembly 23 - Nut 24 - Screw 25 - Bracket 26 - Channel 27 - Washer (4) 28 - Screw (4) Maintaining Power Trim Pump Oil Level IMPORTANT: Check the oil level with the sterndrive in the full down position. IMPORTANT: If Power Trim and Steering Fluid is not available, SAE 10W-30 or 10W-40 engine oil can be used in the system. 1. Raise and lower the sterndrive 6 to 10 times to purge air from the system. Check the oil level visually. 2. Maintain the oil level between the ..Max.. and ..Min.. marks on the side of the reservoir. Fill to the bottom lip on the fill neck. b a 16155 a - Bottom lip on the fill neck b - Vented cap Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Trim pump 92-858074K01 Oildyne Trim Pump Air Bleeding Power Trim System The Power Trim System will purge itself of a small amount of air by raising and lowering the sterndrive several times. However, if a rebuilt trim cylinder is being installed (which has not been filled with oil) use the bleeding procedure to remove the air from the system. Bleeding OUT/UP Trim Circuit 1. Fill the pump reservoir to the proper level. The trim cylinder must be compressed. 2. Disconnect the OUT/UP hose from the front connection on the trim cylinder. If both cylinders were rebuilt, disconnect the hoses from both cylinders. 3. Place the end of the removed trim hoses into a container. 4. Operate the trim pump in the OUT/UP direction until a solid, air-free stream of fluid is expelled from the hoses. Reconnect the hoses and torque. Description Nm lb. in. lb. ft. Trim cylinder hoses 11 100 5. Unplug shore power (if equipped). 6. Refill the trim pump to the proper level. a -OUT/UP trim hose b -Front connection on trim cylinder Bleeding IN/DOWN Trim Circuit 1. Ensure that the pump reservoir is filled to the proper level. 2. Disconnect the IN/DOWN hose from the rear connection on the gimbal housing hydraulic connector. If both cylinders were rebuilt, disconnect the hoses from both sides of the hydraulic connector. 3. Plug the holes in the hydraulic connector using a inverted flare plug or other suitable device. 4. Place the end of the trim hose into a container. 5. Operate the trim pump in the OUT/UP direction until the trim cylinders are fully extended. 6. Remove the plugs from the gimbal housing hydraulic connector and briefly operate the trim pump in the IN/DOWN direction until a solid, air-free stream of fluid is expelled from the rear holes in the hydraulic connector. Reconnect the trim hoses and torque. Page 5A-8 90-865612050 FEBRUARY 2006 Oildyne Trim Pump Description Nm lb. in. lb. ft. Trim cylinder hoses 11 100 ildyne Trim Pump Description Nm lb. in. lb. ft. Trim cylinder hoses 11 100 7. Lower the sterndrive to the full IN/DOWN position and refill the trim pump to the proper level. Operate the trim system IN/DOWN and OUT/UP several times and recheck the fluid level. abc16165 a -IN/DOWN trim hose c - Inverted flare plug b -Hydraulic connector Plug 922-38609 Testing Power Trim Pump IMPORTANT: Cross-connecting the trim hoses during assembly will damage the sterndrive housing. Appropriately mark the trim hose connections to ensure proper reassembly. Test Gauge 1. Check the trim pump oil level. Fill if necessary. 2. Place the sterndrive in the full IN/DOWN position. 90-865612050 FEBRUARY 2006 Page 5A-9 Oildyne Trim Pump ildyne Trim Pump 3. Connect the test gauge at the most convenient location at the pump or hydraulic connector. .... a16174Gauge connected to pump a -Trim pump test gauge kit b -Test gauge valves 4. Open valve ..A.. and ..B.. and operate the pump OUT/UP and IN/DOWN several times to purge air. ABabcd16385Gauge connected to hydraulic connector a -Trim pump test gauge kit b -Gimbal housing hydraulic c -Caps (supplied with gauge) d -Plugs (supplied with gauge) connector Power Trim Test Gauge Kit 91-52915A6 Page 5A-10 90-865612050 FEBRUARY 2006 Oildyne Trim Pump Internal Restriction Test Step Action Yes No 1. Open valves "A" and "B." Operate pump OUT/UP and IN/DOWN while observing gauge. Is the gauge reading above 1379 kPa (200 PSI)? Test complete. Replace adapter. OUT/UP Pressure Test NOTE:The numbers in quotation marks refer to the Trim Pump Hydraulic System diagram on page 5A-12. If gauge reading is not within specifications, perform the following: Step 1. 2. 3. 4. 5. 6. Action Leave valve "A" open and close valve "B." Operate pump OUT/UP while observing the gauge. The reading should be 15173-17932 kPa (2200-2600 PSI). Is the gauge reading within specifications? Replace thermal relief valves "4" and retest. Is the gauge reading within specifications? Operate the pump OUT/UP until the gauge reading reaches 15173-17932 kPa (2200-2600 PSI). Stop pumping OUT/UP. The pressure should not fall below 13104 kPa (1900 PSI). Is the gauge reading above 13104 kPa (1900 PSI)? Check for external oil leaks, correct, and retest. Is the gauge reading above 13104 kPa (1900 PSI)? Replace thermal relief valves "4" and retest. Is the gauge reading above 13104 kPa (1900 PSI)? Install trim pump rebuild kit and retest. Is the gauge reading above 13104 kPa (1900 PSI)? Yes No Go to step 3. Go to step 2. Go to step 3. Replace adapter "2". Test complete. Go to step 4. Test complete. Go to step 5. Test complete. Go to step 6. Test complete. Replace adapter "2". IN/DOWN Pressure Test NOTE:The numbers in quotation marks refer to the Trim Pump Hydraulic System diagram on page 5A-12. If gauge reading is not within specifications, perform the following: Step 1. 2. 3. 4. Action Close valve "A" and open valve "B." Operate the pump IN/ DOWN while observing the gauge. The reading should be 2759-4138 kPa (400-600 PSI) . Is the gauge reading within specifications? Replace DOWN pressure release valves "6" and retest. Is the gauge reading within specifications? Install trim pump rebuild kit. Is the gauge reading within specifications? Operate pump IN/DOWN until gauge reading reaches 2759-4138 kPa (400-600 PSI). Stop pumping IN/DOWN. Pressure should not fall below 2414 kPa (350 PSI). Is the gauge reading above 2414 kPa (350 PSI)? Yes No Go to step 4. Go to step 2. Go to step 4. Go to Step 3. Go to step 4. Replace adapter "2". Test complete. Go to step 5. Check for external oil leaks correct and retest. 5. Test complete. Go to step 6. Is the gauge reading above 2414 kPa (350 PSI)? Install trim pump rebuild kit and retest. Replace 6. Test complete. Is the gauge reading above 2414 kPa (350 PSI)? adapter. 90-865612050 FEBRUARY 2006 Page 5A-11 Oildyne Trim Pump Power Trim Pump Hydraulic System 16167123455565551 -Poppet valves 2 -Pump adapter 3 -OUT/UP pressure relief valve 4 5 6 Thermal relief valve Fitting IN/DOWN pressure relief valve Trim Cylinder Internal Leak Test IMPORTANT: Before performing the following test, ensure that OUT/UP pressure meets specifications designated in OUT/UP pressure test. 1. Reconnect the trim cylinder hoses if disconnected. a. Remove the plugs and caps. b. Install the OUT/UP hose to the forward hole on the hydraulic connector. Torque. Page 5A-12 90-865612050 FEBRUARY 2006 Oildyne Trim Pump ildyne Trim Pump c. Install the IN/DOWN hose to the aft hole on the hydraulic connector. Torque. abc16168 a -OUT/UP hose c - Hydraulic connector b -IN/DOWN hose Description Nm lb. in. lb. ft. Trim cylinder hoses 11 100 Torque Wrench, lb. in. 91-66274 2. Connect the gauge at the most convenient location. adbce16175d -BLACK hose (from gimbal housing) e -GREY Hose (from gimbal housing) Gauge connected to pump a -Hydraulic test gauge b -Hose connected to UP (left hole) c -Fittings (supplied with gauge) Power Trim Test Gauge Kit 91-52915A6 90-865612050 FEBRUARY 2006 Page 5A-13 Oildyne Trim Pump NOTE:If the gauge is connected at the pump, reconnect the gauge at the gimbal housingildyne Trim Pump NOTE:If the gauge is connected at the pump, reconnect the gauge at the gimbal housing hydraulic connector. Repeat step 3, and then operate the pump in the OUT/UP directionuntil the trim cylinder is fully extended. A B b c a 16176 Gauge connected to hydraulic connector a -Test gauge b -Coupling (supplied with gauge) c -Front hydraulic connector port Step Action Yes No 1. Open valves ..A.. and ..B.. and operate the pump OUT/ UP and IN/DOWN several times to purge air. Operate the pump OUT/UP until the trim cylinders are fully extended. Observe the gauge while pumping. The pressure should be 15173-17932 kPa (2200-2600 PSI). Stop pumping OUT/UP. Pressure should not fall below 13104 kPa (1900 PSI). Is the reading below ......04 kPa ......00 PSI.... This condition indicates a trim cylinder leak. Go to step 2. Test complete. 2. Close one valve on the test gauge and repeat Step 1. Is the reading below ......04 kPa ......00 PSI.... Replace the cylinder on the same side of the test gauge connection. Replace the cylinder on the opposite side of the test gauge connection. Trim Cylinder Shock Piston Test If all previous trim system test results meet specifications but the sterndrive will not trim I....D..W.... the problem may be a leaky trim cylinder shock piston. ..se the following test to check for this condition. ..o test gauge is re..uired. 1. Operate the pump in the OUT/UP direction until the trim cylinders are fully extended. Page 5A-14 90-865612050 FEBRUARY 2006 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-15 2. Use a suitable device to keep the trim cylinder piston rods from retracting, such as trailering clips. a 16177 a - Trailering clip 3. Disconnect the UP trim hose from trim cylinders. a - UP trim hose b - Front connection 4. Operate the pump in the IN/DOWN direction. If oil flows from the UP port on the trim cylinder, the shock piston is leaking and must be replaced. Motor and Electrical Bench Tests Power Trim Pump Motor Test (In Boat) ! WARNING A spark may occur when making connections that could result in fire or explosion. Do not perform this test near flammables or explosives. ! WARNING Testing the power trim pump motor may cause the sterndrive or outboard to move unexpectedly causing product damage, serious injury, or death. Keep the area around the sterndrive or outboard clear when testing the power trim pump motor. Oildyne Trim Pump OUT/UP OPERATION ildyne Trim Pump OUT/UP OPERATION 1. Connect a jumper wire between the positive (+) solenoid terminal and the BLUE/WHITE motor lead terminal. a b c d 16178IN / DOWN position a -OUT/UP solenoid b -Positive terminal (+) c -Negative supply lead 2. If the motor does not operate, refer to Motor Repair. 1. Connect a jumper wire between the positive (+) solenoid terminal and the GREEN/ WHITE motor lead terminal. IN/DOWN OPERATION a cd b 16179a -IN/DOWN solenoid b -Positive terminal (+) c - GREEN/WHITE motor lead terminal d -..umper wire 2. If the motor does not operate, refer to Motor Repair. Power Trim Pump Motor Test (Out of Boat) ! WARNING A spark may occur when making connections that could result in fire or explosion. Do not perform this test near flammables or explosives. Page 5A-16 90-865612050 FEBRUARY 2006 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-17 1. Remove the trim pump from the boat. Refer to ..rim Pump Removal. 2. Remove the fluid from the trim pump reservoir. OUT/UP OPERATION 1. Connect a 12-volt positive (+) supply lead to the BLUE/WHITE motor lead terminal. 2. Connect the negative (�) supply lead to a good ground on the pump. a b c 16180 a - OUT/UP solenoid b - 12-volt positive (+) supply lead c - Negative supply lead 3. If the motor does not operate, refer to Motor Repair. IN/DOWN OPERATION 1. Connect a 12-volt positive (+) supply lead to the GREEN/WHITE motor lead terminal. 2. Connect the negative (�) supply lead to a good ground on the pump. a b c 16181 a - IN/DOWN solenoid b - 12-volt positive supply (+) lead c - GREEN/WHITE motor lead 3. If the motor does not operate, refer to Motor Repair. Solenoid Test (Pump In Boat) ! WARNING A spark may occur when making connections that could result in fire or explosion. Do not perform this test near flammables or explosives. ! WARNING Testing the power trim pump motor may cause the sterndrive or outboard to move unexpectedly causing product damage, serious injury, or death. Keep the area around the sterndrive or outboard clear when testing the power trim pump motor. Oildyne Trim Pump UP/OUT SOLENOID ildyne Trim Pump UP/OUT SOLENOID 1. Connect a jumper wire between the positive (+) solenoid terminal and the BLUE/WHITE harness wire terminal. d a c 16182b a -OUT/UP solenoid b -Positive (+) solenoid terminal c - d -..umper wire BLUE/WHITE harness wire terminal 2. If the motor does not operate, refer to Motor Repair. 1. Connect a jumper between the positive (+) solenoid terminal and the GREEN/WHITE harness wire terminal. IN/DOWN SOLENOID b a c d 16183a -IN/DOWN solenoid b -Positive (+) solenoid terminal c - GREEN/WHITE harness wire terminal d -..umper wire 2. If the pump motor does not operate in one direction or another, replace the appropriate solenoid. NOTE:Refer to the wiring diagram at the end of this section. Solenoid Test (Pump Out of Boat) ! WARNING A spark may occur when making connections that could result in fire or explosion. Do not perform this test near flammables or explosives. 1. Remove the trim pump from the boat. Refer to ..rim Pump Removal. Page 5A-18 90-865612050 FEBRUARY 2006 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-19 2. Remove the fluid from the trim pump reservoir. NOTICE Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required. OUT/UP SOLENOID 1. Connect a 12-volt positive (+) supply lead to BLUE/WHITE harness terminal wire. 2. Connect the negative (�) supply lead to the solenoid ground terminal. 3. Connect the ohmmeter leads to the large terminals on the solenoid. 16184 a b d e f c a - OUT/UP solenoid b - 12-volt positive (+) supply lead c - Negative (�) supply lead d - Ohmmeter leads e - BLUE/WHITE harness wire terminal f - Solenoid ground terminal 0 ohms reading (Full Continuity): The solenoid is OK. ..igh ohms reading (No Continuity): Replace the solenoid. IN/DOWN SOLENOID 1. Connect a 12-volt positive (+) supply lead to the GREEN/WHITE harness wire terminal. 2. Connect the negative (�) supply lead to the solenoid ground terminal. Oiilldddyynnee TTrriimm PPuummpp 3. Connect the ohmmeter leads to the large terminals on the solenoid. c d b a e f 16185a -IN/DOWN solenoid b -12-Volt positive (+) supply lead c -Negative (�) supply lead f - d -Ohmmeter leads e -GREEN/WHITE harness wire terminal Solenoid ground terminal 0 ohms reading (Full Continuity): The solenoid is OK. ..igh ohms reading (No Continuity): Replace the solenoid. NOTE:Refer to the wiring diagram at the end of this section. 110-Amp Fuse Test (Pump in Boat) ! WARNING A spark may occur when making connections that could result in fire or explosion. Do not perform this test near flammables or explosives. 1. Check for voltage at the battery power terminal using a volt meter. Voltage must be indicated before proceeding with the next check. a b c d 16186a -Volt meter negative (�) lead b - Volt meter positive (+) lead c - Fuse (RED in color) d -Battery power terminal Page 5A-20 90-865612050 FEBRUARY 2006 Oildyne Trim Pump ildyne Trim Pump 2. Check for voltage at the protected terminal of the 110-amp fuse using a volt meter. a b c d 16187 a -Volt meter negative (�) lead c - Fuse (red in color) b - Volt meter positive (+) lead d -Protected terminal of 110-amp fuse ..oltage indicated.. The fuse is OK. ..oltage not indicated.. Replace the fuse. 110-Amp Fuse Test (Pump Out of Boat) 1. Connect the ohmmeter leads between the terminals on the fuse. b a 16188a -110-amp fuse (red) b -Ohmmeter leads 0 ohms reading (Full Continuity): The fuse is OK. ..igh ohms reading (No Continuity): Replace the fuse. 90-865612050 FEBRUARY 2006 Page 5A-21 Oildyne Trim Pump 20-Amp Fuse Test 1. Remove the fuse from the fuse holder. a c b 19435c -Fuse holder a -Harness connector b -Fuse 2. Connect one ohmmeter lead to each end of the fuse. a b 19471 a -20-amp fuse b -Ohmmeter leads 0 ohms reading (Full Continuity): The fuse is OK. High ohms reading (No Continuity): Replace the fuse Power Trim Pump Removal 1. Disconnect the trim pump battery leads from the power source. Disconnect the negative lead first. 2. Disconnect the trim harness connector (3-pronged connector) from the trim pump. 3. Remove the hydraulic hoses from the trim pump. Cap the hose ends. Page 5A-22 90-865612050 FEBRUARY 2006 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-23 4. Remove the lag bolts and washers and lift the pump and floor bracket from the boat. a b c e d g f h 7698 a - Positive battery lead b - Negative battery lead c - Harness connector d - BLACK hydraulic hose (UP hose) e - GREY hydraulic hose (DOWN hose) f - Fill/vent cap g - Dual mount trim pump bracket h - Trim limit switch wires connected and secured Hydraulic Repair Disassembly 1. Disconnect the trim motor wires. c a b 16192 a - BLUE/WHITE motor wire b - GREEN/WHITE motor wire c - BLACK ground wire Oildyne Trim Pump Page 5A-24 90-865612050 FEBRUARY 2006 2. Remove the mounting bolts and trim pump from the floor bracket. 21082 a b c d a - Mounting bolts b - Washers c - Floor bracket d - Trim pump 3. Remove the solenoids if replacement is necessary. c c b a c 16194 c a - UP solenoid b - DOWN solenoid c - Mounting bolts (2 on each solenoid) Oiilldddyynnee TTrriimm PPuummpp 4. Remove the pump reservoir. abbbbc16189a -Pump reservoir b -Top mount screws (4) c -Pump motor Filter Replacement 1. Remove the filters by twisting while pulling upward. a 16195 a -Filters (2) 2. Install new filters. ba16196a -Filters (2) b -5/8 in. socket UP Pressure Relief Valve Replacement NOTE:The UP pressure relief valve in the kit is BLUE for easy identification. 90-865612050 FEBRUARY 2006 Page 5A-25 Oildyne Trim Pump Page 5A-26 90-865612050 FEBRUARY 2006 IMPORTANT: A difference exists between the factory-installed and the replacement pressure relief valves. If the jam nut is loosened on a factory-installed relief valve, the valve is out of adjustment. IMPORTANT: When installing a replacement pressure relief valve, do not loosen or attempt to remove the hex jam nut. This valve is preset at the factory for proper UP pressure relief. IMPORTANT: The thermal relief valve is factory-preset. Do not loosen or attempt to separate the component parts. Do not use a wrench on the upper silver-colored fitting. Use a wrench on the lower hex fitting to tighten the relief valve. a 16197 a - Factory-installed UP pressure relief valve NOTE: Factory-installed pressure relief valves have a natural steel finishes. They will not be color coded. 1. Loosen the jam nut on the UP pressure relief valve and remove the valve. 2. Remove the pump body components and discard. 3. Ensure that the threaded hole is free of dirt. 4. Lubricate the O-ring at the base of the new valve and install the valve. 5. Tighten the jam nut at the base of the new valve and torque. e f a b c d a 16198 a - Factory-installed UP pressure relief valve b - Replacement UP pressure relief valve c - ..am nut d - Pump body components (spring, eyelet, and check ball) e - ..am nut f - O-ring Description Nm lb. in. lb. ft. UP pressure relief valve 7.9 70 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-27 Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid O-ring at base on new valve. 92-858074K01 DOWN Pressure Relief Valve Replacement NOTE: The DOWN pressure relief valve in the kit is GREEN for easy identification. IMPORTANT: A difference exists between the factory-installed and the replacement pressure relief valves. If the jam nut is loosened on a factory installed relief valve, the valve is out of adjustment. IMPORTANT: When installing a replacement pressure relief valve, do not loosen or attempt to remove the hex jam nut. This valve is preset at the factory for proper DOWN pressure relief. IMPORTANT: The thermal relief valve is preset at the factory. Do not loosen or attempt to separate the component parts. Do not use a wrench on the upper silver-colored fitting. Use a wrench on the lower hex fitting to tighten the relief valve. 1. Loosen the jam nut on the DOWN pressure relief valve and remove valve. 2. Remove the pump body components and discard. 3. Ensure that the threaded hole is free of dirt. 4. Lubricate the O-ring at the base of the new valve and install the valve. 5. Tighten the jam nut at the base of the new valve and torque. a e f b d c a 16291 a - Factory-installed DOWN pressure relief valve b - Replacement DOWN pressure relief valve (green) c - ..am nut d - Pump body components (spring, eyelet, and check ball) e - ..am nut f - O-ring Description Nm lb. in. lb. ft. DOWN pressure relief valve 7.9 70 Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid O-ring at base on new valve 92-858074K01 Oildyne Trim Pump Page 5A-28 90-865612050 FEBRUARY 2006 Thermal Relief Valve Replacement NOTE: The thermal relief valve in the kit is SILVER for easy identification. IMPORTANT: The thermal relief valve is preset at the factory. Do not loosen or attempt to separate the component parts. Do not use a wrench on the upper silver colored fitting. Use a wrench on the lower hex fitting to tighten the relief valve. 1. Remove the thermal relief valve. 2. Remove the pump body components and discard. 3. Ensure that the threaded hole is free of dirt. 4. Lubricate the O-ring at the base of the new valve and install the valve. 5. Tighten the jam nut at the base of the new valve and torque. b c a d 16199 a - Original thermal relief valve b - Replacement thermal relief valve (silver) c - O-ring d - Pump body components (spring, eyelet, check ball) Description Nm lb. in. lb. ft. Thermal relief valve 7.9 70 Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid O-ring at base on new valve 92-858074K01 Pump Replacement NOTE: The pump cannot be rebuilt. If the pump is defective, replace it as an assembly. 1. Remove the pump attaching screws with a hex E6 size lobular socket or standard 5 mm (3/16 in.) socket. Oiilldddyynnee TTrriimm PPuummpp 2. Remove the pump. Do not loosen the pump attaching screws. ab 16200 a -Screw b -Pump attaching screws 3. Remove the O-rings from the old pump and install them on the new pump. 4. Lubricate the lip of the adapter seal. ab 16201 a -O-rings b -Adapter seal Tube Ref No. Description Where Used Part No. 114Power Trim and Steering Fluid Lip of adapter seal 92-858074K01 5. Install the pump and torque the pump attaching screws using a hex lobular E6 size socket or standard (5mm) 3/16 in. 12-point socket. a16202 a -Pump attaching screws 90-865612050 FEBRUARY 2006 Page 5A-29 Oildyne Trim Pump Torque Wrench, lb. in. 91-66274 Description Nm lb. in. lb. ft. Pump attaching screws 7.9 70 Adapter Replacement ildyne Trim Pump Torque Wrench, lb. in. 91-66274 Description Nm lb. in. lb. ft. Pump attaching screws 7.9 70 Adapter Replacement 1. Remove the pump motor attaching screws and remove the pump motor. ab16203a -Pump motor b -Screws (2) 2. Remove and discard the adapter-to-reservoir O-ring. ba 16204 a -Adapter b -O-ring 3. Remove and discard the motor-to-adapter O-ring. 4. Ensure that the coupling is installed with the shallow slot toward the reservoir. Page 5A-30 90-865612050 FEBRUARY 2006 Oildyne Trim Pump ildyne Trim Pump 5. Lubricate the coupling. cab16205 a -Adapter c -Coupling (shallow slot toward b -O-ring reservoir) Tube Ref No. Description Where Used Part No. 952-4-C Marine Lubricant with Teflon Coupling 92-802859A 1 6. Install a new motor-to-adapter O-ring. 7. Align the motor shaft with the coupling and install the motor onto the adapter. 8. Position the motor as shown and secure with screws. Tighten securely. bca a -Motor shaft b -Coupling c 16264 c -Screws (opposite corners) 90-865612050 FEBRUARY 2006 Page 5A-31 Oildyne Trim Pump Adapter Repair INTERNAL O-RING AND POPPET VALVE REPLACEMENT ildyne Trim Pump Adapter Repair INTERNAL O-RING AND POPPET VALVE REPLACEMENT 1. Remove the hex plug retainers and springs (one on each side). ab16265 a -Hex plug retainers (2) b -Springs (2) 2. Remove and discard the poppet valves. a16266a -Poppet valve IMPORTANT: Incorrectly removing the trim pump check valve body from the adapter can damage the poppet valve seat surface. 3. Remove the check valve bodies and spool using a 3 mm (1/8 in.) diameter metal rod and plastic hammer. abc16267a -Check valve body b -Spool c -Metal rod 3 mm (1/8 in.) diameter Page 5A-32 90-865612050 FEBRUARY 2006 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-33 4. Remove and discard the O-rings on the hex plug retainers. 5. Discard the check valve bodies. 6. Clean the hex plug retainers and spool. d b e f e b c a d a c 16268 a - O-rings b - Hex plug retainers c - Springs d - Poppet valves e - Check valve bodies f - Spool 7. Lubricate the check valve body O-rings. Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Check valve body O-rings 92-858074K01 IMPORTANT: Forcing the trim pump check valve bodies into the adapter can damage the O-rings. 8. Place the spool and check valve bodies into the adapter. 9. Place the poppet valves into the check valve bodies. a d b b c 16269 a - Spool b - Check valve body (2) c - Poppet valve (2) d - Check valve body O-ring 10. Lubricate the hex plug retainer O-rings. Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Hex plug retainer O-rings 92-858074K01 11. Place the springs into the hex plug retainers. Oiilldddyynnee TTrriimm PPuummpp 12. Thread the hex plug retainers into the adapter by hand until the retainer touches the check valve body. abc16270a -Spring (2) b -O-ring c -Hex plug retainer (2) IMPORTANT: Incorrectly turning the hex plug retainers into the trim pump adapter can damage the O-rings. 13. Tighten the hex plug retainer securely on each side. aa16271a -Hex plug retainer Pump Shaft Oil Seal Replacement 1. Remove the pump attaching screws with a hex lobular E6 size socket or standard (5mm) 3/16 in. socket. Page 5A-34 90-865612050 FEBRUARY 2006 Oildyne Trim Pump ildyne Trim Pump 2. Remove the pump. Do not loosen or remove the pump attaching screws. ab 16200 a -Screws b -Pump attaching screws 3. Remove the oil seal by prying with a screwdriver. a 16273 a -Oil seal 4. Remove and replace the O-rings on the pump base if they are worn. 5. Install a new seal with the lips toward the pump. Press the oil seal in by hand. 6. Lubricate the lip of the seal with lightweight oil. cba16274 a -Oil seal c - Pump b -O-rings 90-865612050 FEBRUARY 2006 Page 5A-35 Oildyne Trim Pump Page 5A-36 90-865612050 FEBRUARY 2006 Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid O-ring at the base on the new valve 92-858074K01 7. Install the pump. Torque the pump attaching screws using a hex lobular E6 size socket or standard (5mm) 3/16 in. socket. a 16202 a - Pump attaching screws Description Nm lb. in. lb. ft. Pump attaching screws 8 75 8. Install the pump reservoir. a b b b b c 16189 a - Pump reservoir b - Top mount screws (4) c - Pump motor Description Nm lb. in. lb. ft. Top mount resevoir screws 2.8 25 Oildyne Trim Pump Motor Repair Disassembly ildyne Trim Pump Motor Repair Disassembly 1. Remove the trim motor from the adapter. abc 16294 a -Trim motor c -Screws b -Adapter 2. Remove the motor to adapter O-ring. ba16295a -Adapter b -O-ring 3. Remove the motor end cover and washer from the armature shaft. cab16296a -Cover b -Screws (4) c -Washer 4. Loosen the brush hold-down arms. 90-865612050 FEBRUARY 2006 Page 5A-37 Oildyne Trim Pump ildyne Trim Pump 5. ..ater..model only.. Remove the circuit board plate. a b b a 16297b cc d b 16298Early-model Later-model a -Brush hold-down arms b -Screws c -Brush holders d -Circuit board plate IMPORTANT: Use care in removing brush holders to avoid losing springs. 6. Remove the brush holders and springs. b a 16299a -Brush holder b -Spring 7. Remove the thermal switch and brush assembly. a b 16272 a -Thermal switch and brush b -Screw Page 5A-38 90-865612050 FEBRUARY 2006 Oildyne Trim Pump ildyne Trim Pump 8. Remove the brush assembly mounting bracket. aab16275a -Brush assembly bracket b -Screws 9. Remove the armature and thrust washer from the motor housing. abc16304 a -Armature c - Motor housing b -Thrust washer 10. Remove the field assembly from the motor housing. ab16305 a -Field assembly b -Motor housing 90-865612050 FEBRUARY 2006 Page 5A-39 Oildyne Trim Pump 11. Remove the motor housing O-ring... a b 16306 Armature TestsContinuity Test a -O-ring b -Motor housing 1. Set the ohmmeter on the R..1 scale. 2. Place the alligator clip meter lead on the armature shaft. 3. Touch the meter lead probe to each commutator bar one at a time. a c b 16307 a -Ohmmeter set on R..1 scale c - Meter lead b -Meter lead Continuity Indicated: Armature grounded (replace armature). Continuity ..ot Indicated: Armature not grounded. Test For A Shorted Circuit 1. Check the armature on a growler (follow the growler manufacturer..s instructions). Replace the armature if it has a short. Page 5A-40 90-865612050 FEBRUARY 2006.. Oildyne Trim Pump Cleaning Commutator ildyne Trim Pump Cleaning Commutator 1. Clean the commutator with ..00.. garnet grit sandpaper. Do not use emery paper. 2. Check the gaps between the commutator bars for matter. Remove any foreign matter. b a Field Tests Test for Open Circuit 16308 a -Commutator b -Gap 1. Connect the ohmmeter between the field brush lead and the BLUE/WHITE lead. a b 16309 a -Ohmmeter lead connected to b -Ohmmeter lead connected to brush lead BLUE/WHITE lead 0 ohms indicated (full continuity): The field is OK. 0 ohms not indicated (no continuity): Replace the field assembly. 90-865612050 FEBRUARY 2006 Page 5A-41 Oildyne Trim Pump ildyne Trim Pump 2. Connect the ohmmeter between the field brush lead and the GREEN/WHITE lead. a b 16310 a -Ohmmeter lead connected to b -Ohmmeter lead connected to brush lead GREEN/WHITE lead 0 ohms indicated (full continuity): The field is OK. 0 ohms not indicated (no continuity): Replace the field assembly. Test For A Shorted Circuit 1. Connect the ohmmeter between the field brush lead and the field frame. a b 16311 a -Field frame b -Field brush lead 0 ohms indicated (full continuity): A short is indicated (replace field assembly). 0 ohms not indicated (no continuity): The field is OK. Page 5A-42 90-865612050 FEBRUARY 2006 Oildyne Trim Pump Thermal Switch Continuity Test ildyne Trim Pump Thermal Switch Continuity Test 1. Connect the ohmmeter between the spade connector and the brush lead. b a 16312 a -Thermal switch spade connector b -Brush lead 0 ohms indicated (full continuity): Proceed to the next step. 0 ohms not indicated (no continuity): Replace the thermal switch. 2. Insert an insulator such as a piece of paper between the contact points on the ohmmeter (between the spade connector and the brush lead). b c a 16313a -Thermal switch spade connector b -Brush lead c -Insulator 0 ohms indicated (full continuity): Replace the thermal switch. 0 ohms not indicated (no continuity): The thermal switch is OK. 3. Remove the insulator from between the contact points on the thermal switch. Clear all matter away from the points. 90-865612050 FEBRUARY 2006 Page 5A-43 Oildyne Trim Pump Brush Replacement ildyne Trim Pump Brush Replacement 1. Loosen the brush hold-down arms. abab16314a -Brush hold-down arms b -Screws IMPORTANT: Use care in removing brush holders. Do not lose the springs. 2. Remove the brush holders and springs. ba16315a -Brush holder b -Spring 3. Remove the thermal switch and brush assembly. abc 16316 a -Thermal switch and brush b -Screw c -Connector IMPORTANT: When replacing the brush that is connected to the field wires, cut the brush wire as close to the brush as possible. Page 5A-44 90-865612050 FEBRUARY 2006 Oildyne Trim Pump ildyne Trim Pump 4. Cut the brush wire as close to the brush as possible and discard the brush. ba16317a - Brush wire b -Brush 5. Connect the new brush wire to the field wire that you cut in the previous step. Secure by crimping both wires together as shown. acb16318 a -Brush wire c -Crimp connector b -Field wire (old brush wire) 6. Reinstall the spring and brush in the brush holder. bac16319a -Brush holder b -Spring c - Brush 90-865612050 FEBRUARY 2006 Page 5A-45 Oildyne Trim Pump ildyne Trim Pump 7. Position the brush hold-down arms and tighten them securely. Do not overtighten. abab16320 a -Brush hold-down arms b -Screws 8. Position the brush wire as shown before reassembly. a16321a -Brush wire Reassembly 1. Install the motor housing O-ring. ab16322a -O-ring b -Motor housing Page 5A-46 90-865612050 FEBRUARY 2006 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-47 IMPORTANT: The field assembly wires must face the front of the motor housing. Use the notched area in the housing as a reference in determining the front. c b a 16323 a - Motor housing b - Front c - Notched area 2. Install the field assembly into the motor housing. a b 16324 a - Field assembly b - Motor housing 3. Install the thrust washer on the armature and install the armature into the motor housing. a b c 16304 a - Armature b - Thrust washer c - Motor housing Oiilldddyynnee TTrriimm PPuummpp 4. Install the brush assembly mounting bracket. Tighten the screws securely. aab16275a -Brush assembly mounting bracket b -Screws 5. Install the thermal switch and connect the black wire. Do not overtighten the screw. abc16335a -Thermal switch b -Screw c - Black wire connector 6. Install the springs and brushes in the brush holders. bac16336a -Brush holders b -Springs c -Brushes Page 5A-48 90-865612050 FEBRUARY 2006 Oildyne Trim Pump ildyne Trim Pump 7. Position the brush holders and secure them with the brush hold-down arms. Do not overtighten the screws. abab16337a -Brush hold-down arms b -Screws 8. Install the motor end cover. Apply sealant to the screws and tighten securely. Do not overtighten. ab a -Motor end cover b -Screws Tube Ref No. Description Where Used Part No. 7Loctite 271 Threadlocker Screws 92-809819 9. Install the motor-to-adapter O-ring. ba 16295 a -Adapter b -O-ring 90-865612050 FEBRUARY 2006 Page 5A-49 Oildyne Trim Pump Page 5A-50 90-865612050 FEBRUARY 2006 10. Align the motor shaft with the coupler and install the trim motor on the adapter. Torque the screws. a c e d b 16340 a - Trim motor b - Adapter c - Screws (2 in opposite corners) d - Coupler e - Motor shaft Description Nm lb. in. lb. ft. Trim motor screws 2.8 25 11. Install the trim pump on the floor bracket. Tighten securely. 21082 a b c d a - Mounting bolts b - Washers c - Floor bracket d - Trim pump Oiilldddyynnee TTrriimm PPuummpp 12. Connect the trim motor wires to solenoids as shown. cab16192a -BLUE/WHITE motor wire b -GREEN/WHITE motor wire c -BLACK ground wire NOTICE The solenoid terminal cover screw is attached to a 12-volt positive source. Avoid grounding installation tools when installing the cover. 13. Install the solenoid terminal cover. Tighten the screw securely. ab 16346 Installation a -Solenoid terminal cover b -Screw trim pump installation 1. Secure the pump and the mounting bracket to the boat using lag bolts and washers. 2. Reconnect the trim hoses to the pump: black hose to the left connection, grey hose to the right connection. Do not cross-thread or overtighten the hose fittings. Torque the fittings. 3. Reconnect the trim harness connector to the trim pump. 4. Reconnect the trim pump leads to the power source. IMPORTANT: Remove the cap plug from the trim pump fill neck on new or replacement pumps to avoid pump damage. 90-865612050 FEBRUARY 2006 Page 5A-51 Oildyne Trim Pump Page 5A-52 90-865612050 FEBRUARY 2006 5. Check the fluid level and fill if necessary. (Refer to Maintaining Power Trim Pump Oil Level in this section.) a b g f e c d b 16191 a - Battery negative cable (�) b - Battery positive cable (+) c - Up solenoid connection d - Down solenoid connection e - Reservoir cap f - Grey hose (trim down) g - Black hose (trim up) Description Nm lb. in. lb. ft. Hydraulic hose fittings 9 80 Hydraulic hose adapter fittings 9 80 Oildyne Trim Pump 90-865612050 FEBRUARY 2006 Page 5A-53 Trim Pump Wiring Diagrams Model With Three-Button Trim/Trailer Panel YEL/RED YEL/RED BLU/WHT BLU/WHT BLU/WHT BLU/WHT PPL/WHT GRN/WHT GRN/WHT GRN/WHT RED/PPL RED/PPL RED RED BLK BLK BLK BLK BLK BLK 7866 c b a f h g d e a - 20-amp fuse b - Ground bolt (floor mount) c - Up solenoid d - Down solenoid e - 110-amp fuse f - "Y" Harness (optional) g - Neutral switch to instrument wiring harness h - Trim limit switch Oildyne Trim Pump Notes: Page 5A-54 90-865612050 FEBRUARY 2006 Trim Cylinders Power Trim Section 5B - Trim Cylinders Table of Contents Torque Specifications.....................................5B-2 Exploded Views...5B-2 Bravo Trim Cylinders..............................5B-2 Bravo Trim System Components..............5B-6 Power Trim Hydraulic Schematic....................5B-8 Special Information...5B-8 Bravo Three Notice: Trim-In Limit Insert ....5B-8 Trim Cylinder Internal Leak Test.....................5B-9 Trim Cylinder Shock Piston Test.....................5B-9 Trim Cylinder Repair..5B-9 Trim Cylinder Removal...........................5B-9 Trim Cylinder Disassembly....................5B-11 Trim Cylinder Reassembly.....................5B-15 Trim Cylinder Installation......................5B-20 5 B 90-865612050 FEBRUARY 2006 Page 5B- Trim Cylinders Lubricant, Sealant, Adhesives Tube Ref No. Description 7 Loctite 271 Threadlocker 95 2-4-C Marine Lubricant with Teflon 114 Power Trim and Steering Fluid Special Tools Plug Where Used Part No. Threads of piston rod bolt 92-809819 End cap threads 92-802859A1 Anchor pin threads All internal parts 92-802880A1 922-38609 Aids in bleeding the in/down circuit on the remote trim pump. 8862 Trim cylinder end cap tool 91-821709T 9191 Allows easy removal of the trim cylinder end caps. Required if tilt limit spacers are to be installed or if the trim in limit spacer is to be removed (to allow additional trim in range). Torque Specifications Description Piston rod bolt End cap Trim cylinder hoses Exploded Views Bravo Trim Cylinders Nm lb. in. lb. ft. 23 17 61 45 11 100 NOTE: Before reassembly, lubricate all internal parts with power trim and steering fluid or SAE 10W-30 or 10W-40 motor oil. Page 5B-2 90-865612050 FEBRUARY 200 Trim Cylinders Notes: 90-865612050 FEBRUARY 2006 Page 5B- Trim Cylinders Page 5B-4 90-865612050 FEBRUARY 2006 2 1 3 4 5 6 7 8 9 11 12 10 11 24 25 26 27 28 23 14 13 16 18 19 15 17 20 21 10381 22 Trim Cylinders 1 -Pin 15 -Small O-ring 2 -Spring 16 -Continuity spring 3 -Trim cylinder 17 -Large O-ring 4 O- ring 18 -End cap 5 Floating piston 19 -Rod scraper 6 -Bolt 20 -Washer 7 Washer 21 -Retaining ring 8 -Spring guide 22 -Small O-ring 9 -Spring 23 -Piston rod 10 -Spring guide washer 24 -Eyelet 11 -Check balls 25 -Steel ball 12 -Shock piston 26 -Anode 13 -O-ring 27 -Screw 14 -Tilt limit spacer 28 -Star washer 90-865612050 FEBRUARY 2006 Page 5B- ..rim Cylinders Bravo ..rim System Components 2627292357568109410548 ..a......5....6 90..865612050...............A........2006 Trim Cylinders 1 -IN/DOWN hose to trim pump (grey) 2 -Female quick connect fitting 3 -OUT/UP hose to trim pump (black) 4 -Male quick connect fitting 5 -OUT/UP hose to trim cylinder 6 -Starboard trim cylinder 7 -Port trim cylinder 8 -Trim cylinder anode (2) 9 -Screw (4) 10 -Continuity washer (4) 11 -Plate 12 -Screw (2) 13 -Front anchor pin 14 -Retainer clip (2) 15 -Washer (2) 16 -Bushing (4) 17 -Washer with small I.D.(2) 18 -Nut (2) 19 -Cap (2) 20 -Rear anchor pin 21 -Washer (2) 22 -Bushing (4) 23 -Washer with small I.D.(2) 24 -Nut (2) 25 -Cap (2) 26 -IN/DOWN starboard trim cylinder hose 27 -IN/DOWN port trim cylinder hose 28 -Ground strap 29 -Tilt-limit insert (2) (kit) 90-865612050 FEBRUARY 2006 Page 5B- Trim Cylinders Power Trim Hydraulic Schematic 6 -IN/DOWN pressure relief valve 7 -OUT/UP hose 8 -IN/DOWN hose 9 -Poppet valves 14329 1 2 34 5 5 6 7 8 9 1 -Shuttle 2 -Pump adaptor 3 -OUT/UP pressure relief valve 4 -Thermal relief valve 5 -Trim cylinder Special Information Bravo Three Notice: Trim-In Limit Insert Some boats, predominantly deep-V heavy boats, will roll on their side under certain operating conditions. The roll can be either to port or starboard and may occur while moving straight ahead or making a turn. The roll occurs most frequently at or near maximum speed, with the sterndrive trimmed at or near full trim-in. While the boat will not roll completely over, the roll may be sufficient to unseat the operator or passengers. The rolling is caused by stern lift created by excessive trim-in of the sterndrive. Redistributing the weight sternward can reduce stern-lift and help to control the condition. The distribution of weight forward, to port, or starboard, may worsen the condition. Page 5B-8 90-865612050 FEBRUARY 200 Trim Cylinders The trim-in limit insert reduces stern lift by preventing the sterndrive from reaching the last few degrees of full trim-under. Although this device should reduce the tendency to roll, it may not eliminate the tendency entirely. The need for the trim-in limit insert, and its effectiveness, can only be determined through boat testing and is ultimately the responsibility of the boat manufacturer. ! WARNING We recommend that only qualified personnel adjust the trim-in limit inserts. The boat must be water-tested after adjusting the trim-in limit inserts to ensure that the modified trim-in range does not cause the boat to handle poorly when the sterndrive is trimmed in at higher speeds. On some boats, increased trim-in range may cause handling problems, which could result in personal injury. IMPORTANT: On Bravo One, Two, and Three Models, the trim-in limit insert must be properly positioned before installing the trim cylinder anchor pin. NOTE: When removing the sterndrive, make a note of the position of the insert for later installation. 1 If your sterndrive is with a trim-in limit insert, ensure that the insert is positioned as shown for the appropriate Bravo model. b a 14571 a -Trim-in limit insert Bravo One and b -Trim-in limit insert Bravo Three Two (positioned forward) (positioned aft) IMPORTANT: The position of the trim-in limit insert on the Bravo Three sterndrive should only be changed after the boat has been properly tested. Contact the boat manufacturer if you are not sure of the original position for a particular boat application. Trim Cylinder Internal Leak Test Refer to Section 5A Power Trim Pump. Trim Cylinder Shock Piston Test Refer to Section 5A Power Trim Pump. Trim Cylinder Repair Trim Cylinder Removal 1. Disconnect the OUT/UP trim hose from the front hole on the trim cylinder. 2. Disconnect the IN/DOWN trim hose from the hydraulic connector on the gimbal housing. 90-865612050 FEBRUARY 200 Page 5B- ..rim Cylinders 3 ....a.........................a...................ab............. 4 ..a..................... a b c d 14327a .. .. b .. ..c............. c .. .. d .. ..a......c..c........c...... ....922..38609 5 ....a......a..................................a.........a.........................c............. a b c d e e f g h 14326 ..ront a .. A..c............. b .. ..a..........c................... c .. ....a......a..............a................. d .. ..a.........c...... e .. .. f .. ....a......a................a................ g .. ....c........ h .. ....a......c..ca.. ..a......5....10 90..865612050...............A........2006 Trim Cylinders cg f d e 10432 a b c c Rear a -Rear anchor pin b -Flat washer (large I.D.) c -Bushing d -Locknut e -Plastic cap f -Flat washer (small I.D.) g -Trim cylinder Trim Cylinder Disassembly ! CAUTION Ensure work area is clean before disassembling power trim cylinders. Cylinder parts can be damaged by dirt entering into power trim system. ! CAUTION Trim cylinders can be damaged by improper clamping. Clamping the center section of the trim cylinder during service procedures can cause damage that could result in a loss of trim control. Clamp the trim cylinder only on the front mounting flange. 1. Remove the IN/DOWN trim hose from the cylinder. a b c 10389 a -IN/DOWN trim hose b -Clamping plate c -Screws 90-865612050 FEBRUARY 2006 Page 5B-1 Trim Cylinders 2. Remove trim cylinder anodes. 10390 a c b d a -Trim cylinder c -Screw (2) b -Trim cylinder anode d -Washer (2) 3. Use the trim cylinder end cap tool to remove trim cylinder end caps. a 10395 a -Trim cylinder end cap tool Trim cylinder end cap tool 91-821709T 4. Remove the tilt limit insert. a 10397 a a -Tilt limit inserm Page 5B-12 90-865612050 FEBRUARY 200 Trim Cylinders 5 Remove the piston rod assembly from the cylinder. 10433 a c b a -End cap c -Piston rod assembly b -Cylinder 6 Remove the floating piston from the cylinder by tapping the cylinder on a block of wood and removing the O-ring. c a b 10434 a -O-ring b -Floating piston c -Trim cylindek 90-865612050 FEBRUARY 200 Page 5B-1 Trim Cylinders 7. Disassemble the shock piston assembly. Be careful not to lose the check balls. a b c d e f g h 10439 a -Bolt b -Flat washer c -Spring guide d -Spring 8. Remove and disassemble the end cap. a -End cap b -Piston rod c -Large O-ring d -Small O-ring (2) a b cde f g h d 10441 e -Spring guide washer f -Check balls (3) g -Shock piston assembly h -O-ring e -Continuity spring f -Rod scraper g -Plain washer h -Retaining ring Page 5B-14 90-865612050 FEBRUARY 200 Trim Cylinders 9. Remove the small O-ring from the end of the piston rod 10443 a b a -Small O-ring b -Piston rod 10. Clean all parts in solvent. Ensure that all parts are dry before reassembly. Trim Cylinder Reassembly ! CAUTION Ensure that work area and all components are clean before reassembling trim cylinders. Power trim components can become damaged if dirt gets into system. 1. Install the small O-ring into the end of the piston rod. 10448 a b a -Small O-ring b -End of piston rod 2. Install small O-rings and continuity spring into end cap. 3. Install rod scraper, plain washer, and retaining ring into end cap. 4. Install large O-ring onto outside diameter of end cap. 90-865612050 FEBRUARY 2006 Page 5B-1 Trim Cylinders 5. Install the end cap onto the piston rod. a b cde f g h d 10441 a -End cap b -Piston rod c -Large O-ring d -Small O-ring (2) e -Continuity spring f -Rod scraper g -Plain washer h -Retaining ring 6. 7. 8. Install the large O-ring on the shock piston. Install the shock piston, three check balls, the check ball eyelet, spring guide washer, spring, spring guide, spring guide washer and bolt onto the piston rod. Apply sealant to the threads of the piston rod bolt. Torque. a b c d e f g h i j k l b 10454 a -Large O-ring b -Shock piston c -Check ball d -Check ball eyelet e -Spring f -Spring pin g -Bolt h -Check balls i -Spring guide washer j -Spring k -Spring guide l -Spring guide washer Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Threads of piston rod bolt 92-809819 Page 5B-16 90-865612050 FEBRUARY 200 Trim Cylinders Description Nm lb. in. lb. ft. Piston rod bolt 23 17 NOTE: Before reassembly, lubricate all internal parts with power trim and steering fluid or SAE 10W-30 or 10W-40 motor oil. 9. Apply lubricant to the parts. 10. Install the O-ring onto the floating piston and insert floating piston into the cylinder. c a b 10434 a -O-ring b -Floating piston c -Cylinder Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid All internal parts 92-802880A1 IMPORTANT: Some boat configurations may require tilt-limit inserts to limit the total upward travel of the sterndrive. Be sure to install the same number of inserts that were originally removed. There must be an equal number in each cylinder. 11. If applicable, install tilt-limit inserts. a 10397 a a -Tilt-limit inserts ! CAUTION Ensure that work area and all components are clean before reassembling trim cylinders. Power trim components can become damaged if dirt gets into system. ! CAUTION Trim cylinders can be damaged by improper clamping. Clamping on the trim cylinder center section during service procedures can cause damage that could result in a loss of some trim-in or trim-out. Clamp the trim cylinder only on the front mounting flange. 90-865612050 FEBRUARY 2006 Page 5B-1 Trim Cylinders ! CAUTION Use only 2-4-C with Teflon on end cap threads. Other substances may act as an insulator and cause poor electrical continuity between cap and cylinder which could cause a corrosion problem. NOTE: Before reassembly, lubricate all internal parts with power trim and steering fluid or SAE 10W-30 or 10W-40 motor oil. 12. Apply lubricant to the end cap threads and install the piston rod assembly into the cylinder. 10433 a c b a -End cap c -Piston rod assembly b -Cylinder Tube Ref No. Description Where Used Part No. 2-4-C Marine Lubricant with 95 End cap threads 92-802859A1 Teflon 13. Using the trim cylinder end cap tool, torque end cap. a 10395 a -Trim cylinder end cap tool Description End cap Nm 61 lb. in. lb. ft. 45 Trim Cylinder End Cap Tool 91-821709T Page 5B-18 90-865612050 FEBRUARY 200 Trim Cylinders 90-865612050 FEBRUARY 2006 Page 5B-19 14. Install the trim cylinder anodes. 10390 a c b d a - Trim cylinder b - Trim cylinder anode c - Screw (2) d - Washer (2) 15. Position the trim cylinder rear connecting ends as shown. 10499 a b c a - Port trim cylinder b - Starboard trim cylinder c - Connecting ends (angled as shown) Trim Cylinders 16. Install the IN/DOWN trim hose and torque. a b c 10507 a -Down trim hose b -Clamping plate c -Screws Description Trim cylinder hoses Nm 11 lb. in. 100 lb. ft. 17. Check the painted areas of the trim cylinders for scratches that expose metal and paint if necessary. Trim Cylinder Installation NOTE: Refer to Special Information at the front of this section before reinstalling trim cylinders. 1. Install the mounting hardware of the trim cylinder forward as shown. 2. Lubricate anchor pin threads to prevent threads from galling. 3. Hand thread locknuts onto the pin. Do not tighten at this time. a b c d e e f g h 14326 Front a -Anchor pin b -Retainer clip groove c -Flat washer (large I.D.) d -Retainer clip e -Bushing f -Flat washer (small I.D.) g -Locknut h -Plastic cap Tube Ref No. Description Where Used Part No. 2-4-C Marine Lubricant with 95 Anchor pin threads 92-802859A1 Teflon Page 5B-20 90-865612050 FEBRUARY 200 Trim Cylinders IMPORTANT: On Bravo One, Two, and Three Models the trim-in limit insert must be properly positioned before installing the trim cylinder anchor pin in the following steps. NOTE: Ensure that the trim-in limit insert is reinstalled in the same position as before removal of the sterndrive. If you are not sure of the original position, contact the boat manufacturer for their recommendation. Refer to Special Information at the front of this section before reinstalling the trim-in limit insert. 4 Ensure that the trim-in limit insert is positioned as shown for the appropriate Bravo model. b a a -Trim-in limit insert Bravo One and Two (positioned forward) 14571 b -Trim-in limit insert Bravo Three (positioned aft) IMPORTANT: The position of the trim-in limit insert on the Bravo Three sterndrive should only be changed after the boat has been properly tested. Contact the boat manufacturer if you are not sure of the original position for a particular boat application. 5. Install the mounting hardware of the trim cylinder aft as shown. 6. Lubricate anchor pin threads to prevent the threads from galling. 7. Hand-thread locknuts onto the anchor pin. a b c c cg f d e 10432 e -Plastic cap f -Flat washer (small I.D.) g -Trim cylinder a -Aft anchor pig b -Flat washer (large I.D.) c -Bushind d - Locknum Tube Ref No. Description Where Used Part No. 95 2-4-C Marine Lubricant with Anchor pin threads 92-802859A1 Teflon 90-865612050 FEBRUARY 200 Page 5B-2 Trim Cylinders ! CAUTION Avoid damage to the sterndrive. Incorrectly tightened anchor pin locknuts can allow the sterndrive to move too far inward, resulting in damage to the sterndrive. Tighten all four anchor pin locknuts as described in this procedure. 8. Tighten the anchor pin locknuts until the nuts and washers contact the anchor pin shoulder. 9. Install the plastic caps. 10. Reconnect the OUT/UP trim hose to the trim cylinder and torque. Description Nm lb. in. lb. ft. Trim cylinder hoses 11 100 11. Test the operation of the trim cylinder: a Trim the sterndrive in the up and down position 3 times. b Trim the sterndrive in the up position. Place your hands on the sterndrive and try to push the drive down. c Trim the sterndrive in the down position. Place your hands on the sterndrive and try to push the drive up. d If the sterndrive has no movement when pushed in step "b" and "c" the trim cylinders are working properly. If the sterndrive moves, the power trim system must be purged of air. Refer to Section 5A Air Bleeding Power Trim System. Page 5B-2 90-865612050 FEBRUARY 200 Dual Power Trim System Power Trim Section 5C - Dual Power Trim System Table of Contents Important Information......................................5C-2 Testing Dual Power Trim System...................5C-2 Relay Test...5C-2 Testing Relay No. 1.................................5C-2 Testing Relay No. 2.................................5C-3 Diode Module Test..5C-3 Diode No. 1..5C-3 Diode No. 2..5C-3 Diode No. 3..5C-3 Diode No. 4..5C-3 Diode No. 5..5C-4 Diode No. 6..5C-4 Diode No. 7..5C-4 Diode No. 8..5C-4 Trailer Switch Test..5C-4 Starboard Trim Switch Test............................5C-4 Port Trim Switch Test.....................................5C-5 Dual Power Trim System Component Repair ....5C-5 Relay Removal.......................................5C-5 Relay Installation.....................................5C-6 Diode Module Removal.................................5C-7 Diode Module Installation...............................5C-7 Trim Control Panel Switch Removal...............5C-8 Trim Control Panel Switch Installation.............5C-8 Wiring Diagrams...5C-10 Dual Trim...5C-10 Dual Trim Harness Control Module........5C-11 5 C 90-865612050 FEBRUARY 2006 Page 5C- Dual Power Trim System Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used Part No. 25 Liquid Neoprene All terminal connections 92-25711-3 Important Information When testing this Dual Power Trim system, take special note of the following: � Disconnect the control box harness connectors and turn the key switch OFF. � Ensure that the jumper lead used between terminals 3 and 5 is used only when specified. The following tests are listed in order of the likelihood of a component�s failure. We recommend, however, that you perform all tests even if a faulty component is detected early in the sequence. This precaution will guard against repeat failure if more than one component has failed. Testing Dual Power Trim System 10341 a b c e d Dual trim control panel electrical box a - Relay No. 1 b - Relay No. 2 c - Diode module Relay Test Testing Relay No. 1 Step 1. 2. Action Test for 12 volts at terminal 2, using only terminal 4 as a ground. Is a non-zero voltage indicated? Connect a jumper wire between terminals 3 and 5. Test for 12 volts at terminal 2, using only terminal 4 as a ground. Is a non-zero voltage indicated? d - Terminal block e - Control panel Yes No Proceed to 2. Replace the relay. Replace the relay. Relay is OK. Page 5C-2 90-865612050 FEBRUARY 200 Dual Power Trim Systei Testing Relay No. 2 Step 1. 2. Action Test for continuity between terminals 13 and 9. Is continuity indicated? Connect a jumper wire between terminals 3 and 5. Test for continuity between terminals 13 and 9. Is continuity indicated? Yes No Proceed to Step 2. Replace the relay. Replace the relay. Relay is OK. Diode Module TesW Perform the following diode tests using an ohmmeter set on the R�1 scale. When testing diodes, take 2 readings. Note the first reading and then reverse the meter leads. Note the second reading. If the diode is good, the meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading (below 60 ohms) when connected the other way. If both readings are high or infinite, the diode is open. Replace the diode module. Diode No. 1 Step Action Yes No Connect a jumper wire between terminals 3 and 5. Test the diode between terminals 9 and Replace the diode 1. 10. The module is OK.

module. Are both readings high or infinite? Diode No. 2 Step Action Yes No Connect a jumper between terminals 3 and 5. Test diode between terminals 10 and 13. Replace the diode 1. The module is OK. module. Are both readings high or infinite? ! CAUTION Before proceeding with further diode testing, remove fuse from red/purple harness lead so that it will not be possible to short either control box or VOA meter. Diode No. 3 Step Action Yes No Test the diode between terminals 6 and 12. Replace the diode 1. The module is OK. module. Are both readings high or infinite? Diode No. 4 Step Action Yes No Test the diode between terminals 12 and 7. Replace the diode 1. The module is OK. module. Are both readings high or infinite? 90-865612050 FEBRUARY 2006 Page 5C- Dual Power Trim System Diode No. 5 Step Action Yes No Test the diode between terminals 8 and 11. Replace the diode 1. The module is OK. module. Are both readings high or infinite? Diode No. 6 Step Action Yes No Test the diode between terminals 14 and 15. Replace the diode 1. The module is OK. module. Are both readings high or infinite? Diode No. 7 Step Action Yes No Test the diode between terminals 8 and 5. Replace the diode 1. The module is OK. module. Are both readings high or infinite? Diode No. 8 Step Action Yes No Test the diode between terminals 5 and 15. Replace the diode 1. The module is OK. module. Are both readings high or infinite? Trailer Switch Test ! CAUTION Remove fuse from RED/PURPLE harness lead before proceeding with test Step 1. 2. Action Set the ohmmeter on the R�1 scale. Push down on the "Trailer" switch and check for continuity between terminals 10 and 3. Is continuity indicated? Push up on the trailer switch and check for continuity between terminals 2 and 12. Is continuity indicated? Starboard Trim Switch TesW Step Action 1. Set ohmmeter on R�1 scale. Push down on STARBOARD TRIM switch and check for continuity between terminals 1 and 9. Is continuity indicated? Yes No Proceed to Step 2. Replace the switch. The switch is OK. Replace the switch. Yes No Proceed to Step 2. Replace the switch. Page 5C-4 90-865612050 FEBRUARY 200 Dual Power Trim Systei Step Action 2. Push up on STARBOARD TRIM switch and check for continuity between terminals 11 and 6. Is continuity indicated? Port Trim Switch TesW Step 1. 2. Action Set ohmmeter on R�1 scale. Push down on PORT TRIM switch and check for continuity between terminals 2 and 13. Is continuity indicated? Push up on PORT TRIM switch and check for continuity between terminals 14 and 7. Is continuity indicated? Yes No The switch is OK. Replace the switch. Yes No Proceed to Step 2. Replace the switch. The switch is OK. Replace the switch. Dual Power Trim System Component Repair Use care when removing and installing components. Do not force or pull wiring during replacement. Use care to prevent wiring from stretching, pinching, or chafing. Coat all terminals with lubricant. Tube Ref No. Description Where Used Part No. 25 Liquid Neoprene All terminal connections 92-25711-3 Relay Removal 1. Remove the cover of the control box. a b 10342 a - Screws b - Cover 2. Unsolder wires from the relay to be replaced. 90-865612050 FEBRUARY 2006 Page 5C- Dual Power Trim System 3 Remove the relay. a b 10343 a - Relay assemblies (1 and 2) b - Fasteners Relay Installation 1 Install new relay. IMPORTANT: Use 63/67 (tin/lead) alloy solder. Do not use acid core solder, which can damage the relay. Coat terminal connections with liquid neoprene. 2 Using 63/67 (tin/lead) alloy solder, solder wires from terminal block to the relay as shown. 3 Coat the terminal connections with lubricant. b c a c - Terminal block a - Relay number b - Relay number 10345 Tube Ref No. Descriptioj Where Used Part No. 25 Liquid Neoprena All terminal connections 92-25711-3 4. Install control box cover Page 5C- 90-865612050 FEBRUARY 200 Dual Power Trim System 5. Tighten the screws securely. a b 10342 a - Screws b - Cover Diode Module Removal 1. Remove the cover of the control box. a b 10342 a - Screws b - Cover 2. Disconnect the leads from the terminal block. Diode Module Installation 1. Replace the diode module. a c b 10348 a - Diode module c - Bolt b - Nut 2. Reconnect numbered leads to their respective terminals. 3. Install the cover of the control box. 90-865612050 FEBRUARY 2006 Page 5C- Dual Power Trim System 4. Tighten the screws securely. a b 10342 a - Screws b - Cover Trim Control Panel Switch Removal 1. Remove the trim control panel from the dash. 2. Cut the leads from the switch to be replaced as close to the switch terminals as possible. 10350 a c b a - Number 10-24 studs c - U-bracket b - Flat washers and nuts 3. Remove bezel nut. Trim Control Panel Switch Installation 1. Replace switch. 10360 a b a - Bezel nut b - Switch 2. 3. With the new switch properly positioned in the control panel, loop the leads through their respective terminal eyelets. Refer to the Wiring Diagram. Using 60/40 (tin/lead) alloy rosin core solder, solder the leads to the terminals. Page 5C-8 90-865612050 FEBRUARY 200 Dual Power Trim System 4. Secure the trim control panel to the dash. 10350 a c b a - Number 10-24 studs c - U-bracket b - Flat washers and nuts 90-865612050 FEBRUARY 2006 Page 5C- Dual Power Trim System Page 5C-10 90-865612050 FEBRUARY 2006 Wiring Diagrams Dual Trim c d e f g k i j l c h h g e f b d c a m n 10372 a - Starboard trim pump b - Port trim pump c - 20�amp fuse d - Ground bolt (floor mount) e - UP solenoid f - DOWN solenoid g - 110�amp fuse h - Trim limit switch i - Trim switch (various styles) j - Control module k - Trim position sender l - 12�volt power from battery m -Ground wire n - 12�volt power from switched side of the ignition switch Dual Power Trim Systei Dual Trim Harness Control Modula e c ba d 10364 Dual trim control panel electrical box a - Relay No. 1 d - Terminal block b - Relay No. 2 e - Control panel c - Diode module 90-865612050 FEBRUARY 2006 Page 5C-1 Dual Power Trim System Notes: Page 5C-12 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ Steering Systems Section 6A - Power-Assisted Steering Table of Contents Kent-Moore Tools..6A-2 Parts List..6A-2 Torque Specifications....................................6A-3 Description...6A-3 Control Valve..6A-3 Power-Assisted Steering Pump................6A-3 Power-Assisted Steering System Exploded View � Right Turn ....6A-4 Power-Assisted Steering System Exploded View � Left Turn...6A-5 Power-Assisted Steering System Exploded View � Neutral..6A-6 Power-Assisted Steering Pump......................6A-7 Steering Fluid Level For The Remote Reservoir..6A-7 Steering Fluid ....6A-8 Checking The Steering Fluid Level..........6A-8 Filling and Bleeding.................................6A-9 Power-Assisted Steering Assembly Test.......6A-10 Power-Assisted Steering System Pressure Test...6A-10 Power-Assisted Steering Pump Pressure Test ....6A-12 Steering Helm and Cable..............................6A-13 Steering Cable Specifications................6A-15 Power-Assisted Steering Control Valve Removal ....6A-15 Power-Assisted Steering Control Valve Installation ....6A-16 Multiple Sterndrive Steering Tie Bar Arrangements ....6A-19 Internal Power-Assisted Steering With Internal Tie Bar Only..6A-19 Internal Power-Assisted Steering With Internal and External Tie Bar..............................6A-19 External Power-Assisted Steering ....6A-19 External Power-Assisted Steering With Low External Tie Bar....................................6A-19 Determining The Length Of The Tie Bar........6A-20 Selecting a Tie Bar..6A-20 Tie Bar Installation.......................................6A-21 Dual Installations with a Steering Cable Attached to the Starboard Power Package ....6A-21 Dual Installations with a Steering Cable Attached to the Port Power Package......6A-22 Power-Assisted Steering Pump Removal, Disassembly, and Reassembly.....................6A-23 Removal...6A-23 Flow Control Valve Servicing.................6A-24 Power-Assisted Steering Pump Shaft Oil Seal Replacement..6A-25 Disassembly..6A-27 Cleaning And Inspection........................6A-30 Reassembly..6A-30 Installation...6A-36 6 A 90-865612050 FEBRUARY 2006 Page 6A- Power-Assisted SteerinJ Lubricant, Sealant, AdhesiveV Tube Ref No 10 34 114 134 Special Tools Description Loctite 277 Special Lubricant 101 Power Trim and Steering Fluid Loctite 380 Power Steering Test Gauge Kit Where Used Part NoTie bar threads Obtain Locally Bushings Clevis pins, steering cable end Power Trim Pump O-ring End plate O-ring 92-802865A1 92-802880A1 Reservoir O-ringD Power Trim Pump Obtain Locall\ 91-38053A05 Tests the power-assisted steering system pressure. 10804 Power Steering Pump Pulley Remover Kent Moore J-25034-C Removes the pulley on the power steering pump. 18598 Pulley Pusher Installer 91-93656A1 10047 Installs the pulley onto the power steering pump. Kent-Moore Tools Description Kent-Moore Tools, Inc29784 Little Mack Roseville, MI 48066 (313) 774-9500 Part Number Power-Assisted Steering Pump Pulley Remover J-25034 Parts List NOTE: Obtain from a local GM automotive dealer. Description QtyPart Number Power-Assisted Steering Pump Seal kit 1 5688044 Page 6A-2 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ Torque Specifications NOTE: Securely tighten all fasteners not listed in the following table. Description Steering cable coupler nut Steering system pivot bolts Power-assisted steering hydraulic hose fittings Power-assisted steering pump housing studs Pump flow control valve fitting Tie bar locknut Fitting assembly Power-assisted steering pump bolt and nut Description Nm 48 34 31 47 47 68 47 41 lb. in.lb. ft35 25 23 35 35 60 35 30 NOTE: Some power-assisted steering pumps and related components are not covered in this section. Mercury MerCruiser or Cummins MerCruiser diesel engine models. For information on these models refer to the appropriate engine service manual. The Power-Assisted Steering system utilizes an engine-driven, vane-type hydraulic pump that supplies fluid flow and pressure by means of hoses to a control valve that, in turn, controls fluid flow and pressure to and from a booster cylinder. Modes make up the basic function of the Power-Assisted Steering system: 1) neutral mode, 2) left turn mode, and 3) right turn mode. The control valve, which is activated by the steering cable, controls the steering system modes. NOTE: The following Power-Assisted Steering unit installations are viewed from inside boat, looking at transom. Control Valve The control valve is not serviceable and must be replaced as a complete assembly. 10197 Power-Assisted Steering Pump The power-assisted steering pump is not serviceable and must be replaced as a complete assembly. 90-865612050 FEBRUARY 2006 Page 6A- Power-Assisted SteerinJ Power-Assisted Steering System Exploded View � Right TurS 18526 a b c d e e f Right turn (viewed from inside the boat, facing the transom a - Piston d - Pump b - Control valve e - Relief valve c - Oil cooler f - Pump housing Description High pressure Low pressure Internal System Pressure 7929-8618 kPa (1150-1250 psi) 483-862 kPa (70-125 psi) Page 6A-4 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ Power-Assisted Steering System Exploded View � Left TurS 18518 a b c d e e f Left turn (viewed from inside the boat facing the transom a - Piston d - Pump b - Control valve e - Relief valve c - Oil cooler f - Pump housing Description High pressure Low pressure Internal System Pressure 7929-8618 kPa (1150-1250 psi) 483-862 kPa (70-125 psi) 90-865612050 FEBRUARY 2006 Page 6A- Power-Assisted SteerinJ Power-Assisted Steering System Exploded View � NeutraQ 18526 a b c d e e f Neutral (viewed from inside the boat facing the transom a - Piston d - Pump b - Control valve e - Relief valve c - Oil cooler f - Pump housing Description High pressure Low pressure Internal System Pressure 7929-8618 kPa (1150-1250 psi) 483-862 kPa (70-125 psi) Page 6A-6 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ Power-Assisted Steering Pump The 8.1 liter power-assisted steering pump is not serviceable. When removing the power-assisted steering pump from the engine refer to the appropriate Mercury MerCruiser Engine Service Manual. c b a d 21693 a - Power-assisted steering pump b - Low pressure hose (return hose) c - High pressure hose d - Pulley Steering Fluid Level For The Remote Reservoir 1. Using the steering wheel, position the sterndrive so that it is in the straight ahead position. 2. Remove fill cap from power steering pump and note fluid level. 3. The fluid level should be in the operating range on the dipstick. a b c d 21690 Remote reservoir for the 8.1 liter (496) engine power-assisted steering system a - Reservoir c - Operating range b - Fill cap d - Add range 4 If the fluid level is in the add range but fluid is still visible in pump reservoir, add the required amount of fluid through the fill cap opening, to bring the level up to the operating range on the dipstick. Do not overfill. Tube Ref NoDescription Where Used Part No114 Power Trim and Steering Fluid Power Trim Pump 92-802880A1 134 Loctite 380 Power Trim Pump Obtain Locally 90-865612050 FEBRUARY 200 Page 6A- Power-Assisted SteerinJ 5 If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct. Steering Fluid Checking The Steering Fluid Level ENGINE WARM 1. Using the steering wheel, position the sterndrive so that it is in the straight ahead position. 2. Stop the engine. 3. Remove fill cap from power-assisted steering pump and note fluid level. a b 10053 a - Fill cap/dipstick b - Power-assisted steering pump 4. The fluid level should be between the FULL HOT and ADD marks on the dipstick. 10054 a a - Proper fluid level with the engine warm 5 If the fluid level is below the ADD mark but fluid is still visible in pump reservoir, add the required amount of fluid through the fill cap opening, to bring the level up to the FULL HOT mark on the dipstick. Do not overfill. Tube Ref No.DescriptioS Where Used Part No 114 134 Power Trim and Steering Fluid Power Trim Pump 92-802880A1 Loctite 380 Power Trim Pump Obtain Locally ENGINE COLD 6. 1. 2. 3. If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct. Using the steering wheel, position the sterndrive so that it is in the straight ahead position. Stop the engine. Remove fill cap from the power-assisted steering pump and note the fluid level. Page 6A-8 90-865612050 FEBRUARY 2006 Power-Assisted SteerinJ 4. The fluid level should be between the FULL COLD mark and bottom of dipstick a 10056 a - Proper fluid level with engine cold 5 If the fluid level is below bottom of the dipstick but fluid is still visible in the pump reservoir, add the required amount of fluid through the fill cap opening to bring level up to the FULL COLD mark on the dipstick. Do not overfill. Tube Ref NoDescription Where Used Part No114 Power Trim and Steering Fluid Power Trim Pump 92-802880A1 134 Loctite 380 Power Trim Pump Obtain Locally 6 If fluid is not visible in the reservoir, a leak exists in the power-assisted steering system. Find the cause and correct. Filling and Bleeding IMPORTANT: Fill the power-assisted steering system exactly as explained in the following procedure to ensure that all air is bled from the system. Failure to remove the air may cause foam during operation and discharge from pump reservoir. Foamy fluid also may cause power-assisted steering system to become spongy, which may result in poor boat control 1. Using the steering wheel, position the sterndrive so that it is in the straight ahead position. 2. Stop the engine. 3. Remove the fill cap/dipstick from the power-assisted steering pump. 4. Add approved fluid to bring the level up to the FULL COLD mark on the dipstick. IMPORTANT: Use only power trim and steering fluid in power-assisted steering system Tube Ref No.DescriptioS Where Used Part No 114 Power Trim and Steering Fluid Power Trim Pump 92-802880A1 134 Loctite 38 Power Trim Pump Obtain Locally 5 Install the vented fill cap. Tighten securely. ! CAUTION Do not operate the engine without water being supplied to the seawater pickup pumpAn insufficient supply of seawater may damage the impeller. Subsequent overheating could damage the engine itself 6. Start the engine and operate at fast idle (1000�1500 RPM) until the engine reaches normal operating temperature. During this time, turn the steering wheel fully back and forth several times. 7. Using the steering wheel, position the sterndrive so that it is in the straight ahead position. 8. Stop the engine. 90-865612050 FEBRUARY 200 Page 6A- Power-Assisted SteerinJ 9. Remove the fill cap from the reservoir. 10. Allow any foam in the pump reservoir to disperse. 11. Check the fluid level and add fluid as required to bring the level up to the FULL HOT mark on the dipstick. Do not overfill 12. Reinstall the fill cap. Tighten securely IMPORTANT: The sterndrive must be in the straight ahead position and steering fluid must be hot for an accurate reading of the fluid level 13. If the fluid is still foamy, repeat steps 5 through 10 until the fluid does not foam and the level remains constant. Power-Assisted Steering Assembly Test Power-Assisted Steering System Pressure Test The following procedure is arranged so that a defective part can be detected by the process of elimination. Therefore we suggest that you follow the order of the instructions so that the power-assisted steering system can be tested effectively. 1. Remove the front and rear clevis pins 2. Retract the cable into cable guide tube 10272 a b e c d f a - Clevis d - Steering cable end b - Rear clevis pin e - Cable guide tube c - Forward clevis pin f - Cotter pins Page 6A-10 90-865612050 FEBRUARY 200 Power..Assisted Steering 3 A........b......a..............a.........................a........b..S a...............a........ a d c b 19481a .. .. b .. ..a........a........b.... c .. ..a.............c......................a............... d .. ..a...... ....a.............91..38053A05 4 ....a......................a........c.................. !....A.......... Do not operate engine without cooling water being supplied to water pickup holes in gear housing.. or overheating damage to engine may result. ......E.. For complete instructions for attaching a flush test device to the various water inlets.. refer to ..te..n....i..e ..ate.. ..i........s in ..e..tion ..... 5 ....cW ..a ....K ....W ....cH ....R ......H ....a......a....\ ....Q ......H ....a....U ....aS ..a.............a...........a.............a..............a......a.................c...c.........................H c...a...................c..a...O ..a..........a.................... 10061 Standard Bravo shown 6 ....a...........................a..............a......a....1000..1500...ac...............aO ....a.....................a........ 7 ......K ......H ....H ..aW ....H ....W ....a....H ......a......J ....G ..bH ..b..........Q 483..a......862......a......70..a......125...................................c........a.................. 90..865612050................A........2006 ..a......6A..11 Power..Assisted Steering !....A.......... Do not lug pump at maximum pressure for more than 5 seconds in next step or damage to power steering pump may occur. 8 ....a..cab..................a......................a................................a............a..W ....c....a..b.............................b................c.......... 9 ....cab..............................b.............c..ac................K ....a.................................cab..........................ac.............V ..a.................................a........ . ...ab........6897......a......1000... . ...b..........6897......a......1000.............c........c.. Power..Assisted Steering Pump Pressure ..est !....A.......... Blocking the flow of pressuri..ed fluid from a fluid pump results in sustained maximum pressure that could damage the fluid pump. ..he test gauge valve blocks the flow of pressuri..ed fluid when closed. ..he longer the fluid flow is blocked.. the greater the possibility of damage to the pump. Do not close the test gauge valve longer than 5 seconds during testing. 1 ....a......a.............a.........b..a...............a...... a d c b 19481a .. .. b .. ..a........a........b.... c .. ..a.............c.......................a............... d .. ..a...... ....a..............91..38053A05!....A.......... ..verheating from insufficient cooling water will cause engine and drive system damage. ..nsure that there is sufficient water always available at water inlet holes during operation. ......E.. For complete instructions for attaching a flush test device to the various water inlets.. refer to ..te..n....i..e ..ate.. ..i........s in ..e..tion ....a......6A..12 90..865612050................A........2006 Power-Assisted SteerinJ 2 Connect a flush test device to the sterndrive. Partially open water tap (approximately half of maximum) and allow water to enter the cooling system. Do not use full water tap pressure. 10061 Standard Bravo shown 3 Start the engine and operate at 1000�1500 RPM until the engine reaches normal operating temperature. 4 Close the test gauge valve just long enough to obtain maximum pressure reading. 5 Close and open the valve three times. Record the highest pressure reading attained each time a If pressure readings are between 7932 and 8621 kPa (1150 and 1250 PSI) and are within a range of 345 kPa (50 PSI), the pump is within specifications. If the pump tests OK, but system pressure was low (as tested under Power-Assisted Steering System Pressure Test), proceed to Booster Cylinder Test b If pressure readings are between 7932 and 8621 kPa (1150 and 1250 PSI) but are not within a 345 kPa (50 PSI) range, the power-assisted steering pump flow control valve is sticking or the pump hydraulic system is dirty. c If pressure readings are constant, but below 6897 kPa (1000 PSI), replace the power-assisted steering pump. Steering Helm and Cable The transom assembly is shipped with the steering cable guide tube preset for cables with end dimensions that comply with ABYC standards as outlined in the NMMA certification handbook. The steering cable coupler nut must also have a means of locking it to the guide tube, as specified in ABYC requirements. ! WARNING Failure to use a steering cable locking device could cause loss of steering and possibly cause damage to the boat or personal injury 90-865612050 FEBRUARY 200 Page 6A-1 Power-Assisted SteerinJ NOTE: All current�production Quicksilver RideGuide steering cables have a self�locking coupler nut and do not require an external locking device. Other cable manufacturers also make cables with self�locking coupler nut. a 7255 a - Quicksilver RideGuide steering cable self-locking coupler nut (identified by a groove) IMPORTANT: If you are using a steering cable that does not have a self-locking coupler nut, you must use an external locking device such as a locking sleeve ! CAUTION Installing a steering cable with improper dimensions could cause severe damage to the transom assembly or the steering system � Steering cable must be the correct length, particularly when installed in larger boats. � Avoid sharp bends, kinks, loops, or short cables. � Fully extended steering cable end dimension must be as shown. Page 6A-14 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ Steering Cable Specifications IMPORTANT: Power-assisted steering pump lugging (squealing) in a hard right turn (against lock) may mean that a steering cable does not have the correct dimensions CL a b c d e f g h i j k l 7254 a - Coupler nut�7/8 - 14 UNF - 2B g - 15.9 mm (5/8 in.) maximum thread diameter end fitting b - 298 mm (11�� in.) minimum h - 9.5 mm (3/8 in.) c - Interface point i - 9.8 mm (3/8 in.) diameter through d - 12.7 mm (� in.) maximum hole, chamfered each side e - 10.7 mm (27/64 in.) minimum flat j - 34.9 mm (1�3/8 in.) maximum f - 3.1 mm (7/64 in.) minimum radius k - 15.9 mm (5/8 in.) diameter tube l Cable travel:Mid-travel position� 428.6 mm (16-7/8 in.)�Total travel to be 203.2 mm (8 in.) minimum, to 228.6 mm (9 in.) maximum.-- Travel each side of mid�travel position�101.6 mm (4 in.) minimum, 114.3 mm (4-1/2 in.) maximum Power-Assisted Steering Control Valve Removal 1. Remove the rear clevis pin from the steering lever. 2. Remove the forward clevis pin from the steering cable. 3. Using suitable wrenches, hold the flat surfaces on the cable guide tube vertically and then loosen the coupler nut. 4. Remove the steering cable. 5. Remove and recouple the power-assisted steering hoses. 6. Straighten the locking tabs on the pivot bolt washers. 7. Remove the pivot bolts. 90-865612050 FEBRUARY 200 Page 6A-1 Power-Assisted SteerinJ 8. Remove the power-assisted steering unit from the transom 10269 i j f a b g e c h d Control valve a - Clevis f - Pivot bolt b - Rear clevis pin g - Coupler nut c - Forward clevis pin h - Cotter pins d - Steering cable end i - Flat surface on tube e - Cable guide j - Suitable wrench Power-Assisted Steering Control Valve InstallatioS ! CAUTION The outer casing of the steering cable must be free to move back and forth for the steering system to function properly. Do not fasten any items to the steering cable 1. Lubricate the bushings on the valve assembly. a 19480 a - Bushings Tube Ref No.Description Where Used Part No 34 Special Lubricant 101 Bushings 92-802865A1 Page 6A-16 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ 2. Slide the power-assisted steering cylinder bushings between the transom mounting brackets. Tighten the two pivot bolts by hand. Move the steering assembly slightly to ensure proper pin engagement into the pivot bushings. 3. Ensure that the washer tangs straddle the ridges on the inner transom plate. 10059 c - Washer tab b a b c a a - Pivot bolt b - Washer tang 4. Torque the pivot bolts. Description Nm lb. in.lb. ft Steering system pivot bolts 34 25 5. Bend the washer tabs against the corresponding flats on both heads of the pivot bolt. 6. Ensure that the power-assisted steering control valve pivots freely. 7. Connect the power-assisted steering unit to the steering levera. Lubricate the clevis pins. b. Install the clevis pin in the clevis from the top. c. Secure the pin in the clevis with a cotter pin. Spread the ends of the cotter pin. 8. Lubricate the end of the steering cable and install the cable through the guide. 9. Start the coupler nut on the cable guide tube. Do not tighten at this time. 90-865612050 FEBRUARY 2006 Page 6A-1 Power-Assisted SteerinJ 10. Connect the cable end to the clevis with the forward clevis pin. The clevis pin must fit freely. Spread the ends of the cotter pin. e - Cable guide f - Pivot bolt g - Coupler nut h - Cotter pins 10271 f a b g e c h d Control valve a - Clevis b - Rear clevis pin c - Forward clevis pin d - Steering cable end Tube Ref No.Description Where Used Part No 34 Special Lubricant 101 Clevis pins, steering cable end 92-802865A1 11. Using a suitable wrench, hold the flat surfaces on the cable guide tube vertically. Torque the coupler nut. Verify that the flat surfaces are still aligned vertically a b 10224 a - Flat surface b - Suitable wrench Description Nm lb. inlb. ftSteering cable coupler nut 47 35 12. Install power-assisted steering hoses to the power-assisted steering assemblya. Torque both fittings. Route hoses as described in Section 2A to avoid contact with components of the steering system. Page 6A-18 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ Description Nm lb. inlb. ftPower- assisted steering hydraulic hose fittings 31 23 Multiple Sterndrive Steering Tie Bar Arrangements With multiple sterndrives you must select one of several possible steering systems ! CAUTION Failure to observe the recommended tie bar arrangements could result in serious damage to the steering or components of the trim system. This damage could adversely affect control of the boat. Observe the recommended tie bar arrangements in this section Internal Power-Assisted Steering With Internal Tie Bar Only For boats at the lower end of the performance spectrum�not capable of speeds in excess of 97 km/h (60 MPH)�we recommend the basic internal tie bar. An internal tie bar connects the slave sterndrive to the sterndrive which is directly connected to the factory power-assisted steering output. This internal tie bar is available in a variety of lengths from the sterndrive manufacturer. Internal Power-Assisted Steering With Internal and External Tie Bar For boats in the moderate performance range of 97�113 km/h. (60�70 MPH) or for a reduction in steering backlash, we recommend adding an external tie bar. External tie bars usually attach at the aft power trim cylinder bosses. This location is an excellent choice because of its proximity to the propeller. HOWEVER, because of the potential overstress that can occur if one sterndrive is trimmed much differently than the other, a dual trim control kit (part number 90362A3) should be installed to limit this potential tilt differential to about 20�. IMPORTANT: Mercury Marine does not recommend the use of an external tie bar ONLY with no internal tie bar when using the internal power-assisted steering system. Doing so can cause excessive loads on the steering components on the sterndrive connected to the internal power-assisted steering system. These increased loads can damage the steering components, resulting in increased play in the steering External Power-Assisted Steering For boats in the higher performance range�speeds in excess of 113 km/h (70 MPH)�or for reduction of additional steering backlash, we recommend external power-assisted steering. This normally will include an external tie bar mounted in the vicinity of the power-assisted steering cylinders, which are generally attached at the top of the driveshaft housing of the sterndrive. This steering system should not use an internal tie bar. You can attach these external steering cylinders either inboard (between) or outboard of the sterndrives. External Power-Assisted Steering With Low External Tie Bar For the fastest boats, over 129 km/h (80 MPH), or for the ultimate in steering backlash reduction, we recommend use of an external power-assisted steering, BUT (where mechanically possible) with the external tie bar mounted at the location of the trim cylinder boss as previously described in Internal Power-Assisted Steering with Internal and External Tie Bar. Again, this system does not use an internal tie bar. 90-865612050 FEBRUARY 2006 Page 6A-1 Power..Assisted Steering Determining ..he ..ength ..f ..he ..ie Bar !....A.......... ..n dual installations using a starboard tie bar kit.. Bends or loops in the steering cable M..S.. have a minimum radius of 20.. mm ..8 in... at the transom end. A radius less than 20.. mm ..8 in... may kink the steering cable.. impairing steering. If the construction of the boat prohibits this minimum re..uirement .. route the steering cable to the port transom using a port tie bar kit ....08A4.. A5.. or A.... instead of a starboard tie bar kit. ......E.. If the sterndrives are to be angled..in or angled..out.. measure from the center lines of the steering levers (with the sterndrives positioned as desired).. instead of from the center lines of the power packages. In most cases.. sterndrives positioned parallel will provide the best boat handling and performance characteristics. 1 ....ba................ a ....a..........c............................a..c......A..........................ca...................ba....................b......a..........H ....ca..........................c............ b ....a....................................a.............a......c..a..ba................ a b c 12759 a .. ..a..c....b..............c.........................V c .. ....a..b..a..........a........b..\ b .. ..a...........a.........b......c................H c................H Selecting a ..ie Bar ..I.. BAR C..AR.. ..or Dual Installations with Steering Cable Attached to Starboard Power Package ..404..6..762............16........30..........92020A1 ..762..1168..4............30........46..........92020A21168..4..1574..8..........46........62..........92020A3 ....c.............................a..c....................a......a......a..ba.............................a..................... ..I.. BAR C..AR.. ..or Dual Installations with Steering Cable Attached to Port Power Package ..711..952..5..........28........37..1..2..........96708A4 ..952..5..1397..........37..1..2........55..........96708A51397..1828..8..........55........72..........96708A6 ....c............................a..c....................a......a......a..ba...............................a................ ..a......6A..20 90..865612050................A........2006 Power-Assisted SteerinJ Tie Bar Installation Dual Installations with a Steering Cable Attached to the Starboard Power Package 1 Attach fixed end of the bar to the steering lever using a clevis pin and a cotter pin. Spread the ends of the cotter pin. 10155 a b c d a - Fixed end c - Clevis pin b - Steering lever d - Cotter pin 2. Position the sterndrives as desired and turn the adjustable end outward (if necessary) to align the hole at the end of the bar with holes in the steering lever and clevis at the piston rod end. 3. Turn the adjustable end outward three to four turns from this position. 4. Apply sealant to the exposed threads of the tie bar. 5. Thread the tie bar in three to four turns to its previously aligned position. 6. Attach the end of the tie bar using a clevis pin and a cotter pin. 7. Spread the ends of the cotter pin. 8. Apply sealant to the exposed threads of the tie bar. 9. Torque the locknut against the tie bar. 10156 a bc d a - Adjustable end b - Clevis pin c - Cotter pin d - Locknut 90-865612050 FEBRUARY 200 Page 6A-2 Power-Assisted SteerinJ 10 Tube Ref NoDescription Loctite 277 Where Used Tie bar threads Part NoObtain Locally Description Tie bar locknut Nm 68 lb. inlb. ft50 Dual Installations with a Steering Cable Attached to the Port Power Package 1 Attach fixed end of the bar to the steering lever using a clevis pin and a cotter pin. Spread the ends of the cotter pin. 22079 a b c d a b 10279 a - Fixed bar end c - Clevis piS b - Steering lever d - Cotter piS 2 Position the sterndrives as desired and turn the adjustable end outward (if necessary) to align the hole at the end of the bar with holes in the steering lever and clevis at the piston rod end. 3 Turn the adjustable end outward three to four turns from this position. 4 Thread tie bar in 3 to 4 turns to previously aligned position. 5 Attach the end of the tie bar using a clevis pin and a cotter pin. 6 Spread the ends of the cotter pin. 7 Apply sealant to the exposed threads of the tie bar 8 Torque the locknut against the tie bar. a d b c a - Adjustable end b - Clevis pin 10158 c - Cotter pin d - Locknut Page 6A-22 90-865612050 FEBRUARY 2006 Power-Assisted SteerinJ Tube Ref No.DescriptioS Where Used Part No 10 Loctite 27 Tie bar threads Obtain Locally Description Tie bar locknut Nm 68 lb. inlb. ft50 Power-Assisted Steering Pump Removal, Disassembly, and Reassembly Removal 1. Loosen the adjusting stud and remove the serpentine belt from the power-assisted steering pulley. a 10066 a - Adjusting nut NOTE: Use a suitable container to catch steering fluid when removing the power-assisted steering hoses. 2 Remove the high pressure hose and the return hose from the power-assisted steering pump. b a 10067 Power-assisted steering pump�typical location a - Return hose b - High pressure hose 90-865612050 FEBRUARY 200 Page 6A-2 Power-Assisted SteerinJ 3. Remove mounting fasteners from pump b a a 10078 Power-assisted steering pump�typical location a - Nut b - Bolts 4. Remove the power-assisted steering pump from the bracket. Flow Control Valve Servicing ! CAUTION ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing your boat. Contain and dispose of oil or oil waste as directed by local authorities 1. Drain fluid from the pump. 2. Remove the components shown. 10074 a b c dd a - Fitting assembly c - Flow control spring b - Control valve assembly d - O-rings 3. Inspect the control valve assembly and the fitting assembly for contamination and damage. Page 6A-24 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ 4. Install the components shown and torque the fitting 10074 a b c dd a - Fitting assembly b - Control valve assembly c - Flow control spring d - New O-rings Description Pump flow control valve fitting Power-Assisted Steering Pump Shaft Oil Seal Replacement 1. Remove the pump pulley. Nm 47 lb. inlb. ft35 a 10076 a - Pulley removal tool Power Steering Pump Pulley Remover Kent Moore J-25034-C 90-865612050 FEBRUARY 2006 Page 6A-2 Power-Assisted SteerinJ 2. Push a 0.13 mm (0.005 in.) shim stock past the oil seal until it contacts the pump body (approximately 64 mm [2-1/2 in.]). b a 10079 a - Oil seal b - Shim stock 3. Remove oil seal. 4. Remove shim stock. ab 10080 a - SeaO b - Suitable tool 5 Install a new oil seal. Support the pump reservoir so that the back of the reservoir does not become distorted. ab c 10081 a - New oil seal, metal side up c - Pump reservoiU b - Suitable mandreO 6 Install the pulley using pulley pusher installer and a long straightedge a. Place the pulley on the pump shaft. b. Thread the stud all the way into the pump shaft. c. Place the bearing over the stud. d. Do not use a spacer from the kit. e. Thread the nut onto the shaft. Thread the shaft and nut all the way onto the stud. Page 6A-2 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ f. Using a long straightedge to check the drive belt alignment and then turn the large pusher nut until the drive belt is parallel to the straightedge. g. Check pulley installation for correct alignment. e - Shaft f - Crankshaft pulley (shown) or water circulating pump pulley g - Long straightedge h - Drive belt is parallel to the b c d e g f a h 10082 a - Power-assisted steering pump pulley b - Stud c - Bearing d - Nut straightedge Pulley Pusher Installer 91-93656A1 Disassembly ! CAUTION ENVIRONMENTAL HAZARD! Discharge of oil or oil waste into the environment is restricted by law. Do not spill oil or oil waste into the environment when using or servicing the boat. Contain and dispose of oil or oil waste as required by local authorities 1. Drain fluid from the pump. 90-865612050 FEBRUARY 2006 Page 6A-2 Power-Assisted SteerinJ 2 Remove the pump pulley a 10088 a - Pulley remover Power Steering Pump Pulley Remover Kent Moore J-25034-C 3. Remove the reservoir, fitting assembly, control valve assembly, flow control spring, studs, and O-rings. 4. Discard the O-rings and retain the other parts. d - Studs e - Reservoir f - O-rings f d ff ba ffc 10089e a - Fitting assembly b - Control valve assembly c - Flow control spring 5 Position the retaining ring so that the ring end is 25 mm (1 in.) from the end of the hole in housing. 6 Support the housing in a press and push down on the end plate to remove tension on the retaining ring. 7 Insert an awl into the hole in housing to push the ring from the recess. Page 6A-2 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ 8. Use a screwdriver to remove the retaining ring and end plate 22151 a b a - Retaining ring b - Hole c 10090 c - End plate 9. Remove pump components shown d - Pump vanes e - Pump shaft and rotor assembly f - Dowel pins 10. Remove and discard the O-rings from the housing. a b c d e f f 10091 a - Spring b - Pressure plate c - Pump ring a 10092 a - O-ringD 90-865612050 FEBRUARY 2006 Page 6A-2 Power-Assisted SteerinJ 11. Remove the retaining ring, rotor, and thrust plate a b c d 10093 a - Retaining ring b - Rotor c - Thrust plate d - Pump shaft 12. Remove the magnet a 10094 a - Magnet Cleaning And Inspection 1 Clean and inspect all metal parts. Reassembly NOTE: All references to Steering fluid refer to Power Trim and Steering Fluid if a Quicksilver product is not available. NOTE: Obtain and install a Power -Assisted Steering Pump Seal Kit 5688044 from a local GM automotive dealer when reassembling pump. 1 Install the new pump shaft oil seal metal side up. Support the pump reservoir so that the back does not become distorted. a b c 10101 a - New oil seal c - Pump reservoir b - 1 in. socket 2. Lubricate the pressure plate O-ring and place it in the third groove of the housing Page 6A-3 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ Tube Ref NoDescription Where Used Part No114 Power Trim and Steering Fluid O-ring 92-802880A1 3. Install the dowel pins. 10102 a b b a - Pressure plate O-rinL b - Dowel pins 4 Assemble the pump shaft and rotor assembly. The rotor should be installed with the countersunk side facing the thrust plate. c - Thrust plate d - Pump shaft 5. Install the pump shaft�and�rotor assembly. a b c d 10093 a - Retaining ring b - Rotor 10103 b a a - Pump shaft�and�rotor assembly b - Pump housinL 90-865612050 FEBRUARY 200 Page 6A-3 Power-Assisted SteerinJ 6. Install the pump ring by placing the two smaller holes over the dowel pins a 10104 a - Pump ring 7 Install the vanes in the rotor slots with its rounded edges facing the pump ring. The vanes must slide freely. 10105 a a - Vanes 8. Install the pressure plate. Ensure that the spring groove faces upward. a b 10106 a - Pressure platJ b - Spring groovJ Page 6A-3 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ 9. Lubricate the end plate O-ring and place it in the second groove of the housing a 10107 a - End plate O-ring Tube Ref No.Description Where Used Part No 114 Power Trim and Steering Fluid End plate O-ring 92-802880A1 10. Install the pressure plate spring, end plate, and retaining ring. Use care to avoid damaging the end plate and O-ring. c 10108 a b d a - Pressure plate spring c - Retaining rinL b - End plate d - Arbor presD 11. Lubricate the reservoir O-rings and install them in the groove in the pump housing. a a 10110 a - Reservoir O-ringD 90-865612050 FEBRUARY 2006 Page 6A-3 Power-Assisted SteerinJ Tube Ref No.Description Where Used Part No 114 Power Trim and Steering Fluid Reservoir O-rings 92-802880A1 12. Place the magnet on the housing a 10094 a - Magnet 13. Secure the reservoir to the pump housing and torque the studs. c a b 10109 a - Reservoir b - Pump housing c - Studs Description Power-assisted steering pump housing studs Nm 47 lb. inlb. ft35 Page 6A-34 90-865612050 FEBRUARY 200 Power-Assisted SteerinJ 14. Install components as shown. Torque the fitting assembly a b c d 10126 a - Flow control spring b - Control valve assembly c - O-ring for fitting assembly d - Fitting assembly Description Nm lb. inlb. ftFitting assembly 47 35 15. Install the pulley using the pulley pusher installer and a long straightedgea. Place pulley on pump shaft. b Thread the stud all the way into the pump shaft. Place the bearing over stud. Do not use a spacer from kit. c Thread the nut onto the shaft. Thread the shaft and nut all the way onto the stud. d Using a long straightedge to check alignment of the drive belt, turn the large pusher nut until the drive belt is parallel to the straightedge. Pulley Pusher InstalleU 91-93656A1 90-865612050 FEBRUARY 200 Page 6A-3 Power-Assisted SteerinJ e. Check the pulley installation for correct alignment. Do not use a spacer b c d e g f a h 10082 a - Power-assisted steering pump pulley b - Stud c - Bearing d - Nut e - Shaft f - Crankshaft pulley (shown) or water circulating pump pulley g - Long straightedge h - Drive belt parallel Installation IMPORTANT: Be careful to not cross-thread or overtighten hose fittings1. Place the power-assisted steering pump on the bracket. 2. Install the bolt and nut. Torque. b a a 10078 Power-assisted steering pump�typical location a - Nut b - Bolts Description Nm lb. inlb. ftPower- assisted steering pump bolt and nut 41 30 3. Ensure that a new high pressure hose O-ring is installed. Page 6A-36 90-865612050 FEBRUARY 2006 Power-Assisted SteerinJ 4. Install the threaded fitting at the rear of the pump assembly. Tighten the fitting securely. 5. Connect the low�pressure return hose on the rear of the back of pump. Tighten the hose clamp securely. b a 10067 Power steering pump�typical location a - Return hose b - High pressure hose 6. 7. 8. Install mounting hardware and fasteners to hold the pump to bracket. (Refer to Exploded View for specific details on your engine.) Install the the drive belt and adjust tension. Refer to Pump Drive Belt Adjustment. Fill and air�bleed system. Refer to Filling and Bleeding. 90-865612050 FEBRUARY 2006 Page 6A-3 Power-Assisted SteerinJ Notes9 Page 6A-38 90-865612050 FEBRUARY 200 Compact Hydraulic SteerinJ Steering Systems Section 6B - Compact Hydraulic Steering Table of Contents Approved Hydraulic Steering Fluids................6B-2 Important Information About Through the Transom Exhaust..6B-2 Torque Specifications....................................6B-2 Introduction..6B-2 Through the Transom Exhaust................6B-3 Remove the Steering Cylinder........................6B-3 Installing The Steering Cylinder.......................6B-4 Filling and Purging The System.......................6B-6 Filling and Purging the System................6B-6 Twin Station and/or Twin Cylinder............6B-6 Single-Station With Single-Cylinder..........6B-6 Connecting The Clevis...................................6B-9 Hydraulic Fluid Level......................................6B-10 Setting Fluid Level................................6B-10 Maintaining Fluid Level..........................6B-10 System Check..6B-11 Maintenance...6B-11 Troubleshooting Guide.................................6B-11 Important Information.............................6B-11 Troubleshooting Chart...........................6B-12 Standard Tilt-Helm Mounting Reference........6B-14 90-865612050 FEBRUARY 2006 Page 6B- 6 B Compact Hydraulic SteerinJ Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used Part No. 34 Bushings Special Lubricant 101 Upper and lower pivot bolts threads 92-802865A1 Clevis pin and clevis Approved Hydraulic Steering Fluids Description Where used Part Number Hydraulic Helm Steering Fluid Hydraulic hose end O-ring area 92-862014Q1 Important Information About Through the Transom Exhaust NOTICE This hydraulic steering system is not designed for use with through-the-transom exhaust systems. Do not use this hydraulic steering system with a through-the-transom exhaust system. Torque Specifications NOTE: Securely tighten all fasteners not listed below. NOTE: Amounts specified are MINIMUM. Do not exceed 22 Nm (200 lb-in.) for steering hydraulic hose fittings. Description Steering hydraulic hose fittings Pivot bolts Nm 15 34 lb. in. 130 lb. ft. 25 Introduction The system has a pressure-relief valve to protect against internal fluid pressure becoming too high for the individual system components. This valve minimizes the possibility of a total loss of steering. The steering cylinder is an "unbalanced" cylinder: in any position the port and starboard cylinder chambers will have different volumes. This is important when setting the hydraulic fluid level, as outlined later. This precision-built product may not function properly if dirt or contaminants are introduced into the system. ! CAUTION Avoid product malfunction and diminished steering control. Dirt and contamination introduced into the hydraulic system can result in damage to internal parts of steering system. Do not allow dirt or contamination to enter the helm, lines or cylinder of this steering system. IMPORTANT: Due to a small amount of internal hydraulic fluid transfer (slip), a master spoke or centered steering wheel cannot be maintained with a hydraulic steering system. For best results, use an equal-distance spoke steering wheel. Page 6B-2 90-865612050 FEBRUARY 200 Compact Hydraulic Steering 90-865612050 FEBRUARY 2006 Page 6B-3 ! WARNING Avoid serious bodily injury or death due to loss of steering control. Extreme heat will lower the burst pressure of hydraulic hoses or melt hydraulic hoses. In either case, instant loss of steering may occur. Do not allow hydraulic hoses to contact hot objects, such as the engine. Through the Transom Exhaust This Compact Hydraulic Steering System is not designed for use with through-the-transom exhaust systems. Do not use this hydraulic steering system with a through-the-transom exhaust system. Remove the Steering Cylinder ! CAUTION Avoid product malfunction and diminished steering control. Dirt and contamination introduced into the hydraulic system can result in damage to internal parts of steering system. Do not allow dirt or contamination to enter the helm, lines or cylinder of this steering system. ! WARNING Avoid serious bodily injury or death due to loss of steering control. Extreme heat will lower burst pressure or melt steering system hydraulic hoses. Stress on hose fittings or kinks in the hose may cause hose failure. In any case , instant loss of steering may occur. Route the hydraulic hoses to avoid extreme heat, stress on hose fittings, and hose kinks. 1. Loosen the hose fittings and remove the hoses from T-fittings of the steering cylinder. 2. Plug the ends of the hose to prevent fluid loss. a b c d c 10000 a - Steering cylinder b - Hoses c - T-fittings d - Hose fittings 3. Remove the cotter pin from the port clevis pin and remove the clevis pin. 4. Bend the tabs of the tab washer away from the bolts. Compact Hydraulic Steering Page 6B-4 90-865612050 FEBRUARY 2006 5. Remove the pivot bolts. b e c a c c a d e 10002 a - Pivot bolts b - Port clevis pin c - Tab washer d - Tab e - Spacer/pivot bolt bearing 6. Remove the steering cylinder from the transom. Installing The Steering Cylinder 1. Ensure that the bushings are clean. 2. Lubricate the bushings. b a a 10007 a - Bushings b - Steering cylinder assembly Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Bushings 92-802865A1 3. Remove the upper and lower pivot bolts, spacer, and tab washers. Ensure that the threads are well lubricated. Compact Hydraulic Steering 90-865612050 FEBRUARY 2006 Page 6B-5 Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Upper and lower pivot bolts threads 92-802865A1 4. Install the steering cylinder assembly as follows: a. Position the steering cylinder assembly so that the upper and lower pivot bolts (with tab washers and spacers) can be threaded by hand into the transom plate. b. Ensure that the tab washer tangs straddle the ridge on the transom plate. c. Ensure the the steering cylinder assembly pivots freely. d. Torque pivot bolts. Bend the washer tabs against corresponding facets of the bolt heads. NOTE: It may be necessary to tighten pivot bolts further to align flats on bolt with tabs on tab washer. c e 10008 b f h g b d a e c b f g a - Steering cylinder assembly b - Pivot bolt c - Tab washer d - Spacer e - Tab f - Transom plate g - Ridge on transom plate h - Tab washer tangs (straddle ridge) Description Nm lb. in. lb. ft. Pivot bolts 34 25 IMPORTANT: Do not connect the clevis to the steering lever at this time. Bleed and purge the system before connecting the clevis to the steering lever. 5. Connect the hoses to the steering cylinder as follows: a. Apply a small amount of clean lubricant to the hydraulic hose end O-ring area. b. Push the port and starboard hoses completely into the fittings. c. Hand-tighten hose fittings. Compact Hydraulic Steering Page 6B-6 90-865612050 FEBRUARY 2006 d. Torque hose fittings. a b 10012 c d e a - Port T-fitting b - Starboard T-fitting c - Hose O-ring d - Port hose from helm ("P") e - Starboard hose from helm ("S") Description Where used Part Number Hydraulic Helm Steering Fluid Hydraulic hose end O-ring area 92-862014Q1 NOTE: Amount specified is MINIMUM. Do not exceed 22 Nm (200 lb-in.). Description Nm lb. in. lb. ft. Steering hydraulic hose fittings 15 130 Filling and Purging The System Filling and Purging the System NOTE: One technician may not be able to completely purge all the air from the system after installation. The result is spongy and unresponsive steering. Two technicians are required for successful filling and purging of any system. Twin Station and/or Twin Cylinder ! WARNING Avoid serious injury or death resulting from a loss of steering control. Improper venting or plugging of hydraulic helm pump reservoir can cause loss of fluid or introduction of air into hydraulic system resulting in insufficient hydraulic pump pressure for proper steering control. If more than one steering station is being installed, the vent/fill plug on all but the uppermost helm must be replaced with a non-vent plug which is included in a dual station fitting kit. For twin station or twin cylinder filling and purging (bleed) instructions, follow instructions provided by SeaStar�. Refer to Single-Station With Single-Cylinder for instruction on how to fill and purge a single station with single cylinder system. Single-Station With Single-Cylinder FILLING IMPORTANT: Hydraulic fluid must be visible in the filler tube during the entire filling procedure. Do not allow the bottle of fluid used for filling to empty causing the filler tube to empty. This may introduce air into the system and require additional filling and purging. Compact Hydraulic SteerinJ Approximately 2 bottles (2 quarts or liters) of approved hydraulic fluid are required for this single-station and single-cylinder system. The length of hydraulic hoses required will cause the amount to vary. 1. Remove vent/fill plug from helm. 2. Using a filler kit (ordered separately), screw the filler tube into vent/fill plug hole. Hand-tighten. 3. Screw the bottle of hydraulic fluid into cap end of the filler tube bottle. Turn bottle upside down and pierce the bottom of the bottle. Description Where used Part Number Hydraulic Helm Steering Fluid Hydraulic steering system 92-862014Q1 4. Ensure the hydraulic fluid is always visible in the filler tube and fill the helm pump. Install the next bottle while fluid is still visible in filler tube but first bottle is empty. 5. The helm is full when air bubbles no longer appear in the filler tube. Stop filling. b a c e f 10015 b a c e f 10016 Standard helm Sport helm a - Helm d - Bottle cap end b - Vent fill plug e - Hydraulic fluid bottle c - Filler tube f - Pin (to pierce bottle) Description Where used Part Number Hydraulic Helm Steering Fluid Hydraulic steering system 92-862014Q1 IMPORTANT: Do not proceed to the next step until the helm is full of hydraulic fluid. Ensure that no air is visible in the filler tube. 6. Leave a bottle of fluid connected to the helm for use in purging the system of air. 90-865612050 FEBRUARY 2006 Page 6B- Compact Hydraulic Steering Page 6B-8 90-865612050 FEBRUARY 2006 PURGING NOTE: Turning the steering wheel in direction shown moves the cylinder rod as indicated by the arrow. a b 10017 a - Port bleeder valve b - Starboard bleeder valve 1. Remove caps from the bleeder valves on the T-fittings at the cylinder assembly. NOTE: Place temporary hoses (We recommend clear hoses; obtain them locally.) on bleeder outlets and place these hoses in a container to avoid spills and air returning to bleeder. 2. Turn the steering wheel slowly CLOCKWISE while the assistant opens the STARBOARD bleeder valve. 3. Continue to turn steering wheel CLOCKWISE until a stream of air-free hydraulic fluid flows from the bleeder valve. a b c d c 10018 a - Cap b - Starboard fitting c - Starboard bleeder valve d - Temporary hose 4. While continuing to turn the steering wheel slowly close the STARBOARD bleeder valve. 5. Turn the steering wheel CLOCKWISE until the cylinder rod is fully extended. Ensure that the steering lever does not interfere with the cylinder clevis. Compact Hydraulic Steering 90-865612050 FEBRUARY 2006 Page 6B-9 6. Turn the steering wheel slowly COUNTERCLOCKWISE while the assistant opens the PORT bleeder valve on the steering cylinder. 7. Continue to turn the steering wheel until a stream of air-free hydraulic fluid flows from the bleeder valve. 8. Continuing to turn the steering wheel slowly while closing the PORT bleeder valve. 9. Turn the steering wheel COUNTERCLOCKWISE until the cylinder rod is fully retracted. The steering wheel will come to a stop. 10. Open the STARBOARD bleeder valve. 11. Hold the cylinder rod to prevent it from extending. Continue to turn the steering wheel COUNTERCLOCKWISE until a stream of air-free hydraulic fluid flows from the bleeder valve. 12. Close the bleeder valve while continuing to turn steering wheel. 13. Filling and purging is complete. Refer to Hydraulic Fluid Level to set fluid level and to check the system after connecting the clevis. a b c b 10019 a - Starboard T-fitting b - Starboard bleeder valve c - Cap Connecting The Clevis 1. Lubricate the clevis pin and clevis. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Clevis pin and clevis 92-802865A1 2. Connect the clevis to steering lever. Spread both ends of the cotter pin. Compact Hydraulic Steering Page 6B-10 90-865612050 FEBRUARY 2006 IMPORTANT: Ensure that the clevis is positioned as shown below. The angled notch in the clevis must face the rear. b a b c c 10020 a a - Clevis b - Clevis pin and cotter pin c - Steering lever Hydraulic Fluid Level ! WARNING Avoid serious bodily injury or death due to loss of steering control. This system operates with an unbalanced steering cylinder volume. Proper fluid level in the helm can only be set or checked with the cylinder rod fully retracted. Do not set or check hydraulic fluid level in helm with cylinder rod extended. Setting Fluid Level The system must be filled and purged as outlined previously before setting the fluid level. 1. Ensure that the cylinder rod is fully retracted. 2. With the filler tube screwed into the helm filler plug hole, fill the tube approximately half full of air-free hydraulic fluid. 3. Open the starboard bleeder valve and slowly turn the steering wheel CLOCKWISE until the fluid level in the filler tube is at the top of the plastic filler fitting. Continue turning steering wheel CLOCKWISE � turn more, and then stop. Close the bleeder valve. 4. Remove the filler tube. The fluid level should be at the bottom of filler hole. Install the vent/fill plug. Maintaining Fluid Level To maintain proper fluid level, observe the following: � Do not allow the fluid level to drop more than 6 mm (� in.) below the bottom of the filler hole. � Check the fluid level periodically. Compact Hydraulic SteerinJ System Check After filling, purging, and setting the fluid level the system must be checked for proper connections, possible leaks, and complete purging of air. IMPORTANT: In the following procedure, turn the wheel with enough force to exceed the pressure relief valve in the helm. This action should not harm the helm or the system. 1 Turn the steering wheel (any wheel on a multi-steering station) very hard to port to pressurize the system. 2 While maintaining pressure, check all port fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before using. 3 Turn steering wheel (any wheel on multi-steering station) very hard to starboard to pressurize system. 4 While maintaining pressure, check all starboard fittings and hose connections. Ensure that there are no leaks. If leaks are present, correct them before using. NOTE: Observing a significant drop in the fluid level at the helm while performing the system check may mean you are compressing air. Further filling and purging would be required. 5 If no leaks are present, the system is ready for service. Maintenance ! WARNING Avoid possible property damage, serious injury, or death due to the loss of steering control. Failure to perform required maintenance may result in a loss of hydraulic pressure due to insufficient hydraulic fluid needed for the proper mechanical function necessary for steering control. Maintain the hydraulic fluid to avoid the loss of hydraulic pressure. NOTE: A damaged cylinder shaft can cause seal failure and leaks. Replacing seals on a damaged cylinder assembly will not stop leaks. A damaged cylinder shaft must be replaced immediately. Task Check the hydraulic fluid level in the helm pump. Check for leaks. Check mechanical linkages and connections. Tighten loose parts and replace badly worn parts. Check the cylinder shaft for nicks and scratches. Troubleshooting Guide Important Information Interval A minimum of two times a year, or at the first indication that the steering system is not operating correctly; whichever occurs first. Whenever a troubleshooting solution calls for removal from vessel or dismantling of steering system components, such work must be carried out by a qualified marine mechanic. The following is offered as a guide only, and neither Mercury MerCruiser nor the helm manufacturer are responsible for any consequences resulting from incorrect repairs. Most faults occur when the installation instructions are not followed and usually show up immediately upon filling the system. The following troubleshooting chart provides the most common faults encountered and their likely cause and solution. 90-865612050 FEBRUARY 200 Page 6B-1 Compact Hydraulic SteerinJ Sometimes when returning the steering wheel from a hard-over position, a slight resistance may be felt and a clicking noise may be heard. This should not be mistaken as a fault, as it is a completely normal situation caused by the releasing of the lockspool in the system ! WARNING Avoid serious injury or death due to FIRE or EXPLOSION. Ensure that the enginJ compartment is well ventilated and that no gasoline vapors are present to prevent thJ possibility of a FIRE or EXPLOSION Troubleshooting Chart Symptom 1. During filling, the helm becomes completely jammed. 2. System is very difficult to fill. Air keeps burping out top of helm even after system appears full. 3. Steering is stiff and hard to turn, even when the vessel is not moving. 4.The helm unit, or one in the system, is very bumpy and requires too many turns from port hard-over to starboard hard-over. 5. Steering is easy to turn at the dock, but becomes hard to turn when the vessel is underway. Cause Blockage in the line between the helms and the cylinders. Air in system. Steering cylinder pivot bushings are too tight or trunnion is bent, causing mechanical binding. Restrictions in hoses. Air in hydraulic fluid. Wrong hydraulic fluid has been used to fill steering system. Dirt in inlet check of helm pump. Steering wheel is too small. Incorrect setting of trim tabs, if equipped. Solution Ensure that hoses were not kinked or pinched during installation. If so, the hose must be removed and replaced. Review filling instructions. To test, disconnect the clevis from the steering lever and turn the steering wheel. If it does not turn easily, repair trunnion or loosen pivot bushings. Please note that excessively loose connections to a steering cylinder or steering lever can also cause mechanical binding. Find restrictions and correct. Refer to the filling and purging instructions. Drain the system and fill with approved hydraulic fluid. Replace the helm unit. Fit a larger wheel, if possible. See installation instructions. If the problem cannot be rectified by changing the steering wheel, proceed with next cause and solution or consult the factory. Adjust tabs, if equipped. Page 6B-12 90-865612050 FEBRUARY 200 Compact Hydraulic SteerinJ Troubleshooting Chart (continued) 6. Drive drifts to port or starboard while vessel is underway, even when the wheel is not being turned. Dirt in check valves. Remove check valve plugs. These are the larger plugs on either side on rear of the helm. Clean ball seats and balls and reassemble. NOTE: Be prepared to lose a certain amount of hydraulic fluid during this procedure. Have a small can available. Refill the system when check balls have been reassembled. 7. Turning one wheel causes Refer to Number 6. Refer to Number 6. second wheel to rotate. The helm has a field-replaceable wheel shaft seal that can readily be replaced 8. Seals will sometimes leak if by removing the steering wheel and seal steering system is not vented at Refer to Solution. cover held in place by three small uppermost helm. screws. Quad ring No. 210 is supplied in Seastar� Helm Seal Kit HS5151. 9. Vent/fill plug leaks when turning Cylinder rod extended during Ensure that the cylinder rod is retracted to port. filling. during filling. 90-865612050 FEBRUARY 2006 Page 6B-1 Compact Hydraulic SteerinJ Standard Tilt-Helm Mounting ReferencJ Helm Flange Outline for Reference Only 4 HOLES 4 in. (102 mm) TOP 1 HOLE4-1/2 in. (115 mm) Diameter 5-5/32 in. (131 mm) 2-17/32 in. (64 mm) 2-25/32 in. 70 mm) 1-13/16 in.(46 mm) 2-3/16 in. (56 mm) 5/16 in. (8 mm) Diameter 10023 Page 6B-14 90-865612050 FEBRUARY 200 V6 and V8 Gasoline Sterndrive Models Driveshaft Extention (Jackshaft) Section 7A - V6 and V8 Gasoline Sterndrive Models Table of Contents General Information..7A-2 Factory-Order Option...............................7A-4 Driveshaft Extension Maintenance..................7A-4 Scheduled Maintenance�Driveshaft Extension..7A-4 Lubrication Points....................................7A-5 Driveshaft Extension Inspection and Maintenance..7A-5 Installation..7A-6 Seawater Inlet Fitting...............................7A-6 Gear Lube Monitor...................................7A-6 Shift Plate..7A-8 Exhaust Adaptor......................................7A-9 Aft Bearing Support...............................7A-11 Engine Preparation................................7A-13 Engine Placement...................................7A-18 Protractor...7A-19 Driveshaft Extension..............................7A-20 Driveshaft Lubrication............................7A-25 Seawater Inlet Hose..............................7A-26 Engine Connections...............................7A-30 Sterndrive With a Driveshaft Extension (Jackshaft) Assembly..............................7A-30 U-Joints Cross Bearing Centerline.........7A-31 Top Safety Shields.................................7A-32 Predelivery Preparation.........................7A-33 Removal...7A-33 U-Joint Top Shields................................7A-33 Sterndrive...7A-34 Engine Connections...............................7A-34 Driveshaft Extension..............................7A-34 Aft Bearing Support...............................7A-37 Engine Shaft Bearing Support...............7A-37 Bearing Inspection.................................7A-37 Aft Bearing Support Assembly Repair...........7A-38 Bottom Safety Shield Removal..............7A-38 Bearings and Oil Seal Removal.............7A-38 Input Shaft Removal..............................7A-38 Bearings and Oil Seal Install..................7A-39 Input Shaft Install...................................7A-41 Bottom Safety Shield Install....................7A-44 Engine Shaft Bearing Support Assembly Repair ....7A-45 Output Shaft Removal............................7A-45 Bearing Removal...................................7A-46 Bearing Install..7A-46 Output Shaft Install...............................7A-49 7 A 90-865612060 MAY 2008 Page 7A-1 V6 and V8 Gasoline Sterndrive Models Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used 7 Loctite 271 Threadlocker Safety shield bolt threads Bolt threads 33 Loctite 680 Retaining Compound Plug for the input shaft Grease fittings 42 U-joint and Gimbal Bearing Grease Bearing bore of engine shaft bearing support Output shaft Bearing ID 91 Engine Coupler Spline Grease Engine coupler splines Special Tools Alignment Tool Assembly 91-805475A 1 Part No. 92-809819 92-809833 92-802870A1 92-802869A 1 9183 Used to align the engine to the transom assembly for sterndrive installation. Alignment Bar 8M2001017 Aids in aligning the engine to the transom assembly for 26831 sterndrive installation. General Information DRIVESHAFT EXTENSION The driveshaft extension (jackshaft) converts a standard sterndrive package into a driveshaft configuration. A long driveshaft is installed between the engine and the transom assembly. The driveshaft installation moves the weight of the engine forward in the boat providing a better center of gravity and improved boat operation. The driveshaft extension is used with triple, dual, and single engine applications in smaller boats. When the driveshaft extention is installed in boats with center console or staggered engine designs it helps the boat get up on plane quickly. The driveshaft extension is available as a kit and must be used in conjunction with the recommended driveshaft. Other kits or parts are listed with the kit for the specific engine models. The driveshaft is ordered separately. Page 7A-2 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 90-865612060 MAY 2008 Page 7A-3 Access must be provided to grease fittings on the driveshaft U-joints, input shaft, and bearing supports to allow for scheduled maintenance. 33872 a b d c a - 1�3� driveshaft angle required b - Driveshaft extension c - Driveshaft U-joint flange connected to output shaft (engine shaft bearing support) d - Driveshaft U-joint flange connected to input shaft (aft bearing support) ENGINE/EXHAUST We recommend using the through-the-propeller exhaust system supplied with this engine package. If the boat configuration requires using a through-the-transom exhaust system you may special order a through-the-transom exhaust kit that meets the engine requirements. Refer to the Mercury Precision Parts Accessories Guide. MEASUREMENTS We recommend a universal protractor or digital inclinometer for measuring the angles during installation steps. 34826 Universal protractor Digital inclinometer V6 and V8 Gasoline Sterndrive Models Factory-Order Option Specific engine models are ordered from the factory with the driveshaft extension as a factory-order option. The driveshaft extension is also available in a kit. 34002abcdehgf Typical V6 model driveshaft extension installation a -Steering cylinder e -Intermediate exhaust elbow b -Transom input flange f -Exhaust bullhorn c -Driveshaft g -Exhaust tube d -Engine shaft output flange h -Oil drain Important applications information: � The engine shaft bearing support is installed at the factory. � The engine is moved forward in the boat to accommodate the length of the driveshaft. � The driveshaft provided includes a sliding yoke feature, allowing for approximately a plus or minus of 25 mm (1 in.) front-to-rear movement of the engine for easier installation. � The driveshaft is installed at a 1�3� angle versus the sterndrive U-joint shaft and engine crankshaft centerlines. � The driveshaft U-joints are properly phased with the sterndrive U-joint. � The safety shields cover the driveshaft U-joints. � The grease fittings for the driveshaft U-joints and the bearing supports are accessible for scheduled maintenance. � The shift plate is relocated within reach of the transom shift cable. � The through-the-propeller exhaust system is provided. � The exhaust adapter drain plugs are accessible. � The power steering, electrical system, and water pickup hose extensions are provided. � The gear lube monitor bracket is included for relocation from the engine to the boat transom. Driveshaft Extension Maintenance Scheduled Maintenance�Driveshaft Extension Refer to the appropriate manual for power package maintenance and Inspections. Perform the following maintenance at the required task intervail. Page 7A-4 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models Task Interval Every 100 hours or annually (whichever occurs first) Every 300 hours or 3 years (whichever occurs first) Lubrication Points Maintenance to Be Performed � Lubricate the driveshaft U-joints. � Lubricate the input shaft. � Lubricate the aft bearing support (input) � Lubricate the engine shaft bearing support (output) � Inspect the driveshaft U-joints. � Engine shaft bearing support inspection � Aft bearing support inspection Lubricate the bearings grease fittings every 100 hours or annually (whichever occurs first). 1. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the following grease fittings: � Aft bearing support grease fitting � Input shaft grease fitting � Engine shaft bearing support grease fitting 2. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into the driveshaft U-joint grease fittings on the transom and engine end. baedc35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting at transom end d -U-joint grease fitting at engine end e -Engine shaft bearing support grease fitting Driveshaft Extension Inspection and Maintenance U-JOINT INSPECTION Preform the U-joint inspection every 100 hours or annually (whichever occurs first). 1. Remove the driveshaft. 2. Rotate the U-joint on the output and the input end of the driveshaft. The movement of each U-joint yoke, socket, and cross bearing assembly should be smooth. 3. Replace the cross and bearing assembly if the seals are deteriorated or if movement is tight or rough. 4. Reinstall the driveshaft. ENGINE SHAFT BEARING SUPPORT INSPECTION Perform the engine shaft bearing support inspection every 300 hours or 3 years (whichever occurs first). 90-865612060 MAY 2008 Page 7A-5 V6 and V8 Gasoline Sterndrive Models 1. Remove the engine shaft bearing support assembly. 2. Rotate the output shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearing. See Engine Shaft Bearing Support Assembly Repair. AFT BEARING SUPPORT INSPECTION Perform the aft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the aft bearing support assembly. 2. Rotate the input shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearings, spacer, and the oil seal. See Aft Bearing Support Assembly Repair. Installation Seawater Inlet Fitting 1. On Bravo models, install a new gasket, seawater inlet fitting, screws, and washers. Tighten the screws to specification. c a b d a 21634 Bravo Transom a -Seawater inlet fitting b -Screw (2) c -Gasket d -Star washers Description Nm lb-in. lb-ft Seawater inlet fitting screws 5 45 Gear Lube Monitor Relocate the engine mounted gear lube monitor to the boat transom above the steering lever on the transom assembly. The transom mounted bracket and accessories can be ordered in a gear lube monitor relocation kit. 1. Disconnect audio warning system wires from the gear lube monitor on the engine. 2. Remove the gear lube monitor from the bracket. 3. Remove the bracket. Page 7A-6 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 4. Connect the sterndrive gear lube monitor hose to the quick release 90� fitting and secure it with a cable tie. 5. Connect the quick release 90� fitting to the gimbal housing fitting. Position the fitting so the release button will not contact the seawater inlet fitting or block-off plate if equipped. 6. Route the gear lube monitor hose and secure with J-clip. 7. Install the bracket to the boat transom so the gear lube monitor will be higher than the steering lever on the transom assembly. Secure the bracket with lag screws and flat washers as shown. defaghbc6637a -Gear lube monitor bracket b -Lag bolt and washer (2 each) c -Gear lube monitor d -Cap e -Audio warning system wires f -Retaining strap g -Gear lube hose h -Hose clamp IMPORTANT: The gear lube monitor will not function properly if the hose is kinked, and damage to the sterndrive could occur. Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. 8. Install the gear lube monitor in the bracket and secure it with the retaining strap. 90-865612060 MAY 2008 Page 7A-7 V6 and V8 Gasoline Sterndrive Models Page 7A-8 90-865612060 MAY 2008 9. Route the gear lube hose to the monitor and cut off excess hose. Connect the hose to the monitor and secure it with a hose clamp. 35408 a b c d e Alpha model, Bravo similar a - Gear lube monitor is higher than the steering lever b - Gear lube monitor c - Bracket d - Gear lube hose e - Audio warning system connectors 10. Connect the audio warning system connectors to the extension harness. 11. Use cable ties to secure the wires away from moving parts. Shift Plate For driveshaft lengths over 71.1 cm (28 in.) the shift plate must be relocated to the boat transom. The mounting location must allow for proper cable routing with 20 cm (8 in.) radius bends minimum. IMPORTANT: The shift plate assembly must be mounted within the limits of the sterndrive shift cable. Be sure that the mounting location will not interfere with other moving components. 1. Disconnect the shift plate connector from the engine harness. 6673 6674 Alpha shift bracket Bravo shift bracket 2. Remove the shift plate from the exhaust elbow. V6 and V8 Gasoline Sterndrive Models 90-865612060 MAY 2008 Page 7A-9 IMPORTANT: The shift plate and the bracket assembly must be mounted within limits of the sterndrive shift cable. Ensure that the mounting location will not cause interference with other moving components. 3. Attach the shift plate to the bracket and secure it with the hardware provided. Mount the bracket to the desired location. 4. Install the mounting bracket in the desired location on the inner transom using two long lag screws and two washers. a b 6675 b a 6676 Alpha shift bracket and shift plate Bravo shift bracket and shift plate a - Bracket b - Shift plate assembly Exhaust Adaptor This engine model uses the through-the-propeller exhaust system. An exhaust adaptor is installed to the gimbal housing exhaust port and at the engines bullhorn exhaust. The exhaust tube connects the two exhaust adaptors. IMPORTANT: The exhaust adaptor and the gimbal housing mating surfaces must be clean and free of nicks and scratches. The gimbal housing O-ring must be properly seated in the groove, or water and exhaust may leak into boat. a b 6638 a - Gimbal housing mating surface b - O-ring NOTE: The transom end exhaust adapter has a flat surface on the mating face and clearance for the trim hoses. V6 and V8 Gasoline Sterndrive Models Page 7A-10 90-865612060 MAY 2008 1. Install the transom end exhaust adapter to inner transom plate using 12 point flange screws and lockwashers. Tighten the screws to specification. b c b a e d 6639 a - Transom b - 12 point flange screw (4) c - Exhaust adapter d - Flat surface of exhaust adapter e - Open for trim hose clearance Description Nm lb-in. lb-ft Exhaust adapter to transom screws 34 � 25 2. Install the exhaust tube to the exhaust adapter using the hose clamps provided. Tighten clamps securely. c b a 6640 a - Exhaust adapter b - Exhaust tube c - Hose clamps Description Nm lb-in. lb-ft Hose clamp (hex head size 5/16 in.) 4 35 � Hose clamp (hex head size 7 mm) 3 26 � V6 and V8 Gasoline Sterndrive Models 90-865612060 MAY 2008 Page 7A-11 Aft Bearing Support The aft bearing support assembly mounts on the inner transom plate. 34749 1. Remove the fiber washers and adhesive from the inner transom plate. 32696 IMPORTANT: The spherical washers must be positioned so that the rounded side of the washers are toward the bearing support assembly as shown. 2. Install the aft bearing support assembly on the inner transom plate using the hardware as shown. Tighten the bolts until the locknuts contact the bottom of the transom. Do completely tighten the bolts at this time. e f d c d a b 6645 a - Fiber washer b - Bolt (2) c - Flat washer (2) d - Spherical washer (4) e - Aft bearing support f - Locknut (2) V6 and V8 Gasoline Sterndrive Models IMPORTANT: Alignment tools from other manufacturers may improperly align and damage the gimbal bearing, bearing support, or engine coupler. Use one of the listed Quicksilver alignment tools; The Alignment Tool Assembly, or Alignment Bar. 3. Insert the solid end of alignment tool through the bearing in the gimbal housing and into the input shaft splines of the aft bearing support. dabc6646 a -Quicksilver alignment tool b -Gimbal housing c -Gimbal bearing d -Input shaft splines of aft bearing support Alignment Tool Assembly 91-805475A 1 Alignment Bar 8M2001017 4. Do not remove the alignment tool from the gimbal housing. IMPORTANT: Both bolts must be firmly struck in the following step to properly seat the spherical washers. Failure to follow this procedure may result in a difficult installation of the sterndrive. 5. Strike the head of both aft bearing support bolts firmly with a plastic hammer. 34663ba a -Aft bearing support bolts b -Alignment tool 6. Ensure that the alignment tool slides into the input shaft splines easily while tightening the bolts to specification. Page 7A-12 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models NOTE:Rotate the alignment tool while tightening bolts. 34665baa a -Aft bearing support bolts b -Alignment tool Description Nm lb-in. lb-ft Aft bearing support bolts 61 � 45 Engine Preparation 1. Use a suitable lifting device and lift the engine. 2. Remove the existing flywheel housing dust cover (from the front side of the flywheel housing). Set the cover aside and discard the old fasteners. 3. Note the position of any items attached to the flywheel housing. Note the position and length of the fasteners that are being removed. 4. Cut the straps that secure the power steering hoses to the flywheel housing. 5. Remove and discard the flywheel housing. 6. Remove and discard the coupler from the flywheel. Discard the screws, retain the washers. 7. Install the pilot bearing with rounded edge toward the inside of the engine. 8. Install the correct bearing included in the kit. It must be positioned on the crankshaft so that it is flush with the face of the bore into which it is being installed. Do not damage the bushing during installation. NOTE:The496MAGHOusesthesmallerrollerbearing.The496MAGusesthelargersealed bearing. Both are included in the kit. a6650 a -Bearing 90-865612060 MAY 2008 Page 7A-13 V6 and V8 Gasoline Sterndrive Models 9. Install the engine coupler provided in the kit. The Alpha and Bravo models use the original shaped washers and new screws (with pre-applied threadlocker). 10. Tighten the engine coupler bolts to specification. Description Engine coupler bolts 11. Lubricate the engine coupler splines. Nm 47 lb-in. lb-ft � 35 Tube Ref No. Description Where Used Part No. 91 Engine Coupler Spline Grease Engine coupler splines 92-802869A 1 12. Install the new flywheel housing. Ensure that all items that were secured to the flywheel housing are installed in their original position. Tighten fasteners to specification. Description Nm lb-in. lb-ft Flywheel housing fasteners 43.5 � 32 13. Install the starter hole cover plate and tighten securely. ba a -Flywheel housing b -Starter hole cover plate 6652 Page 7A-14 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 14. Install the aft bearing support assembly onto the flywheel housing. The assembly is positioned properly when the grease fittings on the input shaft and the aft bearing support housing are pointed straight up. Tighten the bolts to specification. ba6654 a -Aft bearing support b -Input shaft flange Description Nm lb-in. lb-ft Aft bearing support bolts 47 � 35 15. Install the pedestal mounts on the aft bearing support. Ensure that the tab washer is positioned on the adjustment nut. Install the locknut on the stud but do not tighten it completely at this time. The locknuts are secured after the engine alignment. bac6656 a -Adjustment nut b -Tab washer c -Locknut 16. If applicable, install the flywheel housing dust cover. 17. Install the new power steering hose and wire assembly as follows: a. Note the routing of the high pressure power steering hose and remove it from the rear of the power steering pump. Ensure that the O-ring is removed with the hose. NOTE:Route the hoses exactly as originally installed. This will help avoid stress on thehose fittings and will help avoid kinks in the hoses. b. Route the new high pressure hose to the power steering pump. 90-865612060 MAY 2008 Page 7A-15 V6 and V8 Gasoline Sterndrive Models IMPORTANT: Do not cross-thread or over tighten hose fittings. c. Ensure that a new O-ring is on the hose fitting, and install the new high pressure hose assembly to the power steering pump. Tighten the fitting securely. Do not cross-thread or overtighten. ab6657 a -High pressure hose b -Fitting (with O-ring not visible in this view) d. Note the routing of the low pressure power steering hose and remove it from the oil cooler. NOTE:Route the hoses exactly as originally installed. This will help avoid stress on thehose fittings and will help avoid kinks in the hoses. e. Route the new low pressure hose assembly to the oil cooler and secure it with a hose clamp. f. Ensure that the hose assemblies will not contact the steering system components. g. Route the hose along the flywheel housing and secure it with the J-clamp provided. 6685a Typical a -J-clamps Page 7A-16 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 18. Install the bottom shield to the flywheel housing. Tighten the screws to specification. ab6659 a -Flywheel housing b -Lower shield Description Nm lb-in. lb-ft Lower shield to flywheel housing screws 41 � 30 19. Alpha Models: Complete the following steps to connect the seawater inlet hose assembly. a. Install the reduction fitting in the transom end of the hose. b. Install the small short hose to the fitting. c. Install the long water hose from the kit. d. Tighten the hose clamps securely. abc 6661 Typical a -Hose supplied with kit b -Reducer c -Hose to engine 20. Bravo Models: Complete the following steps to connect the quick connect seawater inlet hose assembly to the engine. a. Remove the seawater inlet hose from engine seawater pump. 90-865612060 MAY 2008 Page 7A-17 V6 and V8 Gasoline Sterndrive Models Page 7A-18 90-865612060 MAY 2008 b. Install the 13 inch seawater inlet hose assembly to the engine seawater pump with its retainer clip positioned away from engine. Secure the hose with a hose clamp at the pump inlet. NOTE: The retainer clip of the quick connect fitting and the printing on the hose are positioned away from the engine. b a c d d 6662 Seawater inlet hose assembly a - To engine seawater pump b - Quick connect fitting toward transom c - Retainer clip position away from engine d - Hose clamp NOTE: Refer to the instruction sheet included in 807130A6 Exhaust Pipe Assembly Kit for installation of the bullhorn to the engine. NOTE: The engine end exhaust adapter has an O-ring installed on the mating face and does not have clearance for the trim hoses. 21. Install the engine end exhaust adapter to the bullhorn. Tighten the bolts to specification. b a c d 6663 a - Engine end exhaust adapter b - Bolt and locknut (4) c - O-ring d - Blocked area Description Nm lb-in. lb-ft Exhaust adapter to bullhorn bolts 34 � 25 Engine Placement NOTE: For ease of installation, we recommend the use of a chain leveler in the following steps. NOTE: If the engine will be tested after installation, install the drain plugs at this time. V6 and V8 Gasoline Sterndrive Models 1. Ensure that the engine mounts are equally adjusted. If not, adjust the engine mounts so that they can be adjusted equally up or down. ! CAUTION Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components. ! WARNING Failure of the lifting eyes will cause the engine to fall suddenly from the hoist, resulting in serious injury, death, or property damage. Keep the engine level while it is hoisted. Do not tilt the engine more than 12� in any direction during installation. 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. 3. Lift the engine and place it into its approximate position in the boat using an overhead hoist. � Leave clearance space equal to the length of your driveshaft between the engine output shaft flange and the aft input flange. � Set the engine so that the clearance space for your driveshaft length will allow 8 mm (5/16 in.) clearance between the shoulder of the engine output shaft and the bearing in the engine shaft bearing support. The engine output shaft flange has a total lateral endplay of 16 mm (5/8 in.). abca32713 a -8 mm (5/16 in.) b -Bearing in engine shaft bearing support c -Shoulder of output shaft Clearance Between Output Shaft and Bearing Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) Protractor NOTE:We recommend a universal protractor for measuring the angles in the following steps. 90-865612060 MAY 2008 Page 7A-19 V6 and V8 Gasoline Sterndrive Models IMPORTANT: In the following steps, the protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0� and the 90� marks will be used. These are only reference marks. Use these marks to determine how many degrees and to which side (right or left) of the reference mark the needle is. View the protractor from the same side of the power package throughout the installation. 32701 Reference mark Driveshaft Extension READING AT THE INPUT SHAFT FLANGE�REFERENCE POINT IMPORTANT: Do not move the boat after taking the reading from the input shaft flange, because this reading establishes a reference point for aligning the driveshaft and engine. If the boat moves, the reference point may change, leading to improper alignment of the driveshaft and engine. 1. Position the base of protractor against the input shaft flange in the aft bearing support assembly on the inner transom. Record the number of degrees, and to which side of the reference mark the indicator needle has moved. 2. Record your data in the chart provided. c b a 6665 a -Input shaft flange b -Protractor c -Indicator needle Direction the Indicator Reading Location Reading Specification Needle Has Moved Reading at input shaft Reference point flange Page 7A-20 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models INSTALLING THE DRIVESHAFT NOTICE Misaligned flanges can allow the bolts to come loose during operation, resulting in product damage. Align the flanges flush with one another before tightening the bolts. 1. Attach the driveshaft to the output flange and input shaft flange. 2. Ensure the pilots on the driveshaft flanges are engaged in the input and output shaft flanges. Ensure that the flanges are flush with each other. 25626ba Typical a -Pilot engaged b -Flanges flush 3. Tighten the bolts to specification. aabbdecd34661 a -Locknut (4) b -Bolt (4) c -Input shaft flange d -Driveshaft e -Output shaft flange Description Driveshaft to input and output shaft flange bolts Nm 102 lb-in. � lb-ft 75 READING AND SETTING THE DRIVESHAFT ANGLE NOTICE Operating the engine with the driveshaft installed at an incorrect angle will result in damage to the driveshaft and the universal joint bearings. Align the engine correctly before operating. 1. Position the base of the protractor on the driveshaft. 90-865612060 MAY 2008 Page 7A-21 V6 and V8 Gasoline Sterndrive Models 2. Compare the protractor reading to the previously recorded reference point reading at the transom input shaft flange. The driveshaft angle must be within 1�3� from either side of the reference point reading. 3. Raise or lower the engine equally until the protractor needle reads exactly as specified. 4. If you are unable to achieve � 1�3� of angle to the driveshaft, adjust the stringer height so that the engine mounts can be adjusted up or down equally. 5. Record the readings in the following chart for later use. b a c 6246 a -Driveshaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading Direction the Indicator Needle Has Moved Specification Reference point � 1�3� from either side of the reference point ENGINE AND DRIVESHAFT LATERAL ALIGNMENT IMPORTANT: Improper positioning of the output shaft flange may cause bearing damage. Position the output shaft flange as specified. 1. "Measure the length of "a" and "b" to the centers of the bolt holes.They must be equal. 2. If the dimensions are not equal, slide the aft and forward ends of the engine equal amounts in opposite directions to obtain equal lengths for "a" and "b". b a 6669 Engine and Driveshaft Lateral Alignment Dimensions Dimension a Equal to dimension b Dimension b Equal to dimension a Page 7A-22 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 3. Measure the clearance between the output shaft shoulder and the bearing in the engine shaft bearing support. Slide the engine fore or aft as needed to obtain the specified clearance. a b c a 32713 a -8 mm (5/16 in.) b -Bearing of the engine shaft bearing support c -Output shaft shoulder Clearance for the Driveshaft Lateral Endplay Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) 4. Recheck step 1. If step 1 is not as specified, adjust and recheck step 3. Continue this process until both steps 1 and 3 are as specified. 5. After engine and driveshaft lateral alignment has been aligned correctly, tighten the front and rear engine mounts securely to the boat stringer. a a b 6670 Typical mounting a -Mounting bolts b -Slotted hole toward front of engine READING AND ALIGNING THE ENGINE OUTPUT 1. Position the protractor on the flywheel housing. Raise or lower the front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as recorded at the Reading At the Input Shaft Flange�Reference Point. 90-865612060 MAY 2008 Page 7A-23 V6 and V8 Gasoline Sterndrive Models 2. Record your data in the chart provided. b a 6671 a -Protractor b -Flywheel housing Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading at output shaft flange Reading Direction the Indicator Needle Has Moved Specification Reference point � 1�3� from either side of the reference point Equal degree to the reference point VERIFYING THE DRIVESHAFT ANGLE 1. Position the protractor on the driveshaft and recheck the driveshaft angle. The angle should be the same as that recorded previously Reading and Setting the Driveshaft Angle. If not, raise or lower all four engine mount adjustment nuts an equal amount until the correct angle is reached. Page 7A-24 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 2. Record your data in the chart provided. c b a a -Drive shaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading at output shaft flange Reading verifying driveshaft angle Reading Direction the Indicator Needle Has Moved 6666 Specification Reference point � 1�3� from either side of the reference point Equal degree to the reference point Same as previously recorded- Reading driveshaft angle 3. When the driveshaft angle is correct the engine and driveshaft are aligned correctly. Tighten all engine mount nuts securely. Bend the washer tab down on each adjustment nut. a b d c 6672 a -Nut and lockwasher b -Adjustment nut c -Slotted hole toward front of engine d -Tab washer Driveshaft Lubrication 1. Lubricate the driveshaft U-joints, input shaft, aft bearing support, and engine shaft bearings support as follows: 90-865612060 MAY 2008 Page 7A-25 V6 and V8 Gasoline Sterndrive Models a. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the aft bearing support grease fitting, input shaft grease fitting, and the engine shaft bearings support grease fitting. b. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into both driveshaft U-joint grease fittings. baedc35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting aft end d -U-joint grease fitting engine end e -Engine shaft bearings support grease fitting Tube Ref No. Description Where Used Part No. 42 U-joint and Gimbal Bearing Grease Grease fittings 92-802870A1 Seawater Inlet Hose 1. Bravo Models: Complete the following steps to assemble the seawater extension hose: a. Route the hose from the transom seawater inlet fitting to the seawater pump inlet hose assembly. Cut off any excess hose. b. Install the quick connect fitting to the transom end of the hose with the retainer clip opening on the plain side of the hose and the opposite with the printing on the hose. Secure with hose clamp. Page 7A-26 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 90-865612060 MAY 2008 Page 7A-27 c. Install the spigot fitting to the open end of the extension hose with the small tab on the fitting aligned to the printing on the hose. Secure with hose clamp. d c b b a 6677 a - Quick connect spigot b - Hose clamp c - Seawater extension hose d - Quick connect fitting to seawater inlet fitting NOTE: The retainer clip must be in the closed position prior to installation. 2. Complete the following steps to install the seawater extension hose assembly to the seawater inlet fitting: a. Position the retainer clip in the closed position. b a 6678 Seawater extension hose assembly a - Retainer clip closed b - Quick connect fitting b. Position the seawater extension hose with the center of the retainer clip and the decal toward the engine. IMPORTANT: Tabs and slots are sized to only mate at the correct orientation. Mate the small tab with the small slot. V6 and V8 Gasoline Sterndrive Models Page 7A-28 90-865612060 MAY 2008 c. Align the slots of the quick connect fitting to the tabs of the water inlet fitting. g b c a h e f d 6679 a - Quick connect fitting b - Small slot c - Large slot d - Seawater inlet fitting e - Small tab f - Large tab g - Center of retainer clip (toward engine) h - Center line of water inlet fitting (toward engine) d. Push the seawater inlet hose assembly onto the water inlet fitting until connected. NOTE: The retainer clip snaps into place and resumes the closed position when properly connected. a b 6680 a - Centerline of water inlet fitting b - Retainer clip in closed position IMPORTANT: Perform a pull test at the seawater inlet connection to ensure the seawater inlet hose is connected properly. 3. Complete the following steps to perform a pull test on the water hose quick connection: V6 and V8 Gasoline Sterndrive Models 90-865612060 MAY 2008 Page 7A-29 a. Pull on the seawater inlet hose near the connection point with an approximate force of 111 Nm (25 lb-ft.) . If the seawater inlet hose does not separate from the seawater inlet fitting when force is applied, the seawater inlet hose is connected and sealed properly. a c b 6681 a - Seawater inlet hose b - Quick connect fitting c - Seawater inlet fitting b. If the seawater inlet hose does separate from the seawater inlet fitting, reassemble as outlined in step 2 d, and the requirements in step 4 for checking the integrity of the connection are satisfied. c. After successfully completing the pull test, check for any leaks at this connection. 4. Complete the following steps to connect the seawater inlet hose assembly to the extension seawater hose assembly: a. Close the retainer clip and ensure that the clip is positioned away from engine. b. Align the slots of the quick connect fitting to the tabs of the spigot fitting and push until connected. NOTE: The retainer clip snaps into place and resumes the closed position when properly connected. a e d b c 6682 a - Retainer clip position (away from engine) b - Extension hose c - Seawater inlet hose (to engine seawater pump) d - Quick connect fitting (to seawater inlet fitting) e - Seawater inlet fitting (at transom) c. Perform a pull test and ensure that the requirements in outlined in step 3 for checking the integrity of the connection are satisfied. V6 and V8 Gasoline Sterndrive Models Page 7A-30 90-865612060 MAY 2008 Engine Connections 1. Refer to the Power Package Installation Manual for your specific model to make all of the following connections: � Electrical wiring harness � Throttle and shift cable installation and adjustments. � Connect the engine harness extension assembly to the engine harness and shift plate � Water hose � Trim position sender wires � MerCathode system wires � Fuel line � Power steering cable � Power steering hoses 2. Connect the power steering hoses to the control valve. Ensure that the quick-connect fittings snap into place. b a 6686 Models with quick connect fittings a - Pressure hose b - Return hose Sterndrive With a Driveshaft Extension (Jackshaft) Assembly IMPORTANT: Note the following exception to the normal sterndrive installation procedure. When the sterndrive is installed, the sterndrive U-joint centerline must be positioned in the same plane as the driveshaft extension (jackshaft) U-joint centerline. See Aligning the Cross Bearings Centerline before installing the sterndrive. 34827 If applicable, the U-joint top safety shields may be removed for sterndrive installation. Install the top safety shields before operation. V6 and V8 Gasoline Sterndrive Models U-Joints Cross Bearing Centerline ! CAUTION Misaligned cross bearings can cause driveshaft failure, leading to possible injury. The driveshaft U-joint cross bearings of both the drive and the driveshaft extension must operate in the same plane to prevent excessive vibration. Align the bearings to operate in the same plane. 1. Momentarily engage the starter motor so that the centerline of the driveshaft yoke is positioned vertically. ab25760 a -Driveshaft flange b -Driveshaft flange yoke centerline (vertical) 2. Place a reference mark on the input shaft to correspond with centerline. abc32722 a -Aft bearing support b -Reference mark c -Input shaft 90-865612060 MAY 2008 Page 7A-31 V6 and V8 Gasoline Sterndrive Models 3. Rotate the sterndrive U-joint shaft so that the centerline of the forward yoke is positioned vertically. The U-Joint must be positioned in this manner when it is installed so that it will be running on the same plane as the extension driveshaft U-joint cross bearings. a bc 35424c b a Alpha Sterndrive Bravo Sterndrive a -Centerline (vertical) b -Forward yoke c -U-joint shaft 4. Using a paint marker, draw a reference mark on the universal joint shaft to correspond with the centerline. NOTE:Draw the reference mark at either location shown so that it will be easy for you toview while installing the sterndrive. b a a b a a 35426 Alpha Sterndrive Bravo Sterndrive a -Reference mark location b -Centerline 5. Install the sterndrive with its U-joint centerline on the same plane as the driveshaft extension centerline. Refer to the appropriate power package installation manual. Top Safety Shields The safety shields mount on the engine shaft bearing support and the aft bearing support assemblies to completely cover the driveshaft U-joints and prevent possible injury from moving parts. 34746 Page 7A-32 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 1. Install the top safety shields If they were removed while installing the sterndrive. Install both top shields as shown. 2. Tighten the bolts and nuts to specification. cab32719d Top shield and bottom shield at transom end (engine end is similar) a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nut 3/8-16 (4) Description Nm lb-in. lb-ft Driveshaft shield bolts and nuts 41 � 30 Predelivery Preparation Refer to the appropriate Mercury MerCruiser installation manual for predelivery preparation and Inspections. Removal U-Joint Top Shields 1. Remove the bolts and nuts securing the top shields. Retain the fasteners. 90-865612060 MAY 2008 Page 7A-33 V6 and V8 Gasoline Sterndrive Models 2. Remove the top shields. cab32719d Top shield and bottom shield at aft end, engine end similar a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nuts 3/8-16 (4) Sterndrive Refer to the Power Package Installation Manual for your specific model to remove the sterndrive from the transom assembly. Engine Connections Refer to the Power Package Installation Manual for your specific model to remove the following connections: � The electrical wiring harness � The throttle and shift cable installation and adjustments � The engine harness extension assembly to the engine harness and shift plate � The water hose � The trim position sender wires � The MerCathode system wires � The fuel line � The power steering cable � The power steering hoses Driveshaft Extension 1. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so the engine will be level when suspended. Do not lift the engine at this time. Page 7A-34 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 2. Straighten the tab of the engine mount tab washer on each adjustment nut. Loosen all engine mount nuts. abdc6672 a -Nut and lockwasher b -Adjustment nut c -Slotted hole toward front of engine d -Tab washer 3. Remove the fasteners securing the front and rear engine mounts to the boat stringer. aab6670 Typical mounting a -Mounting bolts b -Slotted hole toward front of engine 90-865612060 MAY 2008 Page 7A-35 V6 and V8 Gasoline Sterndrive Models Page 7A-36 90-865612060 MAY 2008 4. Remove the fasteners securing the driveshaft to the output flange. b d 33001 c a a - Driveshaft b - Bolt c - Nut d - Engine output shaft flange 5. Remove the fasteners securing the driveshaft to the input flange. a b c d 33002 a - Bolt b - Nut c - Transom input shaft flange d - Driveshaft 6. Lift the driveshaft and remove it from the boat. Use the hoist to slightly move the engine to allow clearance for the driveshaft to be lifted out. V6 and V8 Gasoline Sterndrive Models Aft Bearing Support Remove the aft bearing support bolts, washers, and locknuts. Remove the aft bearing support. d -Spherical washer (4), rounded side toward rear bearing support e -Aft bearing support f -Locknut (2) efdcdab6645a -Fiber washer b -Bolt (2) c -Flat washer (2) Engine Shaft Bearing Support 1. Remove the bolts and washers from the engine shaft bearing support and remove the assembly. ba6654 a -Engine shaft bearing support b -Output shaft flange Bearing Inspection 1. Inspect the bearing of the engine shaft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace the bearing. 2. Inspect the bearings of the aft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace both bearings, spacer, and the oil seal. 90-865612060 MAY 2008 Page 7A-37 V6 and V8 Gasoline Sterndrive Models Aft Bearing Support Assembly Repair Bottom Safety Shield Removal Remove the safety shield bolts and remove the safety shield. 35137bcaaabc35036 a -Bolts b -Aft bearing support c -Safety shield Bearings and Oil Seal Removal 1. Remove the oil seal from the aft bearing support. 2. Remove the snap ring in the groove of the aft bearing support housing just above the bearing. 3. Use a press and suitable mandrel to press the bearings and the spacer from the aft bearing support housing. Input Shaft Removal 1. Use a suitable mandrel and a press the input shaft from the aft bearing support. abdc35135 a -Press b -Suitable mandrel c -Aft bearing support d -Input shaft Page 7A-38 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models Bearings and Oil Seal Install 1. Install the grease fitting to the aft bearing support housing. 35071 2. Grease the inside diameter of the bearing bore in the aft bearing support housing. 35072 3. Use a press and a suitable mandrel and press the bearing, with its open side up, into the bearing bore. abbbfcde35075 a -Bearing open side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support f -Bearing installed 90-865612060 MAY 2008 Page 7A-39 V6 and V8 Gasoline Sterndrive Models 4. Install the spacer. 35076abbc a -Spacer b -Suitable mandrel (guide) c -Aft bearing support 5. Use a press and suitable mandrel and install the second bearing with the covered side up. acdbebbe 35077 a -Bearing covered side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support 6. Install the snap ring in the grove of the housing just above the bearing. 35078 Page 7A-40 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 7. Flip the aft bearing support over and press the oil seal into the housing with the lip of the seal facing inside the housing. abcadcda 35079 a -Suitable mandrel (guide) b -Suitable mandrel c -Oil seal d -Aft bearing support Input Shaft Install 1. Install the grease fitting to the input shaft. abc35081 a -Grease fitting b -Input shaft c -Input shaft flange 2. Apply sealant to the inside edge of the shaft and the outside edge of the plug. 35082 90-865612060 MAY 2008 Page 7A-41 V6 and V8 Gasoline Sterndrive Models Tube Ref No. Description Where Used Part No. 33 Loctite 680 Retaining Plug for the input shaft 92-809833 Compound 3. Use a press to install the plug into the input shaft. aebcdd35083 a -Plug b -Press c -Suitable mandrel d -Input shaft flange e -Plug installed 4. Grease the inside splines and the outer surface of the input shaft. 35084 Page 7A-42 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 5. Align the aft bearing support assembly onto the input shaft with its oil seal facing the shaft flange and the grease fittings aligned. 35085abdc a -Bearing b -Oil seal hidden c -Grease fittings d -Input shaft flange 6. Press the aft bearing support assembly onto the input shaft. ab cd 35086 a -Press b -Suitable mandrel c -Oil seal d -Machined surface on the input shaft 7. Using a hand grease gun pump grease into the aft bearing support grease fitting. 35080 90-865612060 MAY 2008 Page 7A-43 V6 and V8 Gasoline Sterndrive Models Bottom Safety Shield Install 1. Apply Loctite to the threads of the safety shield bolts. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Safety shield bolt threads 92-809819 2. Place the safety shield on the aft bearing support and secure it with the bolts. abc35138 a -Bolts b -Aft bearing support c -Safety shield 3. Tighten the bolts to specification. aaabc3503635137bc a -Bolts b -Aft bearing support c -Safety Shield Description Safety shield bolt Nm 41 lb-in. � lb-ft 30 Page 7A-44 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models Engine Shaft Bearing Support Assembly Repair Output Shaft Removal 1. Remove the snap ring from the groove of the shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft 2. Lift the engine shaft bearing support from the shaft. 34928acb a -Engine shaft bearing support b -Shaft c -Shaft flange 3. Remove the O-rings from the shaft. 90-865612060 MAY 2008 Page 7A-45 V6 and V8 Gasoline Sterndrive Models Bearing Removal 1. Remove the snap ring from the groove just above the bearing in the engine shaft bearing support. 34937 2. Press the bearing out of the engine shaft bearing support. Discard the bearing. abc34939 a -Engine shaft bearing support b -Press c -Suitable mandrel Bearing Install 1. Grease the bearing bore of the engine shaft bearing support. Page 7A-46 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 2. Insert the grease fitting into the engine shaft bearing support. abc34934 a -Engine shaft bearing support housing b -Bearing bore c -Grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing Bearing bore of engine shaft 42 92-802870A1 Grease bearing support NOTE:The bearing has two grease access holes. 34935 3. Align the bearing to the bearing bore, and align the grease fitting hole to the grease access hole in the bearing. 90-865612060 MAY 2008 Page 7A-47 V6 and V8 Gasoline Sterndrive Models 4. Press the bearing into the engine shaft bearing support. acdefb34936 a -Engine shaft bearing support housing b -Suitable mandrel c -Bearing d -Grease access hole e -Grease fitting f -Bearing installed 5. Insert the snap ring into the groove just above the bearing. 34937 6. Insert grease into the grease fitting. 34966ba a -Grease fitting b -Grease gun 7. Align the engine mount brackets to the engine shaft bearing support as shown. Page 7A-48 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 8. Apply sealant to the threads of the bolts. Hand-start the bolts and lockwashers into the engine shaft bearing support to secure the engine mount brackets. 34938aaccb a -Engine mount bracket (2) b -Engine shaft bearing supportc -Bolt and lockwasher (2) Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Bolt threads 92-809819 Output Shaft Install 1. Install new O-rings on the output shaft. 2. Grease the O-rings and around the output shaft. bbac34925 a -Out put shaft b -O-rings c -Grease Tube Ref No. Description U-joint and Gimbal Bearing Grease Where Used Output shaft Part No. 92-802870A1 42 90-865612060 MAY 2008 Page 7A-49 V6 and V8 Gasoline Sterndrive Models 3. Grease the inner diameter of the bearing in the engine shaft bearing support. abc34927 a -Engine shaft bearing support b -Grease applicator c -Inside diameter of bearing Tube Ref No. 42 Description U-joint and Gimbal Bearing Grease Where Used Bearing ID Part No. 92-802870A1 4. Insert the shaft. 34928acb a -Engine shaft bearing support b -Shaft c -Shaft flange Page 7A-50 90-865612060 MAY 2008 V6 and V8 Gasoline Sterndrive Models 5. Insert the snap ring into the groove of the output shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft 90-865612060 MAY 2008 Page 7A-51 V6 and V8 Gasoline Sterndrive Models Notes: Page 7A-52 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models Driveshaft Extention (Jackshaft) Section 7B - 1.7 MS Diesel Sterndrive Models Table of Contents

7 B 90-865612060 MAY 2008 Page 7B-1 1.7 MS Diesel Sterndrive Models Lubricants, Sealants, Adhesives Tube Ref No. Description Where Used 7 Loctite 271 Threadlocker Safety shield bolt threads Bolt threads 9 Loctite 567 PST Pipe Sealant Pipe plugs and fittings 33 Loctite 680 Retaining Compound Plug for the input shaft Grease fittings 42 U-joint and Gimbal Bearing Grease Bearing bore of engine shaft bearing support Output shaft Bearing ID Special Tools Alignment Tool Assembly 91-805475A 1 Part No. 92-809819 92-809822 92-809833 92-802870A1 9183 Used to align the engine to the transom assembly for sterndrive installation. Alignment Bar 8M2001017 Aids in aligning the engine to the transom assembly for 26831 sterndrive installation. General Information DRIVESHAFT EXTENSION The driveshaft extension (jackshaft) converts a standard sterndrive package to a driveshaft configuration. A driveshaft extension is installed between the engine and the transom assembly. The driveshaft installation moves the weight of the engine forward in the boat providing a better center of gravity and improved boat operation. The driveshaft extension is used with triple, dual, and single engine applications in smaller boats. When the driveshaft extention is installed in boats with center console or staggered engine designs it helps the boat get up on plane quickly. The driveshaft extension is available as a kit and must be used in conjunction with the recommended driveshaft. The driveshaft is ordered separately, other Kits or parts are listed with the driveshaft extension kit for specific engine models. Refer to the CMD Diesel Parts & Accessories Guide. For critical power package dimensions and requirements refer to the latest Cummins MerCruiser Diesel OEM CD or installation drawings. Page 7B-2 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7B-3 Access must be provided to grease fittings on the driveshaft U-joints, input shaft, and bearing supports to allow for scheduled maintenance. b f g b c d c e f a 18589 Typical driveshaft extension installation using through the propeller exhaust a - 1�3 degree driveshaft angle required b - Grease fittings (4) c - Safety shrouds d - Driveshaft extension e - Shift plate f - Exhaust adapter drain plug (2) g - Exhaust tube MEASUREMENTS We recommend a universal protractor or digital inclinometer for measuring the angles during installation steps. 34826 Universal protractor Digital inclinometer 1.7 MS Diesel Sterndrive Models Continuity Circuit Ground Wire .7 MS Diesel Sterndrive Models Continuity Circuit Ground Wire In some applications, the transom ground wire will not reach the engine ground or the battery ground connection. This ground wire connection is required to complete the continuity circuit. You must construct a new ground wire long enough to attach to the transom grounding screw and the engine grounding stud or battery ground. ab33323Typical a -Transom grounding screw b -Transom ground wire Driveshaft Extension Maintenance Lubrication Points Lubricate the bearings grease fittings every 100 hours or annually (whichever occurs first). 1. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the following grease fittings: � Aft bearing support grease fitting � Input shaft grease fitting � Engine shaft bearing support grease fitting Page 7B-4 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 2. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into the driveshaft U-joint grease fittings on the transom and engine end. baedc35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting at transom end d -U-joint grease fitting at engine end e -Engine shaft bearing support grease fitting Scheduled Maintenance�Driveshaft Extension Refer to the appropriate manual for power package maintenance and Inspections. Perform the following maintenance at the required task intervail. Task Interval Every 100 hours or annually (whichever occurs first) Every 300 hours or 3 years (whichever occurs first) Maintenance to Be Performed � Lubricate the driveshaft U-joints. � Lubricate the input shaft. � Lubricate the aft bearing support (input) � Lubricate the engine shaft bearing support (output) � Inspect the driveshaft U-joints. � Engine shaft bearing support inspection � Aft bearing support inspection Driveshaft Extension Inspection and Maintenance U-JOINT INSPECTION Preform the U-joint inspection every 100 hours or annually (whichever occurs first). 1. Remove the driveshaft. 2. Rotate the U-joint on the output and the input end of the driveshaft. The movement of each U-joint yoke, socket, and cross bearing assembly should be smooth. 3. Replace the cross and bearing assembly if the seals are deteriorated or if movement is tight or rough. 4. Reinstall the driveshaft. ENGINE SHAFT BEARING SUPPORT INSPECTION Perform the engine shaft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the engine shaft bearing support assembly. 2. Rotate the output shaft and check for rough spots while rotating. 90-865612060 MAY 2008 Page 7B-5 1.7 MS Diesel Sterndrive Models 3. If rough spots exist, replace the bearing. See Engine Shaft Bearing Support Assembly Repair. AFT BEARING SUPPORT INSPECTION Perform the aft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the aft bearing support assembly. 2. Rotate the input shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearings, spacer, and the oil seal. See Aft Bearing Support Assembly Repair. Installation Gear Lube Monitor Relocate the engine mounted gear lube monitor to the boat transom above the steering lever on the transom assembly. The transom mounted bracket and accessories can be ordered in a gear lube monitor relocation kit. 1. Disconnect audio warning system wires from the gear lube monitor on the engine. 2. Remove the gear lube monitor from the bracket. 3. Remove the bracket. 4. Connect the sterndrive gear lube monitor hose to the quick release 90� fitting and secure it with a cable tie. 5. Connect the quick release 90� fitting to the gimbal housing fitting. Position the fitting so the release button will not contact the seawater inlet fitting or block-off plate if equipped. 6. Route the gear lube monitor hose and secure with J-clip. 7. Install the bracket to the boat transom so the gear lube monitor will be higher than the steering lever on the transom assembly. Secure the bracket with lag screws and flat washers as shown. d e f a g h b c 6637a -Gear lube monitor bracket b -Lag bolt and washer (2 each) c -Gear lube monitor d -Cap e -Audio warning system wires f -Retaining strap g -Gear lube hose h -Hose clamp Page 7B-6 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models IMPORTANT: The gear lube monitor will not function properly if the hose is kinked, and damage to the sterndrive could occur. Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. 8. Install the gear lube monitor in the bracket and secure it with the retaining strap. 9. Route the gear lube hose to the monitor and cut off excess hose. Connect the hose to the monitor and secure it with a hose clamp. 35408abcde Alpha model, Bravo similar a -Gear lube monitor is higher than the steering lever b -Gear lube monitor c -Bracket d -Gear lube hose e -Audio warning system connectors 10. Connect the audio warning system connectors to the extension harness. 11. Use cable ties to secure the wires away from moving parts. Shift Plate For driveshaft lengths over 71.1 cm (28 in.) the shift plate must be relocated to the boat transom. The mounting location must allow for proper cable routing with 20 cm (8 in.) radius bends minimum. IMPORTANT: The shift plate assembly must be mounted within the limits of the sterndrive shift cable. Be sure that the mounting location will not interfere with other moving components. 90-865612060 MAY 2008 Page 7B-7 1.7 MS Diesel Sterndrive Models Page 7B-8 90-865612060 MAY 2008 1. Disconnect the shift plate connector from the engine harness. 6673 Alpha shift bracket 2. a. Remove the shift plate from the exhaust elbow. IMPORTANT: The shift plate and the bracket assembly must be mounted within limits of the sterndrive shift cable. Ensure that the mounting location will not cause interference with other moving components. b. Attach the shift plate to the bracket and secure it with the hardware provided. Mount the bracket to the desired location. c. Install the mounting bracket in the desired location on the inner transom using two long lag screws and two washers. a b 6675 Alpha shift bracket and shift plate a - Bracket b - Shift plate assembly Exhaust Adaptor This engine model uses the through-the-propeller exhaust system. An exhaust adaptor is installed to the gimbal housing exhaust port and at the engines bullhorn exhaust. The exhaust tube connects the two exhaust adaptors. 1.7 MS Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7B-9 IMPORTANT: The exhaust adaptor and the gimbal housing mating surfaces must be clean and free of nicks and scratches. The gimbal housing O-ring must be properly seated in the groove, or water and exhaust may leak into boat. a b 6638 a - Gimbal housing mating surface b - O-ring NOTE: The transom end exhaust adapter has a flat surface on the mating face and clearance for the trim hoses. 1. Install the transom end exhaust adapter to inner transom plate using 12 point flange screws and lockwashers. Tighten the screws to specification. b c b a e d 6639 a - Transom b - 12 point flange screw (4) c - Exhaust adapter d - Flat surface of exhaust adapter e - Open for trim hose clearance Description Nm lb-in. lb-ft Exhaust adapter to transom screws 34 � 25 1.7 MS Diesel Sterndrive Models Page 7B-10 90-865612060 MAY 2008 2. Install the exhaust tube to the exhaust adapter using the hose clamps provided. Tighten clamps securely. c b a 6640 a - Exhaust adapter b - Exhaust tube c - Hose clamps Description Nm lb-in. lb-ft Hose clamp (hex head size 5/16 in.) 4 35 � Hose clamp (hex head size 7 mm) 3 26 � Aft Bearing Support The aft bearing support assembly mounts on the inner transom plate. 34749 1. Remove the fiber washers and adhesive from the inner transom plate. 32696 IMPORTANT: The spherical washers must be positioned so that the rounded side of the washers are toward the bearing support assembly as shown. 1.7 MS Diesel Sterndrive Models 2. Install the aft bearing support assembly on the inner transom plate using the hardware as shown. Tighten the bolts until the locknuts contact the bottom of the transom. Do completely tighten the bolts at this time. efdcdab6645 a -Fiber washer d -Spherical washer (4) b -Bolt (2) e -Aft bearing support c -Flat washer (2) f -Locknut (2) IMPORTANT: Alignment tools from other manufacturers may improperly align and damage the gimbal bearing, bearing support, or engine coupler. Use one of the listed Quicksilver alignment tools; The Alignment Tool Assembly, or Alignment Bar. 3. Insert the solid end of alignment tool through the bearing in the gimbal housing and into the input shaft splines of the aft bearing support. dabc6646 a -Quicksilver alignment tool b -Gimbal housing c -Gimbal bearing d -Input shaft splines of aft bearing support Alignment Tool Assembly 91-805475A 1 Alignment Bar 8M2001017 4. Do not remove the alignment tool from the gimbal housing. 90-865612060 MAY 2008 Page 7B-11 1.7 MS Diesel Sterndrive Models IMPORTANT: Both bolts must be firmly struck in the following step to properly seat the spherical washers. Failure to follow this procedure may result in a difficult installation of the sterndrive. 5. Strike the head of both aft bearing support bolts firmly with a plastic hammer. 34663ba a -Aft bearing support bolts b -Alignment tool 6. Ensure that the alignment tool slides into the input shaft splines easily while tightening the bolts to specification. NOTE:Rotate the alignment tool while tightening bolts. 34665baa a -Aft bearing support bolts b -Alignment tool Description Nm lb-in. lb-ft Aft bearing support bolts 61 � 45 Engine Preparation 1. Remove and discard the existing flywheel housing and flywheel coupler. Retain the flywheel housing bolts and hardware. Discard the coupler bolts and washers. Page 7B-12 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7B-13 NOTE: There are different thread patterns and fastener combinations involved. Ensure the proper placement of each. Be sure to not the position and orientation of any electrical harness wires. 6882 g f g c d b d e h j i a a - Flywheel housing b - Bolt, washers, and nut - 10M x 1.5 x 60 c - Bolt and washers - 10M x 1.5 x 30 d - Bolt, washers and nut - 12M x 1.25 x 55 e - Bolt and washers - 12M x 1.75 x 55 f - Bolt and washers - 12M x 1.75 x 35 g - Bolt and washers - 12M x 1.75 x 30 h - Flat washer i - Lockwasher j - Flywheel coupler 2. Install the new flywheel drive plate using the new M7 bolts and lock washers. Tighten the bolts to specification. a b 25624 a - Flywheel drive plate b - M7 bolt and lock washer Description Nm lb-in. lb-ft. Drive plate bolt M7 x 1.0 15 132 � 3. Install the new rear mount and flywheel housing assembly. Attach any electrical harness wires and brackets removed during installation. Torque the bolts and nuts. 1.7 MS Diesel Sterndrive Models Description Flywheel housing bolt and nut M12 Flywheel housing bolt and nut M10 Nm 86 44 lb-in. lb-ft. � 64 � 33 4. Remove and discard the standard exhaust pipe. Retain the hose clamps. ab 6938 a -Standard exhaust pipe b -Hose clamps ! WARNING Stress on hose fittings or kinks in the hoses can damage hydraulic steering components, leading to serious injury or death due to loss of boat control. Extreme heat can lower the hoses' burst pressure or melt the hose. Route hydraulic hoses to avoid kinks, heat sources, or stress on the hose fittings. 5. If equipped with power-assisted steering, install the longer power steering hoses as follows: NOTE:Drain fluid from the pump and hoses into a suitable container. a. Note the routing of the existing high-pressure hose. Remove it from the pump. IMPORTANT: Do not cross-thread or over-tighten the hose fittings. b. Visually inspect the new high-pressure hose, threaded fitting, and O-ring. The O-ring must be seated in the groove of the threaded fitting. Route the new hose assembly to the pump and install the fitting into the pump assembly. Page 7B-14 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models .7 MS Diesel Sterndrive Models c. Position the hose as needed, and tighten the fitting to specification. .. .. 25769 a -High pressure fluid hose b -O-ring c -High pressure fluid hose fitting d -Pump Description Nm lb-in. lb-ft. High pressure fluid hose fitting to power-assisted steering pump 31 � 23 NOTE :Do not connect the power-assisted steering hoses to the control valve until afterthe engine is aligned. d. Note the return hose routing from the control valve to the fluid cooler. Loosen the hose clamp at the fluid cooler and remove the return hose. e. Route the new return hose assembly to the fluid cooler and install it using the existing hose clamp. Tighten the hose clamp. .. .. 25770 a -Low pressure fluid hose b -Power steering fluid cooler c -Hose clamp d -O-ring f. Route and secure the hoses to the engine as needed to avoid kinks, heat sources and stress on the hose fittings. 90-865612060 MAY 2008 Page 7B-15 1.7 MS Diesel Sterndrive Models g. Temparariy store the loose hose fittings out of the way during engine installation to avoid thread damage. Engine Placement NOTE:For ease of installation, we recommend the use of a chain leveler in the following steps. NOTE:If the engine will be tested after installation, install the drain plugs at this time. 1. Ensure that the engine mounts are equally adjusted. If not, adjust the engine mounts so that they can be adjusted equally up or down. ! CAUTION Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components. ! WARNING Failure of the lifting eyes will cause the engine to fall suddenly from the hoist, resulting in serious injury, death, or property damage. Keep the engine level while it is hoisted. Do not tilt the engine more than 12� in any direction during installation. 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. 3. Lift the engine and place it into its approximate position in the boat using an overhead hoist. � Leave clearance space equal to the length of your driveshaft between the engine output shaft flange and the aft input flange. � Set the engine so that the clearance space for your driveshaft length will allow 8 mm (5/16 in.) clearance between the shoulder of the engine output shaft and the bearing in the engine shaft bearing support. The engine output shaft flange has a total lateral endplay of 16 mm (5/8 in.). abca32713 a -8 mm (5/16 in.) b -Bearing in engine shaft bearing support c -Shoulder of output shaft Clearance Between Output Shaft and Bearing Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) Page 7B-16 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models Protractor NOTE:We recommend a universal protractor for measuring the angles in the following steps. IMPORTANT: In the following steps, the protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0� and the 90� marks will be used. These are only reference marks. Use these marks to determine how many degrees and to which side (right or left) of the reference mark the needle is. View the protractor from the same side of the power package throughout the installation. 32701 Reference mark Driveshaft Extension READING AT THE INPUT SHAFT FLANGE�REFERENCE POINT IMPORTANT: Do not move the boat after taking the reading from the input shaft flange, because this reading establishes a reference point for aligning the driveshaft and engine. If the boat moves, the reference point may change, leading to improper alignment of the driveshaft and engine. 1. Position the base of protractor against the input shaft flange in the aft bearing support assembly on the inner transom. Record the number of degrees, and to which side of the reference mark the indicator needle has moved. 90-865612060 MAY 2008 Page 7B-17 1.7 MS Diesel Sterndrive Models 2. Record your data in the chart provided. c b a 6665 a -Input shaft flange b -Protractor c -Indicator needle Direction the Indicator Reading Location Reading Specification Needle Has Moved Reading at input shaft Reference point flange INSTALLING THE DRIVESHAFT NOTICE Misaligned flanges can allow the bolts to come loose during operation, resulting in product damage. Align the flanges flush with one another before tightening the bolts. 1. Attach the driveshaft to the output and input shaft flange. 2. Ensure the pilots on the driveshaft flanges are engaged in the input and output shaft flanges. Ensure that the flanges are flush with each other. 25626b a Typical a -Pilot engaged b -Flanges flush Page 7B-18 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7B-19 3. Tighten the bolts to specification. .. .. 25625 Typical a - Driveshaft b - Output shaft flange c - Input shaft flange d - Bolt (4) 7/16-20 x 1-1/2 e - Locknut (4) Description Nm lb-in. lb-ft Drive shaft to input and output shaft flange bolts 68 � 50 READING AND SETTING THE DRIVESHAFT ANGLE NOTICE Operating the engine with the driveshaft installed at an incorrect angle will result in damage to the driveshaft and the universal joint bearings. Align the engine correctly before operating. 1. Position the base of the protractor on the driveshaft. 2. Compare the protractor reading to the previously recorded reference point reading at the transom input shaft flange. The driveshaft angle must be within 1�3.. from either side of the reference point reading. 3. Raise or lower the engine equally until the protractor needle reads exactly as specified. 4. If you are unable to achieve � 1�3.. of angle to the driveshaft, adjust the stringer height so that the engine mounts can be adjusted up or down equally. 1.7 MS Diesel Sterndrive Models 5. Record the readings in the following chart for later use. b a c 6246 a -Driveshaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading Direction the Indicator Needle Has Moved Specification Reference point � 1�3� from either side of the reference point ENGINE AND DRIVESHAFT LATERAL ALIGNMENT IMPORTANT: Improper positioning of the output shaft flange may cause bearing damage. Position the output shaft flange as specified. 1. "Measure the length of "a" and "b" to the centers of bolt holes. They must be within � 6.35 mm (0.25 in.) of each other. 2. If the dimensions are not as specified, slide the forward and aft ends of the engine equally in opposite directions to obtain the specified lengths for (a) and (b) while maintaining the driveshaft length � 8 mm (5/16 in.). b a 6669 Engine and Driveshaft Lateral Alignment Dimensions Dimension a � 6.35 mm (0.25 in.) of dimension b Dimension b � 6.35 mm (0.25 in.) of dimension a Page 7B-20 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 3. Measure the clearance between the output shaft flange shoulder and the bearing of the engine shaft bearing support. Slide the engine fore or aft as needed to obtain the specified clearance. a b c a 32713 a -8 mm (5/16 in.) b -Bearing of the engine shaft bearing support c -Output shaft flange shoulder Clearance between Output Shaft and Bearing Clearance between the output shaft flange shoulder and the bearing 8 mm (5/16 in.) 4. Recheck step 1. If step 1 is not as specified, adjust and recheck step 3. Continue this process until both steps 1 and 3 are as specified. 5. After engine has been aligned correctly. Tighten the front and rear engine mounts securely to the boat stringer. ba b 35180 a bb 35183 Front engine mount Rear engine mount a -Engine mount b -Mounting bolts READING AND ALIGNING THE ENGINE OUTPUT 1. Position the protractor on the flywheel housing. Raise or lower the front engine mount adjusting nuts so the protractor needle reads exactly the same number of degrees as recorded at the Reading At the Input Shaft Flange�Reference Point. 90-865612060 MAY 2008 Page 7B-21 1.7 MS Diesel Sterndrive Models .7 MS Diesel Sterndrive Models 2. Record your data in the chart provided. a .... a -Protractor Reading ..ocation Reading Direction the Indicator ..eedle ..as Moved Specification Reading at input shaft flange Reference point Reading at setting driveshaft angle � 1�3.. from either side of the reference point Reading at output shaft flange Equal degree to the reference point VERIFYING THE DRIVESHAFT ANGLE 1. Position the protractor on the driveshaft and recheck the driveshaft angle. The angle should be the same as that recorded previously Reading and Setting the Driveshaft Angle. If not, raise or lower all four engine mount adjustment nuts an equal amount until the correct angle is reached. Page 7B-22 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 2. Record your data in the chart provided. c b a a -Drive shaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading at output shaft flange Reading verifying driveshaft angle Reading Direction the Indicator Needle Has Moved 6666 Specification Reference point � 1�3� from either side of the reference point Equal degree to the reference point Same as previously recorded- Reading driveshaft angle 3. When the driveshaft angle is correct the engine and driveshaft are aligned correctly. Tighten all trunnion clamp bolts and engine mount locknuts to specification. If equipped with tab washers, bend the washer tab down on adjusting nut. 25759b e d c c e d a Typical Mount a -Mount bracket b -Trunnion clamp bolt c -Locknut d -Adjusting nut e -Tab washer, if equipped Description Nm Front 57 Trunnion clamp bolt Rear 68 Engine mount locknut 80 lb-in. lb-ft. � 42 � 50 � 59 90-865612060 MAY 2008 Page 7B-23 1.7 MS Diesel Sterndrive Models Driveshaft Lubrication 1. Lubricate the driveshaft U-joints, input shaft, aft bearing support, and engine shaft bearings support as follows: a. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the aft bearing support grease fitting, input shaft grease fitting, and the engine shaft bearings support grease fitting. b. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into both driveshaft U-joint grease fittings. baedc35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting aft end d -U-joint grease fitting engine end e -Engine shaft bearings support grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing 42 Grease fittings 92-802870A1 Grease Exhaust Connections and Top Safety Shields The engine end exhaust pipe connects to the standard exhaust elbow and bellows. The exhaust tube is held in place using stainless steel hose clamps. EXHAUST ELBOW Before installing the exhaust pipe rotate the exhaust elbow as follows: 1. Disconnect the water overboard hose from the exhaust elbow fitting. 2. Remove the plug and the water overboard fitting. 3. Clean any remaining sealant from the threads. 4. Apply sealant to the threads of the plug and the fitting. Tube Ref No. Description Where Used Part No. 9 Loctite 567 PST Pipe Sealant Pipe plugs and fittings 92-809822 5. Install the water overboard fitting where the plug was installed. Tighten securely. 6. Install the plug where the water overboard fitting was installed. Tighten securely. Page 7B-24 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 7. Rotate the exhaust elbow approximately 180�. a b d c 25762 a -Water overboard fitting b -Plug c -Exhaust elbow clamp d -Fitting and plug new locations ! CAUTION Avoid product damage or injury. The turbocharger is hot during engine operation and retains the heat for a period of time after the engine stops. Avoid contact with hot turbochargers. Route and secure all cables, hoses and lines away from the turbocharger. 8. Loosen the exhaust elbow clamp. 9. To prevent damage, ensure that sufficient clearance exists between the turbocharger, thermal blanket and thermal blanket retaining spring, and the exhaust elbow with bellows. The exhaust bellows must not compress or lay against the turbocharger, thermal blanket, or thermal blanket retaining spring. bac 25764 a -Exhaust elbow b -Turbocharger, thermal blanket, and spring c -Sufficient clearance 90-865612060 MAY 2008 Page 7B-25 1.7 MS Diesel Sterndrive Models Page 7B-26 90-865612060 MAY 2008 EXHAUST PIPE AND SAFETY SHEILD 1. Install the exhaust pipe. Use two clamps for each connection. Temporarily lightly tighten the hose clamps on the exhaust bellows and the exhaust tube. a b d e f c 25765 a - Exhaust pipe b - Exhaust bellows c - Hose clamps (4) d - Exhaust tube e - Exhaust connector f - Hose clamps (4) 2. Install the transom and engine end top shields. Temporarily leave the port side bolts out of the engine end top shield. 15407 a b d c e c d b a - Transom end top shield b - Bottom shield c - Bolt (7) d - Locknut e - Engine end top shield 3. Install the exhaust pipe support bracket on the engine end shield (port side). 4. Install the remaining 2 engine end shield bolts. 5. Install and lightly tighten the exhaust pipe to support bracket hose clamp. 1.7 MS Diesel Sterndrive Models 6. Tighten all the transom and engine end top shield bolts to specification. Description Nm lb-in. lb-ft. Top shield bolt 41 � 30 7. Ensure that exhaust elbow, bellows, exhaust pipe and exhaust tube are properly aligned. 25767abcdeef a -Bolt 3/8-16 x 7/8 in. (22 mm) long d -Exhaust pipe b -Locknut e -Support bracket c -Engine end top shield f -Hose clamp 8. Torque the exhaust elbow clamp. Description Nm lb-in. lb-ft. Exhaust elbow clamp M8 10 88 � 9. Securely tighten the hose clamps on exhaust bellows, exhaust tube and support bracket. Engine Connections ! CAUTION Avoid product damage or injury. The turbocharger is hot during engine operation and retains the heat for a period of time after the engine stops. Avoid contact with hot turbochargers. Route and secure all cables, hoses and lines away from the turbocharger. 1. Refer to the appropriate power package installation manual instructions. � Properly route and install the correctly lengthened seawater inlet hose. � Properly route and install the trim sender harness extension. � Properly route and install the ground wire (�). � Properly route and install the gear lube monitor hose. � Properly route and install the shift cables. � Ensure cables, hoses, and lines are routed a minimum of 102 mm (4 in.)from the turbocharger. � Secure the cables, hoses, and lines with tie straps as needed. � Before operation check and fill the power steering system and reservoir. Refer to the appropriate power package installation manual instructions. 90-865612060 MAY 2008 Page 7B-27 1.7 MS Diesel Sterndrive Models IMPORTANT: The gear lube monitor hose should be routed directly to the oil reservoir to avoid low spots in the system. ! WARNING Stress on hose fittings or kinks in the hoses can damage hydraulic steering components, leading to serious injury or death due to loss of boat control. Extreme heat can lower the hoses' burst pressure or melt the hose. Route hydraulic hoses to avoid kinks, heat sources, or stress on the hose fittings. 2. Route the high pressure and low pressure fluid hoses to the control valve. Ensure that the hoses avoid areas of extreme heat and are not kinked. 3. Install the high pressure fluid hose fitting to the control valve. 4. Install the low pressure fluid hose fitting to the control valve. IMPORTANT: Do not restrict control valve movement. 5. Position the hoses as shown; ensure that the final hose position does not cause stress on the hose fittings and that the hoses are not kinked. 25771c b a a -High pressure fluid hose fitting b -Low pressure fluid hose fitting c -Control valve 6. Tighten the hose fittings to specification. Description Nm lb. in. lb. ft. High pressure fluid hose fitting-to-control valve 31 � 23 Low pressure fluid hose fitting-to-control valve 31 � 23 Sterndrive With a Driveshaft Extension (Jackshaft) Assembly IMPORTANT: Note the following exception to the normal sterndrive installation procedure. When the sterndrive is installed, the sterndrive U-joint centerline must be positioned in the same plane as the driveshaft extension (jackshaft) U-joint centerline. See Aligning the Cross Bearings Centerline before installing the sterndrive. 34827 If applicable, the U-joint top safety shields may be removed for sterndrive installation. Install the top safety shields before operation. Page 7B-28 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models U-Joints Cross Bearing Centerline ! CAUTION Misaligned cross bearings can cause driveshaft failure, leading to possible injury. The driveshaft U-joint cross bearings of both the drive and the driveshaft extension must operate in the same plane to prevent excessive vibration. Align the bearings to operate in the same plane. 1. Momentarily engage the starter motor so that the centerline of the driveshaft yoke is positioned vertically. ab25760 a -Driveshaft flange b -Driveshaft flange yoke centerline (vertical) 2. Place a reference mark on the input shaft to correspond with centerline. abc32722 a -Aft bearing support b -Reference mark c -Input shaft 90-865612060 MAY 2008 Page 7B-29 1.7 MS Diesel Sterndrive Models 3. Rotate the sterndrive U-joint shaft so that the centerline of the forward yoke is positioned vertically. The U-Joint must be positioned in this manner when it is installed so that it will be running on the same plane as the extension driveshaft U-joint cross bearings. abc35190 a -Centerline (vertical) b -Forward yoke c -U-joint shaft 4. Using a paint marker, draw a reference mark on the universal joint shaft to correspond with the centerline. NOTE:Draw the referance mark at either location shown that will be easy for you to viewwhile installing the sterndrive. aab35189 a -Reference mark location b -Cernterline 5. Install the sterndrive with its U-joint centerline on the same plane as the driveshaft extension centerline. Refer to the appropriate power package installation manual. Page 7B-30 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models Top Safety Shields The safety shields mount on the engine shaft bearing support and the aft bearing support assemblies to completely cover the driveshaft U-joints and prevent possible injury from moving parts. 34746 1. Install the top safety shields If they were removed while installing the sterndrive. Install both top shields as shown. 2. Tighten the bolts and nuts to specification. c a b 32719d Top shield and bottom shield at transom end (engine end is similar) a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nut 3/8-16 (4) Description Nm lb-in. lb-ft Driveshaft shield bolts and nuts 41 � 30 Predelivery Preparation Refer to the Cummins MerCruiser Diesel Sterndrive Installation Manual for Predelivery Preparation and Inspections. Removal U-Joint Top Shields 1. Remove the bolts and nuts securing the top shields. Retain the fasteners. 90-865612060 MAY 2008 Page 7B-31 1.7 MS Diesel Sterndrive Models 2. Remove the top shields. cab32719d Top shield and bottom shield at aft end, engine end similar a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nuts 3/8-16 (4) Sterndrive Refer to the Power Package Installation Manual for your specific model to remove the sterndrive from the transom assembly. Engine Connections Refer to the appropriate power package manual to disconnect the following: � The seawater inlet hose � The trim sender harness extension � The ground wire (�) � The gear lube monitor hose � The shift cables � The cables, hoses, and lines as needed � The high pressure fluid hose fitting to the control valve � The low pressure fluid hose fitting to the control valve 25771cba a -High pressure fluid hose fitting b -Low pressure fluid hose fitting c -Control valve Page 7B-32 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7B-33 Driveshaft Extension 1. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so the engine will be level when suspended. Do not lift the engine at this time. 2. Bend the tab of the engine mount tab washer straight on each adjustment nut. Loosen all engine mount nuts. 3. Remove the fasteners securing the front and rear engine mounts to the boat stringer. 4. Remove the fasteners securing the driveshaft to the output flange at the engine shaft bearing support. b d 33001 c a a -Driveshaft b - Bolt c - Nut d - Engine output shaft flange 5. Remove the fasteners securing the driveshaft to the input flange at the aft bearing support. a b c d 33002 a - Bolt b - Nut c - Input shaft flange d - Driveshaft 6. Lift the driveshaft from the input and the output flange and remove it from the boat. Use the hoist to slightly move the engine to allow clearance for the driveshaft to be lifted out. 1.7 MS Diesel Sterndrive Models Aft Bearing Support Remove the aft bearing support bolts, washers, and locknuts. Remove the aft bearing support. d -Spherical washer (4), rounded side toward rear bearing support e -Aft bearing support f -Locknut (2) efdcdab6645a -Fiber washer b -Bolt (2) c -Flat washer (2) Engine Shaft Bearing Support NOTE:Theengineshaftbearingsupportassemblyfastenersalsosecuresthespacerplate. 1. Remove the bolts and lock washers from the engine shaft bearing support assembly and remove the assembly and the spacer plate. a35172baaaaa Typical a -Engine shaft bearing support assembly b -Bolt with lock washer (6) Bearing Inspection 1. Inspect the bearing of the engine shaft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace the bearing. Page 7B-34 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 2. Inspect the bearings of the aft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace both bearings, spacer, and the oil seal. Aft Bearing Support Assembly Repair Bottom Safety Shield Removal Remove the safety shield bolts and remove the safety shield. 35137bcaaabc35036 a -Bolts b -Aft bearing support c -Safety shield Bearings and Oil Seal Removal 1. Remove the oil seal from the aft bearing support. 2. Remove the snap ring in the groove of the aft bearing support housing just above the bearing. 3. Use a press and suitable mandrel to press the bearings and the spacer from the aft bearing support housing. Input Shaft Removal 1. Use a suitable mandrel and a press the input shaft from the aft bearing support. abdc35135 a -Press b -Suitable mandrel c -Aft bearing support d -Input shaft 90-865612060 MAY 2008 Page 7B-35 1.7 MS Diesel Sterndrive Models Bearings and Oil Seal Install 1. Install the grease fitting to the aft bearing support housing. 35071 2. Grease the inside diameter of the bearing bore in the aft bearing support housing. 35072 3. Use a press and a suitable mandrel and press the bearing, with its open side up, into the bearing bore. abbbfcde35075 a -Bearing open side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support f -Bearing installed Page 7B-36 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 4. Install the spacer. 35076abbc a -Spacer b -Suitable mandrel (guide) c -Aft bearing support 5. Use a press and suitable mandrel and install the second bearing with the covered side up. acdbebbe 35077 a -Bearing covered side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support 6. Install the snap ring in the grove of the housing just above the bearing. 35078 90-865612060 MAY 2008 Page 7B-37 1.7 MS Diesel Sterndrive Models 7. Flip the aft bearing support over and press the oil seal into the housing with the lip of the seal facing inside the housing. abcadcda 35079 a -Suitable mandrel (guide) b -Suitable mandrel c -Oil seal d -Aft bearing support Input Shaft Install 1. Install the grease fitting to the input shaft. abc35081 a -Grease fitting b -Input shaft c -Input shaft flange 2. Apply sealant to the inside edge of the shaft and the outside edge of the plug. 35082 Page 7B-38 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models Tube Ref No. Description Where Used Part No. 33 Loctite 680 Retaining Plug for the input shaft 92-809833 Compound 3. Use a press to install the plug into the input shaft. aebcdd35083 a -Plug b -Press c -Suitable mandrel d -Input shaft flange e -Plug installed 4. Grease the inside splines and the outer surface of the input shaft. 35084 90-865612060 MAY 2008 Page 7B-39 1.7 MS Diesel Sterndrive Models 5. Align the aft bearing support assembly onto the input shaft with its oil seal facing the shaft flange and the grease fittings aligned. 35085abbc a -Bearing b -Oil seal hidden c -Grease fittings d -Input shaft flange 6. Press the aft bearing support assembly onto the input shaft. ab cd 35086 a -Press b -Suitable mandrel c -Oil seal d -Machined surface on the input shaft 7. Using a hand grease gun pump grease into the aft bearing support grease fitting. 35080 Page 7B-40 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models Bottom Safety Shield Install 1. Apply Loctite to the threads of the safety shield bolts. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Safety shield bolt threads 92-809819 2. Place the safety shield on the aft bearing support and secure it with the bolts. abc35138 a -Bolts b -Aft bearing support c -Safety shield 3. Tighten the bolts to specification. aaabc3503635137bc a -Bolts b -Aft bearing support c -Safety Shield Description Safety shield bolt Nm 41 lb-in. � lb-ft 30 90-865612060 MAY 2008 Page 7B-41 1.7 MS Diesel Sterndrive Models Engine shaft Bearing Support Assembly Repair Output Shaft Removal 1. Remove the snap ring from the groove of the shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft 2. Lift the engine shaft bearing support from the shaft. 34928acb a -Engine shaft bearing support b -Shaft c -Shaft flange 3. Remove the O-rings from the shaft. Page 7B-42 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models Bearing Removal 1. Remove the snap ring from the groove just above the bearing in the engine shaft bearing support. 34937 2. Press the bearing out of the engine shaft bearing support. Discard the bearing. abc34939 a -Engine shaft bearing support b -Press c -Suitable mandrel Bearing Install 1. Grease the bearing bore of the engine shaft bearing support. 90-865612060 MAY 2008 Page 7B-

43 1.7 MS Diesel Sterndrive Models 2. Insert the grease fitting into the engine shaft bearing support. abc34934 a -Engine shaft bearing support housing b -Bearing bore c -Grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing Bearing bore of engine shaft 42 92-802870A1 Grease bearing support NOTE:The bearing has two grease access holes. 34935 3. Align the bearing to the bearing bore, and align the grease fitting hole to the grease access hole in the bearing. Page 7B-44 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 4. Press the bearing into the engine shaft bearing support. acdefb34936 a -Engine shaft bearing support housing b -Suitable mandrel c -Bearing d -Grease access hole e -Grease fitting f -Bearing installed 5. Insert the snap ring into the groove just above the bearing. 34937 6. Insert grease into the grease fitting. 34966ba a -Grease fitting b -Grease gun 7. Align the engine mount brackets to the engine shaft bearing support as shown. 90-865612060 MAY 2008 Page 7B-45 1.7 MS Diesel Sterndrive Models 8. Apply sealant to the threads of the bolts. Hand-start the bolts and lockwashers into the engine shaft bearing support to secure the engine mount brackets. 34938aaccb a -Engine mount bracket (2) b -Engine shaft bearing supportc -Bolt and lockwasher (2) Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Bolt threads 92-809819 Output Shaft Install 1. Install new O-rings on the output shaft. 2. Grease the O-rings and around the output shaft. bbac34925 a -Out put shaft b -O-rings c -Grease Tube Ref No. Description U-joint and Gimbal Bearing Grease Where Used Output shaft Part No. 92-802870A1 42 Page 7B-46 90-865612060 MAY 2008 1.7 MS Diesel Sterndrive Models 3. Grease the inner diameter of the bearing in the engine shaft bearing support. abc34927 a -Engine shaft bearing support b -Grease applicator c -Inside diameter of bearing Tube Ref No. 42 Description U-joint and Gimbal Bearing Grease Where Used Bearing ID Part No. 92-802870A1 4. Insert the shaft. 34928acb a -Engine shaft bearing support b -Shaft c -Shaft flange 90-865612060 MAY 2008 Page 7B-47 1.7 MS Diesel Sterndrive Models 5. Insert the snap ring into the groove of the output shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft Page 7B-48 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models Driveshaft Extention (Jackshaft) Section 7C - 2.8 ES and 4.2 ES Diesel Sterndrive Models Table of Contents General Information..7C-2 Driveshaft Extension Application.............7C-2 Continuity Circuit Ground Wire................7C-4 Driveshaft Extension Maintenance.................7C-4 Scheduled Maintenance�Driveshaft Extension...7C-4 Lubrication Points....................................7C-4 Driveshaft Extension Inspection and Maintenance...7C-5 Installation...7C-6 Seawater Inlet System Preparation..........7C-6 Gear lube Monitor....................................7C-9 Shift Plate...7C-11 Exhaust Block-Off Plate.........................7C-11 Aft Bearing Support...............................7C-12 Preparing the Engine............................7C-15 Engine Placement................................7C-21 Protractor..7C-22 Driveshaft Extension..............................7C-22 Driveshaft Lubrication............................7C-28 Continuity Curcuit Ground Wire.............7C-29 Engine Connections..............................7C-29 Sterndrive With a Driveshaft Extension (Jackshaft) Assembly............................7C-31 Aligning the Cross Bearings Centerline ....7C-31 Top Safety Shields...............................7C-34 Predelivery Preparation.........................7C-34 Removal...7C-34 U-Joint Top Shields...............................7C-34 Sterndrive..7C-35 Engine Connections..............................7C-35 Driveshaft Extention..............................7C-36 Aft Bearing Support...............................7C-38 Engine Shaft Bearing Support...............7C-38 Bearing Inspection................................7C-38 Aft Bearing Support Assembly Repair...........7C-39 Bottom Safety Shield Removal..............7C-39 Bearings and Oil Seal Removal.............7C-39 Input Shaft Removal..............................7C-39 Bearings and Oil Seal Install.................7C-40 Input Shaft Install..................................7C-42 Bottom Safety Shield Install...................7C-45 Engine Shaft Bearing Support Assembly Repair ....7C-46 Output Shaft Removal...........................7C-46 Bearing Removal...................................7C-47 Bearing Install.......................................7C-47 Output Shaft Install...............................7C-50 7 C 90-865612060 MAY 2008 Page 7C-1 2.8 ES and 4.2 ES Diesel Sterndrive Models Lubricants, Sealants, Adhesives Tube Ref No. Description Where Used Engine coupler bolt threads 7 Loctite 271 Threadlocker Engine shaft bearing support bolt threads Safety shield bolt threads Bolt threads 33 Loctite 680 Retaining Compound Plug for the input shaft Grease fittings 42 U-joint and Gimbal Bearing Grease Bearing bore of engine shaft bearing support Output shaft Bearing ID 91 Engine Coupler Spline Grease Engine coupler splines Special Tools Tapered Insert Tool 91-43579 Part No. 92-809819 92-809833 92-802870A1 92-802869A 1 Removes and installs the tapered insert retainer into the water inlet hose. 9197 Alignment Tool Assembly 91-805475A 1 Used to align the engine to the transom assembly for sterndrive installation. 9183 Alignment Bar 8M2001017 Aids in aligning the engine to the transom assembly for 26831 sterndrive installation. General Information Driveshaft Extension Application DRIVESHAFT EXTENSION The driveshaft extension (jackshaft) converts a standard sterndrive package into a driveshaft configuration. A long driveshaft is installed between the engine and the transom assembly. The driveshaft installation moves the weight of the engine forward in the boat providing a better center of gravity and improved boat operation. The driveshaft extension is used with triple, dual, and single engine applications in smaller boats. When the driveshaft extention is installed in boats with center console or staggered engine designs it helps the boat get up on plane quickly. The driveshaft extension is available as a kit and must be used in conjunction with the recommended driveshaft. Other kits or parts are listed with the kit for the specific engine models. The driveshaft is ordered separately. Page 7C-2 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7C-3 Access must be provided to grease fittings on the driveshaft U-joints, input shaft, and bearing supports to allow for scheduled maintenance. 33872 a b d c a - 1�3� driveshaft angle required b - Driveshaft extension c - Driveshaft U-joint flange connected to output shaft (engine shaft bearing support) d - Driveshaft U-joint flange connected to input shaft (aft bearing support) ENGINE / EXHAUST Through the transom exhaust system is required for this engine model. For critical power package dimensions and requirements refer to the latest Cummins MerCruiser Diesel OEM CD or installation drawings. MEASUREMENTS We recommend a universal protractor or digital inclinometer for measuring the angles during installation steps. 34826 Universal protractor Digital inclinometer 2.8 ES and 4.2 ES Diesel Sterndrive Models Continuity Circuit Ground Wire .8 ES and 4.2 ES Diesel Sterndrive Models Continuity Circuit Ground Wire In some applications, the transom ground wire will not reach the engine ground or the battery ground connection. This ground wire connection is required to complete the continuity circuit. You must construct a new ground wire long enough to attach to the transom grounding screw and the engine grounding stud or battery ground. ab33323Typical a -Transom grounding screw b -Transom ground wire Driveshaft Extension Maintenance Scheduled Maintenance�Driveshaft Extension Refer to the appropriate manual for power package maintenance and Inspections. Perform the following maintenance at the required task intervail. Task Interval Maintenance to Be Performed Every 100 hours or annually (whichever occurs first) � Lubricate the driveshaft U-joints. � Lubricate the input shaft. � Lubricate the aft bearing support (input) � Lubricate the engine shaft bearing support (output) � Inspect the driveshaft U-joints. Every 300 hours or 3 years (whichever occurs first) � Engine shaft bearing support inspection � Aft bearing support inspection Lubrication Points Lubricate the bearings grease fittings every 100 hours or annually (whichever occurs first). 1. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the following grease fittings: � Aft bearing support grease fitting � Input shaft grease fitting � Engine shaft bearing support grease fitting Page 7C-4 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into the driveshaft U-joint grease fittings on the transom and engine end. b a e dc 35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting at transom end d -U-joint grease fitting at engine end e -Engine shaft bearing support grease fitting Driveshaft Extension Inspection and Maintenance U-JOINT INSPECTION Preform the U-joint inspection every 100 hours or annually (whichever occurs first). 1. Remove the driveshaft. 2. Rotate the U-joint on the output and the input end of the driveshaft. The movement of each U-joint yoke, socket, and cross bearing assembly should be smooth. 3. Replace the cross and bearing assembly if the seals are deteriorated or if movement is tight or rough. 4. Reinstall the driveshaft. ENGINE SHAFT BEARING SUPPORT INSPECTION Perform the engine shaft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the engine shaft bearing support assembly. 2. Rotate the output shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearing. See Engine Shaft Bearing Support Assembly Repair. AFT BEARING SUPPORT INSPECTION Perform the aft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the aft bearing support assembly. 2. Rotate the input shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearings, spacer, and the oil seal. See Aft Bearing Support Assembly Repair. 90-865612060 MAY 2008 Page 7C-5 2.8 ES and 4.2 ES Diesel Sterndrive Models Installation Seawater Inlet System Preparation Follow the instructions provided with the Thru-The-Hull Seawater Pickup Kit before installing the drive shaft extension. SEAWATER HOSE IMPORTANT: Use a wire-reinforced seawater hose with an adequate wall thickness to keep the hose from collapsing when the seawater pump impeller creates suction. Secure the hose connections with hose clamps. Secure the hose to prevent contact with any moving parts. SPECIFICATIONS Description Seawater pickup�through-the-hull or through-the-transom mounted. Seacock size (internal cross-sectional area). Seawater inlet hose inner diameter (adapter provided for hose). Seawater strainer flow rate. Seawater inlet restriction. SEAWATER STRAINER All Models Minimum 150 L/min. (40 US gal/min) At least: 38 mm (1-1/2 in.) Minimum 38 mm (1-1/2 in.) Minimum 150 L/min. (40 US gal/min) Maximum 125 mm Hg (5 in. Hg) Refer to the power package installation manual for installation, operation, and maintenance instructions. INSTALLING THE STERNDRIVE SEAWATER BLOCK-OFF PLATE Seawater for engine cooling must be supplied through an alternate (separate) seawater pickup instead of through the sterndrive. When using a separate seawater pickup, block the sterndrive seawater passage and cut the water hose that is located between the bell housing and the gimbal housing. This allows water to continue to circulate through the sterndrive for cooling. NOTICE Obstructions in the water passages will keep cooling water from circulating through the sterndrive resulting in damage to the sterndrive. When using a block-off plate ensure that the water hose between the bell housing and gimble housing is cut and removed. Page 7C-6 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 1. Remove the tapered insert in the gimbal housing using the tapered insert tool. Discard the insert. 17857cdba a -Tapered insert location in the gimbal housing b -Ratchet and extension c -Tapered insert d -Tapered insert tool Tapered Insert Tool 91-43579 2. Install the block-off plate with new gasket. Secure with screws and lockwashers. Tighten the screws to specification. aabdc a -Block-off plate b -Gasket c -Screw d -Lockwasher 21683 Description Water inlet block-off screw Nm 5 lb-in. 45 lb-ft � 90-865612060 MAY 2008 Page 7C-7 2.8 ES and 4.2 ES Diesel Sterndrive Models 3. Move the trim limit switch wires and speedometer hose aside. Reach between the gimbal housing and the bell housing and detach the water hose from the gimbal housing where the tapered insert was removed. abecd8489 a -Trim limit switch wires b -Speedometer hose c -Gimbal housing d -Water hose e -Tapered insert NOTE:Move the trim limit switch wires and speedometer hose to avoid damaging themwhen cutting the water hose. The existing tie strap and clip can be reused if they are movedand repositioned after the hose is cut. 4. Cut completely through the water hose 127 mm (5 in.) in front of the aft end of the hose where it is fitted into the bell housing in the area shown. Do not damage the U-joint bellows. 5. Discard the loose hose piece. 6. Secure the trim limit switch wires and speedometer hose to the remaining section of water hose using the existing tie strap and clip. abdf33405cea -Water inlet hose b -Trim limit wire harness c -Tie strap d -Cutting area e -Clip f -Speedometer hose 7. Install a through-the-hull or through-the-transom seawater pickup, seawater strainer, and seacock. Page 7C-8 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 8. Connect the seawater inlet hose between the seawater pump and seawater strainer. 9. Secure all hoses with hose clamps. Gear lube Monitor Relocate the engine mounted gear lube monitor to the boat transom when applicable. The transom mounted bracket and accessories can be ordered in a gear lube monitor relocation kit or included in the driveshaft extension kit. 1. Disconnect audio warning system wires from the gear lube monitor on the engine. 2. Remove the gear lube monitor from the bracket. 3. Remove the bracket. 4. Connect the sterndrive gear lube monitor hose to the quick release 90� fitting and secure it with a stay strap. 5. Connect the quick release 90� fitting to the gimbal housing fitting. Position the fitting so the release button will not contact the seawater inlet fitting or block-off plate if equipped. 6. Route the gear lube monitor hose and secure with J-clip. 34736bca a -Quick release 90� fitting b -Gear lube hose c -J-clip 90-865612060 MAY 2008 Page 7C-9 2.8 ES and 4.2 ES Diesel Sterndrive Models 7. Install the bracket to the boat transom so the gear lube monitor will be higher than the steering lever on the transom assembly. Secure the bracket with lag screws and flat washers as shown. defaghbc6637a -Gear lube monitor bracket b -Lag bolt and washer (2 each) c -Gear lube monitor d -Cap e -Audio warning system wires f -Retaining strap g -Gear lube hose h -Hose clamp IMPORTANT: Do not allow kinks in the gear lube lube monitor hose. The gear lube monitor will not function properly if the hose is kinked and damage to the sterndrive could occur. Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. 8. Install the gear lube monitor in the bracket and secure it with the retaining strap. 9. Route the gear lube hose to the monitor and cut off excess hose. Connect the hose to the monitor and secure it with a hose clamp. 34815abcde a -Gear lube monitor is higher than the steering lever b -Gear lube monitor c -Bracket d -Gear lube hose e -Audio warning system connectors 10. Connect the audio warning system wires to the gear lube monitor. Use the extension harness from the kit if applicable. Page 7C-10 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7C-11 11. Use cable ties to secure the wires away from moving parts. Shift Plate For driveshaft lengths over 71 cm (28 in.) the shift plate must be relocated to the boat transom. The mounting location must allow for proper cable routing with 20 cm (8 in.) radius bends minimum. IMPORTANT: The shift plate assembly must be mounted within the limits of the sterndrive shift cable. Be sure that the mounting location will not interfere with other moving components. 1. Disconnect the shift plate connector from the engine harness. 6674 Bravo shift bracket 2. Remove the shift plate from the exhaust elbow. IMPORTANT: The shift plate and the bracket assembly must be mounted within limits of the sterndrive shift cable. Ensure that the mounting location will not cause interference with other moving components. 3. Attach the shift plate to the bracket and secure it with the hardware provided. Mount the bracket to the desired location. 4. Install the mounting bracket in the desired location on the inner transom using two long lag screws and two washers. b a 6676 Bravo shift bracket and shift plate a - Bracket b - Shift plate assembly Exhaust Block-Off Plate Use the exhaust block-off plate when the engine is installed with a through-transom exhaust system. The through-propeller exhaust route is blocked with a block-off plate. 2.8 ES and 4.2 ES Diesel Sterndrive Models IMPORTANT: When equipped with an exhaust block-off plate, the gimbal housing and exhaust block-off plate mating surfaces must be clean and free of nicks and scratches, and the O-ring must be properly seated in the groove, or water may leak into boat. 1. Ensure that the gimbal housing mating surface is clean and free of nicks and scratches. 2. The O-ring must be properly seated in the groove. a21630 a -O-ring 3. Ensure that the block-off plate mating surface is clean and free of nicks and scratches. 4. Install the block-off plate with the decal toward the engine. 5. Secure with four bolts and lockwashers. 6. Torque the bolts. a21625bca a -Block-off plate b -Bolts c -Lockwashers Description Nm lb. in. Exhaust block-off plate bolts 34 � Aft Bearing Support The aft bearing support assembly mounts on the inner transom plate. lb. ft. 25 34749 Page 7C-12 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7C-13 1. Remove the fiber washers and adhesive from the inner transom plate. 32696 IMPORTANT: The spherical washers must be positioned so that the rounded side of the washers are toward the bearing support assembly as shown. 2. Install the aft bearing support assembly on the inner transom plate using the hardware as shown. Tighten the bolts until the locknuts contact the bottom of the transom. Do completely tighten the bolts at this time. e f d c d a b 6645 a - Fiber washer b - Bolt (2) c - Flat washer (2) d - Spherical washer (4) e - Aft bearing support f - Locknut (2) IMPORTANT: Alignment tools from other manufacturers may improperly align and damage the gimbal bearing, bearing support, or engine coupler. Use one of the listed Quicksilver alignment tools; The Alignment Tool Assembly, or Alignment Bar. 2.8 ES and 4.2 ES Diesel Sterndrive Models 3. Insert the solid end of alignment tool through the bearing in the gimbal housing and into the input shaft splines of the aft bearing support. dabc6646 a -Quicksilver alignment tool b -Gimbal housing c -Gimbal bearing d -Input shaft splines of aft bearing support Alignment Tool Assembly 91-805475A 1 Alignment Bar 8M2001017 4. Do not remove the alignment tool from the gimbal housing. IMPORTANT: Both bolts must be firmly struck in the following step to properly seat the spherical washers. Failure to follow this procedure may result in a difficult installation of the sterndrive. 5. Strike the head of both aft bearing support bolts firmly with a plastic hammer. 34663ba a -Aft bearing support bolts b -Alignment tool 6. Ensure that the alignment tool slides into the input shaft splines easily while tightening the bolts to specification. Page 7C-14 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models NOTE:Rotate the alignment tool while tightening bolts. 34665baa a -Aft bearing support bolts b -Alignment tool Description Nm lb-in. lb-ft Aft bearing support bolts 61 � 45 Preparing the Engine 1. Support the engine. NOTE:Recordthepositionofanyitemsattachedtotheflywheelhousingcover,including thepositionandlengthofthefastenersbeingremoved.Notethepositionandorientation of any electrical harness wires and retainers. 2. Remove the existing flywheel housing cover. 34652ab a -Flywheel housing cover b -Bolt and washer 90-865612060 MAY 2008 Page 7C-15 2.8 ES and 4.2 ES Diesel Sterndrive Models 3. Remove existing coupler from the flywheel. Retain the washers. 34653abc a -Flywheel b -Existing engine coupler c -Bolt and washer 4. Apply adhesive to the threads of new engine coupler bolts. Tube Ref No. Description Where Used Part No. Loctite 271 Threadlocker Engine coupler bolt threads 92-809819 7 5. Install the new engine coupler with the new bolts and the washers retained previously. Tighten the bolts to specification. Description Nm lb-in. lb-ft. Engine coupler bolts 47 � 35 6. Lubricate engine coupler splines with a liberal amount of grease. Tube Ref No. Description Where Used Part No. Engine Coupler Spline Grease Engine coupler splines 92-802869A 1 7. Apply adhesive to the threads of the flywheel housing cover bolts. 91 Page 7C-16 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 8. Install the new flywheel housing cover. Reposition and install all items that were previously removed from the flywheel housing. Tighten the flywheel housing bolts to specification. abcde34654 a -Splines b -Engine coupler bolt and washer (6) c -New engine coupler d -Flywheel housing cover e -Flywheel housing cover bolt (7) Description Nm lb-in. lb-ft. Flywheel housing cover bolts 80 � 60 9. Apply adhesive to the threads of the new engine shaft bearing support bolts 7/16 in.-14 x 1-1/2 in. Tube Ref No. Description Where Used Part No. Engine shaft bearing support 7 Loctite 271 Threadlocker 92-809819 bolt threads 10. Put the spacer plate onto the engine shaft bearing support assembly and align the bolt holes. 90-865612060 MAY 2008 Page 7C-17 2.8 ES and 4.2 ES Diesel Sterndrive Models 11. Install the engine shaft bearing support assembly and the spacer plate onto the flywheel housing with the grease fitting at the output flange pointed straight up. 12. Install the bolts and lockwashers. Tighten the bolts to specification. dabccde34655 a -Engine shaft bearing support assembly b -Continuity wire c -Spacer plate d -Grease insert fitting e -Bolt and lockwasher (6) Description Nm lb-in. lb-ft. Engine shaft bearing support bolts 47 � 35 13. Equally position the alignment nuts midway on the engine mount studs to allow up and down engine alignment. Place a tab washer on each alignment nut. 14. Install the engine rear mounts,adjustment nut, and tab washer from the bottom of the engine shaft bearing support assembly engine mounts. Hand-start a locknut on each engine rear mount stud. Page 7C-18 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 15. Align the slotted hole of the engine mount toward the front of the engine. Do not tighten the locknuts at this time. abc34656d a -Adjustment nut b -Tab washer c -Locknut d -Slotted hole 16. Install new power-assisted steering hoses and wire assembly as follows: NOTE:Catch fluid that drains from the pump and hoses in a suitable container. a. Note the routing of the existing high-pressure hose. Remove it from the pump. ab34657 Pump shown isolated for clarity a -High -pressure hose b -Power-assisted steering pump IMPORTANT: Do not cross-thread or over-tighten the hose fittings. b. Visually inspect the new high-pressure hose, threaded fitting, and O-ring. The O-ring must be seated in the groove of the threaded fitting. 90-865612060 MAY 2008 Page 7C-19 2.8 ES and 4.2 ES Diesel Sterndrive Models c. Route the new hose assembly to the pump and install the fitting into the pump assembly. Position the hose as needed, and tighten the fitting securely. Do not connect the high-pressure hose quick connection to the control valve until after the engine is aligned. abcb34658 a -High-pressure hose b -Fitting c -O-ring d. Note the return hose routing from the control valve to the fluid cooler. Loosen the hose clamp at the fluid cooler and remove the return hose. NOTE:The hose must route into the power steering control valve from the starboard side. e. Route the new return hose assembly to the fluid cooler and install it using the hose clamp. Tighten the hose clamp. Do not connect the return hose quick connection to the control valve until after the engine is aligned. abc34659 Shown with shift plate on engine a -Fluid cooler b -Hose clamp c -Return hose Page 7C-20 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 17. Install the long water inlet hose. Secure the hose as needed. Engine Placement NOTE:For ease of installation, we recommend the use of a chain leveler in the following steps. NOTE:If the engine will be tested after installation, install the drain plugs at this time. 1. Ensure that the engine mounts are equally adjusted. If not, adjust the engine mounts so that they can be adjusted equally up or down. ! CAUTION Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components. ! WARNING Failure of the lifting eyes will cause the engine to fall suddenly from the hoist, resulting in serious injury, death, or property damage. Keep the engine level while it is hoisted. Do not tilt the engine more than 12� in any direction during installation. 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. 3. Lift the engine and place it into its approximate position in the boat using an overhead hoist. � Leave clearance space equal to the length of your driveshaft between the engine output shaft flange and the aft input flange. � Set the engine so that the clearance space for your driveshaft length will allow 8 mm (5/16 in.) clearance between the shoulder of the engine output shaft and the bearing in the engine shaft bearing support. The engine output shaft flange has a total lateral endplay of 16 mm (5/8 in.). abca32713 a -8 mm (5/16 in.) b -Bearing in engine shaft bearing support c -Shoulder of output shaft Clearance Between Output Shaft and Bearing Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) 90-865612060 MAY 2008 Page 7C-21 2.8 ES and 4.2 ES Diesel Sterndrive Models Protractor NOTE:We recommend a universal protractor for measuring the angles in the following steps. IMPORTANT: In the following steps, the protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0� and the 90� marks will be used. These are only reference marks. Use these marks to determine how many degrees and to which side (right or left) of the reference mark the needle is. View the protractor from the same side of the power package throughout the installation. 32701 Reference mark Driveshaft Extension READING AT THE INPUT SHAFT FLANGE�REFERENCE POINT IMPORTANT: Do not move the boat after taking the reading from the input shaft flange, because this reading establishes a reference point for aligning the driveshaft and engine. If the boat moves, the reference point may change, leading to improper alignment of the driveshaft and engine. 1. Position the base of protractor against the input shaft flange in the aft bearing support assembly on the inner transom. Record the number of degrees, and to which side of the reference mark the indicator needle has moved. Page 7C-22 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Record your data in the chart provided. c b a 6665 a -Input shaft flange b -Protractor c -Indicator needle Direction the Indicator Reading Location Reading Specification Needle Has Moved Reading at input shaft Reference point flange INSTALLING THE DRIVESHAFT NOTICE Misaligned flanges can allow the bolts to come loose during operation, resulting in product damage. Align the flanges flush with one another before tightening the bolts. 1. Attach the driveshaft to the output flange and input shaft flange. 2. Ensure the pilots on the driveshaft flanges are engaged in the input and output shaft flanges. Ensure that the flanges are flush with each other. 25626b a Typical a -Pilot engaged b -Flanges flush 90-865612060 MAY 2008 Page 7C-23 2.8 ES and 4.2 ES Diesel Sterndrive Models 3. Tighten the bolts to specification. aabbdecd34661 a -Locknut (4) b -Bolt (4) c -Input shaft flange d -Driveshaft e -Output shaft flange Description Driveshaft to input and output shaft flange bolts Nm 102 lb-in. � lb-ft 75 READING AND SETTING THE DRIVESHAFT ANGLE NOTICE Operating the engine with the driveshaft installed at an incorrect angle will result in damage to the driveshaft and the universal joint bearings. Align the engine correctly before operating. 1. Position the base of the protractor on the driveshaft. 2. Compare the protractor reading to the previously recorded reference point reading at the transom input shaft flange. The driveshaft angle must be within 1�3� from either side of the reference point reading. 3. Raise or lower the engine equally until the protractor needle reads exactly as specified. 4. If you are unable to achieve � 1�3� of angle to the driveshaft, adjust the stringer height so that the engine mounts can be adjusted up or down equally. Page 7C-24 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 5. Record the readings in the following chart for later use. b a c 6246 a -Driveshaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading Direction the Indicator Needle Has Moved Specification Reference point � 1�3� from either side of the reference point ENGINE AND DRIVESHAFT LATERAL ALIGNMENT IMPORTANT: Improper positioning of the output shaft flange may cause bearing damage. Position the output shaft flange as specified. 1. "Measure the length of "a" and "b" to the centers of the bolt holes.They must be within � 6.35 mm (0.25 in.) of each other. 2. If the dimensions are not as specified, slide the forward and aft ends of the engine equally in opposite directions to obtain the specified lengths for (a) and (b) while maintaining the driveshaft length � 8 mm (5/16 in.). b a 6669 Engine and Driveshaft Lateral Alignment Dimensions Dimension a � 6.35 mm (0.25 in.) of dimension b Dimension b � 6.35 mm (0.25 in.) of dimension a 90-865612060 MAY 2008 Page 7C-25 2.8 ES and 4.2 ES Diesel Sterndrive Models 3. Measure the clearance between the output shaft shoulder and the bearing in the engine shaft bearing support. Slide the engine fore or aft as needed to obtain the specified clearance. a b c a 32713 a -8 mm (5/16 in.) b -Bearing of the engine shaft bearing support c -Output shaft shoulder Clearance for the Driveshaft Lateral Endplay Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) 4. Recheck step 1. If step 1 is not as specified, adjust and recheck step 3. Continue this process until both steps 1 and 3 are as specified. 5. After engine and driveshaft lateral alignment has been aligned correctly, tighten the front and rear engine mounts securely to the boat stringer. a a b 6670 Typical mounting a -Mounting bolts b -Slotted hole toward front of engine READING AND ALIGNING THE ENGINE OUTPUT 1. Position the protractor on the flywheel housing. Raise or lower the front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as recorded at the Reading At the Input Shaft Flange�Reference Point. Page 7C-26 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Record your data in the chart provided. b a 6671 a -Protractor b -Flywheel housing Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading at output shaft flange Reading Direction the Indicator Needle Has Moved Specification Reference point � 1�3� from either side of the reference point Equal degree to the reference point VERIFYING THE DRIVESHAFT ANGLE 1. Position the protractor on the driveshaft and recheck the driveshaft angle. The angle should be the same as that recorded previously Reading and Setting the Driveshaft Angle. If not, raise or lower all four engine mount adjustment nuts an equal amount until the correct angle is reached. 90-865612060 MAY 2008 Page 7C-27 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Record your data in the chart provided. c b a a -Drive shaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading at output shaft flange Reading verifying driveshaft angle Reading Direction the Indicator Needle Has Moved 6666 Specification Reference point � 1�3� from either side of the reference point Equal degree to the reference point Same as previously recorded- Reading driveshaft angle 3. When the driveshaft angle is correct the engine and driveshaft are aligned correctly. Tighten all engine mount nuts securely. Bend the washer tab down on each adjustment nut. a b d c 6672 a -Nut and lockwasher b -Adjustment nut c -Slotted hole toward front of engine d -Tab washer Driveshaft Lubrication 1. Lubricate the driveshaft U-joints, input shaft, aft bearing support, and engine shaft bearings support as follows: Page 7C-28 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models a. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the aft bearing support grease fitting, input shaft grease fitting, and the engine shaft bearings support grease fitting. b. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into both driveshaft U-joint grease fittings. baedc35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting aft end d -U-joint grease fitting engine end e -Engine shaft bearings support grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing 42 Grease fittings 92-802870A1 Grease Continuity Curcuit Ground Wire The transom ground wire must be connected to complete the continuity circuit. If the transom ground wire will not reach the engine ground or the battery ground connection, follow the instructions below. 1. Construct a new ground wire using a 14 gauge wire and an eye ring connector on each end. The ground wire must be long enough to attach to the transom grounding screw and the engine grounding stud or battery ground. 2. Attach one end of the ground wire to the transom grounding screw and the opposite end to the engine grounding stud or the battery ground. Engine Connections IMPORTANT: Use a continuity wire from the transom assembly to the engine ground to complete the continuity curcuit. Refer to the power package installation manual for your specific model to make the following connections: � Transom plate continuity curcuit wire to the engine � Electrical wiring harness � Throttle and shift cable installation and adjustments � Water hose � Trim position sender wires � MerCathode system wires � Fuel lines 90-865612060 MAY 2008 Page 7C-29 2.8 ES and 4.2 ES Diesel Sterndrive Models � Power-assisted steering cable � Power-assisted steering hoses ! WARNING Stress on hose fittings or kinks in the hoses can damage hydraulic steering components, leading to serious injury or death due to loss of boat control. Extreme heat can lower the hoses' burst pressure or melt the hose. Route hydraulic hoses to avoid kinks, heat sources, or stress on the hose fittings. IMPORTANT: When installing power-assisted steering hoses, route toward the starboard side as shown. abc32720 Quick connect fittings a -Cable tie b -Return hose (to fluid cooler) c -High-pressure hose (from power steering pump) 25771cba Threaded fittings a -High-pressure hose (from power steering pump) b -Return hose (to fluid cooler) c -Control valve Description Power-assisted steering hose threaded fittings to control valve Nm 31 lb-in. � lb-ft. 23 Page 7C-30 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models Sterndrive With a Driveshaft Extension (Jackshaft) Assembly IMPORTANT: Follow the normal procedure for installing the sterndrive except the following. When the sterndrive is installed, the sterndrive U-joint centerline must be positioned on the same plane as the driveshaft extension (jackshaft) U-joint centerline. See Aligning the Cross Bearings Centerline, before installing the sterndrive. If applicable, the driveshaft extension (jackshaft) U-joint top shields may be removed for sterndrive installation. Install the U-joint top shields before operation. See Installing the U-Joint Top Shields. 34819 Aligning the U-joint cross bearings Refer to the Cummins MerCruiser Diesel Sterndrive Installation Manual for the normal procedure for sterndrive installation. Aligning the Cross Bearings Centerline ! CAUTION Misaligned cross bearings can cause driveshaft failure, leading to possible injury. The driveshaft U-joint cross bearings of both the drive and the driveshaft extension must operate in the same plane to prevent excessive vibration. Align the bearings to operate in the same plane. 90-865612060 MAY 2008 Page 7C-31 2.8 ES and 4.2 ES Diesel Sterndrive Models 1. Momentarily engage the starter motor so that the centerline of the driveshaft yoke is positioned vertically. abc32721 a -Drive shaft extension U-joint yoke b -Bearing support input U-joint yoke c -U-joint cross bearing centerline (vertical) 2. Place a reference mark on the input shaft to correspond with centerline. abc32722 a -Bearing support assembly b -Reference mark c -Input shaft Page 7C-32 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 3. Rotate the sterndrive U-joint shaft so that the centerline of the forward yoke is positioned vertically. The U-Joint must be positioned in this manner when it is installed so that it will be running in the same plane as the extension driveshaft U-joint cross bearings. 32723c b a a -U-joint cross bearing centerline (vertical) b -Forward yoke c -U-joint shaft 4. Using a paint marker, draw a reference mark on the universal joint shaft to correspond with the centerline. NOTE:Draw the referance mark at either location shown that will be easy for you to viewwhile installing the sterndrive. a a b 32768 a -Reference mark location b -Cernterline 5. Install the sterndrive following the instructions in the Cummins MerCruiser Diesel Sterndrive Installation Manual. Make sure the U-joint centerline is in the same plane as the driveshaft extension centerline. 90-865612060 MAY 2008 Page 7C-33 2.8 ES and 4.2 ES Diesel Sterndrive Models Top Safety Shields The safety shields mount on the engine shaft bearing support and the aft bearing support assemblies to completely cover the driveshaft U-joints and prevent possible injury from moving parts. 34746 1. Install the top safety shields If they were removed while installing the sterndrive. Install both top shields as shown. 2. Tighten the bolts and nuts to specification. c a b 32719d Top shield and bottom shield at transom end (engine end is similar) a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nut 3/8-16 (4) Description Nm lb-in. lb-ft Driveshaft shield bolts and nuts 41 � 30 Predelivery Preparation Refer to the Cummins MerCruiser Diesel Sterndrive Installation Manual for Predelivery Preparation and Inspections. Removal U-Joint Top Shields 1. Remove the bolts and nuts securing the top shields. Retain the fasteners. Page 7C-34 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Remove the top shields. cab32719d Top shield and bottom shield at aft end, engine end similar a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nuts 3/8-16 (4) Sterndrive Refer to the Power Package Installation Manual for your specific model to remove the sterndrive from the transom assembly. Engine Connections Refer to the appropriate power package installation manual to disconnect the following connections: � The transom plate continuity circuit wire to the engine � The electrical wiring harness � The throttle and shift cable installation and adjustments � The water hose � The trim position sender wires � The MerCathode system wires � The fuel lines � The power-assisted steering cable 90-865612060 MAY 2008 Page 7C-35 2.8 ES and 4.2 ES Diesel Sterndrive Models Page 7C-36 90-865612060 MAY 2008 � The power-assisted steering hoses a b c 32720 Quick connect fittings a - Cable tie b - Return hose (to fluid cooler) c - High-pressure hose (from power steering pump) 25771 c b a Threaded fittings a - High-pressure hose (from power steering pump) b - Return hose (to fluid cooler) c - Control valve Driveshaft Extention 1. Loosen all engine mount nuts. If applicable, straighten the tab washer. a b 27767 32760 b a Engine rear mount Engine front mount a - Nut b - Adjustment nut 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. Do not lift the engine at this time. 3. Remove the fasteners securing the front and rear engine mounts to the boat stringers. 4. Remove the fasteners securing the driveshaft to the output flange. bdca 33001 a -Driveshaft b -Bolt 7/16-20 x 1-1/2 (4 on each flange) c -Nut (4 on each flange) d -Engine output shaft flange 5. Remove the fasteners securing the driveshaft to the input flange. abcd33002 a -Bolt 7/16-20 x 1-1/2 (4 on each flange) b -Nut (4 on each flange) c -Transom input shaft flange d -Driveshaft 6. Lift the driveshaft from the input and output flanges and remove it from the boat. Use the hoist to slightly move the engine to allow clearance for the driveshaft to be lifted out. 90-865612060 MAY 2008 Page 7C-37 2.8 ES and 4.2 ES Diesel Sterndrive Models Aft Bearing Support Remove the aft bearing support bolts, washers, and locknuts. Remove the aft bearing support. d -Spherical washer (4), rounded side toward rear bearing support e -Aft bearing support f -Locknut (2) efdcdab6645a -Fiber washer b -Bolt (2) c -Flat washer (2) Engine Shaft Bearing Support NOTE:Theengineshaftbearingsupportassemblyfastenersalsosecuresthespacerplate. 1. Remove the bolts and lock washers from the engine shaft bearing support assembly and remove the assembly and the spacer plate. a35172baaaaa Typical a -Engine shaft bearing support assembly b -Bolt with lock washer (6) Bearing Inspection 1. Inspect the bearing of the engine shaft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace the bearing. Page 7C-38 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Inspect the bearings of the aft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace both bearings, spacer, and the oil seal. Aft Bearing Support Assembly Repair Bottom Safety Shield Removal Remove the safety shield bolts and remove the safety shield. 35137bcaaabc35036 a -Bolts b -Aft bearing support c -Safety shield Bearings and Oil Seal Removal 1. Remove the oil seal from the aft bearing support. 2. Remove the snap ring in the groove of the aft bearing support housing just above the bearing. 3. Use a press and suitable mandrel to press the bearings and the spacer from the aft bearing support housing. Input Shaft Removal 1. Use a suitable mandrel and a press the input shaft from the aft bearing support. abdc35135 a -Press b -Suitable mandrel c -Aft bearing support d -Input shaft 90-865612060 MAY 2008 Page 7C-39 2.8 ES and 4.2 ES Diesel Sterndrive Models Bearings and Oil Seal Install 1. Install the grease fitting to the aft bearing support housing. 35071 2. Grease the inside diameter of the bearing bore in the aft bearing support housing. 35072 3. Use a press and a suitable mandrel and press the bearing, with its open side up, into the bearing bore. abbbfcde35075 a -Bearing open side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support f -Bearing installed Page 7C-40 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 4. Install the spacer. 35076abbc a -Spacer b -Suitable mandrel (guide) c -Aft bearing support 5. Use a press and suitable mandrel and install the second bearing with the covered side up. acdbebbe 35077 a -Bearing covered side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support 6. Install the snap ring in the grove of the housing just above the bearing. 35078 90-865612060 MAY 2008 Page 7C-41 2.8 ES and 4.2 ES Diesel Sterndrive Models 7. Flip the aft bearing support over and press the oil seal into the housing with the lip of the seal facing inside the housing. abcadcda 35079 a -Suitable mandrel (guide) b -Suitable mandrel c -Oil seal d -Aft bearing support Input Shaft Install 1. Install the grease fitting to the input shaft. abc35081 a -Grease fitting b -Input shaft c -Input shaft flange 2. Apply sealant to the inside edge of the shaft and the outside edge of the plug. 35082 Page 7C-42 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models Tube Ref No. Description Where Used Part No. 33 Loctite 680 Retaining Plug for the input shaft 92-809833 Compound 3. Use a press to install the plug into the input shaft. aebcdd35083 a -Plug b -Press c -Suitable mandrel d -Input shaft flange e -Plug installed 4. Grease the inside splines and the outer surface of the input shaft. 35084 90-865612060 MAY 2008 Page 7C-43 2.8 ES and 4.2 ES Diesel Sterndrive Models 5. Align the aft bearing support assembly onto the input shaft with its oil seal facing the shaft flange and the grease fittings aligned. 35085abdc a -Bearing b -Oil seal hidden c -Grease fittings d -Input shaft flange 6. Press the aft bearing support assembly onto the input shaft. ab cd 35086 a -Press b -Suitable mandrel c -Oil seal d -Machined surface on the input shaft 7. Using a hand grease gun pump grease into the aft bearing support grease fitting. 35080 Page 7C-44 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models Bottom Safety Shield Install 1. Apply Loctite to the threads of the safety shield bolts. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Safety shield bolt threads 92-809819 2. Place the safety shield on the aft bearing support and secure it with the bolts. abc35138 a -Bolts b -Aft bearing support c -Safety shield 3. Tighten the bolts to specification. aaabc3503635137bc a -Bolts b -Aft bearing support c -Safety Shield Description Safety shield bolt Nm 41 lb-in. � lb-ft 30 90-865612060 MAY 2008 Page 7C-45 2.8 ES and 4.2 ES Diesel Sterndrive Models Engine Shaft Bearing Support Assembly Repair Output Shaft Removal 1. Remove the snap ring from the groove of the shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft 2. Lift the engine shaft bearing support from the shaft. 34928acb a -Engine shaft bearing support b -Shaft c -Shaft flange 3. Remove the O-rings from the shaft. Page 7C-46 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models Bearing Removal 1. Remove the snap ring from the groove just above the bearing in the engine shaft bearing support. 34937 2. Press the bearing out of the engine shaft bearing support. Discard the bearing. abc34939 a -Engine shaft bearing support b -Press c -Suitable mandrel Bearing Install 1. Grease the bearing bore of the engine shaft bearing support. 90-865612060 MAY 2008 Page 7C-47 2.8 ES and 4.2 ES Diesel Sterndrive Models 2. Insert the grease fitting into the engine shaft bearing support. abc34934 a -Engine shaft bearing support housing b -Bearing bore c -Grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing Bearing bore of engine shaft 42 92-802870A1 Grease bearing support NOTE:The bearing has two grease access holes. 34935 3. Align the bearing to the bearing bore, and align the grease fitting hole to the grease access hole in the bearing. Page 7C-48 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 4. Press the bearing into the engine shaft bearing support. acdefb34936 a -Engine shaft bearing support housing b -Suitable mandrel c -Bearing d -Grease access hole e -Grease fitting f -Bearing installed 5. Insert the snap ring into the groove just above the bearing. 34937 6. Insert grease into the grease fitting. 34966ba a -Grease fitting b -Grease gun 7. Align the engine mount brackets to the engine shaft bearing support as shown. 90-865612060 MAY 2008 Page 7C-49 2.8 ES and 4.2 ES Diesel Sterndrive Models 8. Apply sealant to the threads of the bolts. Hand-start the bolts and lockwashers into the engine shaft bearing support to secure the engine mount brackets. 34938aaccb a -Engine mount bracket (2) b -Engine shaft bearing supportc -Bolt and lockwasher (2) Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Bolt threads 92-809819 Output Shaft Install 1. Install new O-rings on the output shaft. 2. Grease the O-rings and around the output shaft. bbac34925 a -Out put shaft b -O-rings c -Grease Tube Ref No. Description U-joint and Gimbal Bearing Grease Where Used Output shaft Part No. 92-802870A1 42 Page 7C-50 90-865612060 MAY 2008 2.8 ES and 4.2 ES Diesel Sterndrive Models 3. Grease the inner diameter of the bearing in the engine shaft bearing support. abc34927 a -Engine shaft bearing support b -Grease applicator c -Inside diameter of bearing Tube Ref No. 42 Description U-joint and Gimbal Bearing Grease Where Used Bearing ID Part No. 92-802870A1 4. Insert the shaft. 34928acb a -Engine shaft bearing support b -Shaft c -Shaft flange 90-865612060 MAY 2008 Page 7C-51 2.8 ES and 4.2 ES Diesel Sterndrive Models 5. Insert the snap ring into the groove of the output shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft Page 7C-52 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Driveshaft Extention (Jackshaft) Section 7D - QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Table of Contents General Information..7D-2 Driveshaft Extension Application.............7D-2 Driveshaft Extention QSD Kit Information ....7D-3 Continuity Circuit Ground Wire................7D-4 Driveshaft Extension Maintenance.................7D-4 Scheduled Maintenance�Driveshaft Extension...7D-4 Lubrication Points....................................7D-4 Driveshaft Extension Inspection and Maintenance...7D-5 Installation...7D-6 Seawater Inlet System Preparation..........7D-6 Gear lube Monitor....................................7D-9 Shift Plate...7D-11 Exhaust Block-Off Plate.........................7D-11 Aft Bearing Support...............................7D-12 Engine Preparation...............................7D-15 Engine Placement................................7D-22 Protractor..7D-23 Engine Alignment..................................7D-24 Driveshaft Lubrication............................7D-33 Continuity Curcuit Ground Wire.............7D-34 Engine Connections..............................7D-34 Sterndrive With a Driveshaft Extension (Jackshaft) Assembly............................7D-35 Aligning the Cross Bearings Centerline ....7D-35 Top Safety Shields...............................7D-38 Predelivery Preparation.........................7D-38 Removal...7D-38 U-Joint Top Shields...............................7D-38 Sterndrive..7D-39 Engine

Connections..............................7D-39 Removing the Driveshaft.......................7D-40 Aft Bearing Support...............................7D-42 Engine Shaft Bearing Support...............7D-42 Bearing Inspection................................7D-42 Aft Bearing Support Assembly Repair...........7D-43 Bottom Safety Shield Removal...............7D-43 Bearings and Oil Seal Removal.............7D-43 Input Shaft Removal..............................7D-43 Bearings and Oil Seal Install.................7D-44 Input Shaft Install..................................7D-46 Bottom Safety Shield Install...................7D-49 Engine Shaft Bearing Support Assembly Repair ....7D-50 Output Shaft Removal...........................7D-50 Bearing Removal..................................7D-51 Bearing Install.......................................7D-51 Output Shaft Install...............................7D-54 7 D 90-865612060 MAY 2008 Page 7D-1 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Lubricants, Sealants, Adhesives Tube Ref No. Description Where Used Engine coupler bolt threads Adapter ring bolt threads Threads of bolts for flywheel housing cover 7 Loctite 271 Threadlocker Tailstock assembly bolt threads Engine rear mount bracket bolts Threads of bolt for safety shields Safety shield bolt threads 33 Loctite 680 Retaining Compound Plug for the input shaft Grease fittings 42 U-joint and Gimbal Bearing Grease Bearing bore of engine shaft bearing support Output shaft Bearing ID 91 Engine Coupler Spline Grease Splines of the engine coupler Special Tools Tapered Insert Tool 91-43579 Part No. 92-809819 92-809833 92-802870A1 92-802869A 1 Removes and installs the tapered insert retainer into the water inlet hose. 9197 Alignment Tool Assembly 91-805475A 1 Used to align the engine to the transom assembly for sterndrive installation. 9183 Alignment Bar 8M2001017 Aids in aligning the engine to the transom assembly for 26831 sterndrive installation. General Information Driveshaft Extension Application DRIVESHAFT EXTENSION The driveshaft extension (jackshaft) converts a standard sterndrive package into a driveshaft configuration. A long driveshaft is installed between the engine and the transom assembly. The driveshaft installation moves the weight of the engine forward in the boat providing a better center of gravity and improved boat operation. The driveshaft extension is used with triple, dual, and single engine applications in smaller boats. When the driveshaft extention is installed in boats with center console or staggered engine designs it helps the boat get up on plane quickly. The driveshaft extension is available as a kit and must be used in conjunction with the recommended driveshaft. Other kits or parts are listed with the kit for the specific engine models. The driveshaft is ordered separately. Page 7D-2 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7D-3 Access must be provided to grease fittings on the driveshaft U-joints, input shaft, and bearing supports to allow for scheduled maintenance. 33872 a b d c a - 1�3� driveshaft angle required b - Driveshaft extension c - Driveshaft U-joint flange connected to output shaft (engine shaft bearing support) d - Driveshaft U-joint flange connected to input shaft (aft bearing support) ENGINE / EXHAUST Through the transom exhaust system is required for this engine model. For critical power package dimensions and requirements refer to the latest Cummins MerCruiser Diesel OEM CD or installation drawings. MEASUREMENTS We recommend a universal protractor or digital inclinometer for measuring the angles during installation steps. 34826 Universal protractor Digital inclinometer Driveshaft Extention QSD Kit Information Use the driveshaft extension kit in conjunction with the following kits (ordered separately): � Driveshaft Kit 876 mm (34.5 in.) 45-94819T5�contains driveshaft only � QSD 2.8L Diesel Sterndrive Engines use two engine mounts 855454 � QSD 4.2L Diesel Sterndrive Engines use two engine mounts 89632029 ..SD 2.8 and ..SD 4.2 Diesel Sterndrive Models Continuity Circuit Ground Wire SD 2.8 and ..SD 4.2 Diesel Sterndrive Models Continuity Circuit Ground Wire In some applications, the transom ground wire will not reach the engine ground or the battery ground connection. This ground wire connection is required to complete the continuity circuit. You must construct a new ground wire long enough to attach to the transom grounding screw and the engine grounding stud or battery ground. ab33323Typical a -Transom grounding screw b -Transom ground wire Driveshaft Extension Maintenance Scheduled Maintenance�Driveshaft Extension Refer to the appropriate manual for power package maintenance and Inspections. Perform the following maintenance at the required task intervail. Task Interval Maintenance to Be Performed Every 100 hours or annually (whichever occurs first) � Lubricate the driveshaft U-joints. � Lubricate the input shaft. � Lubricate the aft bearing support (input) � Lubricate the engine shaft bearing support (output) � Inspect the driveshaft U-joints. Every 300 hours or 3 years (whichever occurs first) � Engine shaft bearing support inspection � Aft bearing support inspection Lubrication Points Lubricate the bearings grease fittings every 100 hours or annually (whichever occurs first). 1. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the following grease fittings: � Aft bearing support grease fitting � Input shaft grease fitting � Engine shaft bearing support grease fitting Page 7D-4 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 2. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into the driveshaft U-joint grease fittings on the transom and engine end. b a e dc 35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting at transom end d -U-joint grease fitting at engine end e -Engine shaft bearing support grease fitting Driveshaft Extension Inspection and Maintenance U-JOINT INSPECTION Preform the U-joint inspection every 100 hours or annually (whichever occurs first). 1. Remove the driveshaft. 2. Rotate the U-joint on the output and the input end of the driveshaft. The movement of each U-joint yoke, socket, and cross bearing assembly should be smooth. 3. Replace the cross and bearing assembly if the seals are deteriorated or if movement is tight or rough. 4. Reinstall the driveshaft. ENGINE SHAFT BEARING SUPPORT INSPECTION Perform the engine shaft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the engine shaft bearing support assembly. 2. Rotate the output shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearing. See Engine Shaft Bearing Support Assembly Repair. AFT BEARING SUPPORT INSPECTION Perform the aft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the aft bearing support assembly. 2. Rotate the input shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearings, spacer, and the oil seal. See Aft Bearing Support Assembly Repair. 90-865612060 MAY 2008 Page 7D-5 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Installation Seawater Inlet System Preparation Follow the instructions provided with the Thru-The-Hull Seawater Pickup Kit before installing the drive shaft extension. SEAWATER HOSE IMPORTANT: Use a wire-reinforced seawater hose with an adequate wall thickness to keep the hose from collapsing when the seawater pump impeller creates suction. Secure the hose connections with hose clamps. Secure the hose to prevent contact with any moving parts. SPECIFICATIONS Description Seawater pickup�through-the-hull or through-the-transom mounted. Seacock size (internal cross-sectional area). Seawater inlet hose inner diameter (adapter provided for hose). Seawater strainer flow rate. Seawater inlet restriction. SEAWATER STRAINER All Models Minimum 150 L/min. (40 US gal/min) At least: 38 mm (1-1/2 in.) Minimum 38 mm (1-1/2 in.) Minimum 150 L/min. (40 US gal/min) Maximum 125 mm Hg (5 in. Hg) Refer to the power package installation manual for installation, operation, and maintenance instructions. INSTALLING THE STERNDRIVE SEAWATER BLOCK-OFF PLATE Seawater for engine cooling must be supplied through an alternate (separate) seawater pickup instead of through the sterndrive. When using a separate seawater pickup, block the sterndrive seawater passage and cut the water hose that is located between the bell housing and the gimbal housing. This allows water to continue to circulate through the sterndrive for cooling. NOTICE Obstructions in the water passages will keep cooling water from circulating through the sterndrive resulting in damage to the sterndrive. When using a block-off plate ensure that the water hose between the bell housing and gimble housing is cut and removed. Page 7D-6 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 1. Remove the tapered insert in the gimbal housing using the tapered insert tool. Discard the insert. 17857cdba a -Tapered insert location in the gimbal housing b -Ratchet and extension c -Tapered insert d -Tapered insert tool Tapered Insert Tool 91-43579 2. Install the block-off plate with new gasket. Secure with screws and lockwashers. Tighten the screws to specification. aabdc a -Block-off plate b -Gasket c -Screw d -Lockwasher 21683 Description Water inlet block-off screw Nm 5 lb-in. 45 lb-ft � 90-865612060 MAY 2008 Page 7D-7 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 3. Move the trim limit switch wires and speedometer hose aside. Reach between the gimbal housing and the bell housing and detach the water hose from the gimbal housing where the tapered insert was removed. abecd8489 a -Trim limit switch wires b -Speedometer hose c -Gimbal housing d -Water hose e -Tapered insert NOTE:Move the trim limit switch wires and speedometer hose to avoid damaging themwhen cutting the water hose. The existing tie strap and clip can be reused if they are movedand repositioned after the hose is cut. 4. Cut completely through the water hose 127 mm (5 in.) in front of the aft end of the hose where it is fitted into the bell housing in the area shown. Do not damage the U-joint bellows. 5. Discard the loose hose piece. 6. Secure the trim limit switch wires and speedometer hose to the remaining section of water hose using the existing tie strap and clip. abdf33405cea -Water inlet hose b -Trim limit wire harness c -Tie strap d -Cutting area e -Clip f -Speedometer hose 7. Install a through-the-hull or through-the-transom seawater pickup, seawater strainer, and seacock. Page 7D-8 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 8. Connect the seawater inlet hose between the seawater pump and seawater strainer. 9. Secure all hoses with hose clamps. Gear lube Monitor Relocate the engine mounted gear lube monitor to the boat transom when applicable. The transom mounted bracket and accessories can be ordered in a gear lube monitor relocation kit or included in the driveshaft extension kit. 1. Disconnect audio warning system wires from the gear lube monitor on the engine. 2. Remove the gear lube monitor from the bracket. 3. Remove the bracket. 4. Connect the sterndrive gear lube monitor hose to the quick release 90� fitting and secure it with a stay strap. 5. Connect the quick release 90� fitting to the gimbal housing fitting. Position the fitting so the release button will not contact the seawater inlet fitting or block-off plate if equipped. 6. Route the gear lube monitor hose and secure with J-clip. 34736bca a -Quick release 90� fitting b -Gear lube hose c -J-clip 90-865612060 MAY 2008 Page 7D-9 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 7. Install the bracket to the boat transom so the gear lube monitor will be higher than the steering lever on the transom assembly. Secure the bracket with lag screws and flat washers as shown. defaghbc6637a -Gear lube monitor bracket b -Lag bolt and washer (2 each) c -Gear lube monitor d -Cap e -Audio warning system wires f -Retaining strap g -Gear lube hose h -Hose clamp IMPORTANT: Do not allow kinks in the gear lube lube monitor hose. The gear lube monitor will not function properly if the hose is kinked and damage to the sterndrive could occur. Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. 8. Install the gear lube monitor in the bracket and secure it with the retaining strap. 9. Route the gear lube hose to the monitor and cut off excess hose. Connect the hose to the monitor and secure it with a hose clamp. 34815abcde a -Gear lube monitor is higher than the steering lever b -Gear lube monitor c -Bracket d -Gear lube hose e -Audio warning system connectors 10. Connect the audio warning system wires to the gear lube monitor. Use the extension harness from the kit if applicable. Page 7D-10 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7D-11 11. Use cable ties to secure the wires away from moving parts. Shift Plate For driveshaft lengths over 71 cm (28 in.) the shift plate must be relocated to the boat transom. The mounting location must allow for proper cable routing with 20 cm (8 in.) radius bends minimum. IMPORTANT: The shift plate assembly must be mounted within the limits of the sterndrive shift cable. Be sure that the mounting location will not interfere with other moving components. 1. Disconnect the shift plate connector from the engine harness. 6674 Bravo shift bracket 2. Remove the shift plate from the exhaust elbow. IMPORTANT: The shift plate and the bracket assembly must be mounted within limits of the sterndrive shift cable. Ensure that the mounting location will not cause interference with other moving components. 3. Attach the shift plate to the bracket and secure it with the hardware provided. Mount the bracket to the desired location. 4. Install the mounting bracket in the desired location on the inner transom using two long lag screws and two washers. b a 6676 Bravo shift bracket and shift plate a - Bracket b - Shift plate assembly Exhaust Block-Off Plate Use the exhaust block-off plate when the engine is installed with a through-transom exhaust system. The through-propeller exhaust route is blocked with a block-off plate. QSD 2.8 and QSD 4.2 Diesel Sterndrive Models IMPORTANT: When equipped with an exhaust block-off plate, the gimbal housing and exhaust block-off plate mating surfaces must be clean and free of nicks and scratches, and the O-ring must be properly seated in the groove, or water may leak into boat. 1. Ensure that the gimbal housing mating surface is clean and free of nicks and scratches. 2. The O-ring must be properly seated in the groove. a21630 a -O-ring 3. Ensure that the block-off plate mating surface is clean and free of nicks and scratches. 4. Install the block-off plate with the decal toward the engine. 5. Secure with four bolts and lockwashers. 6. Torque the bolts. a21625bca a -Block-off plate b -Bolts c -Lockwashers Description Nm lb. in. Exhaust block-off plate bolts 34 � Aft Bearing Support The aft bearing support assembly mounts on the inner transom plate. lb. ft. 25 34749 Page 7D-12 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7D-13 1. Remove the fiber washers and adhesive from the inner transom plate. 32696 IMPORTANT: The spherical washers must be positioned so that the rounded side of the washers are toward the bearing support assembly as shown. 2. Install the aft bearing support assembly on the inner transom plate using the hardware as shown. Tighten the bolts until the locknuts contact the bottom of the transom. Do completely tighten the bolts at this time.. d b e c c a 12565 a - Bolts (2) b - Flat washer (2) c - Spherical washer (4) d - Bearing support e - Locknut (2) 3. Align the bearing support assembly as follows: QSD 2.8 and QSD 4.2 Diesel Sterndrive Models a. Open the perforated area in the bell housing dust cover. 32697 Dust cover IMPORTANT: Alignment tools from other manufacturers may improperly align and damage the gimbal bearing, bearing support, or engine coupler. Use one of the listed Quicksilver alignment tools; The Alignment Tool Assembly, or Alignment Bar. b. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the input shaft splines. ab32699 a -Alignment tool b -Insert this end through gimbal housing Alignment Tool Assembly 91-805475A 1 Alignment Bar 8M2001017 IMPORTANT: Both attaching bolts must be firmly struck in the following step to properly seat the spherical washers. Failure to follow this procedure may result in a difficult installation of the sterndrive. Page 7D-14 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models c. Tap the head of both bearing support attaching bolts with a soft hammer. Check the alignment. When the alignment tool slides freely into the input shaft splines, tighten the bolts to specification. 32700 Alignment tool Description Nm lb-in. lb-ft Bearing support bolts on transom 68 � 50 Engine Preparation IMPORTANT: Do not allow the engine to rest on the oil pan. 1. Support the engine. NOTE:Recordthepositionofanyitemsattachedtotheflywheelhousingcover,including thepositionandlengthofthefastenersbeingremoved.Notethepositionandorientation of any electrical harness wires and retainers. 2. Remove the existing flywheel housing cover. 27415cbaabc a -Bolt and washer b -Flywheel housing cover c -Engine coupler 90-865612060 MAY 2008 Page 7D-15 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 3. Remove the existing outer engine coupler from the inner two-stage coupling. Retain the bolts and washers. ba27416 a -Existing outer engine coupler b -Bolt and washer (6) for engine coupler NOTE:The bolt holes of the two-stage coupling may be cleaned with a wire brush to removeold adhesive from the threads. 4. Apply adhesive to the threads of the engine coupler bolts. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Engine coupler bolt threads 92-809819 5. Install the new engine coupler and secure it with the engine coupler bolts and the washers retained previously. 6. Tighten the bolts to specification. 27419abcd a -Engine flywheel b -Engine two-stage coupling c -New engine coupler d -Bolt and washer (6) for engine coupler Description Bolt for engine coupler Nm 72 lb-in. � lb-ft 53 Page 7D-16 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 7. Lubricate the engine coupler splines with a liberal amount of grease. ba27418 a -Engine coupler b -Splines Tube Ref No. Description Where Used Part No. Engine Coupler Spline Grease Splines of the engine coupler 92-802869A 1 8. Apply Loctite to the threads of each adapter ring bolt M10 � 25 mm. 91 Tube Ref No. Description Where Used Part No. Loctite 271 Threadlocker Adapter ring bolt threads 92-809819 7 NOTE:You must orient the adapter ring as shown or the tailstock assembly can not beinstalled. 9. Install the new SAE 4 to SAE 5 adapter ring to the flywheel housing cover with the bolt holes positioned exactly as shown and secure with the adapter ring bolts. 33072 Correct position Incorrect position 90-865612060 MAY 2008 Page 7D-17 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 10. Tighten the bolts to specification. ab27422c The correct position of the tailstock assembly bolt holes a -Adapter ring b -Adapter ring bolt (12) c -Tailstock assembly bolt holes (8) Description Nm lb-in. lb-ft Adapter ring bolt 50 � 37 11. Apply adhesive to the threads of eight new flywheel housing cover bolts M10 � 50 mm. Tube Ref No. Description Where Used Part No. Threads of bolts for flywheel 7 Loctite 271 Threadlocker 92-809819 housing cover 12. Install the flywheel housing cover with the bearing support bolt holes positioned exactly as shown. Secure the flywheel housing cover with the flywheel housing cover bolts. cca27432bb a -New flywheel housing cover b -Engine grease inserts c -Bearing support bolt holes correct position Page 7D-18 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 13. Tighten the flywheel housing cover bolts to specification. 27423abba a -New flywheel housing cover b -Flywheel housing cover bolt (8) Description Bolts for flywheel housing cover Nm 50 lb-in. � lb-ft 37 NOTE:The tailstock assembly fasteners also secures the spacer plate. 27424ab a -New flywheel housing cover b -Spacer plate 14. Apply adhesive to the threads of six new tailstock assembly bolts M10 � 60 mm. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Tailstock assembly bolt threads 92-809819 15. Position the tailstock assembly so that the grease fitting is upward and install the tailstock assembly on top of the spacer plate on the flywheel housing cover. 90-865612060 MAY 2008 Page 7D-19 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 16. Install the tailstock assembly bolts using new lockwashers. Tighten the bolts to specification. abcccccc27431 a -Tailstock assembly b -Grease fitting c -Bolt with lock washer (6) Description Bolts for tailstock assembly 17. Apply sealant to the threads of the engine rear mount bracket bolts. Nm lb-in. 51 � lb-ft 35 Tube Ref No. Description Loctite 271 Threadlocker Where Used Engine rear mount bracket bolts Part No. 92-809819 7 18. Install an engine rear mount bracket on the port and starboard side of the engine flywheel housing. 19. Install the engine rear mount bracket bolts. Tighten the bolts to specification. 32736cadba -Engine flywheel housing b -Mounting bolt holes c -Engine rear mount bracket d -Engine rear mount slotted hole Page 7D-20 90-865612060 MAY 2008 ..SD 2.8 and ..SD 4.2 Diesel Sterndrive Models Description Nm lb-in. lb-ft Engine rear mount bracket bolt 75 � 55 SD 2.8 and ..SD 4.2 Diesel Sterndrive Models Description Nm lb-in. lb-ft Engine rear mount bracket bolt 75 � 55 NOTE :Ensure that all adjustment nuts are equally positioned midway on the studs to allowup or down engine alignment. 20. Install the engine rear mounts and adjustment nuts from the bottom of the engine rear mount brackets. Hand-start the locknut on each engine rear mount stud. Do not tighten the nuts at this time. abcd 32737 ac - -Engine rear mount bracket b -Locknut Adjustment nut d -Engine rear mount 21. Install the new power-assisted steering hoses as follows: NOTE:Drain fluid from the pump and hoses into a suitable container. a. Note the routing of the existing high-pressure hose. Remove it from the pump. IMPORTANT: Do not cross-thread or over-tighten the hose fittings. b. Visually inspect the new high-pressure hose, threaded fitting, and O-ring. The O-ring must be seated in the groove of the threaded fitting. Route the new hose assembly to the pump and install the fitting into the pump assembly. Position the hose as needed, and tighten the fitting securely. Do not connect the high-pressure hose quick connection to the control valve until after the engine is aligned. 32511ba a -Pressure hose b -O-ring 90-865612060 MAY 2008 Page 7D-21 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models c. Note the return hose routing from the control valve to the fluid cooler. Loosen the hose clamp at the fluid cooler and remove the return hose. d. Route the new return hose assembly to the fluid cooler and install it using the existing hose clamp. Tighten the hose clamp. Do not connect the return hose quick connection to the control valve until after the engine is aligned. e. Route and secure hoses with the J-clip. NOTE:The hose must enter the power steering control valve from the starboard side. 22. Install the long seawater inlet hose. Fasten to boat stringer as needed with the three clips. Engine Placement NOTE:For ease of installation, we recommend the use of a chain leveler in the following steps. NOTE:If the engine will be tested after installation, install the drain plugs at this time. 1. Ensure that the engine mounts are equally adjusted. If not, adjust the engine mounts so that they can be adjusted equally up or down. ! CAUTION Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components. ! WARNING Failure of the lifting eyes will cause the engine to fall suddenly from the hoist, resulting in serious injury, death, or property damage. Keep the engine level while it is hoisted. Do not tilt the engine more than 12� in any direction during installation. 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. 3. Lift the engine and place it into its approximate position in the boat using an overhead hoist. � Leave clearance space equal to the length of your driveshaft between the engine output shaft flange and the aft input flange. Page 7D-22 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models � Set the engine so that the clearance space for your driveshaft length will allow 8 mm (5/16 in.) clearance between the shoulder of the engine output shaft and the bearing in the engine shaft bearing support. The engine output shaft flange has a total lateral endplay of 16 mm (5/8 in.). abca32713 a -8 mm (5/16 in.) b -Bearing in engine shaft bearing support c -Shoulder of output shaft Clearance Between Output Shaft and Bearing Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) Protractor NOTE:We recommend a universal protractor for measuring the angles in the following steps. IMPORTANT: In the following steps, the protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0� and the 90� marks will be used. These are only reference marks. Use these marks to determine how many degrees and to which side (right or left) of the reference mark the needle is. View the protractor from the same side of the power package throughout the installation. 32701 Reference mark 90-865612060 MAY 2008 Page 7D-23 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Engine Alignment READING AT THE INPUT SHAFT FLANGE�REFERENCE POINT IMPORTANT: Do not move the boat after taking the reading from the input shaft flange, because this reading establishes a reference point for aligning the driveshaft and engine. If the boat moves, the reference point may change, leading to improper alignment of the driveshaft and engine. 1. Position the base of protractor against the input shaft flange, as shown. Record the number of degrees, and to which side of the reference mark the indicator needle has moved. 2. Record your data in the chart provided. c b a 6665 a -Input shaft flange b -Protractor c -Indicator needle Direction the Indicator Reading Location Reading Specification Needle Has Moved Reading at input shaft Reference point flange MEASURING THE ENGINE AND DRIVESHAFT LATERAL ALIGNMENT 1. Measure the length of (a) and (b) from the centers of the bolt holes. They must be within � 6.35 mm (0.25 in.) of each other. Page 7D-24 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 2. If the dimensions are not as specified, slide the forward and aft ends of the engine equally in opposite directions to obtain the specified lengths for (a) and (b) while maintaining the driveshaft length � 8 mm (5/16 in.). bac 33066 Engine position for the correct engine and driveshaft lateral alignment Engine and Driveshaft Lateral Alignment Dimensions Dimension a � 6.35 mm (0.25 in.) of dimension b Dimension b � 6.35 mm (0.25 in.) of dimension a Dimension c Driveshaft length � 8 mm (5/16 in.) READING AND ALIGNING THE ENGINE OUTPUT 1. Position the base of protractor against the engine output shaft flange, as shown. 2. Compare the protractor reading to the previously recorded reference point reading at the transom input shaft flange. The measurement between the two flanges must be within 1 degree. NOTE:Move the adjustment nut counter clockwise to raise the engine, or clockwise tolower the engine. 3. Raise or lower the front engine mount adjusting nuts equally until the protractor needle reads exactly the same number of degrees as the reference point at the transom input shaft flange. 90-865612060 MAY 2008 Page 7D-25 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 4. Record your data in the chart provided. a b c 32991 a -Protractor b -Indicator needle c -Output shaft flange Reading Location Reading at input shaft flange Reading at output shaft flange Reading Direction the Indicator Needle Has Moved Specification Reference point � 1 degree of the reference point reading at the input shaft flange ATTACHING THE DRIVESHAFT UNIVERSAL JOINTS NOTICE Misaligned flanges can allow the bolts to come loose during operation, resulting in product damage. Align the flanges flush with one another before tightening the bolts. Page 7D-26 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7D-27 1. Attach the driveshaft input shaft flange and output shaft flange, as shown. Tighten the fasteners to specification. a b c d d b e 32698 a - Bolt 7/16-20 x 1-1/2 (4 on each flange) b - Nut (4 on each flange) c - Transom input shaft flange d - Driveshaft e - Engine output shaft flange Description Nm lb-in. lb-ft Fasteners for driveshaft input shaft flange and output shaft flange 68 � 50 READING AND SETTING THE DRIVESHAFT ANGLE NOTICE Operating the engine with the driveshaft installed at an incorrect angle will result in damage to the driveshaft and the universal joint bearings. Align the engine correctly before operating. 1. Position the base of the protractor on the driveshaft. 2. Compare the protractor reading to the previously recorded reference point reading at the transom input shaft flange. The driveshaft angle must be within 1�3� from either side of the reference point reading. 3. Raise or lower the engine equally until the protractor needle reads exactly as specified. 4. If you are unable to achieve � 1�3� of angle to the driveshaft, adjust the stringer height so that the engine mounts have an equal amount of up and down adjustment. QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 5. Record the readings in the following chart for later use. b a c 6246 a -Driveshaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at output shaft flange Reading at setting driveshaft angle Reading Direction the Indicator Needle Has Moved Specification Reference point � 1� of the reference point reading at the input flange � 1�3� from either side of the reference point VERIFYING THE ALIGNMENTS AND SPECIFICATIONS 1. Relieve the hoist tension from the engine 2. Remove the driveshaft. 3. Verify that the input and output flanges are still parallel, set the protractor on both the output flange and the input flange. The measurement between the two flanges must match � 1�. Page 7D-28 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 4. Record your data in the chart provided. a b c 32991 a -Protractor b -Indicator needle c -Output shaft flange Reading Location Reading at input shaft flange Reading at output shaft flange Reading Direction the Indicator Needle Has Moved Specification Reference point � 1� of the reference point reading at the input flange 5. Re-install the driveshaft to the input flange only. Tighten the mounting bolts to specification. a b c d 33002 a -Bolt 7/16-20 x 1-1/2 (4 on each flange) b -Nut (4 on each flange) c -Transom input shaft flange d -Driveshaft Description Nm lb-in. lb-ft Fasteners for driveshaft input shaft flange and output shaft flange 68 � 50 6. Place the driveshaft against the engine output flange and install a bolt without the nut to position it in place. Do not bolt the driveshaft to the flange. 90-865612060 MAY 2008 Page 7D-29 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 7. Measure between the output shaft shoulder and the bearing in the engine shaft bearing support assembly. 8. If the measurement is not as specified, slide the engine fore or aft as needed to obtain the specified clearance. a b c a 32713 a -8 mm (5/16 in.) b -Bearing in the engine shaft bearing support c -Output shaft shoulder Clearance for the Driveshaft Lateral Endplay Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) 9. Recheck the engine and driveshaft lateral alignment as described in Measuring the Engine and Driveshaft Lateral Alignment. b a 32753 These dimensions must be � 6.35 mm (0.25 in.) of each other a -Dimension a b -Dimension b Engine and Driveshaft Lateral Alignment Dimensions Dimension a � 6.35 mm (0.25 in.) of dimension b Dimension b � 6.35 mm (0.25 in.) of dimension a 10. If the engine and driveshaft lateral alignment dimensions meet the specifications, move to step 11. 11. If the specifications are not met, perform the following steps. a. Adjust the lateral alignment as described in Measuring the Engine and Driveshaft Lateral Alignment Page 7D-30 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7D-31 b. Recheck the Clearance for the Driveshaft Lateral Endplay. If the measurement is not as specified, slide the engine fore or aft as needed to obtain the specified clearance. a b c a 32713 a - 8 mm (5/16 in.) b - Bearing of the engine shaft bearing support c - Output shaft shoulder Clearance for the Driveshaft Lateral Endplay Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) c. Continue this process until the Engine and Driveshaft Lateral Alignment Dimensions and the Clearance for the Driveshaft Lateral Endplay measurements are as specified. 12. Complete the installation of the driveshaft to the output flange, torque the mounting bolts. b d 33001 c a a - Driveshaft b - Bolt 7/16-20 x 1-1/2 (4 on each flange) c - Nut (4 on each flange) d - Engine output shaft flange Description Nm lb-in. lb-ft Fasteners for driveshaft input shaft flange and output shaft flange 68 � 50 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Page 7D-32 90-865612060 MAY 2008 FRONT AND REAR ENGINE MOUNTS�QSD 2.8L/4.2L ONLY 1. After the engine has been aligned correctly, fasten the front and rear engine mounts to the boat stringers. Tighten securely. a b 32746 32754 a b Engine rear mount Engine front mount a - Fasteners b - Boat stringer 2. Position the protractor on the driveshaft and recheck the angle. The angle should be � 1�3� from either side of the reference point reading at the input flange (the same as that recorded earlier). If not, raise or lower all four engine mount adjustment nuts an equal amount until the correct angle is reached. NOTE: Move the adjustment nut counter-clockwise to raise the engine, or clockwise to lower the engine. 3. Record your data in the chart provided. a b 32717 c 32761 d a - Driveshaft b - Protractor c - Engine front mount adjustment nut d - Engine rear mount adjustment nut Reading Location Reading Direction the Indicator Needle Has Moved Specification Reading at input shaft flange Reference point Reading at output shaft flange � 1� of the reference point reading at the input flange Reading at setting driveshaft angle � 1�3� from either side of the reference point QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7D-33 4. Tighten all engine mount nuts securely. If applicable, bend the washer tab down on each adjustment nut. a b 27767 32760 b a Engine rear mount Engine front mount a - Locknut b - Adjustment nut 5. Check the engine input alignment to ensure it has not changed. Insert the alignment tool through the gimbal bearing and into the input shaft splines. The tool must slide in and out of the splines with little or no friction. Remove the alignment tool. Alignment Tool Assembly 91-805475A 1 NOTE: If the sterndrive will not be installed at this point of the installation, fold the bell housing dust cover cutout back into place for boat shipment. SAFETY SHIELDS 1. Apply adhesive to the threads of the bottom driveshaft shield retaining bolts Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Threads of bolt for safety shields 92-809819 2. Install a bottom safety shield on each bearing support, the engine shaft bearing support and the aft bearing support. Tighten the bolts to specification. Description Nm lb-in. lb-ft Bolts safety shields to engine and aft bearing supports 41 � 30 Driveshaft Lubrication 1. Lubricate the driveshaft U-joints, input shaft, aft bearing support, and engine shaft bearings support as follows: a. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the aft bearing support grease fitting, input shaft grease fitting, and the engine shaft bearings support grease fitting. QSD 2.8 and QSD 4.2 Diesel Sterndrive Models b. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into both driveshaft U-joint grease fittings. baedc35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting aft end d -U-joint grease fitting engine end e -Engine shaft bearings support grease fitting Tube Ref No. Description Where Used Part No. 42 U-joint and Gimbal Bearing Grease fittings 92-802870A1 Grease Continuity Curcuit Ground Wire The transom ground wire must be connected to complete the continuity circuit. If the transom ground wire will not reach the engine ground or the battery ground connection, follow the instructions below. 1. Construct a new ground wire using a 14 gauge wire and an eye ring connector on each end. The ground wire must be long enough to attach to the transom grounding screw and the engine grounding stud or battery ground. 2. Attach one end of the ground wire to the transom grounding screw and the opposite end to the engine grounding stud or the battery ground. Engine Connections IMPORTANT: Use a continuity wire from the engine ground to the transom assembly to complete the continuity curcuit. Refer to the power package installation manual for your specific model to make the following connections: � Transom plate continuity curcuit wire to the engine � Electrical wiring harness � Throttle and shift cable installation and adjustments � Water hose � Trim position sender wires � MerCathode system wires � Fuel lines � Power-assisted steering hoses � Power-assisted steering cable Page 7D-34 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models IMPORTANT: When installing power steering hoses, route toward the starboard side as shown. a b c 32720 a -Cable tie b -Return hose (to fluid cooler) c -High-pressure hose (from power steering pump) Sterndrive With a Driveshaft Extension (Jackshaft) Assembly IMPORTANT: Follow the normal procedure for installing the sterndrive except the following. When the sterndrive is installed, the sterndrive U-joint centerline must be positioned on the same plane as the driveshaft extension (jackshaft) U-joint centerline. See Aligning the Cross Bearings Centerline, before installing the sterndrive. If applicable, the driveshaft extension (jackshaft) U-joint top shields may be removed for sterndrive installation. Install the U-joint top shields before operation. See Installing the U-Joint Top Shields. 34819 Aligning the U-joint cross bearings Refer to the Cummins MerCruiser Diesel Sterndrive Installation Manual for the normal procedure for sterndrive installation. Aligning the Cross Bearings Centerline ! CAUTION Misaligned cross bearings can cause driveshaft failure, leading to possible injury. The driveshaft U-joint cross bearings of both the drive and the driveshaft extension must operate in the same plane to prevent excessive vibration. Align the bearings to operate in the same plane. 90-865612060 MAY 2008 Page 7D-35 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 1. Momentarily engage the starter motor so that the centerline of the driveshaft yoke is positioned vertically. abc32721 a -Drive shaft extension U-joint yoke b -Bearing support input U-joint yoke c -U-joint cross bearing centerline (vertical) 2. Place a reference mark on the input shaft to correspond with centerline. abc32722 a -Bearing support assembly b -Reference mark c -Input shaft Page 7D-36 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 3. Rotate the sterndrive U-joint shaft so that the centerline of the forward yoke is positioned vertically. The U-Joint must be positioned in this manner when it is installed so that it will be running in the same plane as the extension driveshaft U-joint cross bearings. 32723c b a a -U-joint cross bearing centerline (vertical) b -Forward yoke c -U-joint shaft 4. Using a paint marker, draw a reference mark on the universal joint shaft to correspond with the centerline. NOTE:Draw the referance mark at either location shown that will be easy for you to viewwhile installing the sterndrive. a a b 32768 a -Reference mark location b -Cernterline 5. Install the sterndrive following the instructions in the Cummins MerCruiser Diesel Sterndrive Installation Manual. Make sure the U-joint centerline is in the same plane as the driveshaft extension centerline. 90-865612060 MAY 2008 Page 7D-37 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Top Safety Shields The safety shields mount on the engine shaft bearing support and the aft bearing support assemblies to completely cover the driveshaft U-joints and prevent possible injury from moving parts. 34746 1. Install the top safety shields If they were removed while installing the sterndrive. Install both top shields as shown. 2. Tighten the bolts and nuts to specification. c a b 32719d Top shield and bottom shield at transom end (engine end is similar) a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nut 3/8-16 (4) Description Nm lb-in. lb-ft Driveshaft shield bolts and nuts 41 � 30 Predelivery Preparation Refer to the Cummins MerCruiser Diesel Sterndrive Installation Manual for Predelivery Preparation and Inspections. Removal U-Joint Top Shields 1. Remove the bolts and nuts securing the top shields. Retain the fasteners. Page 7D-38 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 2. Remove the top shields. cab32719d Top shield and bottom shield at aft end, engine end similar a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nuts 3/8-16 (4) Sterndrive Refer to the Power Package Installation Manual for your specific model to remove the sterndrive from the transom assembly. Engine Connections Refer to the appropriate power package service manual to remove the following connections: � The continuity wire from the engine ground to the transom assembly � The electrical wiring harness � The throttle and shift cable � The seawater supply hoses � The trim position sender wires � The MerCathode system wires � The fuel lines � The power-assisted steering hoses � The power-assisted steering cable 90-865612060 MAY 2008 Page 7D-39 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Page 7D-40 90-865612060 MAY 2008 Removing the Driveshaft 1. Loosen all engine mount nuts. If applicable, bend the washer tab off the adjustment nut. a b 27767 32760 b a Engine rear mount Engine front mount a - Locknut b - Adjustment nut 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. Do not lift the engine at this time. 3. Remove the fasteners securing the front and rear engine mounts to the boat stringers. a b 32746 32754 a b Engine rear mount Engine front mount a - Fasteners b - Boat stringer QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 4. Remove the fasteners securing the driveshaft to the output flange. bdca 33001 a -Driveshaft b -Bolt 7/16-20 x 1-1/2 (4 on each flange) c -Nut (4 on each flange) d -Engine output shaft flange 5. Remove the fasteners securing the driveshaft to the input flange. abcd33002 a -Bolt 7/16-20 x 1-1/2 (4 on each flange) b -Nut (4 on each flange) c -Transom input shaft flange d -Driveshaft 6. Lift the driveshaft and remove it from the boat. Use the hoist to slightly move the engine to allow clearance for the driveshaft to be lifted out. 90-865612060 MAY 2008 Page 7D-41 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Aft Bearing Support Remove the aft bearing support bolts, washers, and locknuts. Remove the aft bearing support. d -Spherical washer (4), rounded side toward rear bearing support e -Aft bearing support f -Locknut (2) efdcdab6645a -Fiber washer b -Bolt (2) c -Flat washer (2) Engine Shaft Bearing Support NOTE:The tailstock assembly fasteners also secures the spacer plate. 1. Remove the bolts and lock washers from the tailstock assembly and remove the tailstock and the spacer plate. abcccccc27431 a -Tailstock assembly b -Grease fitting c -Bolt with lock washer (6) Bearing Inspection 1. Inspect the bearing of the engine shaft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace the bearing. Page 7D-42 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 2. Inspect the bearings of the aft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace both bearings, spacer, and the oil seal. Aft Bearing Support Assembly Repair Bottom Safety Shield Removal Remove the safety shield bolts and remove the safety shield. 35137bcaaabc35036 a -Bolts b -Aft bearing support c -Safety shield Bearings and Oil Seal Removal 1. Remove the oil seal from the aft bearing support. 2. Remove the snap ring in the groove of the aft bearing support housing just above the bearing. 3. Use a press and suitable mandrel to press the bearings and the spacer from the aft bearing support housing. Input Shaft Removal 1. Use a suitable mandrel and a press the input shaft from the aft bearing support. abdc35135 a -Press b -Suitable mandrel c -Aft bearing support d -Input shaft 90-865612060 MAY 2008 Page 7D-43 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Bearings and Oil Seal Install 1. Install the grease fitting to the aft bearing support housing. 35071 2. Grease the inside diameter of the bearing bore in the aft bearing support housing. 35072 3. Use a press and a suitable mandrel and press the bearing, with its open side up, into the bearing bore. abbbfcde35075 a -Bearing open side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support f -Bearing installed Page 7D-44 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 4. Install the spacer. 35076abbc a -Spacer b -Suitable mandrel (guide) c -Aft bearing support 5. Use a press and suitable mandrel and install the second bearing with the covered side up. acdbebbe 35077 a -Bearing covered side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support 6. Install the snap ring in the grove of the housing just above the bearing. 35078 90-865612060 MAY 2008 Page 7D-45 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 7. Flip the aft bearing support over and press the oil seal into the housing with the lip of the seal facing inside the housing. abcadcda 35079 a -Suitable mandrel (guide) b -Suitable mandrel c -Oil seal d -Aft bearing support Input Shaft Install 1. Install the grease fitting to the input shaft. abc35081 a -Grease fitting b -Input shaft c -Input shaft flange 2. Apply sealant to the inside edge of the shaft and the outside edge of the plug. 35082 Page 7D-46 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Tube Ref No. Description Where Used Part No. 33 Loctite 680 Retaining Compound Plug for the input shaft 92-809833 3. Use a press to install the plug into the input shaft. aebcdd35083 a -Plug b -Press c -Suitable mandrel d -Input shaft flange e -Plug installed 4. Grease the inside splines and the outer surface of the input shaft. 35084 90-865612060 MAY 2008 Page 7D-47 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 5. Align the aft bearing support assembly onto the input shaft with its oil seal facing the shaft flange and the grease fittings aligned. 35085abdc a -Bearing b -Oil seal hidden c -Grease fittings d -Input shaft flange 6. Press the aft bearing support assembly onto the input shaft. ab cd 35086 a -Press b -Suitable mandrel c -Oil seal d -Machined surface on the input shaft 7. Using a hand grease gun pump grease into the aft bearing support grease fitting. 35080 Page 7D-48 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Bottom Safety Shield Install 1. Apply Loctite to the threads of the safety shield bolts. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Safety shield bolt threads 92-809819 2. Place the safety shield on the aft bearing support and secure it with the bolts. abc35138 a -Bolts b -Aft bearing support c -Safety shield 3. Tighten the bolts to specification. aaabc3503635137bc a -Bolts b -Aft bearing support c -Safety Shield Description Safety shield bolt Nm 41 lb-in. � lb-ft 30 90-865612060 MAY 2008 Page 7D-49 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Engine Shaft Bearing Support Assembly Repair Output Shaft Removal 1. Remove the snap ring from the groove of the shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft 2. Lift the engine shaft bearing support from the shaft. 35890acb a -Engine shaft bearing support b -Shaft c -Shaft flange 3. Remove the O-rings from the shaft. Page 7D-50 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Bearing Removal 1. Remove the snap ring from the groove just above the bearing in the engine shaft bearing support. 34937 2. Press the bearing out of the engine shaft bearing support. Discard the bearing. abc34939 a -Engine shaft bearing support b -Press c -Suitable mandrel Bearing Install 1. Grease the bearing bore of the engine shaft bearing support. 90-865612060 MAY 2008 Page 7D-51 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 2. Insert the grease fitting into the engine shaft bearing support. abc34934 a -Engine shaft bearing support housing b -Bearing bore c -Grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing Bearing bore of engine shaft 42 92-802870A1 Grease bearing support NOTE:The bearing has two grease access holes. 34935 3. Align the bearing to the bearing bore, and align the grease fitting hole to the grease access hole in the bearing. Page 7D-52 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 4. Press the bearing into the engine shaft bearing support. acdefb34936 a -Engine shaft bearing support housing b -Suitable mandrel c -Bearing d -Grease access hole e -Grease fitting f -Bearing installed 5. Insert the snap ring into the groove just above the bearing. 34937 6. Insert grease into the grease fitting. 34966ba a -Grease fitting b -Grease gun 90-865612060 MAY 2008 Page 7D-53 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Output Shaft Install 1. Install new O-rings on the output shaft. 2. Grease the O-rings and around the output shaft. bbac34925 a -Out put shaft b -O-rings c -Grease Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing 42 Output shaft 92-802870A1 Grease 3. Grease the inner diameter of the bearing in the engine shaft bearing support. abc34927 a -Engine shaft bearing support b -Grease applicator c -Inside diameter of bearing Tube Ref No. Description U-joint and Gimbal Bearing Grease Where Used Bearing ID Part No. 92-802870A1 42 Page 7D-54 90-865612060 MAY 2008 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models 4. Insert the shaft. 35890acb a -Engine shaft bearing support b -Shaft c -Shaft flange 5. Insert the snap ring into the groove of the output shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft 90-865612060 MAY 2008 Page 7D-55 QSD 2.8 and QSD 4.2 Diesel Sterndrive Models Notes: Page 7D-56 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models Driveshaft Extention (Jackshaft) Section 7E - QSB 5.9 ES 230 Diesel Sterndrive Models Table of Contents General Information.......................................7E-2 Driveshaft Extension Application.............7E-2 Continuity Circuit Ground Wire................7E-4 Driveshaft Extension Maintenance.................7E-4 Scheduled Maintenance�Driveshaft Extension...7E-4 Lubrication Points...................................7E-4 Driveshaft Extension Inspection and Maintenance...7E-5 Installation..7E-6 Seawater Inlet System Preparation..........7E-6 Gear lube Monitor....................................7E-

9 Shift Plate..7E-11 Exhaust Block-Off Plate.........................7E-11 Aft Bearing Support..............................7E-12 Engine Preparation.................................7E-15 Engine Placement.................................7E-16 Protractor..7E-17 Engine Alignment ....7E-18 Driveshaft Lubrication...........................7E-24 Continuity Curcuit Ground Wire.............7E-25 Engine Connections.............................7E-25 Sterndrive With a Driveshaft Extension (Jackshaft) Assembly.............................7E-26 Aligning the Cross Bearings Centerline ....7E-26 Top Safety Shields...............................7E-29 Predelivery Preparation........................7E-29 Removal...7E-29 U-Joint Top Shields..............................7E-29 Sterndrive...7E-30 Engine Connections..............................7E-30 Removing the Driveshaft - 5.9 MS.........7E-31 Aft Bearing Support..............................7E-33 Engine Shaft Bearing Support...............7E-33 Bearing Inspection................................7E-33 Aft Bearing Support Assembly Repair..........7E-34 Bottom Safety Shield Removal..............7E-34 Bearings and Oil Seal Removal.............7E-34 Input Shaft Removal............................7E-34 Bearings and Oil Seal Install..................7E-35 Input Shaft Install..................................7E-37 Bottom Safety Shield Install...................7E-40 Engine Shaft Bearing Support Assembly Repair ....7E-41 Output Shaft Removal..........................7E-41 Bearing Removal.................................7E-42 Bearing Install.......................................7E-42 Output Shaft Install...............................7E-45 7 E 90-865612060 MAY 2008 Page 7E-1 7 QSB 5.9 ES 230 Diesel Sterndrive Models Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used Part No. Loctite 088 Engine shaft bearing support mounting bolts Obtain Locally Loctite 271 Threadlocker Safety shield bolt threads 92-809819 33 Loctite 680 Retaining Compound Plug for the input shaft 92-809833 Grease fittings 42 U-joint and Gimbal Bearing Grease Bearing bore of engine shaft bearing support Output shaft 92-802870A1 Bearing ID 91 Engine Coupler Spline Grease Output shaft splines 92-802869A 1 Special Tools Tapered Insert Tool 91-43579 Removes and installs the tapered insert retainer into the water inlet hose. 9197 Alignment Tool Assembly 91-805475A 1 Used to align the engine to the transom assembly for sterndrive installation. 9183 Alignment Bar 8M2001017 Aids in aligning the engine to the transom assembly for 26831 sterndrive installation. General Information Driveshaft Extension Application DRIVESHAFT EXTENSION The driveshaft extension (jackshaft) converts a standard sterndrive package into a driveshaft configuration. A long driveshaft is installed between the engine and the transom assembly. The driveshaft installation moves the weight of the engine forward in the boat providing a better center of gravity and improved boat operation. The driveshaft extension is used with triple, dual, and single engine applications in smaller boats. When the driveshaft extention is installed in boats with center console or staggered engine designs it helps the boat get up on plane quickly. The driveshaft extension is available as a kit and must be used in conjunction with the recommended driveshaft. Other kits or parts are listed with the kit for the specific engine models. The driveshaft is ordered separately. Page 7E-2 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7E-3 Access must be provided to grease fittings on the driveshaft U-joints, input shaft, and bearing supports to allow for scheduled maintenance. 33872 a b d c a - 1�3� driveshaft angle required b - Driveshaft extension c - Driveshaft U-joint flange connected to output shaft (engine shaft bearing support) d - Driveshaft U-joint flange connected to input shaft (aft bearing support) ENGINE / EXHAUST Through the transom exhaust system is required for this engine model. For critical power package dimensions and requirements refer to the latest Cummins MerCruiser Diesel OEM CD or installation drawings. MEASUREMENTS We recommend a universal protractor or digital inclinometer for measuring the angles during installation steps. 34826 Universal protractor Digital inclinometer ..SB 5.9 ES 230 Diesel Sterndrive Models Continuity Circuit Ground Wire SB 5.9 ES 230 Diesel Sterndrive Models Continuity Circuit Ground Wire In some applications, the transom ground wire will not reach the engine ground or the battery ground connection. This ground wire connection is required to complete the continuity circuit. You must construct a new ground wire long enough to attach to the transom grounding screw and the engine grounding stud or battery ground. ab33323Typical a -Transom grounding screw b -Transom ground wire Driveshaft Extension Maintenance Scheduled Maintenance�Driveshaft Extension Refer to the appropriate manual for power package maintenance and Inspections. Perform the following maintenance at the required task intervail. Task Interval Maintenance to Be Performed Every 100 hours or annually (whichever occurs first) � Lubricate the driveshaft U-joints. � Lubricate the input shaft. � Lubricate the aft bearing support (input) � Lubricate the engine shaft bearing support (output) � Inspect the driveshaft U-joints. Every 300 hours or 3 years (whichever occurs first) � Engine shaft bearing support inspection � Aft bearing support inspection Lubrication Points Lubricate the bearings grease fittings every 100 hours or annually (whichever occurs first). 1. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the following grease fittings: � Aft bearing support grease fitting � Input shaft grease fitting � Engine shaft bearing support grease fitting Page 7E-4 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 2. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into the driveshaft U-joint grease fittings on the transom and engine end. b a e dc 35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting at transom end d -U-joint grease fitting at engine end e -Engine shaft bearing support grease fitting Driveshaft Extension Inspection and Maintenance U-JOINT INSPECTION Preform the U-joint inspection every 100 hours or annually (whichever occurs first). 1. Remove the driveshaft. 2. Rotate the U-joint on the output and the input end of the driveshaft. The movement of each U-joint yoke, socket, and cross bearing assembly should be smooth. 3. Replace the cross and bearing assembly if the seals are deteriorated or if movement is tight or rough. 4. Reinstall the driveshaft. ENGINE SHAFT BEARING SUPPORT INSPECTION Perform the engine shaft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the engine shaft bearing support assembly. 2. Rotate the output shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearing. See Engine Shaft Bearing Support Assembly Repair. AFT BEARING SUPPORT INSPECTION Perform the aft bearing support inspection every 300 hours or 3 years (whichever occurs first). 1. Remove the aft bearing support assembly. 2. Rotate the input shaft and check for rough spots while rotating. 3. If rough spots exist, replace the bearings, spacer, and the oil seal. See Aft Bearing Support Assembly Repair. 90-865612060 MAY 2008 Page 7E-5 QSB 5.9 ES 230 Diesel Sterndrive Models Installation Seawater Inlet System Preparation Follow the instructions provided with the Thru-The-Hull Seawater Pickup Kit before installing the drive shaft extension. SEAWATER HOSE IMPORTANT: Use a wire-reinforced seawater hose with an adequate wall thickness to keep the hose from collapsing when the seawater pump impeller creates suction. Secure the hose connections with hose clamps. Secure the hose to prevent contact with any moving parts. SPECIFICATIONS Description Seawater pickup�through-the-hull or through-the-transom mounted. Seacock size (internal cross-sectional area). Seawater inlet hose inner diameter (adapter provided for hose). Seawater strainer flow rate. Seawater inlet restriction. SEAWATER STRAINER All Models Minimum 150 L/min. (40 US gal/min) At least: 38 mm (1-1/2 in.) Minimum 38 mm (1-1/2 in.) Minimum 150 L/min. (40 US gal/min) Maximum 125 mm Hg (5 in. Hg) Refer to the power package installation manual for installation, operation, and maintenance instructions. INSTALLING THE STERNDRIVE SEAWATER BLOCK-OFF PLATE Seawater for engine cooling must be supplied through an alternate (separate) seawater pickup instead of through the sterndrive. When using a separate seawater pickup, block the sterndrive seawater passage and cut the water hose that is located between the bell housing and the gimbal housing. This allows water to continue to circulate through the sterndrive for cooling. NOTICE Obstructions in the water passages will keep cooling water from circulating through the sterndrive resulting in damage to the sterndrive. When using a block-off plate ensure that the water hose between the bell housing and gimble housing is cut and removed. Page 7E-6 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 1. Remove the tapered insert in the gimbal housing using the tapered insert tool. Discard the insert. 17857cdba a -Tapered insert location in the gimbal housing b -Ratchet and extension c -Tapered insert d -Tapered insert tool Tapered Insert Tool 91-43579 2. Install the block-off plate with new gasket. Secure with screws and lockwashers. Tighten the screws to specification. aabdc a -Block-off plate b -Gasket c -Screw d -Lockwasher 21683 Description Water inlet block-off screw Nm 5 lb-in. 45 lb-ft � 90-865612060 MAY 2008 Page 7E-7 QSB 5.9 ES 230 Diesel Sterndrive Models 3. Move the trim limit switch wires and speedometer hose aside. Reach between the gimbal housing and the bell housing and detach the water hose from the gimbal housing where the tapered insert was removed. abecd8489 a -Trim limit switch wires b -Speedometer hose c -Gimbal housing d -Water hose e -Tapered insert NOTE:Move the trim limit switch wires and speedometer hose to avoid damaging themwhen cutting the water hose. The existing tie strap and clip can be reused if they are movedand repositioned after the hose is cut. 4. Cut completely through the water hose 127 mm (5 in.) in front of the aft end of the hose where it is fitted into the bell housing in the area shown. Do not damage the U-joint bellows. 5. Discard the loose hose piece. 6. Secure the trim limit switch wires and speedometer hose to the remaining section of water hose using the existing tie strap and clip. abdf33405cea -Water inlet hose b -Trim limit wire harness c -Tie strap d -Cutting area e -Clip f -Speedometer hose 7. Install a through-the-hull or through-the-transom seawater pickup, seawater strainer, and seacock. Page 7E-8 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 8. Connect the seawater inlet hose between the seawater pump and seawater strainer. 9. Secure all hoses with hose clamps. Gear lube Monitor Relocate the engine mounted gear lube monitor to the boat transom when applicable. The transom mounted bracket and accessories can be ordered in a gear lube monitor relocation kit or included in the driveshaft extension kit. 1. Disconnect audio warning system wires from the gear lube monitor on the engine. 2. Remove the gear lube monitor from the bracket. 3. Remove the bracket. 4. Connect the sterndrive gear lube monitor hose to the quick release 90� fitting and secure it with a stay strap. 5. Connect the quick release 90� fitting to the gimbal housing fitting. Position the fitting so the release button will not contact the seawater inlet fitting or block-off plate if equipped. 6. Route the gear lube monitor hose and secure with J-clip. 34736bca a -Quick release 90� fitting b -Gear lube hose c -J-clip 90-865612060 MAY 2008 Page 7E-9 QSB 5.9 ES 230 Diesel Sterndrive Models 7. Install the bracket to the boat transom so the gear lube monitor will be higher than the steering lever on the transom assembly. Secure the bracket with lag screws and flat washers as shown. defaghbc6637a -Gear lube monitor bracket b -Lag bolt and washer (2 each) c -Gear lube monitor d -Cap e -Audio warning system wires f -Retaining strap g -Gear lube hose h -Hose clamp IMPORTANT: Do not allow kinks in the gear lube lube monitor hose. The gear lube monitor will not function properly if the hose is kinked and damage to the sterndrive could occur. Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. 8. Install the gear lube monitor in the bracket and secure it with the retaining strap. 9. Route the gear lube hose to the monitor and cut off excess hose. Connect the hose to the monitor and secure it with a hose clamp. 34815abcde a -Gear lube monitor is higher than the steering lever b -Gear lube monitor c -Bracket d -Gear lube hose e -Audio warning system connectors 10. Connect the audio warning system wires to the gear lube monitor. Use the extension harness from the kit if applicable. Page 7E-10 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7E-11 11. Use cable ties to secure the wires away from moving parts. Shift Plate For driveshaft lengths over 71 cm (28 in.) the shift plate must be relocated to the boat transom. The mounting location must allow for proper cable routing with 20 cm (8 in.) radius bends minimum. IMPORTANT: The shift plate assembly must be mounted within the limits of the sterndrive shift cable. Be sure that the mounting location will not interfere with other moving components. 1. Disconnect the shift plate connector from the engine harness. 6674 Bravo shift bracket 2. Remove the shift plate from the exhaust elbow. IMPORTANT: The shift plate and the bracket assembly must be mounted within limits of the sterndrive shift cable. Ensure that the mounting location will not cause interference with other moving components. 3. Attach the shift plate to the bracket and secure it with the hardware provided. Mount the bracket to the desired location. 4. Install the mounting bracket in the desired location on the inner transom using two long lag screws and two washers. b a 6676 Bravo shift bracket and shift plate a - Bracket b - Shift plate assembly Exhaust Block-Off Plate Use the exhaust block-off plate when the engine is installed with a through-transom exhaust system. The through-propeller exhaust route is blocked with a block-off plate. QSB 5.9 ES 230 Diesel Sterndrive Models IMPORTANT: When equipped with an exhaust block-off plate, the gimbal housing and exhaust block-off plate mating surfaces must be clean and free of nicks and scratches, and the O-ring must be properly seated in the groove, or water may leak into boat. 1. Ensure that the gimbal housing mating surface is clean and free of nicks and scratches. 2. The O-ring must be properly seated in the groove. a21630 a -O-ring 3. Ensure that the block-off plate mating surface is clean and free of nicks and scratches. 4. Install the block-off plate with the decal toward the engine. 5. Secure with four bolts and lockwashers. 6. Torque the bolts. a21625bca a -Block-off plate b -Bolts c -Lockwashers Description Nm lb. in. Exhaust block-off plate bolts 34 � Aft Bearing Support The aft bearing support assembly mounts on the inner transom plate. lb. ft. 25 34749 Page 7E-12 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 90-865612060 MAY 2008 Page 7E-13 1. Remove the fiber washers and adhesive from the inner transom plate. 32696 IMPORTANT: The spherical washers must be positioned so that the rounded side of the washers are toward the bearing support assembly as shown. 2. Install the aft bearing support assembly on the inner transom plate using the hardware as shown. Tighten the bolts until the locknuts contact the bottom of the transom. Do completely tighten the bolts at this time.. d b e c c a 12565 a - Bolts (2) b - Flat washer (2) c - Spherical washer (4) d - Bearing support e - Locknut (2) 3. Align the bearing support assembly as follows: QSB 5.9 ES 230 Diesel Sterndrive Models a. Open the perforated area in the bell housing dust cover. 32697 Dust cover IMPORTANT: Alignment tools from other manufacturers may improperly align and damage the gimbal bearing, bearing support, or engine coupler. Use one of the listed Quicksilver alignment tools; The Alignment Tool Assembly, or Alignment Bar. b. Attempt to insert the solid end of the alignment tool through the gimbal bearing and into the input shaft splines. ab32699 a -Alignment tool b -Insert this end through gimbal housing Alignment Tool Assembly 91-805475A 1 Alignment Bar 8M2001017 IMPORTANT: Both attaching bolts must be firmly struck in the following step to properly seat the spherical washers. Failure to follow this procedure may result in a difficult installation of the sterndrive. Page 7E-14 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models c. Tap the head of both bearing support attaching bolts with a soft hammer. Check the alignment. When the alignment tool slides freely into the input shaft splines, tighten the bolts to specification. 32700 Alignment tool Description Bearing support bolts on transom Nm 68 lb-in. � lb-ft 50 Engine Preparation The engine comes fitted with the correct coupler and adapter plate. 11463 1. Install the front engine mount support to the front of the engine block. Tighten the engine mount support bolts to specification. Description Nm lb-in. lb-ft. Front engine mount support bolts 77 � 55 2. Install the rear engine mount support to the flywheel housing. Tighten the engine mounting support bolts to specification. Description Nm lb-in. lb-ft. Rear engine mount support bolts 50 � 35 90-865612060 MAY 2008 Page 7E-15 QSB 5.9 ES 230 Diesel Sterndrive Models 3. Install the front and rear engine vibration isolators. Install the nut and lockwasher onto the stud, but do not tighten it completely at this time. The nut will be secured after engine alignment. 11467ab11466ab Front engine mount Rear engine mount a -Engine mount support b -Vibration isolator 4. Apply lubricant to the output shaft splines of the engine shaft bearing support assembly. Tube Ref No. Description Where Used Part No. Engine Coupler Spline Grease Output shaft splines 92-802869A 1 5. Apply threadlocker to the engine shaft bearing support mounting bolts. 91 Tube Ref No. Description Where Used Part No. Engine shaft bearing support Loctite 088 Obtain Locally mounting bolts 6. Install the engine shaft bearing support components as shown. Tighten the mounting bolts to specification. 11465Description Nm lb-in. lb-ft. Engine shaft bearing support mounting bolts 47 � 35 Engine Placement NOTE:For ease of installation, we recommend the use of a chain leveler in the following steps. NOTE:If the engine will be tested after installation, install the drain plugs at this time. 1. Ensure that the engine mounts are equally adjusted. If not, adjust the engine mounts so that they can be adjusted equally up or down. Page 7E-16 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models ! CAUTION Improper lifting during removal or installation of the engine can cause injury or damage to engine components. Use a hoist, lifting arm, or other approved lifting device. Do not allow the lifting device to hook or compress any engine components. ! WARNING Failure of the lifting eyes will cause the engine to fall suddenly from the hoist, resulting in serious injury, death, or property damage. Keep the engine level while it is hoisted. Do not tilt the engine more than 12� in any direction during installation. 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. 3. Lift the engine and place it into its approximate position in the boat using an overhead hoist. � Leave clearance space equal to the length of your driveshaft between the engine output shaft flange and the aft input flange. � Set the engine so that the clearance space for your driveshaft length will allow 8 mm (5/16 in.) clearance between the shoulder of the engine output shaft and the bearing in the engine shaft bearing support. The engine output shaft flange has a total lateral endplay of 16 mm (5/8 in.). abca32713 a -8 mm (5/16 in.) b -Bearing in engine shaft bearing support c -Shoulder of output shaft Clearance Between Output Shaft and Bearing Clearance between the output shaft shoulder and the bearing 8 mm (5/16 in.) Protractor NOTE:We recommend a universal protractor for measuring the angles in the following steps. 90-865612060 MAY 2008 Page 7E-17 QSB 5.9 ES 230 Diesel Sterndrive Models IMPORTANT: In the following steps, the protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0� and the 90� marks will be used. These are only reference marks. Use these marks to determine how many degrees and to which side (right or left) of the reference mark the needle is. View the protractor from the same side of the power package throughout the installation. 32701 Reference mark Engine Alignment READING AT THE INPUT SHAFT FLANGE�REFERANCE POINT IMPORTANT: Do not move the boat after taking the reading from the input shaft flange, because this reading establishes a reference point for aligning the driveshaft and engine. If the boat moves, the reference point may change, leading to improper alignment of the driveshaft and engine. 1. Position the base of protractor against the input shaft flange in the bearing support assembly on the inner transom. Record the number of degrees, and to which side of the reference mark the indicator needle has moved. 20994a b a -Protractor b -Transom input flange Direction the Indicator Reading Location Reading Specification Needle Has Moved Reading at input shaft Reference point flange Page 7E-18 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models INSTALLING THE DRIVESHAFT NOTICE Misaligned flanges can allow the bolts to come loose during operation, resulting in product damage. Align the flanges flush with one another before tightening the bolts. IMPORTANT: If equipped, The driveshaft splines must be fully collapsed. Push the splined portion of the driveshaft together until fully collapsed. 1. Attach the driveshaft to the transom input shaft flange and the engine output shaft flange. 2. Ensure the pilots on the driveshaft (obtain locally) flanges are engaged in the input and output shaft flanges. Ensure that the flanges are flush with each other. 25626ba Typical a -Pilot engaged b -Flanges flush 3. Tighten the bolts to specification. ab6659 a -Transom input shaft flange b -Bolt and locknut 90-865612060 MAY 2008 Page 7E-19 QSB 5.9 ES 230 Diesel Sterndrive Models ab19378 a -Engine output shaft flange b -Bolt and locknut (4) Description Driveshaft to input and output shaft flange locknuts READING AND SETTING THE DRIVESHAFT ANGLE Nm 68 lb. in. � lb. ft. 50 NOTICE Operating the engine with the driveshaft installed at an incorrect angle will result in damage to the driveshaft and the universal joint bearings. Align the engine correctly before operating. NOTE:If the driveshaft is too short for the protractor to fit on the driveshaft, rotate thedriveshaft until the bearing caps are facing up, place a straightedge across the bearingcaps, and then take the measurement from the straightedge. 1. Position the base of the protractor on the driveshaft. 2. Compare the protractor reading to the previously recorded referance point reading at the transom input shaft flange. The driveshaft angle must be within � 1�3 degrees from either side of the referance point reading. 3. Raise or lower the engine equally until the protractor needle reads exactly as specified. 4. If you are unable to achieve � 1�3 degrees of angle to the driveshaft, adjust the stringer height so that the engine mounts have an equal amount of up and down adjustment. Page 7E-20 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 5. Record the readings in the following chart for later use. b a c 6246 a -Driveshaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading Direction the Indicator Needle Has Moved Specification Reference point � 1�3� from either side of the reference point ENGINE AND DRIVESHAFT LATERAL ALIGNMENT IMPORTANT: Improper positioning of the output shaft flange may cause bearing damage. Position the output shaft flange as specified. 1. "Measure the length of "a" and "b" to the centers of bolt holes. They must be within � 6.35 mm (0.25 in.) of each other. 2. If the dimensions are not as specified, slide the forward and aft ends of the engine equally in opposite directions to obtain the specified lengths for (a) and (b) while maintaining the driveshaft length � 8 mm (5/16 in.). b a 6669 Engine and Driveshaft Lateral Alignment Dimensions Dimension a � 6.35 mm (0.25 in.) of dimension b Dimension b � 6.35 mm (0.25 in.) of dimension a 90-865612060 MAY 2008 Page 7E-21 QSB 5.9 ES 230 Diesel Sterndrive Models 3. Measure the clearance between the output flange shoulder and the extention shaft housing bearing. Slide the engine fore or aft as needed to obtain the specified clearance. abca32713 a -8 mm (5/16 in.) b -Extension shaft housing bearing c -Engine tailstock output flange shoulder Clearance at Tailstock Output Flange Clearance between the tailstock output flange shoulder and the extension shaft housing 8 mm (5/16 in.) bearing 4. Recheck step 1. If step 1 is not as specified, adjust and recheck step 3. Continue this process until both steps 1 and 3 are as specified. 5. After engine and driveshaft lateral alignment has been aligned correctly, tighten the front and rear engine mounts securely to the boat stringer. ba35173baa35174 Front engine mount Rear engine mount a -Mounting bolts b -Boat stringer Page 7E-22 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models READING AND ALIGNING THE ENGINE OUTPUT 1. Position protractor on flywheel housing. Raise or lower the front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as recorded at the Reading At the Input Shaft Flange�Referance Point. 20996b a Typical Engine (driveshaft shown removed; attached in the actual process) a -Bearing support assembly b -Protractor Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading at output shaft flange Reading Direction the Indicator Needle Has Moved Specification Reference point � 1�3� from either side of the reference point Equal degree to the reference point 90-865612060 MAY 2008 Page 7E-23 QSB 5.9 ES 230 Diesel Sterndrive Models VERIFYING THE DRIVESHAFT ANGLE 1. Position the protractor on the driveshaft and recheck the driveshaft angle. The angle should be the same as that recorded previously Reading and Setting the Driveshaft Angle. If not, raise or lower all four engine mount adjustment nuts an equal amount until the correct angle is reached. c b a a -Drive shaft b -Protractor c -Output shaft flange Reading Location Reading at input shaft flange Reading at setting driveshaft angle Reading at output shaft flange Reading verifying driveshaft angle Reading 2. When the driveshaft angle Direction the Indicator Needle Has Moved 6666 Specification Reference point � 1�3� from either side of the reference point Equal degree to the reference point Same as previously recorded- Reading driveshaft angle is correct the engine and driveshaft are aligned correctly.Tighten ALL engine mount nuts securely. baa b 35175 Front engine mount Rear engine mount a -Nut and lockwasher b -Adjustment nut Driveshaft Lubrication 1. Lubricate the driveshaft U-joints, input shaft, aft bearing support, and engine shaft bearings support as follows: Page 7E-24 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models a. Use a typical hand operated grease gun and insert approximately 10�12 pumps of grease into the aft bearing support grease fitting, input shaft grease fitting, and the engine shaft bearings support grease fitting. b. Use a typical hand operated grease gun and insert approximately 3�4 pumps of grease into both driveshaft U-joint grease fittings. baedc35153 a -Aft bearing support grease fitting b -Input shaft grease fitting c -U-joint grease fitting aft end d -U-joint grease fitting engine end e -Engine shaft bearings support grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing 42 Grease fittings 92-802870A1 Grease Continuity Curcuit Ground Wire The transom ground wire must be connected to complete the continuity circuit. If the transom ground wire will not reach the engine ground or the battery ground connection, follow the instructions below. 1. Construct a new ground wire using a 14 gauge wire and an eye ring connector on each end. The ground wire must be long enough to attach to the transom grounding screw and the engine grounding stud or battery ground. 2. Attach one end of the ground wire to the transom grounding screw and the opposite end to the engine grounding stud or the battery ground. Engine Connections IMPORTANT: Use a continuity wire from the engine ground to the transom assembly to complete the continuity curcuit. Refer to the power package installation manual for your specific model to make the following connections: � Transom plate continuity curcuit wire to the engine � Electrical wiring harness � Throttle and shift cable installation and adjustments � Water hose � Trim position sender wires � MerCathode system wires � Fuel lines 90-865612060 MAY 2008 Page 7E-25 QSB 5.9 ES 230 Diesel Sterndrive Models � Power-assisted steering hoses � Power-assisted steering cable IMPORTANT: When installing power steering hoses, route toward the starboard side as shown. a b c 32720 a -Cable tie b -Return hose (to fluid cooler) c -High-pressure hose (from power steering pump) Sterndrive With a Driveshaft Extension (Jackshaft) Assembly IMPORTANT: Follow the normal procedure for installing the sterndrive except the following. When the sterndrive is installed, the sterndrive U-joint centerline must be positioned on the same plane as the driveshaft extension (jackshaft) U-joint centerline. See Aligning the Cross Bearings Centerline, before installing the sterndrive. If applicable, the driveshaft extension (jackshaft) U-joint top shields may be removed for sterndrive installation. Install the U-joint top shields before operation. See Installing the U-Joint Top Shields. 34819 Aligning the U-joint cross bearings Refer to the Cummins MerCruiser Diesel Sterndrive Installation Manual for the normal procedure for sterndrive installation. Aligning the Cross Bearings Centerline ! CAUTION Misaligned cross bearings can cause driveshaft failure, leading to possible injury. The driveshaft U-joint cross bearings of both the drive and the driveshaft extension must operate in the same plane to prevent excessive vibration. Align the bearings to operate in the same plane. Page 7E-26 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 1. Momentarily engage the starter motor so that the centerline of the driveshaft yoke is positioned vertically. abc32721 a -Drive shaft extension U-joint yoke b -Bearing support input U-joint yoke c -U-joint cross bearing centerline (vertical) 2. Place a reference mark on the input shaft to correspond with centerline. abc32722 a -Bearing support assembly b -Reference mark c -Input shaft 90-865612060 MAY 2008 Page 7E-27 QSB 5.9 ES 230 Diesel Sterndrive Models 3. Rotate the sterndrive U-joint shaft so that the centerline of the forward yoke is positioned vertically. The U-Joint must be positioned in this manner when it is installed so that it will be running in the same plane as the extension driveshaft U-joint cross bearings. 32723c b a a -U-joint cross bearing centerline (vertical) b -Forward yoke c -U-joint shaft 4. Using a paint marker, draw a reference mark on the universal joint shaft to correspond with the centerline. NOTE:Draw the referance mark at either location shown that will be easy for you to viewwhile installing the sterndrive. a a b 32768 a -Reference mark location b -Cernterline 5. Install the sterndrive following the instructions in the Cummins MerCruiser Diesel Sterndrive Installation Manual. Make sure the U-joint centerline is in the same plane as the driveshaft extension centerline. Page 7E-28 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models Top Safety Shields The safety shields mount on the engine shaft bearing support and the aft bearing support assemblies to completely cover the driveshaft U-joints and prevent possible injury from moving parts. 34746 1. Install the top safety shields If they were removed while installing the sterndrive. Install both top shields as shown. 2. Tighten the bolts and nuts to specification. c a b 32719d Top shield and bottom shield at transom end (engine end is similar) a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nut 3/8-16 (4) Description Nm lb-in. lb-ft Driveshaft shield bolts and nuts 41 � 30 Predelivery Preparation Refer to the Cummins MerCruiser Diesel Sterndrive Installation Manual for Predelivery Preparation and Inspections. Removal U-Joint Top Shields 1. Remove the bolts and nuts securing the top shields. Retain the fasteners. 90-865612060 MAY 2008 Page 7E-29 QSB 5.9 ES 230 Diesel Sterndrive Models 2. Remove the top shields. cab32719d Top shield and bottom shield at aft end, engine end similar a -Top shield b -Bolt 3/8-16 x 7/8 in. (4) c -Bottom shield d -Nuts 3/8-16 (4) Sterndrive Refer to the Power Package Installation Manual for your specific model to remove the sterndrive from the transom assembly. Engine Connections Refer to the appropriate power package service manual to remove the following connections: � The continuity wire from the engine ground to the transom assembly � The electrical wiring harness � The throttle and shift cable � The seawater supply hoses � The trim position sender wires � The MerCathode system wires � The fuel lines � The power-assisted steering hoses � The power-assisted steering cable Page 7E-30 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models Removing the Driveshaft - 5.9 MS 1. Loosen all engine mount nuts. baab 35175 Front engine mount Rear engine mount a -Nut and lockwasher b -Adjustment nut 2. Attach a suitable lifting chain to the lifting eyes on the engine. Adjust it so that the engine will be level when suspended. Do not lift the engine at this time. 3. Remove the fasteners securing the front and rear engine mounts to the boat stringers. ba35173baa35174 Front engine mount Rear engine mount a -Mounting bolts b -Boat stringer 90-865612060 MAY 2008 Page 7E-31 QSB 5.9 ES 230 Diesel Sterndrive Models 4. Remove the fasteners securing the driveshaft to the output flange. ab19378 a -Engine output shaft flange b -Bolt and locknut 5. Remove the fasteners securing the driveshaft to the input flange. ab6659 a -Transom input shaft flange b -Bolt and locknut 6. Lift the driveshaft from the input and output flange and remove it from the boat. Use the hoist to slightly move the engine to allow clearance for the driveshaft to be lifted out. Page 7E-32 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models Aft Bearing Support Remove the aft bearing support bolts, washers, and locknuts. Remove the aft bearing support. d -Spherical washer (4), rounded side toward rear bearing support e -Aft bearing support f -Locknut (2) efdcdab6645a -Fiber washer b -Bolt (2) c -Flat washer (2) Engine Shaft Bearing Support 1. Remove the bolts and lock washers from the engine shaft bearing support assembly and remove the assembly. 11465 Bearing Inspection 1. Inspect the bearing of the engine shaft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace the bearing. 2. Inspect the bearings of the aft bearing support, rotate the output shaft and check for rough spots while rotating. If rough spots exist, replace both bearings, spacer, and the oil seal. 90-865612060 MAY 2008 Page 7E-33 QSB 5.9 ES 230 Diesel Sterndrive Models Aft Bearing Support Assembly Repair Bottom Safety Shield Removal Remove the safety shield bolts and remove the safety shield. 35137bcaaabc35036 a -Bolts b -Aft bearing support c -Safety shield Bearings and Oil Seal Removal 1. Remove the oil seal from the aft bearing support. 2. Remove the snap ring in the groove of the aft bearing support housing just above the bearing. 3. Use a press and suitable mandrel to press the bearings and the spacer from the aft bearing support housing. Input Shaft Removal 1. Use a suitable mandrel and a press the input shaft from the aft bearing support. abdc35135 a -Press b -Suitable mandrel c -Aft bearing support d -Input shaft Page 7E-34 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models Bearings and Oil Seal Install 1. Install the grease fitting to the aft bearing support housing. 35071 2. Grease the inside diameter of the bearing bore in the aft bearing support housing. 35072 3. Use a press and a suitable mandrel and press the bearing, with its open side up, into the bearing bore. abbbfcde35075 a -Bearing open side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support f -Bearing installed 90-865612060 MAY 2008 Page 7E-35 QSB 5.9 ES 230 Diesel Sterndrive Models 4. Install the spacer. 35076abbc a -Spacer b -Suitable mandrel (guide) c -Aft bearing support 5. Use a press and suitable mandrel and install the second bearing with the covered side up. acdbebbe 35077 a -Bearing covered side up b -Suitable mandrel (guide) c -Press d -Suitable mandrel e -Aft bearing support 6. Install the snap ring in the grove of the housing just above the bearing. 35078 Page 7E-36 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 7. Flip the aft bearing support over and press the oil seal into the housing with the lip of the seal facing inside the housing. abcadcda 35079 a -Suitable mandrel (guide) b -Suitable mandrel c -Oil seal d -Aft bearing support Input Shaft Install 1. Install the grease fitting to the input shaft. abc35081 a -Grease fitting b -Input shaft c -Input shaft flange 2. Apply sealant to the inside edge of the shaft and the outside edge of the plug. 35082 90-865612060 MAY 2008 Page 7E-37 QSB 5.9 ES 230 Diesel Sterndrive Models Tube Ref No. Description Where Used Part No. 33 Loctite 680 Retaining Compound Plug for the input shaft 92-809833 3. Use a press to install the plug into the input shaft. aebcdd35083 a -Plug b -Press c -Suitable mandrel d -Input shaft flange e -Plug installed 4. Grease the inside splines and the outer surface of the input shaft. 35084 Page 7E-38 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 5. Align the aft bearing support assembly onto the input shaft with its oil seal facing the shaft flange and the grease fittings aligned. 35085abdc a -Bearing b -Oil seal hidden c -Grease fittings d -Input shaft flange 6. Press the aft bearing support assembly onto the input shaft. ab cd 35086 a -Press b -Suitable mandrel c -Oil seal d -Machined surface on the input shaft 7. Using a hand grease gun pump grease into the aft bearing support grease fitting. 35080 90-865612060 MAY 2008 Page 7E-39 QSB 5.9 ES 230 Diesel Sterndrive Models Bottom Safety Shield Install 1. Apply Loctite to the threads of the safety shield bolts. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Safety shield bolt threads 92-809819 2. Place the safety shield on the aft bearing support and secure it with the bolts. abc35138 a -Bolts b -Aft bearing support c -Safety shield 3. Tighten the bolts to specification. aaabc3503635137bc a -Bolts b -Aft bearing support c -Safety Shield Description Safety shield bolt Nm 41 lb-in. � lb-ft 30 Page 7E-40 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models Engine Shaft Bearing Support Assembly Repair Output Shaft Removal 1. Remove the snap ring from the groove of the shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft 2. Lift the engine shaft bearing support from the shaft. 35890acb a -Engine shaft bearing support b -Shaft c -Shaft flange 3. Remove the O-rings from the shaft. 90-865612060 MAY 2008 Page 7E-41 QSB 5.9 ES 230 Diesel Sterndrive Models Bearing Removal 1. Remove the snap ring from the groove just above the bearing in the engine shaft bearing support. 34937 2. Press the bearing out of the engine shaft bearing support. Discard the bearing. abc34939 a -Engine shaft bearing support b -Press c -Suitable mandrel Bearing Install 1. Grease the bearing bore of the engine shaft bearing support. Page 7E-42 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models 2. Insert the grease fitting into the engine shaft bearing support. abc34934 a -Engine shaft bearing support housing b -Bearing bore c -Grease fitting Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing Bearing bore of engine shaft 42 92-802870A1 Grease bearing support NOTE:The bearing has two grease access holes. 34935 3. Align the bearing to the bearing bore, and align the grease fitting hole to the grease access hole in the bearing. 90-865612060 MAY 2008 Page 7E-43 QSB 5.9 ES 230 Diesel Sterndrive Models 4. Press the bearing into the engine shaft bearing support. acdefb34936 a -Engine shaft bearing support housing b -Suitable mandrel c -Bearing d -Grease access hole e -Grease fitting f -Bearing installed 5. Insert the snap ring into the groove just above the bearing. 34937 6. Insert grease into the grease fitting. 34966ba a -Grease fitting b -Grease gun Page 7E-44 90-865612060 MAY 2008 QSB 5.9 ES 230 Diesel Sterndrive Models Output Shaft Install 1. Install new O-rings on the output shaft. 2. Grease the O-rings and around the output shaft. bbac34925 a -Out put shaft b -O-rings c -Grease Tube Ref No. Description Where Used Part No. U-joint and Gimbal Bearing 42 Output shaft 92-802870A1 Grease 3. Grease the inner diameter of the bearing in the engine shaft bearing support. abc34927 a -Engine shaft bearing support b -Grease applicator c -Inside diameter of bearing Tube Ref No. Description U-joint and Gimbal Bearing Grease Where Used Bearing ID Part No. 92-802870A1 42 90-865612060 MAY 2008 Page 7E-45 QSB 5.9 ES 230 Diesel Sterndrive Models 4. Insert the shaft. 35890acb a -Engine shaft bearing support b -Shaft c -Shaft flange 5. Insert the snap ring into the groove of the output shaft. 34932abcd a -Engine shaft bearing support b -Bearing c -Snap ring d -Shaft Page 7E-46 90-865612060 MAY 2008 Removal and InstallatioS Integrated Transom System (ITS) Section 8A - Removal and Installation Table of Contents Removal...8A-2 Transom Connections.............................8A-2 Installation..8A-4 Transom Specifications...........................8A-4 Exhaust Block-Off Plate...........................8A-4 Installing the ITS to the Transom ....8A-5 Mercury Racing Product Steering SysteR ....8A-6 496 HO Steering System.........................8A-8 Power Steering Filter.............................8A-10 Digital Trim Sender................................8A-12 Power Trim Pump..................................8A-14 Gear Lube Monitor.................................8A-15 ITS Water Pickup Connection................8A-19 Power Steering System Bleeding ProcedurJ ....8A-24 90-865612070 JUNE 2007 Page 8A-1 8 A Removal and InstallatioS Lubricant, Sealant, Adhesives Tube Ref No. Description 114 Power Trim and Steering Fluid Where Used Power steering reservoir Part No. 92-858074K01 Special Tools Tapered Insert Tool 91-43579 Removes and installs the tapered insert retainer into the water inlet hose. 9197 Removal Transom Connections 1. Remove the drive, refer to the appropriate service manual. IMPORTANT: You do not have to disassemble the transom assembly any further to replacJ the gimbal bearing assembly. Follow the instructions pertaining to removal anI replacement of the gimbal bearing. 2. Disconnect: a. MerCathode electrical connector b. Trim position sender connection c. Cooling hose to the water separator or sea pump d. Trim hydraulic connections e. Power steering hydraulic connections f. Exhaust system g. Shift cable h. Lube monitor i. Speedo connection j. Ground connection 3. Remove the engine on Close Couple units or disconnect the driveshaft on Driveline units. 4. Support the gimbal housing. Page 8A-2 90-865612070 JUNE 2007 Removal and Installation 90-865612070 JUNE 2007 Page 8A-3 5. Remove the nuts securing the inner transom to the gimbal housing and remove the gimbal housing. 30936 Lifting Points 8 14660 o i g e c a b d f h j l m n k k a - Power steering hose (right) b - Power steering hose (left) c - Power trim down (gray) d - Power trim up (black) e - Valve block assembly f - Speedo connection g - Water inlet hose connection h - Bonding wire i - Lube monitor connection j - Trim sender connection k - Engine rear mount l - Ground wire to engine m -Exhaust connection n - MerCathode connection o - Shift cable Removal and InstallatioS Installation Transom Specifications Ensure that the transom surface thickness and flatness are within the following specifications: � Transom thickness - 51 mm (2 in.) minimum to 57 mm (2.25 in.) maximum � Transom surfaces must be parallel - Within 2 mm (0.078 in.) measured at top and bottom of the cutout hole � Area covered by the inner transom plate - Must be flat within 2 mm (0.078 in.) � Area covered by the outer transom assembly - Must be flat within 1 mm (0.031 in.) � Transom angle - 10� to 16� bac7231 a -Measuring thickness b -Measuring flatness c -Mandrel to check for uniform transom thickness NOTE:The transom thickness must be between 51 mm (2 in.) and 57 mm (2-1/4 in.). Theremust be 203 mm (8 in.) available on either side of the vertical centerline. Exhaust Block-Off Plate In most Mercury Racing power package installations, the engine exhaust will be routed through the transom with tailpipes rather than through the propeller shaft housing of the drive unit. In this case the exhaust port in the gimbal housing will be covered with a block-off plate. 1. Ensure that the gimbal housing exhaust block-off plate surface is clean and free of nicks and scratches and that the O-ring is properly seated in the groove. Page 8A-4 90-865612070 JUNE 2007 Removal and Installation 90-865612070 JUNE 2007 Page 8A-5 2. Install the gimbal housing exhaust block-off plate and torque locknuts to specifications. a b d 7276 c a - Gimbal housing mating surface b - O-ring c - Block-off plate d - Shift cable bracket Description Nm lb. in. lb. ft. Gimbal housing block-off plate bolts and locknuts 31 23 Installing the ITS to the Transom IMPORTANT: Review all installation procedures in this manual prior to installing the inner transom plate and outer transom assembly. Avoid drive movement and helm steering input until all air is purged from the steering hoses and connections. 1. Carefully remove the ITS from the shipping carton. 2. Remove and read all tags which are attached to the ITS. 3. Remove the inner transom plate from the outer transom assembly of the ITS. 4. Install the outer transom assembly on the boat's transom. 5. Install the inner transom plate, routing the wires, hoses and shift cable through the appropriate openings. Review other installation procedures in this manual for proper routing. 6. Install the washers and nuts to the transom assembly studs. 7. Use the tightening sequence as numbered in the following illustration. Torque to specifications. Removal and Installation Page 8A-6 90-865612070 JUNE 2007 NOTE: When tightening the transom assembly fasteners, tighten in small increments and go around the pattern several times until the proper torque is achieved. 1 3 8 6 4 2 5 7 14660 a b d e f g h i j k l m n o p c c a - Shift cable b - Transom plate mounting studs, nuts, and washers c - Engine flywheel mounts with fiber washers d - Lube monitor reservoir quick-connect fitting e - Water inlet fitting f - Valve block assembly mounting location g - Power trim down (gray hose) h - Power steering right (braided hose) i - Power steering left (braided hose) j - Power trim up (black hose) k - Speedo connection l - Transom plate ground wire m -Trim position connector n - Transom to engine ground wire (connect to flywheel stud) o - Exhaust inlet (blocked off with Mercury Racing engines) p - MerCathode connection Description Nm lb. in. lb. ft. Transom assembly locknuts 31 23 Mercury Racing Product Steering System STEERING HOSE CONNECTION 1. Disconnect the fluid hose at the power steering cooler and connect it to the bottom of the high pressure filter; a 3/8 pipe to a # 6 adaptor must be installed into the bottom of the filter. Removal and Installation 90-865612070 JUNE 2007 Page 8A-7 2. Install a 3/8 pipe to a # 6 adaptor into the top of the filter. 3. Connect a # 6 high pressure hose from the top of the filter to the port at the helm steering marked "P." 4. Remove the fitting adaptor from the cooler. 5. Connect a # 6 high pressure hose from the port marked "T" at the helm steering to the power steering fluid cooler. 6. Follow the helm steering manufacturer's instructions for installing and purging (bleeding) the hydraulic system before connecting the helm hydraulic hoses to the cross port relief valve block. NOTE: The drive, power steering pump, and cooler are filled with fluid at the factory. a b c d f h h i g e j L R P T g g 26141 a - To tank or reservoir b - From pump c - Right turn d - Left turn e - Filter f - Reservoir adaptor P/N 8M8020356 g - Pump h - Fluid cooler i - Check valve j - Reservoir (port) Removal and InstallatioS STEERING ADAPTOR BLOCK The steering adapter block is the large block that handles all hydraulic steering connections. This block is required for all engines equipped with an ITS. The following illustration shows the steering adapter block connections. Also refer to the Power Steering Diagrams (Mercury Racing Product) located near the end of this manual. NOTE:Use either RD (right drive) and LD (left drive) or RH (right helm) and LH (left helm) for lines coming in from the helm. Plug the unused connections. If installing a multiple engine application, one pair of connections serves as the IN from helm connection. The other can serve as the OUT to another drive connection. RD LD a b c d e f 13856Steering Adapter Block (Top View) Description Connection a b c d e f RD and LD RH and LH (bottom of block) RV2 - Cross port pressure relief valve RV1 - Cross port pressure relief valve R (side of block) Mounting pivot point L (side of block) IN from helm or OUT to second drive (plug if not used) None None OUT to right turn connection, outer transom Bolted to the inner transom plate OUT to left turn connection, outer transom The two pressure relief valves are set to open at 13,790 kPa (2000 psi). 496 HO Steering System PUMP ADAPTOR BLOCK (496 HO) NOTE:Order the pump adaptor block if needed (P/N 8M8021152) The pump adapter block allows you to adapt the special Saginaw fittings from the power steering pump to standard SAE fittings for the helm. This block is required for all two engine applications where both power steering pumps are used. On 3 or 4 engine applications, any engine not utilizing the power steering pump does not require the pump adapter block. Page 8A-8 90-865612070 JUNE 2007 Removal and InstallatioS The following illustration shows the pump adapter block connections. Also refer to the Power Steering Diagrams (496 HO) located near the end of this manual. 13849TH PH BOTT1 P1 TOP a d b c e Pump Adapter Block (Top View Pump Adapter Block (Bottom View Description a b c d e T1 - Return line P1 - Pressure inlet line PH - Pressure line TH - Return line CV - Check valve Connection OUT to power steering cooler IN from power steering pump OUT to filter/helm IN from helm None 1. All engines equipped with power steering require both the pump adapter block and the steering adapter block. 2. Any engines not utilizing or not equipped with a power steering pump do not require the pump adapter block. 3. Each configuration can be

installed using the inner transom plate pivot bolts. 4. The pump adapter block may be located remotely if rigging issues prevent installing it next to the steering adapter block. CVRVIa b c 13796c d a -Pump adapter block b -Steering adapter block c -Attaching/pivot bolts d -Inner transom plate STEERING ADAPTOR BLOC. The steering adapter block is the large block that handles all hydraulic steerinL connections. This block is required for all engines equipped with an ITS. 90-865612070 JUNE 2007 Page 8A-9 Removal and InstallatioS The following illustration shows the steering adapter block connections. Also refer to the Power Steering Diagrams located near the end of this manual. NOTE:Use either RD (right drive) and LD (left drive) or RH (right helm) and LH (left helm) for lines coming in from the helm. Plug the unused connections. If installing a multiple engine application, one pair of connections serves as the IN from helm connection. The other can serve as the OUT to another drive connection. RD LD a b c d e f 13856Steering Adapter Block (Top View) Description Connection a b c d e f RD and LD RH and LH (bottom of block) RV2 - Cross port pressure relief valve RV1 - Cross port pressure relief valve R (side of block) Mounting pivot point L (side of block) IN from helm or OUT to second drive (plug if not used) None None OUT to right turn connection, outer transom Bolted to the inner transom plate OUT to left turn connection, outer transom The two pressure relief valves are set to open at 13,790 kPa (2000 psi). Power Steering Filter The transom assembly includes a power steering filter, which uses 3/8 in. NPT fittings. NOTE:Hoses to and from the filter may be purchased separately. Page 8A-10 90-865612070 JUNE 2007 Removal and InstallatioS 1. Install the filter so it is easily accessible for maintenance and service, and above any possible water areas. ab 13858 Description Connection ` IN connection IN from PH on the pump adapter block a OUT connection OUT to P on the helm 90-865612070 JUNE 2007 Page 8A-11 Removal and Installation Page 8A-12 90-865612070 JUNE 2007 Digital Trim Sender A digital trim sender is mounted on the gimbal bellhousing assembly of the sterndrive unit. The trim sender will indicate the trim (up/down) position of the drive unit and can also set a trim limit (maximum up travel) to prevent over-trimming and subsequent damage to the drive unit while under way. 14345 a b c a - Digital trim sender b - Actuator arm c - Trim sender connector (routed through transom) The trim sender uses a digital signal which can be connected directly to a SmartCraft system harness for digital trim position display. No trim limit is available with this type of installation. If both trim position display and trim limit are desired, then the trim sender must be connected to an analog trim sender conversion module. An analog gauge can be installed to display trim position. HOW THE CONVERSION MODULE WORKS The conversion module is powered by 12 volts. The module reduces the 12 volts to 5 volts as an output reference voltage. The module sends 5 volts to the trim sender located on the drive unit. The trim sender returns a voltage back to the module in the range of 0.75 to 4.25 volts based on the trim angle of the drive unit. When the voltage reaches 2.5 volts (approximately 16� of trim angle) or higher, the trim limit is activated. Removal and InstallatioS INSTALLING THE TRIM SENDER CONVERSION MODUL* NOTE:The trim sender conversion module is not used with SmartCraft installations. fdolmnhgeabc7310ijk a -Instrument cable (BRN/WHT) - trim gauge b -Instrument cable (BLK) - ground c -Instrument cable (PPL) - to 12V keyed connection (PPL/WHT) d -Spacers e -Instrument harness f -Trim sender conversion module g -Trim sender connector h -Conversion module connector i -Negative - ground (BLK/ORG) j -0-5 volts from trim sender (GRN) k -Positive 5 volts to trim sender (PPL/YEL) l -Trim pump harness m -To trim pump solenoid connector (BLU/WHT) n -To trim switch connector (PPL/WHT) o -Screws IMPORTANT: Refer to the Wiring Diagrams in this manual for more information. 1. Mount the conversion module to the transom where it can be plugged into the digital trim sender connector. 2. Route the wires away from any hot or moving engine or drive components. 3. Connect the trim sender connector to the conversion module connector. 4. Connect the PPL/WHT wire to the wires coming from the trim "UP" switch. 5. Attach the BLU/WHT wire to the wires coming from the pump solenoid. 6. Attach the BLK wire in the instrument harness to a ground connection. 7. Attach the PPL wire in the instrument harness to the (+12V) keyed power source on the accessory harness. 8. Attach the BRN/WHT wire in the instrument harness to the trim gauge at the helm. 90-865612070 JUNE 2007 Page 8A-13 Removal and Installation ' THE ANALOG TRIM GAUGE INDICATES OFF-SCALE HIGH WITH NO SELF-TEST FUNCTION 1. Disconnect the trim sender from the trim sender module. 2. Place the key switch to the "RUN" position. The pointer on the analog gauge will sweep from the bottom of the scale to the top of the scale and then point to the actual trim position: � If the analog gauge performs the self-test; either the sender is defective or the wiring from the sender to the trim sender module is defective. � If the analog gauge does not perform the self-test; inspect the trim sender module circuit. The wiring to the module is defective or the module is defective. THE ANALOG TRIM GAUGE DOES NOT INDICATE PROPERLY - SELF-TEST FUNCTION WORKS Probable cause: � The trim sender is not indexed properly. a b 7366c a -Groove in link arm b -Raised index mark c -Forward � The trim sender circuit or the trim sender is defective. Power Trim Pump ! WARNING Excessive trim can cause serious injury or death at high speeds, and single-ram trim systems do not provide a trim-out limiting device or trim indicator. Use caution when trimming with a single-ram trim system and never trim out beyond the unit's side support flanges while the boat is underway or at engine speeds above 1200 RPM. 1. Mount the pump in the desired location and discard the disposable shipping cap and plug. 2. Remove and discard the shipping cap and plug from the pump reservoir. 3. Install the vented cap on the pump reservoir. 4. Connect the hydraulic hoses to the trim pump. 5. Connect the trim pump control harness to the trim pump up and down solenoids, and secure the harness with a clamp. If necessary see Wiring Diagrams. Page 8A-14 90-865612070 JUNE 2007' Removal and Installation 90-865612070 JUNE 2007 Page 8A-15 6. Connect the trim pump power cables to the battery. a b d e h g f 7357 c a - Battery negative cable (-) b - Battery positive cable (+) c - Trim switch connection d - Shipping cap (discard) e - Shipping plug (discard) f - Reservoir cap g - Gray hose (trim down) h - Black hose (trim up) Gear Lube Monitor The gear lube monitor consists of an electronically monitored reservoir, a supply hose that connects to the transom assembly, fittings, and a mounting bracket. The reservoir should be mounted in a location with easy access for service, such as on the transom or mounted to a bracket on the front of the engine. It should be mounted at a location higher than the connection point on the transom assembly, avoiding low spots in the hose. Each boat's installation layout will determine the best location for the reservoir. 1. Determine the best mounting location for the gear lube reservoir. Removal and Installation Page 8A-16 90-865612070 JUNE 2007 2. Confirm that the hose assembly with the 90� quick release fitting is properly secured to the gimbal housing fitting and is positioned with the quick release button on the 90� fitting away from water inlet fitting or block-off plate. The quick release button must not contact the water inlet hose, water inlet fitting or, if used, the block-off plate. 14835 a c e d b f a - Water inlet fitting and hose b - Quick release fitting c - J-clip d - Gear lube monitor hose e - Quick release button f - Water block-off plate (optional) 3. Route the hose through any opening in the inner transom plate that will allow for a direct path to the reservoir. IMPORTANT: The hose must be routed directly to the gear lube monitor reservoir, avoiding low spots (traps) in the system. 4. Connect the gear lube monitor hose assemblies. 7800 b c a a - Gear lube monitor hose assembly from drive unit b - Gear lube monitor hose assembly from gear lube reservoir c - Quick connect fitting IMPORTANT: Route hoses to determine the minimum length of hose needed and trim off the excess to avoid low spots in the system. Avoid kinks and route in a straight path. 5. Mount the reservoir bracket to its mounting location. Removal and InstallatioS 6. Position the gear lube monitor reservoir in the bracket and secure it with a rubber tie strap. c7257ba a -BrackeE b -Gear lube monitor reservoiU c -Rubber tie straU 7. Route the hose to the monitor and cut the hose to length. Connect the hose to the monitor and secure it with a hose clamp. 8. Connect the audio warning system wires, located above the oil cooler on the rear starboard side of the engine, (BLU/TAN and BLK) to the gear lube monitor (BLK and BLK). Use the extension harness from this kit or the extension harness from the drive shaft extension kit (if applicable). NOTE:Wire polarity does not matter. 9. Use extra J-clips on the hose to secure the hose. 90-865612070 JUNE 2007 Page 8A-17 Removal and Installation Page 8A-18 90-865612070 JUNE 2007 10. Check the hose and quick release fittings. The hose assemblies must not be kinked or come in contact with steering system components, engine coupler, u-joint shaft, or driveshaft. The quick release fittings must be positioned away from any object that might cause the connection to release. d e f g 14826 CV RVI a b c a - Gear lube monitor connection at the transom (inner transom plate cut away to show connection) b - Route hose through appropriate opening in inner transom plate (based on reservoir location) c - Use J-clip to secure hose if needed d - Gear lube monitor reservoir e - Hose clamp f - Audio warning system wires g - Additional J-clips to secure hose as needed Removal and Installation 90-865612070 JUNE 2007 Page 8A-19 ITS Water Pickup Connection An engine may use an external cooling system. The external cooling system has water supplied to the engine from sea water outside the boat. This can be done by either lower, side, or both (called "dual") water pick-up holes in the Bravo drive unit or by an alternative external water pick-up device. The power package's cooling requirements will determine if an alternative water pick-up device would be required. Determine if the external water supply to the engine will be provided by the Bravo drive unit or by an alternative water pick-up device, then follow the installation instructions for the appropriate method. a b c 14029 d a - Side pick-up b - Lower pick-up c - Alternative external pick-up (optional) d - Transom water inlet BRAVO DRIVE UNIT WATER PICK-UP CONNECTION When using the water supplied by the water pick-up holes in the Bravo drive unit, a stainless steel water inlet elbow fitting will be installed to the transom assembly at the factory to allow for hose connection to the sea strainer. IMPORTANT: When routing the hoses, verify that they are routed and secured to avoid contact with hot engine components and moving parts. Removal and Installation Page 8A-20 90-865612070 JUNE 2007 1. Connect a section of water hose between the stainless steel water inlet elbow fitting and the sea strainer and secure it with hose clamps. 14817 a CV RVI a - Water inlet fitting Removal and Installation 90-865612070 JUNE 2007 Page 8A-21 2. Connect another section of hose between the sea strainer and sea pump a secure with hose clamps. 14820 a c d b e a - Water inlet fitting b - Sea strainer c - Connect hose to sea pump d - Sea pump e - Shut-off valve ALTERNATIVE WATER PICK-UPS If the power package's cooling requires an alternative water pick-up, then an external water pick-up device must be installed in the transom or hull of the boat. It is important to properly install these components. They should be mounted as close to the bottom of the boat as possible to reduce the possibility of air being drawn into the sea pump. Refer to the Requirements Manual for more information. Also, a water block-off plate will be installed to the water inlet of the transom assembly of the drive unit. Refer to the Mercury Marine Precision Parts and Accessories Guide for the water block-off plate part number. When installing the block-off plate, it is necessary to remove the water hose that is located between the bell housing and the gimbal housing. This allows water to continue to circulate through the sterndrive unit for cooling. NOTICE Obstructions in the water passages will keep cooling water from circulating through the engine, resulting in damage to the sterndrive. When using a block-off plate ensure that the water hose between the bell housing and gimble housing is cut and removed. 1. If the inner transom plate is installed, remove it to access the water inlet connection on the outer transom assembly. 2. Remove the water inlet fittings and extention hose. Removal and InstallatioS 3. Remove and discard the tapered plastic hose expander insert in the gimbal housing using the tapered insert tool. This will release the hose from inside the housing. abca7261 a -Tapered insertb -Tapered insert toolc -Gimbal housing cross-sectional view Tapered Insert Tool91-43579 4.Install the new gasket and block-off plate. Secure with screws and lockwashers. Torque the screws to specifications. abdc7262a -Block-off plate b -Gasket c -Screw d -Lockwasher Description Nm lb. in. lb. ft. Screw, water fitting 5 45 Page 8A-22 90-865612070 JUNE 2007 Removal and Installation 90-865612070 ..UNE 2007 Page 8A-23 5. Move aside the trim limit sender wires and speedometer hose. Reach between the gimbal housing and the bell housing and detach the water hose from the gimbal housing where the tapered plastic hose expander insert was removed in step two. a b e c d 7265 a - Trim limit sender wires b - Speedometer hose c - Gimbal housing d - Water hose e - Tapered insert ! WARNING Improper reassembly of the U-joint and pinion gear assembly can damage the sterndrive or sink the boat. The U-joint bellows must provide a watertight seal to prevent water from entering the boat. Assemble and install the U-joint and pinion gear as specified. NOTE: Move the trim limit sender wires and speedometer hose to avoid damaging them when cutting the water hose. The existing tie strap and clip can be re-used if they are moved and re-positioned after the hose is cut. 6. Cut completely through the water hose 127 mm (5 in.) in front of the aft end of the hose where it is fitted into the bell housing in the area shown. Do not damage the U-joint bellows. Discard the hose piece. 7. Secure the trim limit sender wires and speedometer hose to the remaining section of the water hose using the existing tie strap and clip. c e a d b f 7270 a - Tie strap b - Clip c - Water inlet hose d - Speedometer hose e - Trim limit wire harness f - Cutting area Removal and Installation Page 8A-24 90-865612070 JUNE 2007 To complete the installation of the alternative water pick-up, complete the following connections. 1. Route the hoses to avoid sharp bends while keeping the number of fittings to a minimum. 2. Install a seacock to the external water pick-up. Use sealant on pipe fittings and high pressure grease on AN fittings. 3. Connect the hose to the seacock and secure with a hose clamp. 4. Make connections to the sea strainer and secure with hose clamps. 5. Connect the hose to the sea pump and secure with a hose clamp. 6. Check for leaks at initial start-up. 14821 a b c d e a - External water pick-up b - Seacock c - Sea strainer d - Connect hose to sea pump e - Sea pump Power Steering System Bleeding Procedure SINGLE ENGINE APPLICATION The drive-mounted steering cylinders and lines are pre-filled with power steering fluid at the factory. All additional hoses will need to be purged of air and filled with power steering fluid. The easiest method to do this is to use a remote pump and reservoir filling system which can be purchased from the supplier of the helm steering components. However, if a remote filling system is not available, the following procedures represent the steps by which air can be bled from the system using the helm steering pump. The intent is to fill the system with power steering fluid and simultaneously purge all the air from the system prior to actually turning the drive unit with helm pump. Refer to the Power Steering Diagrams. In order to successfully complete the bleeding procedure: � The engine and complete steering system must be installed. � Do not start the engine until instructed to do so later in this procedure. � Do not turn the drive unit prior to starting the bleeding procedures. Removal and InstallatioS � Do not operate the power steering pump without a sufficient amount of fluid in the reservoir or serious damage to the pump could occur. Items needed to perform the procedure: � Two lengths of temporary tubing to fit over the bleeder valves and long enough to reach a storage container � An appropriate storage container to hold the fluid to be bled off � Power steering fluid � Hose clamp pliers � Box wrenches and shop towels HOSE SPECIFICATIONS Type of Hose Description: Steering hoses (L and R) and pump output Working hoses (P) pressure: Burst Pressure: Low pressure return hose (T) Specification # 6 SAE certified with O-ring fittings (minimum) 13790 kPa (2000 psi) 55160 kPa (8000 psi) 3/8 in. SAE J189 certified or push on hose with working pressure of 1379 kPa (200 psi) and a burst pressure of 5516 kPa (800 psi) (minimum). 1. Remove the fill cap from the power steering reservoir and check the fluid level. Add fluid as required. Leave the cap off and closely monitor the fluid level. It will need to be refilled several times. IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or Dexron III automatic transmission fluid (ATF) in the power steering system. Tube Ref No. DescriptioS Where Used Part No. 114 Power Trim and Steering Fluid Power steering reservoir 92-858074K01 2. Remove the protective covers from the bleeder valves. 3. Secure the temporary tubing on each bleeder valve. 90-865612070 JUNE 2007 Page 8A-25 Removal and InstallatioS 4. Secure the other end of the tubing in a storage container to hold the fluid to be bled off. abcd14887 a -Valve block assembly (496 HO only) b -Temporary tubing c -Protective caps d -Bleeder valve assemblies 5. Open each bleeder valve (located on the steering adaptor side of the valve block assembly) approximately 1/2 turn, counter-clockwise. 6. Locate a return line that runs between the valve block assembly and the power steering reservoir. Pinch off the return line with a hose-clamp pliers (Snap-On P/N PHP1, YA965 or equivalent). NOTE:This allows fluid to be drawn through the power steering pump to the helm pump, which will push the fluid to the bleeder valves. Otherwise the fluid will take the path of least resistance and flow to the helm pump through the return line and leave air trapped in the pressure line. 7. Verify that the reservoir is full. Be prepared to fill the reservoir as the level drops. IMPORTANT: Do not allow the fluid level to drop too low in the reservoir while turning the helm pump. Air must not enter the system through the reservoir during this process. Turning the helm pump can be interrupted while filling the reservoir, but when resuming the process, the helm pump must be turned in the same direction as previously turned. 8. Slowly turn the helm in one direction until a steady stream of fluid can be observed flowing out of one of the bleeder tubing. This may take some time as the air in the lines is displaced by power steering fluid. Page 8A-26 90-865612070 JUNE 2007 Removal and InstallatioS NOTE: The engine is not running during the bleeding process. Therefore, the helm pump will be pulling fluid from the reservoir through the power steering pump. A vacuum will be created on the return side of the pump circuit and the fluid level in the reservoir may drop quickly when the restriction on the return line is removed. 26160RDLDcagfdjhie Mercury Racing Product a -Power steering pump f -Filter b -Power steering fluid reservoir g -Helm pump c -Check valve h -Bleeder valves d -Cooler i -Temporary bleeder tubing e -Restriction (hose clamp pliers) j -Storage container 90-865612070 JUNE 2007 Page 8A-27 Removal and InstallatioS 14907T1P1RDLDbadgceef (496 HO only) a -Power steering pump e -Bleeder valves b -Power steering fluid reservoir f -Temporary bleeder tubing c -Restriction (hose clamp pliers) g -Storage container d -Helm pump 9. Remove the hose-clamp pliers. Due to the vacuum that was created in the return side of the pump circuit, there will be a rapid drop in the fluid level in the reservoir. Be prepared to fill the reservoir as the fluid drops. 10. Slowly turn the helm in the opposite direction until a steady stream of fluid can be observed flowing out of the second bleeder tubing. Be sure to maintain the proper fluid level in the reservoir. Page 8A-28 90-865612070 JUNE 2007 Removal and InstallatioS NOTE:At this point there is still some air in the system. But a majority of the air was removed. If desired, the open end of the temporary bleeder tubing can now be moved from the storage container to the power steering reservoir. 26161RDLDbcafedigh Mercury Racing Product a -Power steering pump f -Helm pump b -Power steering fluid reservoir g -Second bleeder valves c -Check valve h -Temporary bleeder tubing d -Cooler i -Storage container e -Filter 90-865612070 JUNE 2007 Page 8A-29 Removal and InstallatioS 14908T1P1RDLDbacfeed (496 HO only) a -Power steering pump d -Second bleeder valves b -Power steering fluid reservoir e -Temporary bleeder tubing c -Helm pump f -Storage container 11. While maintaining the pump reservoir fluid level, turn the helm several times in each direction until a steady stream of fluid can be observed flowing out of both bleeder tubes. The helm may become increasingly more difficult to turn. 12. Start the engine. Wait for the engine to warm and change from cold start fast idle, to normal warm idle. IMPORTANT: Do not turn the helm until the engine falls to normal idle. 13. While maintaining the reservoir fluid level, turn the helm fully to starboard and back to port several times to remove any air that may still be in the system. 14. Shut off the engine. The fluid in the reservoir should have little or no foam and be maintaining a consistent level. IMPORTANT: If large amounts of foam can be seen in the fluid, do not continue to the next step. The bleeding process will need to be repeated. Allow the air to separate out from the fluid for a period of at least sixty minutes and start the bleeding process over. 15. Close the bleeder valves. 16. Remove the temporary bleeder tubing and storage container. 17. Install the two protective caps over the bleeder valves. 18. Install the cap on the reservoir. 19. Start the engine and check for leaks. 20. Turn the helm one turn in each direction. This will pressurize the steering circuit. 21. Turn off the engine. 22. By hand, try to move the drive from side to side. Confirm that there is no free movement in the steering cylinders. Page 8A-30 90-865612070 JUNE 2007 Removal and InstallatioS MULTIPLE ENGINE APPLICATION The drive-mounted steering cylinders and lines are pre-filled with power steering fluid at the factory. All additional hoses will need to be purged of air and filled with power steering fluid. The easiest method to do this is to use a remote pump and reservoir filling system which can be purchased from the supplier of the helm steering components. However, if a remote filling system is not available, the following procedures represent the steps by which air can be bled from the system using the helm steering pump. The intent is to fill the system with power steering fluid and simultaneously purge all the air from the system prior to actually turning the drive units with helm pump. In order to successfully complete the bleeding procedure: � The engines and complete steering system must be installed. � Do not attach tie bars to the drives prior to bleeding the power steering system. � Do not start the engines. � Do not turn the drive units prior to starting the bleeding procedures. � Do not operate the power steering pump with out a sufficient amount of fluid in the reservoir or serious damage to the pumps could occur. Items needed to perform the procedure: � Two lengths of temporary tubing to fit over the bleeder valves and long enough to reach a storage container � An appropriate storage container to hold the fluid to be bled off � Power steering fluid � Hose clamp pliers � Box wrenches and shop towels HOSE SPECIFICATIONS Type of Hose Description: Steering hoses (L and R) and pump output Working hoses (P) pressure: Burst Pressure: Low pressure return hose (T) Specification # 6 SAE certified with O-ring fittings (minimum) 13790 kPa (2000 psi) 55160 kPa (8000 psi) 3/8 in. and 1/2 in. SAE J189 certified or push on hose with working pressure of 1379 kPa (200 psi) and a burst pressure of 5516 kPa (800 psi) (minimum). 1. Depending on the after-market steering equipment installed, the individual power steering reservoirs on the engines may have a special cap installed with hoses routed to a common reservoir which is mounted higher than the reservoirs mounted on the engine. The individual reservoirs should be completely filled with fluid. 2. Remove the fill cap from the common power steering reservoir and check the fluid level. Add fluid as required. Leave the cap off and closely monitor the fluid level. It will need to be refilled several times. IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or Dexron III automatic transmission fluid (ATF) in the power steering system. Tube Ref No. DescriptioS Where Used Part No. 114 Power Trim and Steering Fluid Power steering reservoir 92-858074K01 3. Remove the protective covers from the bleeder valves. 90-865612070 JUNE 2007 Page 8A-31 Removal and InstallatioS 4. Secure the temporary tubing on each bleeder valve. 5. Secure the other end of the tubing in a storage container to hold the fluid to be bled off. abcd14887 a -Valve block assembly (496 HO only) b -Temporary tubing c -Protective caps d -Bleeder valve assemblies 6. Open each bleeder valve (located on the steering adaptor side of the valve block assembly) approximately 1/2 turn, counter-clockwise. 7. Locate the return lines that run between the valve block assembly and the power steering reservoirs. Pinch off the return line with a hose-clamp pliers (Snap-On P/N PHP1, YA965 or equivalent). NOTE:This allows fluid to be drawn through the power steering pumps to the helm pump, which will push the fluid to the bleeder valves. Otherwise the fluid will take the path of least resistance and flow to the helm pump through the return lines and leave air trapped in the pressure lines. 8. Verify that the common reservoir is full. Be prepared to fill the reservoir as the level drops. IMPORTANT: Do not allow the fluid level to drop too low in the reservoir while turning the helm pump. Air must not enter the system through the reservoir during this process. Turning the helm pump can be interrupted while filling the reservoir, but when resuming the process, the helm pump must be turned in the same direction as previously turned. 9. Slowly turn the helm in one direction until a steady stream of fluid can be observed flowing out of one of the bleeder tubes. This may take some time as the air in the lines is displaced by power steering fluid. Page 8A-32 90-865612070 JUNE 2007 Removal and InstallatioS NOTE:Theenginesarenotrunningduringthebleedingprocess.Therefore,thehelmpump willbepullingfluidfromthereservoirthroughthepowersteeringpump.Avacuumwillbe created on the return side of the pump circuit and the fluid level in the reservoir may drop quickly when the restrictions on the return lines are removed. 26162RDLDLDaidhRDeebbccffga Mercury Racing Product a -Power steering pump f -Bleeder valves b -Power steering fluid reservoir g -Temporary bleeder tubing c -Restriction (hose clamp) h -Storage container d -Helm pump i -Common reservoir e -Flow through connections (bleeder valves removed) 90-865612070 JUNE 2007 Page 8A-33 Removal and InstallatioS 14983T1T1P1P1RDLDLDaaidhRDebbccfg (496 HO only) a -Power steering pump f -Bleeder valves b -Power steering fluid reservoir g -Temporary bleeder tubing c -Restriction (hose clamp) h -Storage container d -Helm pump i -Common reservoir e -Flow through connections (bleeder valves removed) 10. Remove the hose-clamp pliers. Due to the vacuum that was created in the return side of the pump circuit, there will be a rapid drop in the fluid level in the reservoir. Be prepared to fill the reservoir as the fluid drops. Page 8A-34 90-865612070 JUNE 2007 Removal and InstallatioS 11. Slowly turn the helm in the opposite direction until a steady stream of fluid can be observed flowing out of the second bleeder tubing. Be sure to maintain the proper fluid level in the reservoir. NOTE:Atthispointthereisstillsomeairinthesystem.Butamajorityoftheairwas removed.Ifdesired,theopenendofthetemporarybleedertubingcannowbemovedfrom the storage container to the common power steering reservoir. 26164RDLDLDbbaahcgRDedeefMercury Racing Product a -Power steering pump b -Power steering fluid reservoir c -Helm pump d -Flow through connections (bleeder valves removed) e -Bleeder valves (located on the last drive in the system) f -Temporary bleeder tubing g -Storage container h -Common reservoir 90-865612070 JUNE 2007 Page 8A-35 Removal and InstallatioS 14984T1T1P1P1RDLDLDbbaahcgRDdef (496 HO only) a -Power steering pump e -Bleeder valves (located on the last b -Power steering fluid reservoir drive in the system) c -Helm pump f -Temporary bleeder tubing d -Flow through connections g -Storage container (bleeder valves removed) h -Common reservoir 12. While maintaining the common reservoir fluid level, turn the helm several times in each direction until a steady stream of fluid can be observed flowing out of both bleeder tubes. The helm may become increasingly more difficult to turn. 13. Start the engines. Wait for the engines to warm and change from cold start fast idle, to normal warm idle. IMPORTANT: Do not turn the helm until the engines falls to normal idle. Page 8A-36 90-865612070 JUNE 2007 Removal and InstallatioS 14. While maintaining pump reservoir fluid level, turn the helm fully to starboard and back to port several times to remove any air that may still be in the system. 15. Shut off the engines. The fluid in the common reservoir should have little or no foam and be maintaining a consistent level. IMPORTANT: If large amounts of foam can be seen in the fluid, do not continue to the next step. The bleeding process will need to be repeated. Allow the air to separate out from the fluid for a period of at least sixty minutes and start the bleeding process over. 16. Close the bleeder valves. 17. Remove the temporary bleeder tubing and storage container. 18. Install the two protective caps over the bleeder valves. 19. Install the cap on the common reservoir. 20. Start the engines and check for leaks. 21. Turn the helm one turn in each direction. This will pressurize the steering circuit. 22. Turn off the engines. 23. By hand, try to move the drive from side to side. Confirm that there is no free movement in the steering cylinders. 24. If the common reservoir is attached to the cap of the individual power steering reservoirs on the engines; loosen the individual reservoir caps and verify that the reservoirs are full to the cap. Tighten all reservoir caps. 25. Drive tie bar(s) may now be attached and adjusted. 90-865612070 JUNE 2007 Page 8A-37 Removal and InstallatioS Notes: Page 8A-38 90-865612070 JUNE 2007 Steering and Trim CircuitD Integrated Transom System (ITS) Section 8B - Steering and Trim Circuits Table of Contents Hydraulic and Electrical Circuits.....................8B-2 496 HO Steering System.........................8B-2 Mercury Racing Product Steering System ....8B-4 Single Engine Power Steering Diagram ....8B-7 Twin Engine Power Steering Diagram......8B-9 Triple Or Quad Engine Power SteerinL Diagram...8B-11 MerCathode System..............................8B-13 MerCathode Connections......................8B-13 Power Trim (Single Engine)...................8B-14 Power Trim (Dual Engine)....................8B-16 90-865612070 JUNE 2007 Page 8B-1 8 B Steering and Trim CircuitD Hydraulic and Electrical Circuits 496 HO Steering System PUMP ADAPTOR BLOCK (496 HO) NOTE:Order the pump adaptor block if needed (P/N 8M8021152) The pump adapter block allows you to adapt the special Saginaw fittings from the power steering pump to standard SAE fittings for the helm. This block is required for all two engine applications where both power steering pumps are used. On 3 or 4 engine applications, any engine not utilizing the power steering pump does not require the pump adapter block. The following illustration shows the pump adapter block connections. Also refer to the Power Steering Diagrams (496 HO) located near the end of this manual. 13849TH PHBOTT1 P1 TOP a d b c e Pump Adapter Block (Top View Pump Adapter Block (Bottom View Description a b c d e T1 - Return line P1 - Pressure inlet line PH - Pressure line TH - Return line CV - Check valve Connection OUT to power steering cooler IN from power steering pump OUT to filter/helm IN from helm None 1. All engines equipped with power steering require both the pump adapter block and the steering adapter block. 2. Any engines not utilizing or not equipped with a power steering pump do not require the pump adapter block. 3. Each configuration can be installed using the inner transom plate pivot bolts. Page 8B-2 90-865612070 JUNE 2007 Steering and Trim CircuitD 4. The pump adapter block may be located remotely if rigging issues prevent installing it next to the steering adapter block. CVRVIa b c 13796c d a -Pump adapter block c -Attaching/pivot bolts b -Steering adapter block d -Inner transom plate STEERING ADAPTOR BLOCK The steering adapter block is the large block that handles all hydraulic steering connections. This block is required for all engines equipped with an ITS. The following illustration shows the steering adapter block connections. Also refer to the Power Steering Diagrams located near the end of this manual. 90-865612070 JUNE 2007 Page 8B-3 Steering and Trim Circuits ' NOTE:Use either RD (right drive) and LD (left drive) or RH (right helm) and LH (left helm) for lines coming in from the helm. Plug the unused connections. If installing a multiple engine application, one pair of connections serves as the IN from helm connection. The other can serve as the OUT to another drive connection. RD LD abcdef 13856 Steering Adapter Block (Top View) Description] ^ _ ` a b RD and LD RH and LH (bottom of block) RV2 - Cross port pressure relief valve RV1 - Cross port pressure relief valve R (side of block) Mounting pivot point L (side of block) Connection IN from helm or OUT to second drive (plug if not used) None None OUT to right turn connection, outer transom Bolted to the inner transom plate OUT to left turn connection, outer transom The two pressure relief valves are set to open at 13,790 kPa (2000 psi). Mercury Racing Product Steering System STEERING HOSE CONNECTION 1. Disconnect the fluid hose at the power steering cooler and connect it to the bottom of the high pressure filter; a 3/8 pipe to a # 6 adaptor must be installed into the bottom of the filter. 2. Install a 3/8 pipe to a # 6 adaptor into the top of the filter. 3. Connect a # 6 high pressure hose from the top of the filter to the port at the helm steering marked "P." 4. Remove the fitting adaptor from the cooler. 5. Connect a # 6 high pressure hose from the port marked "T" at the helm steering to the power steering fluid cooler. 6. Follow the helm steering manufacturer's instructions for installing and purging (bleeding) the hydraulic system before connecting the helm hydraulic hoses to the cross port relief valve block. Page 8B-4 90-865612070 JUNE 2007' Steering and Trim Circuits 90-865612070 JUNE 2007 Page 8B-5 NOTE: The drive, power steering pump, and cooler are filled with fluid at the factory. a b c d f h h i g e j L R P T g g 26141 a - To tank or reservoir b - From pump c - Right turn d - Left turn e - Filter f - Reservoir adaptor P/N 8M8020356 g - Pump h - Fluid cooler i - Check valve j - Reservoir (port) STEERING ADAPTOR BLOCK The steering adapter block is the large block that handles all hydraulic steering connections. This block is required for all engines equipped with an ITS. The following illustration shows the steering adapter block connections. Also refer to the Power Steering Diagrams (Mercury Racing Product) located near the end of this manual. Steering and Trim CircuitD NOTE:Use either RD (right drive) and LD (left drive) or RH (right helm) and LH (left helm) for lines coming in from the helm. Plug the unused connections. If installing a multiple engine application, one pair of connections serves as the IN from helm connection. The other can serve as the OUT to another drive connection. RD LD abcdef 13856 Steering Adapter Block (Top View) Description] ^ _ ` a b RD and LD RH and LH (bottom of block) RV2 - Cross port pressure relief valve RV1 - Cross port pressure relief valve R (side of block) Mounting pivot point L (side of block) Connection IN from helm or OUT to second drive (plug if not used) None None OUT to right turn connection, outer transom Bolted to the inner transom plate OUT to left turn connection, outer transom The two pressure relief valves are set to open at 13,790 kPa (2000 psi). Page 8B-6 90-865612070 JUNE 2007 Steering and Trim CircuitD Single Engine Power Steering DiagraR 6 6 6 3/8 6 3/8 abcehgijdRD LD TOP f Mercury Racing Product a -Helm steering pump b -High pressure hose (#6 minimum) c -Filter - From adapter block (PH) To Helm (P) d -Check valve e -Steering adapter block (on inner transom plate) 26169 f -Right and left drive lines - From steering adapter block (R and L) g -Power steering cooler - From steering adapter block (T1) h -Low pressure return hose (3/8 in. minimum) i -Power steering pump j -Reservoir 90-865612070 JUNE 2007 Page 8B-7 Steering and Trim CircuitD 6 6 6 3/8 3/8 6 3/8 abcdefhgij13894T1P1RDLDTOPTOP 496 HO a -Helm steering pump f -Right and left drive lines - From b -High pressure hose (#6 minimum) steering adapter block (R and L) c -Filter - From adapter block (PH) To g -Power steering cooler - From Helm (P) steering adapter block (T1) d -Pump adapter block h -Low pressure return hose (3/8 in. minimum) e -Steering adapter block (on inner transom plate) i -Power steering pump j -Reservoir NOTE:The numbers on the hoses in the figure above correspond to the hose specification (below). NOTE:Locations on the helm and the adapter block are marked with an L or R and must be connected in series. HOSE SPECIFICATIONS Type of Hose Description: Steering hoses (L and R) and pump output hoses (P) Working pressure: Burst Pressure: Low pressure return hose (T) Specification # 6 SAE certified with O-ring fittings (minimum) 13790 kPa (2000 psi) 55160 kPa (8000 psi) 3/8 in. SAE J189 certified or push on hose with working pressure of 1379 kPa (200 psi) and a burst pressure of 5516 kPa (800 psi) (minimum). Page 8B-8 90-865612070 JUNE 2007 Steering and Trim CircuitD Twin Engine Power Steering Diagram Although the system could be installed using one power steering pump to operate two drives, it is not recommended. The preferred method is shown in the following illustration using two pumps to operate two drives. In case of a power steering system failure, the redundant system will allow the boat to continue to function until repairs can be made. 6 6 3/8 6 3/8 3/86 3/8 6 3/8 3/8 8 6 acddkelbgfchjjigf26170 RD LD TOP RD LD TOPTOP ih3/8 6 e3/8 6 Mercury Racing Product a -Helm steering pump b -Reservoir return line c -T-fitting d -Filter - From steering adapter block (PH) to helm (P) e -Power steering pump f -Power steering cooler - From steering adapter block (T1) g -Individual engine reservoir h -Steering adapter block i -Check valve j -Right and left hoses to drive unit From steering adapter block (R and L) k -High pressure hose (#6 minimum) l -High pressure, high volume hose (#8 minimum) 90-865612070 JUNE 2007 Page 8B-9 Steering and Trim CircuitD 6 6 6 6 3/8 6 3/8 3/8 3/8 3/86 3/8 6 1/2 3/8 8 6 acddkelmgfchjjigf14985 T1 P1 RD LD TOPTOP bT1 P1 RD LD TOPTOP ih3/8 6 e 496 HO a -Helm steering pump h -Steering adapter block b -Common P/S reservoir (not i -Pump adapter block supplied) j -Right and left hoses to drive unit c -T-fitting From steering adapter block (R and d -Filter - From steering adapter L) block (PH) to helm (P) k -High pressure hose (#6 minimum) e -Power steering pump l -High pressure, high volume hose f -Power steering cooler - From (#8 minimum) steering adapter block (T1) m -Low pressure, high volume return g -Individual engine reservoir hose (1/2 in. minimum) NOTE:The numbers on the hoses in the figure above correspond to the hose specification (below). NOTE:Locations on the helm and the adapter block are marked with an L or R and must be connected in series. HOSE SPECIFICATIONS Type of Hose Description: Steering hoses (L and R) and pump output hoses (P) Working pressure: Burst Pressure: Low pressure return hose (T) Specification # 6 SAE certified with O-ring fittings (minimum) 13790 kPa (2000 psi) 55160 kPa (8000 psi) 3/8 in. and 1/2 in. SAE J189 certified or push on hose with working pressure of 1379 kPa (200 psi) and a burst pressure of 5516 kPa (800 psi) (minimum). Page 8B-10 90-865612070 JUNE 2007 Steering and Trim Circuits' Triple Or Quad Engine Power Steering Diagram In a three or four engine application it is possible to install the power steering system the same as a two engine application by adding the third and fourth drive's adaptor block in series as shown in the following diagram. Any engine not using its power steering pump can either have the lines to and from the power steering pump joined together by a union to create a loop or the power steering pump and reservoir can be removed and replaced with an idler pulley. 6 6 3/8 6 3/8 3/8 3/86 3/8 6 3/8 3/8 8 6 acddkelbgfihjjigRD LD TOP RD LD TOP h6 26171 RD LD TOP hjeRD LD TOP hj3/8 Mercury Racing Product a -Helm steering pump b -Reservoirreturn hose c -T-fitting d -Filter - From steering adapter block (PH) to helm (P) e -Power steering pump f -Power steering cooler - From steering adapter block (T1) g -Individual engine reservoir h -Steering adapter block i -Check valve j -Right and left hoses to drive unit From steering adapter block (R and L) k -High pressure hose (#6 minimum) l -High pressure, high volume hose (#8 minimum) 90-865612070 JUNE 2007 Page 8B-11' Steering and Trim CircuitD 6 6 6 6 3/8 6 3/8 3/8 3/8 3/86 3/8 6 1/2 3/8 8 6 acddkelmgfchjjigfT1 P1 RD LD TOPTOP bT1 P1 RD LD TOPTOP ih3/8 6 e RD LD TOP hjRD LD TOP hj 496 HO a -Helm steering pump h -Steering adapter block b -Common P/S reservoir (not i -Pump adapter block supplied) j -Right and left hoses to drive unit c -T-fitting From steering adapter block (R and d -Filter - From steering adapter L) block (PH) to helm (P) k -High pressure hose (#6 minimum) e -Power steering pump l -High pressure, high volume hose f -Power steering cooler - From (#8 minimum) steering adapter block (T1) m -Low pressure, high volume return g -Individual engine reservoir hose (1/2 in. minimum) NOTE:The numbers on the hoses in the figure above correspond to the hose specification (below). NOTE:Locations on the helm and the adapter block are marked with an L or R and must be connected in series. HOSE SPECIFICATIONS Type of Hose Description: Steering hoses (L and R) and pump output hoses (P) Working pressure: Burst Pressure: Low pressure return hose (T) Specification # 6 SAE certified with O-ring fittings (minimum) 13790 kPa (2000 psi) 55160 kPa (8000 psi) 3/8 in. and 1/2 in. SAE J189 certified or push on hose with working pressure of 1379 kPa (200 psi) and a burst pressure of 5516 kPa (800 psi) (minimum). Page 8B-12 90-865612070 JUNE 2007 Steering and Trim CircuitD MerCathode SysteR abc7367dMERCATHODEARBLKBLKORNBRNORNBRNBRNRED/PUR a -Controller c -Electrode b -20 amp fuse d -Battery MerCathode Connections IMPORTANT: The opposite end of the RED/PPL power wire must be connected directly to the battery positive (+) terminal. Do not connect it to a switched positive (+) circuit. The MerCathode system must function continuously for proper corrosion protection. 1. RED/PPL Lead - Connect to the positive (+) battery terminal. 2. Connect the connector maked "MerCathode" on the engine electrical panel near the bullet connectors to the connector on the transom marked "MerCathode". 90-865612070 JUNE 2007 Page 8B-13 Steering and Trim Circuits Page 8B-14 90-865612070 JUNE 2007 Power Trim (Single Engine) B L U /WH T GRN /WH T RED B L K BLK BLK B LK a R E D B L U / W H T PPL/ W H T UP CIRCUIT DOWN CIRCUIT b c d e h f g i 14435 GRN/WHT a - Control b - Trim sender c - Instrument harness d - Conversion module e - Trim Pump f - 10 amp fuse g - 110 amp fuse h - Trim UP solenoid i - Trim DOWN solenoid Steering and Trim CircuitD Notes: 90-865612070 JUNE 2007 Page 8B-15 Steering and Trim Circuits Page 8B-16 90-865612070 JUNE 2007 Power Trim (Dual Engine) B L U /WH T GRN /WH T RED B L K BLK BLK B LK B L U /WH T GRN /WH T RED B L K BLK BLK B LK 10745 a c d e f g h i j l k R E D b b m n o m n o p q q B L U / W H T PPL/ W H T B L U / W H T PPL/ W H T DOWN CIRCUIT UP CIRCUIT GRN/WHT GRN/WHT Steering and Trim CircuitD a -Control b -Diode c -Port trim pump d -Starboard trim pump e -Port trim switch f -Starboard trim switch g -Port UP solenoid h -Port DOWN solenoid i -Starboard UP solenoid j -Starboard DOWN solenoid k -110 amp starboard trim pump fuse l -110 amp port trim pump fuse m -Conversion module n -Instrument harness o -Trim sender p -Ground tie q -10 amp fuse 90-865612070 JUNE 2007 Page 8B-17 Steering and Trim CircuitD Notes: Page 8B-18 90-865612070 JUNE 2007 Bell Housing Assembly Integrated Transom System (ITS) Section 8C - Bell Housing Assembly Table of Contents Disassembly...8C-3 Retention Sleeve.....................................8C-3 Cooling Hose...8C-5 Shift Cable�Bell Housing Removal...........8C-5 Dribble Valve Removal............................8C-5 Ground Strap�Bell Housing Removal.......8C-6 Hinge Pin...8C-6 U-joint Bellows � Gimbal Housing Removal ....8C-7 Exhaust Tube..8C-8 Assembly..8C-9 Inlet Water Hose, Tapered Insert, and Retainer Clips � Gimbal Housing Installation..........8C-9 U-joint Bellows � Gimbal Housing Installation ....8C-10 Shift Cable � Gimbal Housing Installation ....8C-12 Gimbal Ring Phenolic Washer Replacement ....8C-13 Hinge Pin Bushing.................................8C-14 Bell Housing..8C-15 Retention Sleeve...................................8C-16 Tapered Insert � Bell Housing...............8C-16 Dribble Valve Installation.......................8C-16 Shift Cable � Bell Housing Installation....8C-17 Gimbal Beraing Replacement.......................8C-18 Removal..8C-18 Installation...8C-19 90-865612070 JUNE 2007 Page 8C- 8 C Bell Housing Assembly Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used Part No. 19 27 34 66 95 130 U-joint bellows Lacquer thinner U-joint bellows mounting flange on the gimbal Obtain Locally housing Perfect Seal Threads of the shift cable retaining nut 92-34227-1 Bellows Adhesive U-joint bellows 92-86166Q1 Special Lubricant 101 Hinge pin 92-802865Q02 Loctite 242 Threadlocker Torx head screws 92-809821 2-4-C with Teflon Hose inner diameter 92-802859A1 Sealer Kit, Two Part Epoxy Hinge pin bushing 92-65150-1 Special Tools Retention Sleeve Removal Tool 91-862546 10851 Removes the aluminum sleeve from the U-joint bellows of all the Bravo and Blackhawk drive units, Serial Number 0L999999 and below. Puller Plate 91-29310 18600 Aids in the removal and installation of the gimbal bearing, as well as various bearings in the gear housing. Also included in the Bearing Removal and Installation Kit (91-31229A 7). Washer 11-34961 Aids in the removal and installation of various engine components. May use with Puller Shaft (91-31229); also included in the Bearing Removal and Installation Kit 18661 (91-31229A 7). Puller Shaft 91-31229 A 5/8 in. x 18 in. (15.875 mm) long threaded rod which aids in the removal and installation of various engine components. Also included in the Bearing Removal and Installation Kit (91-31229A 7). Tapered Insert Tool 91-43579 18604 Removes and installs the tapered insert retainer into the water inlet hose. 9197 Page 8C-2 90-865612070 JUNE 200 Bell Housing Assembly Puller Head 91-63616T Removes the upper swivel shaft on gimbal rings. 10678 Slide Hammer 91-34569A 1 Aids in the removal of various engine components. Use with 6761 puller jaws. Bushing/Bearing/Seal Driver 91-43578A1 10484 Installs the transom assembly bushings, bearings, and seals. Collar #3 Bearing Installation Tool 91-30366T1 Use with Plate Puller (91-29310), Driver Rod (91-37323) and Bearing Head (91-32335T) to install the gimbal bearing. 10777 Puller Rod Head 91-32325T 10474 Installs the gimbal bearing into the transom gimbal housing; use with gimbal bearing installation collar number 3 (91-30366T1) and driver rod (91-37323). Driver Rod 91-37323 Aids in the removal and installation of various bearings and 25431 bearing races Disassembly Retention Sleeve 1. Remove the drive, refer to the appropriate Service Manual. 90-865612070 JUNE 2007 Page 8C- Bell Housing Assembly 2. Use the tools listed to remove the u-joint bellows retention sleeve. ab 17858 a - Plate b - Retention sleeve abc 16521 a - Puller plate c - Nut and flat washer b - Threaded rod Retention Sleeve Removal Tool 91-862546 Puller Plate 91-29310 Washer 11-34961 Puller Shaft 91-31229 Page 8C-4 90-865612070 JUNE 200 Bell Housing Assembly Cooling Hose 1. Remove the tapered insert. ab a - Cooling hose b - Ratchet and extension dc 16486 c - Tapered insert d - Insert tool Tapered Insert Tool 91-43579 Shift Cable�Bell Housing Removal 1. On the bell housing, loosen and remove the flanged nut that attaches the intermediate shift cable assembly to bell housing. Retain the flanged nut. ab a - Intermediate shift cable b - Flanged nut c 16490 c - Deep socket 2. Push the cable back toward the gimbal housing. Dribble Valve Removal 1. Remove the dribble valve by pulling straight out. ab 16492 a - Dribble valve b - O-ring in the bell housing 90-865612070 JUNE 2007 Page 8C- Bell Housing Assembly INSPECTION 1. Check the O-ring on the dribble valve for nicks and cuts. 2. Ensure that the end of the dribble valve is not damaged. 3. Check the O-ring in the bell housing for nicks and cuts. 4. Inspect the bell housing for corrosion at the hole of the dribble valve. 5. Replace damaged parts. Ground Strap�Bell Housing Removal 1. Lift the bell housing to locate the ground strap that attaches to the gimbal ring. 2. Remove the ground strap at the bell housing connection. Retain the hardware. ab 16526 a - Ground strap b - Torx screw GROUND STRAP INSPECTION 1. Inspect the ground strap for frayed wire and loose end connectors. Hinge Pin 1. Remove the clevis pin and link arm from the hinge pin. bac30107 a - Trim sender c - Link arm b - Clevis pin IMPORTANT: Use heat around the threaded portion of the gimbal ring where the Torx screws are located before loosening the screws. Heat softens the Loctite used on the threads of the screws. If you feel the screw binding as you turn it out, stop, rotate the screw back in and then try loosening it again. Page 8C-6 90-

865612070 JUNE 200 Bell Housing Assembly 2 Remove the Torx screws securing the hinge pins to the gimbal ring and use the tools listed to remove the hinge pins. bba 16529 a - Hinge pin b - Torx head screws cab a - Hinge pin b - Puller head tool 16530abc c - Slide hammer Puller Head 91-63616T Slide Hammer 91-34569A 1 U-joint Bellows � Gimbal Housing Removal 1. Loosen the hose clamp securing the U-joint bellows to the gimbal housing 90-865612070 JUNE 200 Page 8C- Bell Housing Assembly 2. Pull the U-joint bellows from the gimbal housing. ab a 16539 a - U-joint bellows b - Hose clamp U-JOINT BELLOWS INSPECTION 1. Inspect the U-joint bellows for tears, holes, and wear damage. 2. Replace the U-joint bellows if you detect damage. Exhaust Tube Loosen the retaining clamp and remove the exhaust tube. 30113 Page 8C-8 90-865612070 JUNE 200 Bell Housing Assembly Assembly Inlet Water Hose, Tapered Insert, and Retainer Clips � Gimbal Housing Installation 1. Install the inlet water hose to the gimbal housing. ab 18138 Gimbal housing a - Water inlet hose b - Water inlet through hole 2. Install the tapered insert to secure the inlet water hose to the gimbal housing. a. Position the water hose so that approximately 3 mm (1/8 in.) protrudes from edge of the opening of the gimbal housing. b. Apply a small amount of lubricant to the ID of the hose. Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Hose inner diameter 92-802859A1 c. Install tapered inserts using the tapered insert tool ba cd 18135 a - Tapered insert location in gimbal housing b - Ratchet and extension c - Tapered insert d - Tapered insert tool Tapered insert tool 91-43579 3. Install the retaining clips to the inlet water hose. 90-865612070 JUNE 2007 Page 8C- Bell Housing Assembly a Install the top retaining clip to hold the trim limit switch wire in position. ab 18136 a - Trim limit switch wire b - Retaining clip b. Install the bottom retaining clip to hold the speedometer hose in position. ab 18137 a - Retaining clip b - Speedometer hose c Push the inlet water hose back into position in the gimbal housing, taking care not to pinch the trim limit wire and the speedometer hose. ab 19599 a - Retain clip b - Inlet water hose U-joint Bellows � Gimbal Housing Installation 1. If reusing the U-joint bellows, remove the old adhesive from the U-joint bellows using lacquer thinner. Page 8C-1 90-865612070 JUNE 200 Bell Housing Assembly Tube Ref No. Description Where Used Part No. Lacquer thinner U-joint bellows Obtain Locally 2 Clean the U-joint bellows mounting flange on the gimbal housing with sandpaper and wipe clean with lacquer thinner. Do not harm the paint. If paint has been removed, repaint before installing bellows. Tube Ref No. Description Where Used Part No. Lacquer thinner U-joint bellows mounting flange on the gimbal housing Obtain Locally ! WARNING Improper reassembly of the U-joint and pinion gear assembly can damage the sterndrive or sink the boat. The U-joint bellows must provide a watertight seal to prevent water from entering the boat. Assemble and install the U-joint and pinion gear as specified. NOTICE A corroded bellows hose clamp can allow water to enter the bilge. Install the ground clip and maintain the electrical circuit at all times to avoid premature corrosion. 3. 4. 5. Install the ground clip on the U-joint bellows close to the "TOP" mark on bellows. Apply adhesive to the inside diameter side of the U-joint bellows to be attached to the gimbal housing. Allow adhesive to dry until no longer tacky (approximately 10 minutes). Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive U-joint bellows 92-86166Q1 6 Position the hose clamp on the U-joint bellows so that the hose clamp fitting is facing downward on the starboard side when the U-joint bellows are installed. IMPORTANT: The "TOP" mark on the U-joint bellows must be facing upward when installing onto the gimbal housing. 7 Position the U-joint bellows "TOP" mark facing upwards. 8 Push the U-joint bellows onto the gimbal housing flange until the bead on the inner matting surface of the U-joint bellows is in the grove of the gimbal housing flange. ab 18087 a - U-joint bellows b - Hose clamp IMPORTANT: Ensure that the U-joint bellows is correctly positioned in the groove of the gimbal housing flange. 90-865612070 JUNE 200 Page 8C-1 Bell Housing Assembly 9. Tighten and torque the hose clamp of the U-joint bellows. ba 18086 a - Hose clamp b - Swivel socket with extension Description Nm lb. in. lb. ft. U-joint bellows hose clamp 4 35 Shift Cable � Gimbal Housing Installation 1. If applicable, install the shift cable housing insert into the gimbal housing and snap it into place. NOTE:The shift cable housing insert must be installed from transom side. ab18101 a - Shift cable housing insert b - Gimbal housing Page 8C-12 90-865612070 JUNE 200 Bell Housing Assembly 2 Locate the shift cable end without fittings. Insert the shift cable into the small end of the shift cable bellows and through the gimbal housing. ab 18102 a - Shift cable b - Shift cable bellows 3 Pull the shift cable through the gimbal housing until the shift cable with brass end fittings contacts the small end of the bellows. NOTE:Allow the shift cable end with fittings to remain loose at the shift cable bellows untilthe bell housing is installed. 18106baa a - Shift cable b - Control cable Gimbal Ring Phenolic Washer Replacement 1 Peel the damaged phenolic washer from the gimbal ring. 2 Carefully remove glue residue from gimbal ring surface. Do not scratch or remove paint. ab 16568 a - Phenolic washer locations b - Gimbal ring 90-865612070 JUNE 200 Page 8C-1 Bell Housing Assembly 3. To install a new phenolic washer: a. Temporarily place a hinge pin in the gimbal ring. b. Peel the backing off the phenolic washer. c. Place the new phenolic washer onto the gimbal ring using the hinge pin for alignment. aab16569 a - Phenolic washer b - Hinge pin Hinge Pin Bushing 1. Remove the hinge bushing from the bell housing with the tool listed. 2.Bushing/Bearing/Seal Driver 91-43578A1 Check the bushing bore for damage and replace the bell housing if necessary. 3. Apply the epoxy to the outside of the bushing and place the bushing onto the hinge pin. ab 16608 a - Hinge pin driver b - Mandrel Tube Ref No. Description Where Used Part No. 130 Sealer Kit, Two Part Epoxy Hinge pin bushing 92-65150-1 Page 8C-14 90-865612070 JUNE 200 Bell Housing Assembly 4 Press or drive the bushing into the bell housing until it is flush with the ouside of the bushing bore. 30131 Bell Housing 1. Lubricate the hinge pin. 2. Align the bell housing with the gimbal ring and guide the hinge pin through the gimbal ring and bell housing. 3. Align the screw holes in the hinge pin with the gimbal ring using the tools listed to finish the installation if necessary. 4. Apply Loctite to the threads of the Torx head screws and install and tighten to specification. abc a - Hinge pin b - Puller head tool cab 19557 c - Slide hammer Tube Ref No. Description Special Lubricant 101 Where Used Hinge pin Part No. 92-802865Q02 Puller Head 91-63616T Slide Hammer 91-34569A 1 Tube Ref No. Description Loctite 242 Threadlocker Where Used Torx head screws Part No. 92-809821 Description Hinge pin screws Nm 12.4 lb. in. 110 lb. ft. 34 66 90-865612070 JUNE 200 Page 8C-1 Bell Housing Assembly 5. Attach the link arm to the hinge pin and trim sender. bac30107 a - Trim sender c - Link arm b - Clevis pin Retention Sleeve Tapered Insert � Bell Housing 1. Position the water hose so that approximately 3 mm (1/8 in.) protrudes from the edge of the opening of the bell housing. 2. Apply a small amount of lubricant to the inner diameter of the hose and install tapered inserts using the tapered insert tool. abdc16486 a - Tapered insert location in the bell c - Tapered Insert housing d - Tapered Insert tool b - Rachet and extension Tube Ref No. Description Where Used Part No. 95 2-4-C with Teflon Hose inner diameter 92-802859A1 Tapered insert tool 91-43579 Dribble Valve Installation NOTE:Unless damaged during disassembly or by heat, these check valves should lastthe life of the sterndrive unit. The bell housing check valve is replaced as an assembly withthe check ball in the Bravo drive shaft housing. Refer toBell Housing Dribble Valve And Drive Shaft Housing Check Ball Replacement.. 1. Ensure that the O-ring in the bell housing is not damaged. Page 8C-16 90-865612070 JUNE 200 Bell Housing Assembly ell Housing Assembly 2. Push the dribble valve into the bell housing until both O-rings are inserted. b a 16462 a -Dribble valve b -O-ring in bell housing Shift Cable � Bell Housing Installation 1. Apply sealant to the threads of the shift cable retaining nut. Tube Ref No. Description Where Used Part No. 19Perfect Seal Threads of the shift cable retaining nut 92-34227-1 2. Secure shift cable to bell housing. bca 19437 Shift cable secured to bell housing a -Shift cable retaining nut b -Seal washer c -Flanged nut NOTICE A damaged bellows can create leak damage. Do not flatten the end of the shift bellows when crimping the shift bellows clamp. 3. Install the shift cable bellows crimp clamp. 90-865612070 ..UNE 2007 Page 8C-17 Bell Housing Assembly IMPORTANT: Do not compress the crimp clamp with pliers. ba 16491 Tool shown is not for compressing the crimp clamp a - Crimp clamp b - Shift cable bellows 4. Compress the shift cable bellows crimp clamp, maintaining a 13 mm (� in.) outer diameter. 5. Ensure that the clamp is crimped evenly to maintain a good seal between the bellows and the shift cable. Do not allow the bellows to flatten. Gimbal Beraing Replacement Removal IMPORTANT: The gimbal bearing and tolerance ring are not reusable. Do not remove them unless you intend to replace them. 1. Remove the drive. 2. Reach through the bell housing and rotate the gimbal bearing with your hand to check for roughness. Replace bearings that do not rotate smoothly or have front-to-rear play. 3. Remove the gimbal bearing using the tools as shown. efgcabd16245a - Puller shaft (91-31229) b - Nut (11-24156) c - Washer (12-34961) d - Plates (2) (91-29310) e - Slide hammer puller f - Gimbal bearing inner race g - Gimbal bearing carrier Page 8C-18 90-865612070 JUNE 200 Bell Housing Assembly 4 Remove the grease seal. ab16247 a - Gimbal housing b - Seal Installation 1 Install the grease seal with the seal lip facing the rear of the housing. ab16247 a - Gimbal housing b - Seal (lip facing rear) 2 Install the new tolerance ring onto the bearing with the gap in the ring exposing the grease gallery as shown. eabdc16244 a - Inner race d - Red dot b - Outer race e - Grease gallery c - Tolerance ring 3 Install the bearing with the tools listed as described below: � Red dot on bearing facing rear � Grease gallery aligned with grease insert on outer transom 90-865612070 JUNE 200 Page 8C-1 Bell Housing Assembly � Bearing firmly seated in gimbal housing a a - Grease gallery and grease insert b - Grease gallery Collar #3 Bearing Installation Tool 91-30366T1 Puller Rod Head 91-32325T Driver Rod 91-37323 bdc 16254 c - Opening in tolerance ring d - Notch in bearing Page 8C-20 90-865612070 JUNE 200 Gimbal Ring Repair Integrated Transom System (ITS) Section 8D - Gimbal Ring Repair Table of Contents Disassembly..8D-2 Gimbal Housing Swivel Shaft Bushing And Seal Preparation...8D-2 Replacement..8D-6 Gimbal Ring Assembly Removal.............8D-3 Gimbal Ring Lower Swivel Pin Bushing Assembly...8D-6 Replacement..8D-9 8 D 90-865612070 JUNE 2007 Page 8D- Gimbal Ring Repair Lubricant, Sealant, Adhesives Tube Ref No. Description Where Used Part No. 7 130 Loctite 271 Threadlocker Swivel shaft seal 92-809819 Sealer Kit, Two Part Epoxy Lower swivel pin 92-65150-1 Special Tools Puller head 91-63616T 10678 Removes the upper swivel shaft on gimbal rings. Slide Hammer 91-34569A 1 Aids in the removal of various engine components. Use with 6761 puller jaws. Expanding Rod Snap-On CG45-4 Aids in the removal of the upper swivel shaft lower bearing in 17771 the gimbal housing. Use with Snap-On Collet (CG45-15). Collet Snap-On CG45-15 Aids in the removal of the upper swivel shaft lower bearing in the gimbal housing. Use with Snap-On Expanding Rod 10774 (CG-45-4). Collet Snap-On CG40A-6 Aids in the removal of gears or bearings; use with expanding rod. 12534 Expanding rod Snap-On CG40-4 Aids in the removal of gears and bearings; use with collet. 12538 Bushing/bearing/seal driver 91-43578A1 10484 Installs the transom assembly bushings, bearings, and seals. Disassembly Preparation 1. Remove the drive, refer to the appropriate Service Manual. 2. Remove the bell housing. Page 8D-2 90-865612070 JUNE 200 Gimbal Ring Repaid Gimbal Ring Assembly Removal 1. Loosen the U-bolt nuts. a 16575 a - U-bolt nuts 2. Loosen clamping bolt and nut on the steering lever. ab 13576 Engine and transom assembly removed a - Wrench on clamping bolt b - Wrench on nut. 3. Remove the upper swivel shaft locking nut. ab 16577 a - Upper swivel shaft locking nut. b - Wrench 90-865612070 JUNE 2007 Page 8D- Gimbal Ring Repair 4. Remove the cotter pin. a a - Cotter pin5. Remove the lower swivel pin. a 16578 a 16579 a - Lower swivel pin 6. Remove the washer. a 16580 a - Washer Page 8D-4 90-865612070 JUNE 200 Gimbal Ring Repaid 7. Remove the upper swivel shaft from the gimbal ring using the slide hammer puller and puller head tools. abbccaa 16581 a - Slide hammer puller c - Puller head tool b - Upper swivel shaft Puller head 91-63616T Slide Hammer 91-34569A 1 8. Remove the large ID washer, steering lever, small ID washer, and locknut dcba a - Locknut b - Small ID washer 17907 c - Steering lever d - Washer 9. Remove the gimbal ring. GIMBAL RING ASSEMBLY INSPECTION 1. Inspect the painted surfaces and bushings on the gimbal ring. 2. Inspect the upper swivel shaft threads for damage, corrosion and rust. 3. Inspect the lower swivel pin for nicks. 4. Replace the cotter pin. 90-865612070 JUNE 2007 Page 8D- Gimbal Ring Repair Assembly Gimbal Housing Swivel Shaft Bushing And Seal Replacement 1. Remove the swivel shaft seal and the lower swivel shaft bushing from the gimbal housing using the bushing removal tool with the slide hammer tool. aa 17895 a - Bushing removal tool (expanding rod and collet) Expanding Rod Snap-On CG45-4 Collet Snap-On CG45-15 Slide hammer 91-34569A 1 2. Remove the upper swivel shaft bushing from the gimbal housing using the bushing removal tool. aa 17895 a - Bushing removal tool (expanding rod and collet) Collet Snap-On CG40A- Expanding rod Snap-On CG40- Page 8D-6 90-865612070 JUNE 200 Gimbal Ring Repaid 3. Install new swivel shaft bushings and seal abc 16615 Swivel shaft bushing and seal replacement parts a - Swivel shaft seal c - Upper swivel shaft bushing b - Lower swivel shaft bushing 4 Install the upper swivel shaft bushing: a. Place the upper swivel shaft bushing on the bushing/bearing/seal driver tool. 16616ab a - Upper swivel shaft bushing b - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Install upper swivel shaft bushing by tapping it in place with a hammer. ab 16617 a - Bushing/bearing/seal driver tool b - Hammer 5. Install the lower swivel shaft bushing: 90-865612070 JUNE 200 Page 8D- Gimbal Ring Repair a. Place the lower swivel shaft bushing on the bushing/bearing/seal driver tool ab 16618 a - Lower swivel shaft bushing b - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Install lower swivel shaft bushing by tapping it in place with a hammer. ab a - Bushing/bearing/seal driver tool 16617 b - Hammer 6. Install the swivel shaft seal: a. Apply sealant to outside surface of swivel shaft seal. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Swivel shaft seal 92-809819 Page 8D-8 90-865612070 JUNE 200 Gimbal Ring Repair b Place seal on bushing/bearing/seal driver tool with lip facing the end of the tool with the smaller diameter. 16620abc a - Swivel shaft seal b - Seal lip c - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 c. Install the swivel shaft seal by tapping it in place with a hammer. ab 16617 a - Bushing/bearing/seal driver tool b - Hammer Gimbal Ring Lower Swivel Pin Bushing Replacement IMPORTANT: Be careful not to damage the gimbal ring bore with the mandrel when removing the bushing. 1. Place a suitable mandrel on the lower swivel pin bushing of the gimbal ring. 90-865612070 JUNE 200 Page 8D- Gimbal Ring Repair 2 Use a hammer to tap on the mandrel until the bushing is completely removed. 17905dabc a - Hammer c - Gimbal rine b - Suitable mandrej 3 Inspect the bore for cleanliness and damage before installing the bushing of the lower swivel pin. 4 Replace the gimbal ring if the bore is damaged. 5 Install a new bushing on the lower swivel pin: a. Thread the hinge pin tool into the bushing/bearing/seal driver tool. ab 16608 a - Hinge pil b - Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Apply sealer to the outside surface of the bushing onto the lower swivel pin. Tube Ref No. Description Where Used Part No. 130 Sealer Kit, Two Part Epoxy Lower swivel pin 92-65150-1 c. Place the lower swivel pin bushing over the hinge pin tool. NOTE:Use only one of the following procedures: Page 8D-1 90-865612070 JUNE 200 Gimbal Ring Repair d. Press the bushing of the lower swivel pin into gimbal ring. dabc16610 a - Press c - Bushing b - Bushing/bearing/seal driver d - Bushing installed e. Drive the lower swivel pin bushing into the gimbal ring using a hammer. abc 17906 a - Hammer c - Bushing b - Bushing/bearing/seal driver 90-865612070 JUNE 2007 Page 8D-1 Gimbal Ring Repair Notes: Page 8D-12 90-865612070 JUNE 200 Gimbal Housing Repair Integrated Transom System (ITS) Section 8E - Gimbal Housing Repair Table of Contents Disassembly..8E-2 Valve Block Assembly.............................8E-3 Preparation and Removal........................8E-2 Outer Transom Plate Components...........8E-5 Assembly...8E-3 8 E 90-865612070 JUNE 2007 Page 8E-1 Gimbal Housing Repair Lubricants, Sealants, Adhesives Tube Ref No. Description Where Used Part No. Loctite 404 Transom plate sealing ring Obtain Locally 27 O-ring for hydraulic manifold Bellows Adhesive 92-86166Q1 O-rings for exhaust extension Disassembly Preparation and Removal 1. Remove the drive, refer to the appropriate service manual. IMPORTANT: You do not have to disassemble the transom assembly any further to replace the gimbal bearing assembly. Follow the instructions in pertaining to removal and replacement of the gimbal bearing. 2. Remove the bell housing. 3. Refer to Bell Housing Disassembly to remove and replace these items: � Exhaust tube � Shift cable boot � Cooling hose 4. Disconnect: a. MerCathode electrical connector b. Trim position sender connection c. Cooling hose to the water separator or sea pump d. Trim hydraulic connections e. Power steering hydraulic connections f. Exhaust system g. Shift cable 5. Remove the engine or driveshaft if applicable 6. Support the gimbal housing 30936 Lifting Points 7. Remove the nuts securing the inner transom to the gimbal housing and remove the gimbal housing. Page 8E-2 90-865612070 JUNE 2007 Gimbal Housing Repair Assembly Valve Block Assembly 1. Use the following illustration to make the hydraulic connections. 2. Apply oil to the threads and flares of the hydraulic fittings. Tightening torque values apply to the hydraulic hoses attached at the bottom of the hydraulic manifold only, tighten the remaining fittings enough to prevent leakage. 90-865612070 JUNE 2007 Page 8E-3 Gimbal Housing Repair Page 8E-4 90-865612070 JUNE 2007 3. Use Bellows Adhesive to hold the O-ring in position. a b d c e c d b a c d b a a b d c f g h i 30243 a - Trim in b - Trim out c - Left turn d - Right turn e - O-ring f - Port steering cylinder g - Port trim cylinder h - Starboard steering cylinder i - Starboard trim cylinder Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive O-ring for hydraulic manifold 92-86166Q1 Description Nm lb. in. lb. ft. Hydraulic steering hose connections 34 25 Gimbal Housing RepaiW Description Nm lb. in. lb. ft. Trim cylinder hose connections 27 20 Outer Transom Plate Components 1 Exhaust extension assembly�Use Bellows Adhesive to secure the O-rings to the extension and fasten the assembly to the gimbal housing with washers and bolts, tighten to specifications. 2 Water supply assembly�Assemble the water supply hose, tube and adaptor without tightening the hose clamps. Attach the assembly to the gimbal housing, rotate the tube until it faces the notch in the transom box and then tighten the hose clamps and adaptor to specifications. 3 Extension tube�Apply grease to the O-ring and install it in the groove of the extension tube. Slide the extension tube over the opening in the gimbal housing. 4 Exhaust block-off plate�Install the block-off plate and shift cable bracket as shown and tighten the fasteners to specification. 90-865612070 JUNE 2007 Page 8E-5 Gimbal Housing Repair Page 8E-6 90-865612070 JUNE 2007 5. Seal ring� Apply a bead of Loctite 404 to the ring groove and install the seal ring with the seam of the seal ring at the top of the groove. a b c f e g h d 30321 a - Shift cable bracket b - Exhaust block-off plate c - Notch in transom box d - Hose retaining clamp e - Extension tube f - Water supply assembly g - Seal ring h - Exhaust extension assembly Tube Ref No. Description Where Used Part No. 27 Bellows Adhesive O-rings for exhaust extension 92-86166Q1 Loctite 404 Transom plate sealing ring Obtain Locally Description Nm lb. in. lb. ft. Exhaust extension to gimbal housing bolts 20 15 Exhaust block-off plate bolts 31 23 Transom box to gimbal housing nuts 34 25 Water inlet housing to gimbal housing 7 60 Steering Cylinder Service Integrated Transom System (ITS) Section 8F - Steering Cylinder Service Table of Contents Disassembly and Assembly...........................8F-2 8 F 90-865612070 JUNE 2007 Page 8F-1 Steering Cylinder Service Lubricants, Sealants, Adhesives Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Threads of the bolt securing the piston to the rod 92-809819 Disassembly and Assembly 1. Disconnect the hydraulic lines at the cylinder and drain the fluid. 2. Remove the end cap with a spanner wrench and remove the piston and rod assembly from the cylinder. 3. Remove the piston from the rod and remove the O-ring seals from the piston. 4. Slide the end cap off of the rod and remove the seals, washer, and scraper from the end cap. 5. Inspect all parts for damage and the cylinder lining for scoring or damage that will damage the O-ring. Replace any worn or damaged parts. 6. Replace any broken or frayed bonding straps and the anode if eroded 50% or more. 7. Clean all parts with hot soapy water and dry them with compressed air. 8. Preassemble the end cap: a. Coat all seals and the scraper with the same type of fluid used in the power steering reservoir. b. Assemble the washer and retainer for the the scraper with the rounded side of these parts facing the scraper. 9. Slide the end cap onto the rod. 10. Lubricate and install the O-rings onto the piston. 11. Secure the piston to the rod and tighten the bolt to specification. Tube Ref No. Description Where Used Part No. Threads of the bolt securing the 7 Loctite 271 Threadlocker 92-809819 piston to the rod Description Nm lb. in. lb. ft. Bolt securing the piston to the rod 47 35 12. Slide the piston and rod assembly into the cylinder, apply some oil to the threads of the end cap and tighten the end cap to specification with a spanner wrench. Description Nm lb. in. lb. ft. Steering cylinder end cap 115 85 Page 8F-2 90-865612070 JUNE 2007 Steering Cylinder Service 90-865612070 JUNE 2007 Page 8F-3 13. Install the bushings, anode, and bonding straps. 30153 b c d e f g i j k l m c a h a - Bonding strap b - Cylinder c - Bushings d - piston rod e - Retainer f - Washer g - Scraper h - O-rings (3) i - End cap j - O-ring k - Piston l - O-ring m -Anode 14. Refer to bleeding procedures in Section 1. Steering Cylinder Service Notes: Page 8F-4 90-865612070 JUNE 2007 General Information Important Information Section 9A - General Information Table of Contents Notice..9A-2 Notice to Users of This Manual.......................9A-2 Precautions...9A-3 Engine Mechanical Components....................9A-3 Models Covered In This Manual......................9A-3 Bravo Sterndrive Serial Number and Identification ....9A-4 Bravo Transom Serial Number.......................9A-4 Replacement Parts...9A-5 Introduction...9A-5 How To Use This Manual................................9A-5 Service Manual Page Identification.........9A-6 Directional References............................9A-6 Sterndrive 10-Hour Break-In Period (New or With Replacement Gears).......................................9A-6 Bravo Three Notice: Trim-in Limit Insert..........9A-7 Axius Sterndrive Steering Arrangement...........9A-7 Fault Modes...9A-7 SeaCore Equipped Drives..............................9A-7 SeaCore Components and Castings........9A-7 Stainless Steel Fasteners........................9A-7 90-865612080 FEBRUARY 2009 Page 9A-1 Preliminary Electronic Release 9 A General Information Lubricants, Sealants, Adhesives Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Threads of stainless steel fasteners 92-802865Q02 Notice This publication uses warnings and cautions (accompanied by the international hazard symbol) to alert the mechanic about special instructions concerning a particular service or operation that may be hazardous if it is performed incorrectly or carelessly. Observe Them Carefully! These safety alerts alone cannot eliminate the hazards that they signal. Complying with these safety alerts must also be accompanied by the exercise of common sense to prevent accidents. ! DANGER Indicates a hazardous situation which, if not avoided, will result in death or serious injury. ! WARNING Indicates a hazardous situation which, if not avoided, could result in death or serious injury. ! CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. Notice to Users of This Manual This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein. This manual assumes that these personnel are familiar with procedures for servicing marine products. Furthermore, it assumes that they have been trained in the recommended service procedures for Mercury MerCruiser products, including the use of mechanics' common hand tools and the special tools of Mercury Marine or recommended tools from other suppliers. We cannot anticipate all conceivable installations and their possible hazards or results. Therefore, anyone who uses a service procedure or tool that is not recommended by Mercury Mercruiser must first determine that doing so will not damage the product or cause injury to persons. All information, illustrations, and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell or service these products. We reserve the right to make changes to this manual without prior notification. Refer to dealer service bulletins, operation, maintenance, and warranty manuals, and installation manuals for additional information concerning the products described in this manual. Page 9A-2 90-865612080 FEBRUARY 2009 Preliminary Electronic Release General Information Precautions Note that the electrical system and ignition system are capable of violent, damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, disconnect the battery cables at the battery. Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started. IMPORTANT: During any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, but most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, you should save removed fasteners for reuse in the same locations whenever possible. For situations in which the fasteners are not satisfactory for reuse, select a replacement that matches the original. Engine Mechanical Components Many of the engine mechanical components are for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and operation at wide-open throttle and therefore require heavy-duty components. Marine engine parts must also be able to resist the corrosive action of salt water or brackish water, each of which will rust or corrode standard automotive parts within a short period of time. We have manufactured special marine engine parts that meet specifications required for long life and dependable performance. Failure to use recommended Quicksilver service replacement parts can result in poor engine performance or durability, rapid corrosion of parts subjected to salt water, and possibly complete failure of the engine. Models Covered In This Manual Model Serial Number Axius and Axius SeaCore�QSD 2.8 and 4.2 Models All Axius and Axius SeaCore�5.0 Models All Axius and Axius SeaCore�5.0 Models with ECT All Axius and Axius SeaCore�350 MAG and 377 MAG Models All Axius and Axius SeaCore�350 MAG and 377 MAG Models with ECT All Axius and Axius SeaCore�496 MAG and 496 MAG H.O. Models All Axius and Axius SeaCore�496 MAG and 496 MAG H.O. Models with ECT All 90-865612080 FEBRUARY 2009 Page 9A-3 Preliminary Electronic Release General Information Bravo Sterndrive Serial Number and Identification The Bravo sterndrive serial number, gear ratio, model number, and bar code are embedded in the ground plate on the port side of the sterndrive. 33533 Bravo sterndrive information on ground plate The serial number is also stamped as a permanent reference on the sterndrive casting inside the back cover. 33534 Bravo sterndrive serial number stamping Bravo Transom Serial Number The Bravo transom serial number is stamped in the U-bolt plate of the Bravo transom assembly. a a -Transom serial number 25904 Page 9A-4 90-865612080 FEBRUARY 2009 Preliminary Electronic Release General Information The transom serial number is also stamped on the gimbal housing. This provides a permanent reference for authorized Mercury MerCruiser dealers. a b 32672 a -Gimbal housing b -Transom serial number Replacement Parts ! WARNING Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components. Introduction This overhaul and repair manual is intended as a comprehensive service guide for the models listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair these products. Before attempting repairs we suggest that the procedure first be read in its entirety to gain knowledge of the methods and tools used and of the cautions and warnings required for safety. How To Use This Manual This manual is divided into sections, which represent major components and systems. Some sections are further divided into parts that more fully describe the component. For this service manual's section titles, refer to the Table of Contents. 90-865612080 FEBRUARY 2009 Page 9A-5 Preliminary Electronic Release General Information Service Manual Page Identification The service manual number and section title appear at the top of the page. Two number groups appear at the bottom of each page. Following is an example and a description. Page 1A-3 abc90-865612 FEBRUARY 2006 e d 18407 a -Section number d -Manual number b -Section part e -Month and year of publication c -Page number Directional References The front of the boat is the bow; the rear is the stern. Starboard side is the right side; the port side is the left side. In this document, all directional references are given as they appear when viewing boat from the stern, looking toward the bow. 9515 a b c d a -Fore or bow (front) c -Starboard (right) b -Aft or stern (rear) d -Port (left) Sterndrive 10-Hour Break-In Period (New or With Replacement Gears) It is important that the following procedure be used on new sterndrive units. This break-in procedure allows the proper seating of drive unit gears and related components, which greatly reduces the likelihood of problems. � Avoid full throttle starts. � Do not operate at any one constant speed for extended periods of time. � Do not exceed 75% of full throttle during the first 5 hours. During the next 5 hours, operate at intermittent full throttle. � Sterndrive should be shifted into forward gear a minimum of 10 times during break-in, with run-in time at moderate rpm after each shift. Page 9A-6 90-865612080 FEBRUARY 2009 Preliminary Electronic Release General Information Bravo Three Notice: Trim-in Limit Insert NOTE:Bravo One, Two and Three Models are equipped with a trim-in limit insert. It has been brought to our attention that some boats (predominantly deep-V heavy boats) will roll up on their side under certain operating conditions. The roll can be either to port or starboard and may be experienced while moving straight ahead or making a turn. The roll occurs most frequently at or near maximum speed, with the sterndrive trimmed at or near full trim-in. Although the boat will not roll completely over, the roll may be sufficient to unseat the operator or passengers and thereby create an unsafe situation. The roll is caused by stern lift created from excessive trim-in of the sterndrive. Redistributing the weight sternward can reduce stern-lift and help to control the condition. The distribution of weight forward, to port, or starboard may worsen the condition. The trim-in limit insert reduces stern lift by preventing the sterndrive from reaching the last few degrees of full trim-under. Although this device should reduce the tendency to roll, it may not eliminate the tendency entirely. The need for this trim-in limit insert, and its effectiveness, can only be determined through boat testing and is ultimately the responsibility of the boat manufacturer. ! WARNING On some boats, increased trim-in range can cause handling problems at high speeds, resulting in personal injury or death. We recommend that only qualified personnel adjust the trim-in limit inserts and test the boat for handling problems. Axius Sterndrive Steering Arrangement NOTICE Installing internal or external tie bars on vessels equipped with Axius will damage the drive system. Do not install tie bars on boats equipped with Axius. Fault Modes Fault codes have three modes, based on the type of fault and the method required to clear it. Type of fault Non-Sticky Sticky Sticky - Persistent Method to clear Clears immediately after fault is resolved Requires a key cycle (off and on) after the fault is resolved to clear Requires further action to clear; usually drive initialization SeaCore Equipped Drives SeaCore Components and Castings Mercury MerCruiser SeaCore power packages are equipped with additional stainless steel components and particular aluminum castings with special coatings. Do not replace SeaCore components with non-SeaCore. Use only the specified Mercury MerCruiser SeaCore components and castings on these power packages. Stainless Steel Fasteners SeaCore models are equipped with additional stainless steel fasteners to maximize corrosion resistance in salt water environments. 90-865612080 FEBRUARY 2009 Page 9A-7 Preliminary Electronic Release General Information Stainless steel fasteners are subject to galling when installed without lubrication. Galling can result in fastener destruction, improper clamp loads, or both. Galled fasteners may appear to torque properly, but still have incorrect clamp loads. Apply a lubricant, such as Special Lubricant 101 or an equivalent, on the threads of stainless steel fasteners during installation to avoid galling. Lubricate at least the first 8 mm (1/4 in.) of the threads before installation. Tube Ref No. Description Where Used Part No. Threads of stainless steel 34 Special Lubricant 101 92-802865Q02 fasteners Page 9A-8 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance Important Information Section 9B - Maintenance Table of Contents Maintenance and Service...............................9B-2 Axius System..9B-2 Gas Models�Maintenance Schedules...........9B-2 Routine Maintenance�Axius Models.......9B-2 Scheduled Maintenance�Axius Models ....9B-3 Diesel Models�Maintenance Schedules........9B-4 Routine Maintenance..............................9B-4 Scheduled Maintenance.........................9B-4 Steering Fluid..9B-5 Power-Assisted Steering Fluid.................9B-5 Checking and Filling...............................9B-5 Changing...9B-6 Diesel Models�Low-pressure Filter Service ....9B-7 Gas Models�Drive Belt.................................9B-8 Axius Serpentine Drive Belt Routing�Gasoline Engines...9B-8 Checking..9B-8 Replacing or Adjusting the Axius Serpentine Belt�Gasoline Engines..........................9B-9 Diesel Models�Drive Belts..........................9B-11 Belt Routing..9B-11 Power-Assisted Steering Pump Belt Inspection..9B-11 Power-Assisted Steering Pump Belt Removal ....9B-12 Power-Assisted Steering Pump Belt Installation...9B-13 Serpentine Belt Inspection.....................9B-14 Serpentine Belt Removal.......................9B-15 Serpentine Belt Installation....................9B-16 90-865612080 FEBRUARY 2009 Page 9B-1 Preliminary Electronic Release 9 B Maintenance Lubricant, Sealant, Adhesives Tube Ref No. 28 Description Dexron III Automatic Transmission Fluid Where Used Steering system O-ring seal Part No. Obtain Locally Special Tools Belt Installer 91-879150022 39259 Used to install CMD stretch belts. Maintenance and Service Axius System This section addresses parts unique to the Axius system, including the electronic helm, the hydraulic pump, the wiring harnesses, and the power steering cylinders. This section also covers the additional parts and components utilized by the optional Axius Premier package, including the Global Positioning System (GPS) and Inertial Measurement Unit (IMU). For engine maintenance and service information, refer to the appropriate engine service manual. For Bravo Three sterndrive maintenance and service information, refer to the appropriate sections of this service manual, Service Manual #39. Gas Models�Maintenance Schedules Routine Maintenance�Axius Models NOTE:Only perform maintenance that applies to your particular power package. Task Interval Each day start Each day end Weekly Maintenance to Be Performed � Check the engine oil level. (You can extend this interval based on experience with the product.) � Check the sterndrive gear lube level. � Check the trim pump oil level. � Check the power steering pump fluid level. � If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use. � Check the water inlets for debris or marine growth. � Check and clean the seawater strainer, if equipped. � Check the coolant level. � Inspect the sterndrive anodes and replace if 50% eroded. Page 9B-2 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance Task Interval Maintenance to Be Performed Every two months or 50 hours � Lubricate the propeller shafts and tighten the propeller nuts to specifications. (If operating only in freshwater, you can extend the interval to four months.) � If operating in saltwater, brackish water, or polluted water, apply Corrosion Guard to the power package. � Check the battery connections and the fluid level. � Ensure that the gauges and the wiring connections are secure. Clean the gauges. (If operating in saltwater, reduce this interval to 25 hours or 30 days, whichever occurs first.) Scheduled Maintenance�Axius Models NOTE:Only perform maintenance that applies to your particular power package. Task Interval After the first 20 hours and not to exceed 25 hours Every 100 hours or annually (whichever occurs first) Every 200 hours or 3 years Maintenance to Be Performed � Change the engine oil and filter. � Check and adjust the serpentine belt tension. � Touch up the paint on the power package. � Change the engine oil and filter. � Change the sterndrive gear lube. � If the condition of the spark plugs, spark plug wires, and the distributor cap and rotor was satisfactory at the initial inspection (as listed in Every 300 hours or 3 years), inspect the condition of these components. Replace as necessary. � Tighten the connection of the gimbal ring to the steering shaft to specifications. � Replace the water-separating fuel filter element. � Check the steering system and the remote control for loose, missing, or damaged parts. Lubricate the cables and the linkages. � Check the continuity circuit for loose or damaged connections. If the package is equipped with a MerCathode, test the MerCathode unit output. � Clean the flame arrestor, IAC muffler (MPI engines), and the crankcase ventilation hoses. Inspect the PCV valve (if equipped) and replace if needed. � Inspect the condition and the tension of the belts. � Check the coolant level and antifreeze concentration for adequate freeze protection. Correct if necessary. Refer to the Specifications section. � Inspect the U-joints, the splines, and the bellows. Check the clamps. � Check the engine alignment. � Lubricate the U-joint splines and cross bearing, if equipped with grease fittings. � Lubricate the gimbal bearing and the engine coupler. NOTE:Lubricate the engine coupler every 50 hours if operated at idle forprolonged periods of time. 90-865612080 FEBRUARY 2009 Page 9B-3 Preliminary Electronic Release Maintenance Task Interval Maintenance to Be Performed Every 300 hours or 3 years � Check the engine mounts for tightness and tighten to specifications if necessary. � Inspect the condition of the spark plugs, spark plug wires, and the distributor cap and rotor, if equipped. Replace as necessary. If the condition of these components is satisfactory at inspection, repeat inspection every 100 hours or once a year, whichever occurs first. � Check the electrical system for loose, damaged, or corroded fasteners. � Check the cooling system and the exhaust system hose clamps for tightness. Inspect both systems for damage or leaks. � Disassemble and inspect the seawater pump and replace worn components. � Clean the seawater section of the closed-cooling system. Clean, inspect, and test the pressure cap. � Inspect the exhaust system components. If the package was equipped with water shutters (flapper valves), verify that they are not missing or worn. � Replace the coolant/anitifreeze. Replace every two years if not using Every 5 years extended-life coolant/antifreeze. Diesel Models�Maintenance Schedules Routine Maintenance NOTE:Perform only the maintenance tasks that apply to your particular power package. Task Interval Each day start Each day end Weekly Every two months Maintenance to Be Performed � Check the engine oil level. (You may extend this interval based on operator experience with the product.) � Check the engine coolant level. � Check the power-assisted steering fluid level. � Check the sterndrive gear lube level in the gear lube monitor. � If operating in saltwater, brackish water, or polluted water, flush the seawater section of the cooling system after each use. � Drain any water from the primary fuel filter after each use. (Drain all water from both fuel filters if operating in freezing temperatures.) � Drain any water from the fuel filters. � Check the trim pump fluid level. � Check the seawater inlets for debris or marine growth. � Check and clean the seawater strainer. � Inspect the sterndrive anodes and replace if eroded 50% or more. � Check the battery connections and fluid level. � Lubricate the propeller shaft and torque the propeller nut (If operating only in freshwater, you may extend this maintenance to every four months). � Treat the engine surfaces with Corrosion Guard if operating in saltwater, brackish water, or polluted waters. � Inspect the air filter. (Every two months or every 50 hours, whichever occurs first.) � Inspect the engine anodes and replace if eroded 50% or more. � Ensure that the gauges and the wiring connections are secure and clean the gauges. (Every two months or every 50 hours, whichever occurs first. If operating in saltwater, reduce the interval to every 25 hours or 30 days, whichever occurs first.) Scheduled Maintenance NOTE:Perform only the maintenance tasks that apply to your particular power package. Page 9B-4 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance Task Interval Maintenance to Be Performed After first 25 hours � Change the engine oil and filter. and not to exceed 30 � Check and adjust belt tension. hours Annually � Touch up the power package with paint and spray with Corrosion Guard. Every 100 hours or annually (whichever occurs first) Every 2 years Every 300 hours or 3 years (whichever occurs first) Every 500 hours or 5 years (whichever occurs first) Every 1000 hours or 5 years (whichever occurs first) Steering Fluid Power-Assisted Steering Fluid � Change the engine oil and filter. � Change the sterndrive gear lube. � Torque the gimbal ring U-bolt locknuts. � Replace the fuel filters. � Check the steering system and the remote control for loose, missing, or damaged parts. Lubricate the cables and linkages. � Tighten the connection of the gimbal ring to the steering shaft to specifications. � Inspect and lubricate the sterndrive U-joint splines. Inspect the bellows, the exhaust tube, and check the clamps. � Lubricate the gimbal bearing and engine coupler (Lubricate the engine coupler every 50 hours if operated at idle for prolonged periods of time). � Check the continuity circuit for loose or damaged connections. If equipped with MerCathode, test the unit output. � Check the engine alignment. � Torque the engine mounts. � Check the electrical system for loose, damaged, or corroded fasteners. � On driveshaft extension models, lubricate the drive shaft U-joints, transom end (tailstock) bearings, and engine end (output) bearings. � Inspect the condition and tension of the belts. � Inspect the cooling system and the exhaust system for damage or leaks. Check the hose clamps for tightness. � Disassemble and inspect the seawater pump and replace worn components. � Clean the seawater section of the closed cooling system. Clean, inspect, and test the pressure cap. Check the anodes and replace if eroded 50% or more. � Replace the air filter. � Replace the engine coolant. � Replace the steering fluid low pressure filter. � Clean the aftercooler core. � Clean the fuel tank. IMPORTANT: Use only Dexron III automatic transmission fluid (ATF) in the Axius steering system. IMPORTANT: Low steering fluid levels will damage Axius system components. Always check steering fluid levels before operating the boat. Checking and Filling IMPORTANT: Use only specified lubricant. 90-865612080 FEBRUARY 2009 Page 9B-5 Preliminary Electronic Release Maintenance IMPORTANT: Running the pump dry will damage the pump. Always check steering fluid levels before operating the boat. 1. With the engine running, center the sterndrive units. 2. Stop the engine. 3. Using a clean, lint-free cloth, wipe the dirt and debris from the fill cap and the exterior of the fluid reservoir. 4. Remove the fill cap from the reservoir and observe the fluid level using the dipstick. IMPORTANT: If fluid is not visible in the reservoir, inspect steering system components. Repair any steering system leaks before operating the boat. � When the engine is warm the fluid level must within the warm range and not above the full hot mark. � When the engine is cold the fluid level must be in the cold range and not above the full cold mark. 5. Add the specified fluid if required. a b c d 32276f e a -Reservoir b -Fill cap c -Warm range d -Cold range e -Full hot mark f -Full cold mark Tube Ref No. Description Where Used Part No. 28 Dexron III Automatic Steering system Obtain Locally Transmission Fluid 6. Reinstall the fill cap. NOTE:If the fluid level was low or you are installing or performing service to the system, be prepared to stop the engine and add fluid after the first operation. Changing IMPORTANT: Do not allow dirt or contaminants to enter the power steering system. Clean steering system components prior to service and maintain clean working conditions at all times. Seal all open connections with the appropriate size service cap. Minimize the time the hydraulic system is open to the environment. Only change the steering fluid if it becomes contaminated. For the Axius steering fluid changing procedure, refer to Section 9D: Power Steering�Changing the Power Steering Fluid. Page 9B-6 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance Diesel Models�Low-pressure Filter Service NOTICE Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required. IMPORTANT: Do not allow dirt or contaminants to enter the power steering system. Clean steering system components prior to service and maintain clean working conditions at all times. Seal all open connections with the appropriate size service cap. Minimize the time the hydraulic system is open to the environment. 1. Using a clean, lint-free cloth, wipe the dirt and debris away from the low pressure filter. 2. Place oil-absorbent wipes or similar material around the area to contain any spilled lubricant. 3. Place an appropriate container beneath the steering fluid low pressure filter. 4. Remove the low-pressure filter from the filter head. ab 39359 a -Filter b -Filter head 5. Coat the new filter O-ring seal with lubricant. 39358 O-ring seal Tube Ref No. Description Where Used Part No. 28 Dexron III Automatic O-ring seal Obtain Locally 6. Install the filter on the filter head. Tighten the filter until the O-ring contacts the filter head and then tighten an additional 1/2�3/4 turn. 90-865612080 FEBRUARY 2009 Page 9B-7 Preliminary Electronic Release Maintenance 7. Fill the steering actuator and trim fluid reservoir with the specified fluid. Refer to Steering Fluid�Checking and Filling. 8. Check the fluid level after the first use. Refer to Steering Fluid�Checking and Filling. Gas Models�Drive Belt Axius Serpentine Drive Belt Routing�Gasoline Engines 33283h a b c e fg d 5.0 L, 350 CID, and 377 CID engines a -Alternator pulley e -Power-assisted steering pump b -Water circulating pump pulley pulley c -Tensioner pulley and adjustment f -Crankshaft pulley stud g -Seawater pump pulley d -Serpentine belt h -Idler pulley e -Seawater pump pulley f -Power-assisted steering pump pulley g -Tensioner pulley b a c d e f 8118g 496 CID engines a -Idler pulley b -Water circulating pump pulley c -Crankshaft pulley d -Alternator pulley Checking Inspect the drive belt for: � Excessive wear � Cracks Page 9B-8 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance � Fraying � Glazed surfaces � Proper deflection Description Deflection 13 mm (1/2 in.) NOTE:Minor, transverse cracks (across the belt width) may be acceptable. Longitudinalcracks (in the direction of belt length) that join transverse cracks are not acceptable. 21062 Replacing or Adjusting the Axius Serpentine Belt�Gasoline Engines 5.0L, 5.7L, AND 6.2L GASOLINE ENGINES IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before. 1. Loosen the 16 mm (5/8 in.) locking nut on the adjustment stud. 2. Turn the adjustment stud and loosen the belt, if a new serpentine drive belt is required. Remove the old belt and install a new belt onto the pulleys. NOTE:Belt tension is measured on the belt at the location that has the longest distancebetween two pulleys. 3. Attach the Kent Moore belt tension gauge, or equivalent, to the belt. 4. Put a wrench on the adjustment stud 16 mm (5/8 in.) locking nut. 5. Use a 8 mm (5/16 in.) socket and tighten the adjusting stud to adjust the belt tension. 6. Check the gauge for correct belt tension. The gauge has different ranges for new and used belts. 32544 aCOLOR GUIDEforPATENT2.83918 NEWT ONE NEWTONE b Kent Moore belt tension gauge shown, all similar a -Kent Moore belt tension gauge b -Serpentine belt . Serpentine belt tension using a tension gauge Used belt 356�378 N (80�85 lbf) 90-865612080 FEBRUARY 2009 Page 9B-9 Preliminary Electronic Release Preliminary Electronic Release Maintenance Page 9B-10 90-865612080 FEBRUARY 2009 Serpentine belt tension using a tension gauge New belt 467�489 N (105�110 lbf) 7. While holding the adjustment stud at the correct belt tension, tighten the 16 mm (5/8 in.) locking nut. a b 32545 a - 16 mm (5/8 in.) locking nut b - 8 mm (5/16 in.) adjusting stud 8. Operate the engine for a short period of time and recheck the belt adjustment. 496 GASOLINE ENGINES IMPORTANT: If reusing a belt, install it in the same direction of rotation as before. The belt tensioner operates within the limits of movement provided by the cast stops when the belt length and geometry are correct. If the tensioner contacts either of the cast stops during operation, check the mounting brackets and the belt length. Loose brackets, bracket failure, accessory drive component movement, incorrect belt length, or belt failure can cause the tensioner to contact the cast stops. See your authorized MerCruiser dealer for service if these conditions exist. ! CAUTION Rapid release of the belt tensioner, or allowing the tensioner to snap back quickly, could cause injury or product damage. Relieve the spring tension slowly. 1. Use a breaker bar and appropriate socket to relieve the tensioner. Rotate the tensioner away from belt until it stops. 2. Remove the belt from the idler pulley and slowly relieve the tension on the breaker bar. 31653 3. Remove the belt and route the replacement belt according to the belt routing diagram. 4. Carefully release the tensioner and ensure that the belt stays positioned properly. 5. Check the belt tension. Maintenance Description Deflection1. 13 mm (1/2 in.) Diesel Models�Drive Belts Belt Routing 40229bacd 4.2L diesel engine shown, 2.8L similar a -Power-assisted steering stretch c -Serpentine belt belt d -Crankshaft dampener adaptor b -Power-assisted steering pump pulley pulley Power-Assisted Steering Pump Belt Inspection ! WARNING Inspecting the belts with the engine running may cause serious injury or death. Turn off the engine and remove the ignition key before adjusting tension or inspecting belts. Axius equipped 2.8L and 4.2L diesel engines use a stretch-belt to drive the power-assisted steering pump. The stretch-belt is engineered to have a certain amount of elasticity and is designed to have self tensioning and vibration damping characteristics not found in standard serpentine accessory drive belts. Stretch-belt service and maintenance procedures differ from standard accessory drive belts. Should the power-assisted steering pump stretch-belt need replacement we recommend you consult your Cummins MerCruiser Authorized Repair Facility. 1. Inspect the power�assisted steering stretch belt for: � Excessive wear � Cracks � Fiber fraying 1. Use moderate thumb pressure on the belt at the location that has the longest distance between two pulleys. 90-865612080 FEBRUARY 2009 Page 9B-11 Preliminary Electronic Release Maintenance � Glazed surface 37948ba a -Power assisted steering belt b -Serpentine belt 2. Replace the belt if it is damaged or excessively worn. 3. The power-assisted steering pump stretch-belt is not adjustable. If the belt becomes loose or noisy it has worn out and must be replaced. 4. Replace the power-assisted steering belt at the recommended service interval. Refer to Maintenance Schedule. Power-Assisted Steering Pump Belt Removal ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. IMPORTANT: Replace the power-assisted steering pump belt if it is removed for any reason. 1. Disconnect both battery cables. 2. Position a tool suitable for rotating the engine on the crankshaft pulley nut. 3. Loop a light weight shop towel around the power-assisted steering stretch belt so that the loose ends are even and oriented away from the engine. 4. Position the shop towel so that it is in between the stretch belt and the crankshaft pulley. Page 9B-12 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance IMPORTANT: Do not rotate the engine in a counterclockwise direction. Counterclockwise engine rotation will damage the seawater pump impeller and could affect crankshaft pulley nut torque. 39387abc Belt removal a -Position of shop towel b -Removal direction c -Crankshaft rotation 5. While slowly rotating the engine clockwise, pull out on the shop towel and work the stretch belt off of the top of the crankshaft pulley. 6. Remove the stretch belt from the engine and discard. Power-Assisted Steering Pump Belt Installation 1. Route the new stretch belt around the power-assisted steering pump pulley. 2. Route the stretch belt over the top of the crankshaft pulley. 3. Confirm that the stretch belt is properly aligned with the grooves in both pulleys. 4. Position the stretch belt installation tool on the crankshaft pulley. 39384abc a -Stretch belt b -Installation tool c -Crankshaft pulley Belt Installer 91-879150022 5. Position a suitable tool on the crankshaft pulley nut. 90-865612080 FEBRUARY 2009 Page 9B-13 Preliminary Electronic Release Maintenance 6. Slowly rotate the engine clockwise using the belt installation tool to guide the stretch belt on to the crankshaft pulley. abc 39385 a -Belt engagement b -Installation tool c -Drive and socket 7. Confirm that the stretch belt is properly aligned with the grooves in both pulleys. 8. Connect both battery cables. Serpentine Belt Inspection ! WARNING Inspecting the belts with the engine running may cause serious injury or death. Turn off the engine and remove the ignition key before adjusting tension or inspecting belts. 1. Inspect the serpentine belt for proper tension by checking belt deflection between the alternator and water pump pulleys. Serpentine belt tension Belt deflection 5 mm (3/16 in.) 2. Inspect the serpentine belt for: 37948ba a -Power assisted steering belt b -Serpentine belt Page 9B-14 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance � Excessive wear � Cracks NOTE:Minor transverse cracks (across the belt width) may be acceptable. Longitudinalcracks (in the direction of belt length) that join transverse cracks are not acceptable. � Fraying � Glazed surface 21062 3. Check the operation of the automatic belt tensioner. a. Position a suitable tool in the automatic tensioner release slot. b. Rotate the automatic tensioner toward the crankshaft pulley. 23256ba a -Automatic tensioner b -Release slot IMPORTANT: The tensioner should move without binding and provide positive resistance throughout its range of motion. c. Release the tensioner and allow it to return to its original position. d. Replace the tensioner if it sticks, binds, or is loose and does not provide adequate tension to the serpentine belt. Serpentine Belt Removal ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. IMPORTANT: If the serpentine belt is being reused note or mark the original direction of rotation. 1. Disconnect both battery cables. 90-865612080 FEBRUARY 2009 Page 9B-15 Preliminary Electronic Release Maintenance 2. Remove the power-assisted steering belt. Refer to Power-Assisted Steering Pump Belt Removal. 3. Position a suitable tool in the automatic tensioner release slot. 4. Rotate the automatic tensioner toward the crankshaft pulley to remove tension on the serpentine belt. b a 23258 a -Serpentine belt b -Release slot 5. Remove the serpentine belt from the water pump and automatic tensioner pulleys. 6. Remove the serpentine belt from the engine. Serpentine Belt Installation IMPORTANT: If the serpentine belt is being reused, install the belt so that it has the same direction of rotation as the previous installation. 1. Position the serpentine belt around the tensioner pulley. b a 39393 a -Water pump b -Automatic tensioner 2. Route the serpentine belt around the other pulleys in the following order: a. Crankshaft b. Seawater pump c. Idler Page 9B-16 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Maintenance d. Alternator f e d c b a 39391 a -Crankshaft d -Alternator b -Seawater pump e -Water pump c -Idler f -Automatic tensioner 3. Work any slack in the belt around the pulley system to the portion of the belt around the automatic tensioner. 4. Confirm that the belt is properly aligned in the pulley grooves. 5. Position a suitable tool in the automatic tensioner release slot and rotate the tensioner toward the crankshaft pulley. 6. Position the belt around the water pump pulley. 7. Slowly release the automatic tensioner. 8. Confirm that the belt is properly aligned with all pulley grooves. 9. Install a new power-assisted steering stretch belt. Refer to Power-Assisted Steering Pump Belt Installation 90-865612080 FEBRUARY 2009 Page 9B-17 Preliminary Electronic Release Maintenance Notes: Page 9B-18 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Important Information Section 9C - Troubleshooting Table of Contents Fault Codes�Gasoline Models......................9C-2 Warning Horn Strategy...........................9C-2 Axius Fault Code Table�Gasoline Models ....9C-2 Fault Codes�Diesel Models..........................9C-9 Important Information.............................9C-9 Audio Warning System...........................9C-9 Axius Fault Code Table�Diesel..............9C-9 Troubleshooting..9C-16 Joystick...9C-16 Electronic Remote Controls..................9C-16 Steering System...................................9C-17 90-865612080 FEBRUARY 2009 Page 9C-1 Preliminary Electronic Release 9 C Troubleshooting Fault Codes�Gasoline Models Warning Horn Strategy The following table describes how the horn sounds to indicate the level of warning for the following fault table. Horn Type Off On Caution1 Caution2 Warning1 Warning2 Severe1 Severe2 Critical1 Critical2 Single beep Double beep On time � 1 0.5 0.75 0.5 2 1.5 � 6 � 0.2 0.2 Off time � 0 0.5 0.25 0.5 0.5 0.5 � 0 � 0.2 0.2 Axius Fault Code Table�Gasoline Models Fault ID Fault Name Sub System CCM-AP-10 AutoPilot08_PV1p1 -MagneticVariationNotValid Compass CCM-AP-11 AutoPilot08_PV1p1 - No_GPS_Fix GPS Extended Off Time NumCycles �� 00 12 13 02 01 03 �� 01 �� 11 12 Associated Plain Term Module Compass Calibration Not Valid CCM GPS Not Receiving Satellite CCM Information CCM-AP-12 AutoPilot08_PV1p1 - PadFault Helm Component Precision Pilot Pad Fault CCM AutoPilot08_PV1p1 CCM-AP-13 CAN APM to CCM message not received CCM PilotMasterHelmToSlaveAgePg0 AutoPilot08_PV1p1 CCM-AP-14 CAN APM to CCM message not received CCM PilotMasterHelmToSlaveAgePg1 CCM-AP-15 AutoPilot08_PV1p1 - SCv2_0x20C_Rx CAN APM CAN H Message error CCM AutoPilot08_PV1p1 CCM-AP-16 CAN APM CAN H Message error CCM SCv2_0x210_Pg0_Rx AutoPilot08_PV1p1 CCM-AP-17 CAN APM CAN H Message error CCM SCv2_0x210_Pg1_Rx AutoPilot08_PV1p1 CCM-AP-18 CAN APM CAN H Message error CCM SCv2_0x210_Pg2_Rx CCM-AP-19 AutoPilot08_PV1p1 - SCv2_0x21D_Rx CAN APM CAN H Message error CCM CCM-AP-20 AutoPilot08_PV1p1 - SCv2_211_Pg0_Age CAN Origination Page Data Time out CCM CCM-AP-21 AutoPilot08_PV1p1 - SCv2_211_Pg1_Age CAN Destination Page Data Time out CCM CCM-AP-22 AutoPilot08_PV1p1 - SCv2_211_Pg2_Age CAN Cross Track Page Data Time out CCM CCM-AP-23 AutoPilot08_PV1p1 - SCv2_211_Pg3_Age CAN Bearing Page Data Time out CCM CCM-AP-24 AutoPilot08_PV1p1 - SCv2_211_Pg4_Age CAN Arrival Page Data Time out CCM CCM-AP-25 AutoPilot08_PV1p1 - SCv2_580_Pg0_Age CAN CAN Message error CCM CCM-AP-26 AutoPilot08_PV1p1 - SCv2_580_Pg1_Age CAN CAN Message error CCM Page 9C-2 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System CCM-AP-27 AutoPilot08_PV1p1 - SCv2_580_Pg2_Age CAN CCM-AP-28 AutoPilot08_PV1p1 - SCv2_580_Pg3_Age CAN CCM-AP-29 AutoPilot08_PV1p1 - SCv2_581_Pg0_Age CAN CCM-AP-30 AutoPilot08_PV1p1 - SCv2_581_Pg1_Age CAN CCM-AP-31 AutoPilot08_PV1p1 - SCv2_581_Pg2_Age CAN CCM-AP-32 AutoPilot08_PV1p1 - SCv2_GPS1_Rx CAN AutoPilot08_PV1p1 CCM-AP-35 CAN SCv2ChartPlotterMessageAge CCM-AP-36 AutoPilot08_PV1p1 - SOG_Not_Valid GPS AutoPilot08_PV1p1 CCM-AP-37 Compass Unable_To_Maintain_Heading CCM-AP-4 AutoPilot08_PV1p1 - COG_Not_Valid GPS AutoPilot08_PV1p1 CCM-AP-5 Compass CompassHeadingInvalid AutoPilot08_PV1p1 CCM-AP-6 Compass CompassNotWorking CCM-AP-7 AutoPilot08_PV1p1 - CTE_Not_Valid GPS AutoPilot08_PV1p1 CCM-AP-8 GPS GPS_SOG_Not_Valid CCM-AP-9 AutoPilot08_PV1p1 - GPSNotWorking GPS CCM-CAN-3 MY08DTS - Configuration_Fault CAN CCM-CAN-4 PeerStationKeepingFaulted CAN CCM-DRV-1 MY08Steering4 - AbsPos_Range Drive CCM-DRV-10 TVM_Force_Idle Drive CCM-DRV-12 TVM_Standby Drive CCM-DRV-13 TVM_Steering_Unavailable Drive CCM-DRV-2 MY08Steering4 - AbsPos_RangeHigh Drive CCM-DRV-9 TVM_Drive_Unavailable Drive CCM-JS-1 MY08Joystick - Joystick_ForeAft JoyStick CCM-JS-10 MY08Joystick - Joystick_Y_Range JoyStick CCM-JS-11 MY08Joystick - Joystick_Ya_RangeHigh JoyStick CCM-JS-12 MY08Joystick - Joystick_Ya_RangeLow JoyStick CCM-JS-13 MY08Joystick - Joystick_Yaw JoyStick CCM-JS-14 MY08Joystick - Joystick_Yb_RangeHigh JoyStick CCM-JS-15 MY08Joystick - Joystick_Yb_RangeLow JoyStick CCM-JS-16 MY08Joystick - Joystick_Z_Diff JoyStick Associated Plain Term Module CAN Message error CCM CAN Message error CCM CAN Message error CCM CAN Message error CCM CAN Message error CCM APM to GPS CAN Message error CCM APM to Chartplotter Message error CCM GPS Speed Over Ground Not Valid CCM Autopilot unable to maintain Heading CCM Course Over Ground Not Valid CCM Compass Heading Invalid CCM Compass Not Communicating CCM Cross Track Error Not Valid CCM GPS Speed Over Ground Not Valid CCM GPS Not Communicating CCM DTS Control Head Initialization Not CCM Complete Secondary Drive Skyhook Fault CCM Steering Wheel Absolute Position CCM Sensor Signal Out of Range TVM Has Commanded Forced Idle CCM TVM Has Commanded Standby CCM Mode TVM Has Commanded Steering CCM Unavailable Steering Wheel Absolute Position CCM Sensor Signal Out of Range High TVM Has Commanded Drive CCM Unavailable Joystick Fore/Aft Sensor Error CCM Joystick Primary Fore/Aft Sensor CCM Voltage Out of Range Joystick Primary Fore/Aft Sensor CCM Voltage Out of Range High Joystick Primary Fore/Aft Sensor CCM Voltage Out of Range Low Joystick Yaw Sensor Error CCM Joystick Redundant Fore/Aft Sensor CCM Voltage Out of Range High Joystick Redundant Fore/Aft Sensor CCM Voltage Out of Range Low Joystick Yaw Sensor Deviation Error CCM 90-865612080 FEBRUARY 2009 Page 9C-3 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System Plain Term Associated Module CCM-JS-17 MY08Joystick - Joystick_Z_Range JoyStick Joystick Primary Yaw Sensor Voltage Out of Range CCM CCM-JS-18 MY08Joystick - Joystick_Za_RangeHigh JoyStick Joystick Primary Yaw Sensor Voltage Out of Range High CCM CCM-JS-19 MY08Joystick - Joystick_Za_RangeLow JoyStick Joystick Primary Yaw Sensor Voltage Out of Range Low CCM CCM-JS-2 MY08Joystick - Joystick_Multi_Sensor JoyStick Joystick Multiple Sensor Fault CCM CCM-JS-20 MY08Joystick - Joystick_Zb_RangeHigh JoyStick Joystick Redundant Yaw Sensor Voltage Out of Range High CCM CCM-JS-21 MY08Joystick - Joystick_Zb_RangeLow JoyStick Joystick Redundant Yaw Sensor Voltage Out of Range Low CCM CCM-JS-23 MY08Joystick - Joystick JoyStick Joystick Error CCM CCM-JS-3 MY08Joystick - Joystick_RightLeft JoyStick Joystick Right/Left Sensor Error CCM CCM-JS-4 MY08Joystick - Joystick_X_Diff JoyStick Joystick Right/Left Sensor Deviation Error CCM CCM-JS-5 MY08Joystick - Joystick_X_Range JoyStick Joystick Primary Right/Left Sensor Voltage Out of Range CCM CCM-JS-6 MY08Joystick - Joystick_Xa_RangeHigh JoyStick Joystick Primary Right/Left Sensor Voltage Out of Range High CCM CCM-JS-7 MY08Joystick - Joystick_Xa_RangeLow JoyStick Joystick Primary Right/Left Sensor Voltage Out of Range Low CCM CCM-JS-8 MY08Joystick - Joystick_Xb_RangeHigh JoyStick Joystick Redundant Right/Left Sensor Voltage Out of Range High CCM CCM-JS-9 MY08Joystick - Joystick_Y_Diff JoyStick Joystick Fore/Aft Sensor Deviation Error CCM CCM-KS-1 BATT_RangeHigh Keyswitch System Voltage High Warning CCM CCM-KS-2 BATT_RangeLow Keyswitch System Voltage Low Warning CCM CCM-KS-3 ECUP_RangeHigh Keyswitch CCM Keyswitch Supply Voltage High Warning CCM CCM-KS-4 ECUP_RangeLow Keyswitch CCM Keyswitch Supply Voltage Low Warning CCM CCM-KS-5 XDRP_RangeHigh Keyswitch Transducer Power Voltage High Warning CCM CCM-KS-6 XDRP_RangeLow Keyswitch Transducer Power Voltage Low Warning CCM CCM-LVR-1 MY08Lever - Lever1_Dec Levers Control 1 Lever Decrement Potentiometer Error CCM Control 1 Lever Hi-Resolution CCM-LVR-10 MY08Lever - Lever1_Hires_RangeLow Levers Potentiometer Voltage Out of Range Low CCM CCM-LVR-11 MY08Lever - Lever1_Multi_Sensor Levers Control 1 Lever Multiple Potentiometer Failure CCM CCM-LVR-2 MY08Lever - Lever1_Dec_Diff Levers Control 1 Lever Decrement Potentiometer Deviation Error CCM CCM-LVR-29 MY08DTS - Single_Lever_Fault Levers Single Lever Mode Failure CCM Control Lever 1 Decrement CCM-LVR-3 MY08Lever - Lever1_Dec_Range Levers Potentiometer Voltage Out of Range CCM CCM-LVR-30 MY08Lever - Lever1 Levers Control Lever 1 Sensor Error CCM Page 9C-4 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Fault ID Fault Name Sub System CCM-LVR-32 MY08Lever - Lever1_Inc Levers CCM-LVR-33 MY08Lever - Lever1_Inc_Diff Levers CCM-LVR-34 MY08Lever - Lever1_Inc_Range Levers CCM-LVR-35 MY08Lever - Lever1_Inc_RangeHigh Levers CCM-LVR-36 MY08Lever - Lever1_Inc_RangeLow Levers CCM-LVR-4 MY08Lever - Lever1_Dec_RangeHigh Levers CCM-LVR-5 MY08Lever - Lever1_Dec_RangeLow Levers CCM-LVR-6 MY08Lever - Lever1_Hires Levers CCM-LVR-7 MY08Lever - Lever1_Hires_Diff Levers CCM-LVR-8 MY08Lever - Lever1_Hires_Range Levers CCM-LVR-9 MY08Lever - Lever1_Hires_RangeHigh Levers CCM-SOH-1 CCM-SOH-10 CCM-SOH-11 CCM-SOH-12 CCM-SOH-13 CCM-SOH-14 CCM-SOH-15 CCM-SOH-16 CCM-SOH-17 CCM-SOH-18 CCMData_0x3A0_p0_SOH CAN MY08DTS Engine_ Crosscheck_Data_0x160p1_SOH CAN MY08DTS Engine_ Crosscheck_Data_0x160p2_SOH CAN MY08DTS Engine_ Crosscheck_Data_0x160p255_S OH CAN MY08DTS Engine_ Crosscheck_Data_0x160p3_SOH CAN MY08DTS Engine_ Synchronization_0x200_SOH CAN MY08DTS Low_ Speed_Engine_Data_0x1A0p9_SOH CAN MY08DTS Medium_ Speed_Engine_Data_0x170p0_ SOH CAN MY08DTS Medium_ Speed_Engine_Data_0x170p25 5_SOH CAN MY08DTS Medium_ Speed_Engine_Data_0x170p3_ SOH CAN Troubleshooting Associated Plain Term Module Control Lever 1 Increment CCM Potentiometer Error Control Lever 1 Increment CCM Potentiometer Deviation Error Control Lever 1 Increment Potentiometer Voltage Out of Range CCM Control Lever 1 Increment Potentiometer Voltage Out of Range CCM High Control Lever 1 Increment Potentiometer Voltage Out of Range CCM Low Control Lever 1 Decrement Potentiometer Voltage Out of Range CCM High Control Lever 1 Decrement Potentiometer Voltage Out of Range CCM Low Control Lever 1 Hi-Resolution CCM Potentiometer Error Control Lever 1 Hi-Resolution CCM Potentiometer Deviation Error Control Lever 1 Hi-Resolution Potentiometer Voltage Out of Range CCM Control Lever 1 Hi-Resolution Potentiometer Voltage Out of Range CCM High State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM 90-865612080 FEBRUARY 2009 Page 9C-5 Preliminary Electronic Release Troubleshooting Fault ID Fault Name MY08DTS CCM-SOH-19 Medium_Speed_Engine_Data_0x170p5_ SOH CCM-SOH-2 CCMFeedback_p0_SOH MY08DTS CCM-SOH-20 Medium_Speed_Engine_Data_0x170p6_ SOH CCM-SOH-21 TVM_Status_Message_0x3E0p0_SOH CCM-SOH-22 TVM_Status_Message_0x3F0p0_SOH CCM-SOH-3 CCMFeedback_p1_SOH CCM-SOH-4 CCMFeedback_p2_SOH CCM-SOH-5 CCMFeedback_p3_SOH MY08AutoTrim CCM-SOH-6 Medium_Speed_Engine_Data_0x170p3_ AT_SOH_AT T MY08AutoTrim CCM-SOH-7 Medium_Speed_Engine_Data_0x171p3_ SOH_A CCM-SOH-8 MY08DTS - Cruise_Display_SOH MY08DTS CCM-SOH-9 -Engine_Crosscheck_Data_0x160p0_SO H CCM-STR-10 MY08Steering4 - WheelPosMyRel_diff CCM-STR-11 MY08Steering4 - WheelPosPeerRel_diff MY08Steering4 CCM-STR-12 WheelReturntoCenterFault MY08Steering4 CCM-STR-13 MotorOpenShortDetected MY08Steering4 CCM-STR-5 Wheel_EndStopExceeded CCM-STR-6 MY08Steering4 - WheelEndStopFault MY08Steering4 CCM-STR-7 WheelForceFeedbackFault CCM-STR-9 MY08Steering4 - WheelPosAbsolute_diff TVM-CAN-1 CCM_CAN_P_Auth_Timeout TVM-CAN-2 CCM_CAN_P_Authentication_Fault TVM-CAN-3 CCM_CAN_X_Auth_Timeout TVM-CAN-4 CCM_CAN_X_Authentication_Fault TVM-CAN-5 NoValidCommandMessage TVM-CAN-6 NoValidRPMMessage TVM-CAN-7 TVM_Command_Message_0x3D0SOH Sub System CAN CAN CAN CAN CAN CAN C CAN CAN CAN CAN CAN CAN SteerWheel SteerWheel SteerWheel SteerWheel SteerWheel SteerWheel SteerWheel SteerWheel SteerWheel CAN CAN CAN CAN CAN CAN CAN Associated Plain Term Module State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM State of Health Message CCM Steering Wheel Encoder to Absolute CCM Position Sensor Crosscheck Error Steering Wheel Encoder CCM Crosscheck Deviation Error Steering Wheel Return to Center CCM Fault Steering Wheel Motor Open or Short CCM Detected Steering Wheel End Stop Passed CCM Steering Wheel End Stop Fault Steering Wheel Force Feedback CCM Error Steering Wheel Absolute Position Sensor to Encoder Crosscheck Error CCM CCM CAN P Authentication TVM Message Timeout CCM CAN P Authentication Fault TVM CCM CAN X Authentication TVM Message Timeout CCM CAN X Authentication Fault TVM No Valid Command Message TVM No Valid RPM Message TVM The TVM Has Not Received a Valid Primary Command Message From TVM the CCM - CAN X Page 9C-6 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System TVM-CAN-8 TVM_Red_Command_Message_0x5D0S OH CAN TVM-DRV-1 Both_Pos_Sensor_Failure Drive Position TVM-DRV-11 Secondary_Pos_Sensor_Failure Drive Position TVM-DRV-12 DriveUnavailable Drive Position TVM-DRV-2 Drive_Pos_Pri_Fault Drive Position TVM-DRV-3 Drive_Pos_Pri_RangeHigh Drive Position TVM-DRV-4 Drive_Pos_Pri_RangeLow Drive Position TVM-DRV-5 Drive_Pos_Sec_Fault Drive Position TVM-DRV-6 Drive_Pos_Sec_RangeHigh Drive Position TVM-DRV-7 Drive_Pos_Sec_RangeLow Drive Position TVM-DRV-8 Drive_Position_Follow_Fault Drive Position TVM-DRV-9 Drive_Position_Sensor_Crosscheck_Fault Drive Position TVM-FL-3 Tank_Press_Fault Fluid Levels TVM-FL-4 Tank_Press_RangeHigh Fluid Levels TVM-FL-5 Tank_Press_RangeLow Fluid Levels TVM-FLT-1 Filter_Clog_Fault Drive Filter TVM-FLT-2 Filter_Dirty_Fault Drive Filter TVM-INT-1 Init_Drive_Pos_Pri_InHi Initialization TVM-INT-15 InitializationFailed Initialization TVM-INT-2 Init_Drive_Pos_Pri_InLo Initialization TVM-INT-3 Init_Drive_Pos_Sec_InHi Initialization TVM-INT-4 Init_Drive_Pos_Sec_InLo Initialization TVM-INT-5 Init_Oil_Temp Initialization TVM-INT-9 Init_Steer_Pressure Initialization Associated Plain Term Module The TVM Has Not Received a Valid Redundant Command Message TVM From the CCM - CAN P Primary & Secondary Drive Position TVM Sensor Failure Secondary Drive Position Sensor Failure TVM Drive Has Set Unavailable TVM Primary Drive Position Sensor Voltage Out of Range TVM Primary Drive Position Sensor Voltage Out of Range High TVM Primary Drive Position Sensor Voltage Out of Range Low TVM Secondary Drive Position Sensor Voltage Out of Range TVM Secondary Drive Position Sensor Voltage Out of Range High TVM Secondary Drive Position Sensor Voltage Out of Range Low TVM Drive Not Responding To Steer TVM Commands In Time Primary & Secondary Drive Position TVM Sensor Crosscheck Error Hydraulic Tank Pressure Sensor TVM Failure Tank Pressure Sensor Voltage Out TVM of Range High Tank Pressure Sensor Voltage Out TVM of Range Low Hydraulic Oil Filter Clogged Warning TVM Hydraulic Oil Filter Dirty Warning TVM Drive Initialization Failed - Primary Drive Position Sensor Signal In TVM Range High Drive Initialization Failed Drive Initialization Failed - Primary Drive TVM Position Sensor Signal In Range Low Drive Initialization Failed Secondary Drive Position Sensor TVM Signal In Range High Drive Initialization Failed TVM Secondary Drive Position Sensor Signal In TVM Range Low Drive Initialization Failed - Hydraulic TVM Oil Temperature Fault Drive Initialization Failed - Steer TVM Pressure Fault 90-865612080 FEBRUARY 2009 Page 9C-7 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System Plain Term Associated Module TVM-PMP-10 Pump_Press_Sensor_Failure Primary Pump Hydraulic Oil Pressure Sensor Failure TVM TVM-PMP-12 High_Hydraulic_Oil_Temp_Fault Primary Pump Critical High Hydraulic Oil Temperature TVM TVM-PMP-13 Hydraulic_Oil_Temp_Warning Primary Pump High Hydraulic Oil Temperature Warning TVM TVM-PMP-5 Primary_Pos_Sensor_Failure Primary Pump Primary Drive Position Sensor Failure TVM TVM-PMP-6 Pump_Failure_Fault Primary Pump Hydraulic Pump Failure TVM TVM-PMP-7 Pump_Press_Fault Primary Pump Hydraulic Pump Pressure Failure TVM TVM-PMP-8 Pump_Press_RangeHigh Primary Pump Hydraulic Oil Pressure Sensor Voltage Out of Range High TVM TVM-PMP-9 Pump_Press_RangeLow Primary Pump Hydraulic Oil Pressure Sensor Voltage Out of Range Low TVM TVM-STR-1 Steer_A_Press_Fault Steering Steering Pressure A Sensor Failure TVM TVM-STR-12 SteerCoil_A_Failure_Fault Steering Steering Coil A Failure TVM TVM-STR-13 SteerCoil_A_Pin_Fault Steering Steering Coil A Open Circuit TVM TVM-STR-14 SteerCoil_B_Failure_Fault Steering Steering Coil B Failure TVM TVM-STR-15 SteerCoil_B_Pin_Fault Steering Steering Coil B Open Circuit TVM TVM-STR-17 SteeringUnavailable Steering Steering is Unavailable TVM TVM-STR-2 Steer_A_Press_RangeHigh Steering Steering Pressure A Sensor Voltage Out of Range High TVM TVM-STR-3 Steer_A_Press_RangeLow Steering Steering Pressure A Sensor Voltage Out of Range Low TVM TVM-STR-4 Steer_B_Press_Fault Steering Steering Pressure B Sensor Failure TVM TVM-STR-5 Steer_B_Press_RangeHigh Steering Steering Pressure B Sensor Voltage Out of Range High TVM TVM-STR-6 Steer_B_Press_RangeLow Steering Steering Pressure B Sensor Voltage Out of Range Low TVM TVM-STR-7 Steer_Oil_Temp_Fault Steering Steering Hydraulic Oil Temperature Sensor Failure TVM TVM-STR-8 Steer_Oil_Temp_RangeHigh Steering Steering Hydraulic Oil Temperature Sensor Voltage Out of Range High TVM TVM-STR-9 Steer_Oil_Temp_RangeLow Steering Steering Hydraulic Oil Temperature Sensor Voltage Out of Range Low TVM TVM-VLT-2 SysVolt_Fault Drive Voltage TVM Supply Voltage Out of Range Warning TVM TVM-VLT-3 SysVolt_RangeHigh Drive Voltage TVM Supply Voltage High Warning TVM TVM-VLT-4 SysVolt_RangeLow Drive Voltage TVM Supply Voltage Low Warning TVM TVM-VLT-5 XDRPVolt_Fault Drive Voltage Transducer Power Failure TVM TVM-VLT-6 XDRPVolt_RangeHigh Drive Voltage Transducer Power Voltage Out of Range High TVM TVM-VLT-7 XDRPVolt_RangeLow Drive Voltage Transducer Power Voltage Out of Range Low TVM Page 9C-8 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Fault Codes�Diesel Models Important Information For additional diesel model repair and diagnostic information refer to the latest Cummins MerCruiser Diesel Cummins Master Repair Manual (PN 4022081) and Axius Wiring Diagram (PN 4082052). Cummins MerCruiser Diesel is committed to providing premium service for the Axius product. In order to meet our customers' expectation, CMD has introduced Marine Repair Logistics (MRL). Contact MRL for any Axius specific non-scheduled maintenance repair. In the USA, please contact our Toll free Number 1-866-549-6458 . For International access, please call +1-843-329-5735. Marine Repair Logistics will be the liaison between the customer and the Service Location. The MRL team will ensure customer satisfaction by locating Certified Service locations for supporting the Axis product. Once the call is made into MRL, we will work with the Service Location to develop a customer support plan to insure the repair is completed in a minimum amount of time. Audio Warning System Your Cummins MerCruiser Diesel power package may be equipped with an audio warning system. The audio warning system is designed to warn the operator that a malfunction has occurred and will not protect the engine from damage. IMPORTANT: If the audio warning sounds, stop the engine immediately if you are not in a hazardous situation. Investigate the cause and correct it, if possible. If you cannot determine the cause, consult your Cummins MerCruiser Diesel Authorized Repair Facility. Operating the vessel with a critical fault malfunction may cause engine, drive, and control system damage. The audio warning will sound if the engine control module (ECM) detects a malfunction. Malfunction fault code information can be displayed on the following SmartCraft instruments: � VesselView � System tachometer or speedometer Audio Warning Tones � Six long (1.5 second) beeps at 1/2 second intervals Critical Faults � 2 minute pause followed by � One long (1.5 second) beep every two minutes until the fault is corrected � Six short (0.5 second) beeps at 1/2 second intervals Non-critical fault � There will be no additional warning tones IMPORTANT: Fault codes generated by a malfunction will remain in the system until corrected and cleared. Axius Fault Code Table�Diesel Fault ID Fault Name CCM-AP-10 AutoPilot08_PV1p1 -MagneticVariationNotValid CCM-AP-11 AutoPilot08_PV1p1 - No_GPS_Fix CCM-AP-12 AutoPilot08_PV1p1 - PadFault CCM-AP-13 AutoPilot08_PV1p1 PilotMasterHelmToSlaveAgePg0 Associated Sub System Plain Term Module Compass Compass Calibration Not Valid CCM GPS GPS Not Receiving Satellite GPS CCM Information Helm Component Precision Pilot Pad Fault CCM CAN APM to CCM message not received CCM 90-865612080 FEBRUARY 2009 Page 9C-9 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System AutoPilot08_PV1p1 CCM-AP-14 CAN PilotMasterHelmToSlaveAgePg1 CCM-AP-15 AutoPilot08_PV1p1 - SCv2_0x20C_Rx CAN AutoPilot08_PV1p1 CCM-AP-16 CAN SCv2_0x210_Pg0_Rx AutoPilot08_PV1p1 CCM-AP-17 CAN SCv2_0x210_Pg1_Rx AutoPilot08_PV1p1 CCM-AP-18 CAN SCv2_0x210_Pg2_Rx CCM-AP-19 AutoPilot08_PV1p1 - SCv2_0x21D_Rx CAN CCM-AP-20 AutoPilot08_PV1p1 - SCv2_211_Pg0_Age CAN CCM-AP-21 AutoPilot08_PV1p1 - SCv2_211_Pg1_Age CAN CCM-AP-22 AutoPilot08_PV1p1 - SCv2_211_Pg2_Age CAN CCM-AP-23 AutoPilot08_PV1p1 - SCv2_211_Pg3_Age CAN CCM-AP-24 AutoPilot08_PV1p1 - SCv2_211_Pg4_Age CAN CCM-AP-25 AutoPilot08_PV1p1 - SCv2_580_Pg0_Age CAN CCM-AP-26 AutoPilot08_PV1p1 - SCv2_580_Pg1_Age CAN CCM-AP-27 AutoPilot08_PV1p1 - SCv2_580_Pg2_Age CAN CCM-AP-28 AutoPilot08_PV1p1 - SCv2_580_Pg3_Age CAN CCM-AP-29 AutoPilot08_PV1p1 - SCv2_581_Pg0_Age CAN CCM-AP-30 AutoPilot08_PV1p1 - SCv2_581_Pg1_Age CAN CCM-AP-31 AutoPilot08_PV1p1 - SCv2_581_Pg2_Age CAN CCM-AP-32 AutoPilot08_PV1p1 - SCv2_GPS1_Rx CAN AutoPilot08_PV1p1 CCM-AP-35 CAN SCv2ChartPlotterMessageAge CCM-AP-36 AutoPilot08_PV1p1 - SOG_Not_Valid GPS AutoPilot08_PV1p1 CCM-AP-37 Compass Unable_To_Maintain_Heading CCM-AP-4 AutoPilot08_PV1p1 - COG_Not_Valid GPS AutoPilot08_PV1p1 CCM-AP-5 Compass CompassHeadingInvalid AutoPilot08_PV1p1 CCM-AP-6 Compass CompassNotWorking CCM-AP-7 AutoPilot08_PV1p1 - CTE_Not_Valid GPS AutoPilot08_PV1p1 CCM-AP-8 GPS GPS_SOG_Not_Valid CCM-AP-9 AutoPilot08_PV1p1 - GPSNotWorking GPS CCM-CAN-3 MY08DTS - Configuration_Fault CAN CCM-CAN-4 PeerStationKeepingFaulted CAN CCM-DRV-1 MY08Steering4 - AbsPos_Range Drive CCM-DRV-10 TVM_Force_Idle Drive CCM-DRV-12 TVM_Standby Drive Associated Plain Term Module APM to CCM message not received CCM APM CAN H Message error CCM APM CAN H Message error CCM APM CAN H Message error CCM APM CAN H Message error CCM Origination Page Data Time out CCM Destination Page Data Time out CCM Cross Track Page Data Time out CCM Bearing Page Data Time out CCM Arrival Page Data Time out CCM CAN Message error CCM CAN Message error CCM CAN Message error CCM CAN Message error CCM CAN Message error CCM CAN Message error CCM APM to GPS CAN Message error CCM APM to Chartplotter Message error CCM GPS Speed Over Ground Not Valid CCM Autopilot unable to maintain Heading CCM Course Over Ground Not Valid CCM Compass Heading Invalid CCM Compass Not Communicating CCM Cross Track Error Not Valid CCM GPS Speed Over Ground Not Valid CCM GPS Not Communicating CCM DTS Control Head Initialization Not CCM Complete Secondary Drive Skyhook Fault CCM Steering Wheel Absolute Position CCM Sensor Signal Out of Range TVM Has Commanded Forced Idle CCM TVM Has Commanded Standby CCM Mode Page 9C-10 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Fault ID Fault Name CCM-DRV-13 TVM_Steering_Unavailable CCM-DRV-2 MY08Steering4 - AbsPos_RangeHigh CCM-DRV-9 TVM_Drive_Unavailable CCM-JS-1 MY08Joystick - Joystick_ForeAft CCM-JS-10 MY08Joystick - Joystick_Y_Range CCM-JS-11 MY08Joystick - Joystick_Ya_RangeHigh CCM-JS-12 MY08Joystick - Joystick_Ya_RangeLow CCM-JS-13 MY08Joystick - Joystick_Yaw CCM-JS-14 MY08Joystick - Joystick_Yb_RangeHigh CCM-JS-15 MY08Joystick - Joystick_Yb_RangeLow CCM-JS-16 MY08Joystick - Joystick_Z_Diff CCM-JS-17 MY08Joystick - Joystick_Z_Range CCM-JS-18 MY08Joystick - Joystick_Za_RangeHigh CCM-JS-19 MY08Joystick - Joystick_Za_RangeLow CCM-JS-2 MY08Joystick - Joystick_Multi_Sensor CCM-JS-20 MY08Joystick - Joystick_Zb_RangeHigh CCM-JS-21 MY08Joystick - Joystick_Zb_RangeLow CCM-JS-23 MY08Joystick - Joystick CCM-JS-3 MY08Joystick - Joystick_RightLeft CCM-JS-4 MY08Joystick - Joystick_X_Diff CCM-JS-5 MY08Joystick - Joystick_X_Range CCM-JS-6 MY08Joystick - Joystick_Xa_RangeHigh CCM-JS-7 MY08Joystick - Joystick_Xa_RangeLow CCM-JS-8 MY08Joystick - Joystick_Xb_RangeHigh CCM-JS-9 MY08Joystick - Joystick_Y_Diff CCM-KS-1 BATT_RangeHigh CCM-KS-2 BATT_RangeLow CCM-KS-3 ECUP_RangeHigh Sub System Drive Drive Drive JoyStick Keyswitch Keyswitch Keyswitch Plain Term Associated Module TVM Has Commanded Steering Unavailable CCM Steering Wheel Absolute Position Sensor Signal Out of Range High CCM TVM Has Commanded Drive Unavailable CCM Joystick Fore/Aft Sensor Error CCM Joystick Primary Fore/Aft Sensor Voltage Out of Range CCM Joystick Primary Fore/Aft Sensor Voltage Out of Range High CCM Joystick Primary Fore/Aft Sensor Voltage Out of Range Low CCM Joystick Yaw Sensor Error CCM Joystick Redundant Fore/Aft Sensor CCM Voltage Out of Range High Joystick Redundant Fore/Aft Sensor CCM Voltage Out of Range Low Joystick Yaw Sensor Deviation Error CCM Joystick Primary Yaw Sensor CCM Voltage Out of Range Joystick Primary Yaw Sensor CCM Voltage Out of Range High Joystick Primary Yaw Sensor CCM Voltage Out of Range Low Joystick Multiple Sensor Fault CCM Joystick Redundant Yaw Sensor CCM Voltage Out of Range High Joystick Redundant Yaw Sensor CCM Voltage Out of Range Low Joystick Error CCM Joystick Right/Left Sensor Error CCM Joystick Right/Left Sensor Deviation CCM Error Joystick Primary Right/Left Sensor CCM Voltage Out of Range Joystick Primary Right/Left Sensor CCM Voltage Out of Range High Joystick Primary Right/Left Sensor CCM Voltage Out of Range Low Joystick Redundant Right/Left CCM Sensor Voltage Out of Range High Joystick Fore/Aft Sensor Deviation CCM Error System Voltage High Warning CCM System Voltage Low Warning CCM CCM Keyswitch Supply Voltage CCM High Warning 90-865612080 FEBRUARY 2009 Page 9C-11 Preliminary Electronic Release Troubleshooting Fault ID Fault Name CCM-KS-4 ECUP_RangeLow CCM-KS-5 XDRP_RangeHigh CCM-KS-6 XDRP_RangeLow CCM-LVR-1 MY08Lever - Lever1_Dec CCM-LVR-10 MY08Lever - Lever1_Hires_RangeLow CCM-LVR-11 MY08Lever - Lever1_Multi_Sensor CCM-LVR-2 MY08Lever - Lever1_Dec_Diff CCM-LVR-29 MY08DTS - Single_Lever_Fault CCM-LVR-3 MY08Lever - Lever1_Dec_Range CCM-LVR-30 MY08Lever - Lever1 CCM-LVR-32 MY08Lever - Lever1_Inc CCM-LVR-33 MY08Lever - Lever1_Inc_Diff CCM-LVR-34 MY08Lever - Lever1_Inc_Range CCM-LVR-35 MY08Lever - Lever1_Inc_RangeHigh CCM-LVR-36 MY08Lever - Lever1_Inc_RangeLow CCM-LVR-4 MY08Lever - Lever1_Dec_RangeHigh CCM-LVR-5 MY08Lever - Lever1_Dec_RangeLow CCM-LVR-6 MY08Lever - Lever1_Hires CCM-LVR-7 MY08Lever - Lever1_Hires_Diff CCM-LVR-8 MY08Lever - Lever1_Hires_Range CCM-LVR-9 MY08Lever - Lever1_Hires_RangeHigh CCM-SOH-1 CCMData_0x3A0_p0_SOH MY08DTS CCM-SOH-10 Engine_Crosscheck_Data_0x160p1_SOH MY08DTS CCM-SOH-11 Engine_Crosscheck_Data_0x160p2_SOH Sub System Keyswitch Keyswitch Keyswitch Levers CAN CAN CAN Associated Plain Term Module CCM Keyswitch Supply Voltage Low CCM Warning Transducer Power Voltage High Warning CCM Transducer Power Voltage Low Warning CCM Control 1 Lever Decrement Potentiometer Error CCM Control 1 Lever Hi-Resolution Potentiometer Voltage Out of Range CCM Low Control 1 Lever Multiple CCM Potentiometer Failure Control 1 Lever Decrement CCM Potentiometer Deviation Error Single Lever Mode Failure CCM Control Lever 1 Decrement Potentiometer Voltage Out of Range CCM Control Lever 1 Sensor Error CCM Control Lever 1 Increment CCM Potentiometer Error Control Lever 1 Increment CCM Potentiometer Deviation Error Control Lever 1 Increment Potentiometer Voltage Out of Range CCM Control Lever 1 Increment Potentiometer Voltage Out of Range CCM High Control Lever 1 Increment Potentiometer Voltage Out of Range CCM Low Control Lever 1 Decrement Potentiometer Voltage Out of Range CCM High Control Lever 1 Decrement Potentiometer Voltage Out of Range CCM Low Control Lever 1 Hi-Resolution CCM Potentiometer Error Control Lever 1 Hi-Resolution CCM Potentiometer Deviation Error Control Lever 1 Hi-Resolution Potentiometer Voltage Out of Range CCM Control Lever 1 Hi-Resolution Potentiometer Voltage Out of Range CCM High State of Health Message CCM State of Health Message CCM State of Health Message CCM Page 9C-12 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System Plain Term Associated Module CCM-SOH-12 MY08DTS Engine_ Crosscheck_Data_0x160p255_S OH CAN State of Health Message CCM CCM-SOH-13 MY08DTS Engine_ Crosscheck_Data_0x160p3_SOH CAN State of Health Message CCM CCM-SOH-14 MY08DTS Engine_ Synchronization_0x200_SOH CAN State of Health Message CCM CCM-SOH-15 MY08DTS Low_ Speed_Engine_Data_0x1A0p9_SOH CAN State of Health Message CCM CCM-SOH-16 MY08DTS Medium_ Speed_Engine_Data_0x170p0_ SOH CAN State of Health Message CCM CCM-SOH-17 MY08DTS Medium_ Speed_Engine_Data_0x170p25 5_SOH CAN State of Health Message CCM CCM-SOH-18 MY08DTS Medium_ Speed_Engine_Data_0x170p3_ SOH CAN State of Health Message CCM CCM-SOH-19 MY08DTS Medium_ Speed_Engine_Data_0x170p5_ SOH CAN State of Health Message CCM CCM-SOH-2 CCMFeedback_p0_SOH CAN State of Health Message CCM CCM-SOH-20 MY08DTS Medium_ Speed_Engine_Data_0x170p6_ SOH CAN State of Health Message CCM CCM-SOH-21 TVM_Status_Message_0x3E0p0_SOH CAN State of Health Message CCM CCM-SOH-22 TVM_Status_Message_0x3F0p0_SOH CAN State of Health Message CCM CCM-SOH-3 CCMFeedback_p1_SOH CAN C State of Health Message CCM CCM-SOH-4 CCMFeedback_p2_SOH CAN State of Health Message CCM CCM-SOH-5 CCMFeedback_p3_SOH CAN State of Health Message CCM CCM-SOH-6 MY08AutoTrim Medium_ Speed_Engine_Data_0x170p3_ AT_SOH_AT T CAN State of Health Message CCM CCM-SOH-7 MY08AutoTrim Medium_ Speed_Engine_Data_0x171p3_ SOH_A CAN State of Health Message CCM CCM-SOH-8 MY08DTS - Cruise_Display_SOH CAN State of Health Message CCM CCM-SOH-9 MY08DTS -Engine_Crosscheck_Data_0x160p0_SO H CAN State of Health Message CCM CCM-STR-10 MY08Steering4 - WheelPosMyRel_diff SteerWheel State of Health Message CCM CCM-STR-11 MY08Steering4 - WheelPosPeerRel_diff SteerWheel Steering Wheel Encoder to Absolute Position Sensor Crosscheck Error CCM CCM-STR-12 MY08Steering4 -WheelReturntoCenterFault SteerWheel Steering Wheel Encoder Crosscheck Deviation Error CCM CCM-STR-13 MY08Steering4 -MotorOpenShortDetected SteerWheel Steering Wheel Return to Center Fault CCM CCM-STR-5 MY08Steering4 Wheel_ EndStopExceeded SteerWheel Steering Wheel Motor Open or Short Detected CCM CCM-STR-6 MY08Steering4 - WheelEndStopFault SteerWheel Steering Wheel End Stop Passed CCM 90-865612080 FEBRUARY 2009 Page 9C-13 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System CCM-STR-7 MY08Steering4 -WheelForceFeedbackFault SteerWheel CCM-STR-9 MY08Steering4 - WheelPosAbsolute_diff SteerWheel TVM-CAN-1 CCM_CAN_P_Auth_Timeout CAN TVM-CAN-2 CCM_CAN_P_Authentication_Fault CAN TVM-CAN-3 CCM_CAN_X_Auth_Timeout CAN TVM-CAN-4 CCM_CAN_X_Authentication_Fault CAN TVM-CAN-5 NoValidCommandMessage CAN TVM-CAN-6 NoValidRPMMessage CAN TVM-CAN-7 TVM_Command_Message_0x3D0SOH CAN TVM-CAN-8 TVM_Red_Command_Message_0x5D0S OH CAN TVM-DRV-1 Both_Pos_Sensor_Failure Drive Position TVM-DRV-11 Secondary_Pos_Sensor_Failure Drive Position TVM-DRV-12 DriveUnavailable Drive Position TVM-DRV-2 Drive_Pos_Pri_Fault Drive Position TVM-DRV-3 Drive_Pos_Pri_RangeHigh Drive Position TVM-DRV-4 Drive_Pos_Pri_RangeLow Drive Position TVM-DRV-5 Drive_Pos_Sec_Fault Drive Position TVM-DRV-6 Drive_Pos_Sec_RangeHigh Drive Position TVM-DRV-7 Drive_Pos_Sec_RangeLow Drive Position TVM-DRV-8 Drive_Position_Follow_Fault Drive Position TVM-DRV-9 Drive_Position_Sensor_Crosscheck_Fault Drive Position TVM-FL-3 Tank_Press_Fault Fluid Levels TVM-FL-4 Tank_Press_RangeHigh Fluid Levels TVM-FL-5 Tank_Press_RangeLow Fluid Levels Associated Plain Term Module Steering Wheel End Stop Fault Steering Wheel Force Feedback CCM Error Steering Wheel Absolute Position Sensor to Encoder Crosscheck Error CCM CCM CAN P Authentication TVM Message Timeout CCM CAN P Authentication Fault TVM CCM CAN X Authentication TVM Message Timeout CCM CAN X Authentication Fault TVM No Valid Command Message TVM No Valid RPM Message TVM The TVM Has Not Received a Valid Primary Command Message From TVM the CCM - CAN X The TVM Has Not Received a Valid Redundant Command Message TVM From the CCM - CAN P Primary & Secondary Drive Position TVM Sensor Failure Secondary Drive Position Sensor TVM Failure Drive Has Set Unavailable TVM Primary Drive Position Sensor TVM Voltage Out of Range Primary Drive Position Sensor TVM Voltage Out of Range High Primary Drive Position Sensor TVM Voltage Out of Range Low Secondary Drive Position Sensor TVM Voltage Out of Range Secondary Drive Position Sensor TVM Voltage Out of Range High Secondary Drive Position Sensor TVM Voltage Out of Range Low Drive Not Responding To Steer TVM Commands In Time Primary & Secondary Drive Position TVM Sensor Crosscheck Error Hydraulic Tank Pressure Sensor TVM Failure Tank Pressure Sensor Voltage Out TVM of Range High Tank Pressure Sensor Voltage Out TVM of Range Low TVM-FLT-1 Filter_Clog_Fault Drive Filter Hydraulic Oil Filter Clogged Warning TVM TVM-FLT-2 Filter_Dirty_Fault Drive Filter Hydraulic Oil Filter Dirty Warning TVM Page 9C-14 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Fault ID Fault Name Sub System Plain Term Associated Module TVM-INT-1 Init_Drive_Pos_Pri_InHi Initialization Drive Initialization Failed - Primary Drive Position Sensor Signal In Range High TVM TVM-INT-15 InitializationFailed Initialization Drive Initialization Failed Drive Initialization Failed - Primary Drive Position Sensor Signal In Range Low TVM TVM-INT-2 Init_Drive_Pos_Pri_InLo Initialization Drive Initialization Failed Secondary Drive Position Sensor Signal In Range High TVM TVM-INT-3 Init_Drive_Pos_Sec_InHi Initialization Drive Initialization Failed Secondary TVM TVM-INT-4 Init_Drive_Pos_Sec_InLo Initialization Drive Position Sensor Signal In Range Low TVM TVM-INT-5 Init_Oil_Temp Initialization Drive Initialization Failed - Hydraulic Oil Temperature Fault TVM TVM-INT-9 Init_Steer_Pressure Initialization Drive Initialization Failed - Steer Pressure Fault TVM TVM-PMP-10 Pump_Press_Sensor_Failure Primary Pump Hydraulic Oil Pressure Sensor Failure TVM TVM-PMP-12 High_Hydraulic_Oil_Temp_Fault Primary Pump Critical High Hydraulic Oil Temperature TVM TVM-PMP-13 Hydraulic_Oil_Temp_Warning Primary Pump High Hydraulic Oil Temperature Warning TVM TVM-PMP-5 Primary_Pos_Sensor_Failure Primary Pump Primary Drive Position Sensor Failure TVM TVM-PMP-6 Pump_Failure_Fault Primary Pump Hydraulic Pump Failure TVM TVM-PMP-7 Pump_Press_Fault Primary Pump Hydraulic Pump Pressure Failure TVM TVM-PMP-8 Pump_Press_RangeHigh Primary Pump Hydraulic Oil Pressure Sensor Voltage Out of Range High TVM TVM-PMP-9 Pump_Press_RangeLow Primary Pump Hydraulic Oil Pressure Sensor Voltage Out of Range Low TVM TVM-STR-1 Steer_A_Press_Fault Steering Steering Pressure A Sensor Failure TVM TVM-STR-12 SteerCoil_A_Failure_Fault Steering Steering Coil A Failure TVM TVM-STR-13 SteerCoil_A_Pin_Fault Steering Steering Coil A Open Circuit TVM TVM-STR-14 SteerCoil_B_Failure_Fault Steering Steering Coil B Failure TVM TVM-STR-15 SteerCoil_B_Pin_Fault Steering Steering Coil B Open Circuit TVM TVM-STR-17 SteeringUnavailable Steering Steering is Unavailable TVM TVM-STR-2 Steer_A_Press_RangeHigh Steering Steering Pressure A Sensor Voltage Out of Range High TVM TVM-STR-3 Steer_A_Press_RangeLow Steering Steering Pressure A Sensor Voltage Out of Range Low TVM TVM-STR-4 Steer_B_Press_Fault Steering Steering Pressure B Sensor Failure TVM TVM-STR-5 Steer_B_Press_RangeHigh Steering Steering Pressure B Sensor Voltage Out of Range High TVM TVM-STR-6 Steer_B_Press_RangeLow Steering Steering Pressure B Sensor Voltage Out of Range Low TVM TVM-STR-7 Steer_Oil_Temp_Fault Steering Steering Hydraulic Oil Temperature Sensor Failure TVM 90-865612080 FEBRUARY 2009 Page 9C-15 Preliminary Electronic Release Troubleshooting Fault ID Fault Name TVM-STR-8 Steer_Oil_Temp_RangeHigh TVM-STR-9 Steer_Oil_Temp_RangeLow TVM-VLT-2 SysVolt_Fault TVM-VLT-3 SysVolt_RangeHigh TVM-VLT-4 SysVolt_RangeLow TVM-VLT-5 XDRPVolt_Fault TVM-VLT-6 XDRPVolt_RangeHigh TVM-VLT-7 XDRPVolt_RangeLow Troubleshooting Joystick Symptom Sub System Steering Steering Drive Voltage

Drive Voltage Drive Voltage Drive Voltage Drive Voltage Drive Voltage The joystick does not control the boat. Response to joystick input is erratic, or the joystick operates independent of input. The joystick does not function properly and a fault code is set. The joystick does not work; No fault code is set and cruise control engaged. Electronic Remote Controls Symptom The electronic remote control (ERC) lever is too hard or too easy to move out of neutral detent. The ERC lever has too much or too little resistance through its range of motion. The ERC lever increases engine RPM, but does not engage gears and the boat does not move. Associated Plain Term Module Steering Hydraulic Oil Temperature TVM Sensor Voltage Out of Range High Steering Hydraulic Oil Temperature TVM Sensor Voltage Out of Range Low TVM Supply Voltage Out of Range TVM Warning TVM Supply Voltage High Warning TVM TVM Supply Voltage Low Warning TVM Transducer Power Failure TVM Transducer Power Voltage Out of TVM Range High Transducer Power Voltage Out of TVM Range Low Remedy One or both remote controls are not in neutral. Put both remote controls in neutral. One or both engines are not running. Start the engine or engines. Ensure there are no radios or other sources of electronic or magnetic interference near the joystick. Check VesselView for Guardian fault codes that indicate reduced engine power. If found, check the indicated part of the system. Disengage cruise control. Remedy Adjust detent tension. See Section 2, Dual Handle Electronic Remote Control with DTS Trackpad Features and Operation in the owners and operators manual. Adjust the handle tension screw. See Section 2, Dual Handle Electronic Remote Control with DTS Trackpad Features and Operation in the owners and operators manual. Key off and then key on. Check the "Throttle Only" button on the DTS trackpad. If the indicator is on, put the ERC levers in neutral and push the button to disengage. Engage gears manually. See Section 3, Gear Engagement�Emergency Procedure in the owners and operators manual. Page 9C-16 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Troubleshooting Symptom Remedy The ERC lever controls the engine and drive, but does not reach wide open throttle. If the engine only reaches 50% of WOT, check the "DOCKING" button on the DTS trackpad. If the indicator is on, put the handles in neutral and push the button to disengage. Check VesselView to see if cruise control enabled. Turn cruise control off. Check for damage to the propeller. Check VesselView for Guardian fault codes that indicate reduced engine power. If found, contact your authorized Mercury MerCruiser or Cummins MerCruiser Diesel authorized dealer to ask if the propellers need to be changed. Check the "TROLL" button on the DTS track pad. If the indicator is on, put the handles in Neutral and push the The ERC lever controls the engine and drive, but does "TROLL" button to disengage. not respond in a linear manner. Check whether dock mode or cruise control are on. If on, turn off or disengage. Check the "1 LEVER" button on the DTS track pad. If When one ERC lever is moved, both engines respond. the indicator is on, put the handles in neutral and push the "1 LEVER" button to disengage. The ERC control, joystick, and steering wheel do not Press "HELM" on DTS track pad to restore helm function. control (multiple helm boats only). Steering System Symptom Remedy The starboard key switch is tuned off. Turn on the key. The steering wheel steers the boat, but operates Check and start the starboard engine. without resistance. Check if the starboard harness circuit breaker has tripped. Reset the circuit breaker, if tripped. For emergengy control, reduce speed and change to joystick for directional control. Steering wheel does not steer the boat. Check steering fluid level and fill if necessary. See Section 1B� Maintenance. Steering works, but the boat is not as responsive. Key off and key on. Check and start the port engine. Check the trim tab function. Check the steering fluid level and fill if necessary. See Section 1B� Maintenance. Key off and key on to restore steering wheel The steering wheel turned past end stop. self-centering, cruise control, and to eliminate the fault code. 90-865612080 FEBRUARY 2009 Page 9C-17 Preliminary Electronic Release Troubleshooting Notes: Page 9C-18 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering Important Information Section 9D - Power-assisted Steering Table of Contents Axius Hydraulic Flow Diagram........................9D-3 Engine Clearance and the Axius Power Steering Actuator..9D-3 Changing the Power-assisted Steering Fluid ....9D-3 Axius Power Steering Actuator Removal.........9D-5 Disconnecting the Axius Steering Actuator Clevis..9D-5 14-Pin T-Harness Removal.....................9D-6 Hydraulic Line Removal..........................9D-6 Removing the Axius Steering Actuator.....9D-7 Axius Power Steering Actuator Installation......9D-8 Installing the Axius Steering Cylinder.......9D-8 14-Pin T-Harness Connection ....9D-11 Connecting the Axius Steering Cylinder Hydraulic Lines......................................9D-12 Connecting the Axius Steering Cylinder Clevis ....9D-14 Power Steering Pump�Gasoline Models.....9D-15 Power Steering Pump Replacement......9D-15 Axius Power Steering Pump Pulley�Removal ....9D-16 Axius Power Steering Pump Pulley� Installation..9D-16 Axius Power Steering Pump�Removal ....9D-18 Axius Power Steering Pump�Installation ....9D-20 Power Steering Pump�Diesel Models..........9D-23 Power Steering Pump Replacement�Diesel Models...9D-23 The Importance of Clean Fluid..............9D-23 Crankshaft Pulley Removal...................9D-23 Crankshaft Pulley Installation................9D-24 Power Steering Pump Removal............9D-24 Cleaning and Inspection........................9D-26 Pump Installation...................................9D-26 90-865612080 FEBRUARY 2009 Page 9D-1 Preliminary Electronic Release 9 D Power-assisted Steering Lubricant, Sealant, Adhesives Tube Ref No. Description 28 Dexron III Automatic 34 Special Lubricant 101 114 Power Trim and Steering Fluid Special Tools Orifice Fitting 40128 Where Used Threads of hydraulic line fittings and O-rings Power steering pump Power steering bushings Pivot bolts Steering cylinder clevis, steering lever bushing, and clevis pin Power-assisted steering pump shaft Part No. Obtain Locally 92-802865Q02 92-858074K01 8M2006785 Used for Axius system Power-Assisted Steering Pump Pulley Kent Moore J-25034-C Remover Removes the pulley on the power steering pump. 18598 Pulley Pusher Installer 91-93656A1 Installs the pulley onto the power steering pump. 10047 Page 9D-2 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering Axius Hydraulic Flow Diagram 40301acdfghibe a -High-pressure pump f -Low-pressure filter b -High-pressure flow g -Cooler c -Reservoir h -Seawater outlet d -Steering actuator i -Seawater inlet e -Return flow Engine Clearance and the Axius Power Steering Actuator Engine compartment clearance issues associated with non-Axius specific boat designs can cause clearance issues when removing and installing the Axius power steering actuator. Temporary repositioning of the engine and other engine compartment components may be required. Refer to the appropriate engine service manual for instructions. Changing the Power-assisted Steering Fluid IMPORTANT: Do not allow dirt or contaminants to enter the power steering system. Clean steering system components prior to service and maintain clean working conditions at all times. Seal all open connections with the appropriate size service cap. Minimize the time the hydraulic system is open to the environment. IMPORTANT: Only change the steering fluid if it becomes contaminated. ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. 1. Disconnect the battery cables from the battery. IMPORTANT: If replacing the power steering pump, fill the pump with fluid prior to installation. Refer to Section 9D: Power Steering. 2. Disconnect the high and low pressure hydraulic hoses at the power steering cylinder. 3. Install service caps on both power steering cylinder hydraulic fittings. 90-865612080 FEBRUARY 2009 Page 9D-3 Preliminary Electronic Release Power-assisted Steering 4. Connect the high and low pressure hydraulic hoses with the orifice fitting special tool. Orifice Fitting 8M2006785 40280 High and low pressure lines connected with orifice fitting (typical) 5. Disconnect the case drain hose from the back of the pump. 6. Remove the case drain fitting from the back of the pump. 40281 Case drain fitting 7. Using a suitable pump, fill the pump through the case drain hole until the fluid level reaches the appropriate mark in the reservoir. 8. Connect the battery cables to the batteries. 9. For gasoline applications, disconnect the engine coil control harness. 10. For diesel applications, disconnect all fuel injector electrical connectors. NOTICE Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation. 11. Provide cooling water to the engine. 12. Crank the engine for 5 seconds. 13. Check and fill the fluid level in the reservoir to the appropriate mark. 14. Continue cranking the engine, in 5 second intervals, and refilling the reservoir until a refill is not required. 15. For gasoline applications, connect the engine coil control harness. Page 9D-4 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering 16. For diesel applications, connect all fuel injector electrical connectors. 17. Provide cooling water to the engine. 18. Start the engine while monitoring the power steering fluid level. NOTE:The "Low Pump Pressure Fault " will appear. Disregard at this time. 19. With the electronic remote control in "Throttle Only" mode, increase engine speed to 1000 RPM. 20. Check the system for leaks. 21. Add fluid if necessary to maintain the appropriate level in the reservoir. 22. Continue to operate the engine at 1000 RPM for 30 minutes, then turn off the engine. 23. Remove the orifice fitting and connect the high- and low-pressure hydraulic hoses to the appropriate ports on the Axius steering cylinder. 24. Clear any active fault codes with the following procedure: a. Turn the key to the "OFF" position. b. Move the ERC handles to reverse WOT. c. Turn the key to the "ON" position. 25. Start the engine and let idle. 26. Cycle the drives from full port to full starboard at least twice. 27. Check the system for leaks. 28. Check and fill the fluid level in the reservoir to the appropriate mark. 29. Turn off the engine. Axius Power Steering Actuator Removal Disconnecting the Axius Steering Actuator Clevis 1. Bend the washer tab away from the clevis pin retaining bolt head. acdb 32389 a -Tab washer c -Clevis pin retaining bolt b -Clevis pin head d -Washer tab 2. Remove and retain the clevis pin retaining bolt. 3. Remove and discard the tab washer from the clevis pin. 90-865612080 FEBRUARY 2009 Page 9D-5 Preliminary Electronic Release Preliminary Electronic Release Power-assisted Steering Page 9D-6 90-865612080 FEBRUARY 2009 4. Remove the clevis pin from the clevis and steering arm. 31924 a b c a - Steering arm b - Clevis c - Clevis pin 14-Pin T-Harness Removal IMPORTANT: For diesel models, the T-Harness connects the helm extension harness to the 14-pin connectors on the Axius steering actuator and the vessel interface panel. 1. Disconnect the 14-pin T-Harness connecting the helm harness to the 14-pin connector on the Axius steering actuator Thrust Vector Module (TVM). 31875 a b c d Typical engine a - T-Harness b - Helm harness 14-pin connector c - Engine 14-pin connection d - 14-Pin connector from TVM 2. Relocate and secure the loose end of the T-Harness to avoid damage during service. Hydraulic Line Removal NOTE: Keep hydraulic connections as clean as possible. Use appropriate seals for all connections, and limit the time that any connection is open to the environment. Take steps necessary to catch any fluid that may drip or spill from the connections. 1. Remove the high pressure hose. 2. Install the shipping caps to both connections. 3. Remove the low pressure hose. Power-assisted Steering 4. Install the shipping caps to both connections. Removing the Axius Steering Actuator ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. 1. Disconnect battery power at the battery. 2. Disconnect the 14-Pin T-Harness from the steering actuator 14-pin connector. 3. Disconnect the high and low-pressure hydraulic hoses from the steering manifold. 4. Cap all hydraulic fittings and hoses to prevent contamination. 5. Pivot the starboard end of the steering actuator assembly away from the transom to provide additional clearance for service. NOTE:Pivoting the steering actuator assembly in this manner moves the clevis end asclose to the transom as possible. Move the steering lever for added clearance if needed. ab31872c Engine shown removed for clarity a -Starboard end of the steering actuator assembly b -Clevis end c -Transom mount bolt hole 6. Bend the upper tabs of the safety clip away from the corresponding flats on the bolt head. 90-865612080 FEBRUARY 2009 Page 9D-7 Preliminary Electronic Release Power-assisted Steering 7. Loosen the upper pivot bolt until clear from the bushings. Support the power steering module to ensure it does not fall. ab 31869 a -Upper pivot bolt b -Safety clip 8. Remove and retain the upper pivot bolt. 9. Remove the safety clip from the bolt heads. 10. Loosen the lower pivot bolt until clear from the bushing. 11. Remove the power steering actuator. Axius Power Steering Actuator Installation Installing the Axius Steering Cylinder 1. Inspect the steering cylinder assembly pivot bolt bushings for debris. Remove any debris and lubricate the bushings with the specified lubricant. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Power steering bushings 92-802865Q02 2. Install the flat washer on the lower pivot bolt. 3. Lubricate the threads of the lower pivot bolt. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Pivot bolts 92-802865Q02 IMPORTANT: An Axius steering cylinder assembly is specifically port or starboard. Use the label on the TVM to identify the proper location�(port or starboard)�for each steering cylinder. 4. Position the port or starboard steering cylinder assembly on the appropriate transom so that the pivot bolts will enter the bushings. Page 9D-8 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering 5. Install the lower pivot bolt and washer. Turn the pivot bolt all the way in by hand to ensure proper alignment. Tighten the lower pivot bolt to specification. ab 31867 a -Washer b -Lower pivot bolt Description Nm lb-in. lb-ft Upper and lower pivot bolt 34 � 25 IMPORTANT: Do not spread or bend the safety clip (locking tab washer) while placing it over the lower bolt head and upper bolt hole. 6. Use a new safety clip. Ensure that all bends are 90�. cba 32682 Safety clip (locking tab washer) a -Do not bend b -90 deg bend c -Do not bend the lower tabs NOTE:When the safety clip is installed correctly, the flat side of the C-clip should be parallelor close to parallel to the transom. 90-865612080 FEBRUARY 2009 Page 9D-9 Preliminary Electronic Release Power-assisted Steering 7. Install the safety clip over the head of the lower bolt, and align the upper hole with tabs over the upper bolt hole. Ensure the flat of the C clip is parallel or close to parallel with the transom. 31868ab a -Safety clip b -Lower pivot bolt 8. Lubricate the threads and install the upper pivot bolt through the safety clip upper bolt hole, and into the steering cylinder pivot upper bushing. ab 31869 a -Upper pivot bolt b -Safety clip 9. Turn the pivot bolt all the way in by hand to ensure proper alignment. Tube Ref No. Description Where Used Part No. 34 Special Lubricant 101 Pivot bolts 92-802865Q02 10. Tighten the upper pivot bolt to specification. Description Nm lb. in. lb. ft. Upper and lower pivot bolt 34 � 25 11. Bend the upper tabs of the safety clip against the corresponding flats on the bolt head. NOTE:It may be necessary to tighten the pivot bolt further to align the flats on bolt headwith the tabs on the safety clip. 12. Ensure that the steering cylinder assembly pivots freely. 13. Do not connect the steering cylinder clevis to the steering lever at this time. 14. Pivot the starboard end of the steering cylinder assembly away from the transom. Page 9D-10 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering NOTE:Pivoting the steering cylinder assembly in this manner moves the clevis end asower-assisted Steering NOTE:Pivoting the steering cylinder assembly in this manner moves the clevis end as close to the transom as possible and leaves clearance for the installation of the rear enginemounting bolts. Move the steering lever for added clearance if needed. abca -Starboard end of the steering cylinder assembly b -Clevis end c -Transom mount bolt hole. NOT:The steering cylinder clevis is connected to the steering arm after the engine is 31872 Einstalled, if moved or removed. SeeEngine Installation in the appropriate engine. 14-Pin T-Harness Connection 1. Clean both halves of the 14-Pin connector. 2. Connect the 14-pin T-Harness to the 14-Pin connector from the TVM on the Axius steering cylinder. abcd 31875 3. Turn the connector locking ring to secure the connector. Typical engine a -T-Harness b -Helm harness 14-Pin connector c -Engine 14-Pin connection d -14-Pin connector from TVM 90-865612080 FEBRUARY 2009 Page 9D-11 Preliminary Electronic Release Power-assisted Steering Connecting the Axius Steering Cylinder Hydraulic Lines IMPORTANT: Do not allow dirt or contaminants to enter the power steering system. Keep all hydraulic connections clean during assembly and limit the time that any connection is open to the environment. To ensure cleanliness of the hydraulic system, clean the steering cylinder, fittings, and shipping caps with a clean cloth before removing the caps. Maintain clean conditions through this procedure. Continue the installation of the hydraulic lines until the process is complete and all lines are secured. 1. Using a clean lint-free cloth, clean the steering actuator, fittings, and shipping caps. 2. Loosen the shipping caps on the hydraulic manifold and hose fittings. Do not remove the shipping caps until just prior to installing the hydraulic lines. NOTE:For Diesel models, the hydraulic fittings are located on the front of the hydraulicmanifold. aab 32390 a -Shipping cap b -Hydraulic block fitting abc 40291 Diesel model a -High-pressure supply connection b -Low-pressure return connection c -Hydraulic manifold NOTE:Retain the shipping caps for later use. IMPORTANT: Minimize the amount of time that the hydraulic connections are open to the environment. Page 9D-12 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering 3. Disconnect the hydraulic lines from the orifice fitting and lubricate the threads of the hydraulic line fittings and the O-rings with clean lubricant. bac 32739 Gasoline models a -Orifice fitting b -Low-pressure return line c -High-pressure supply line 40358cba Diesel models orifice fitting a -High-pressure supply line b -Orifice fitting c -Low-pressure return line Tube Ref No. Description Where Used Part No. 28 Dexron III Automatic Threads of hydraulic line fittings and O-rings Obtain Locally IMPORTANT: Route the hydraulic lines over the wiring harness and its connector to minimize chaffing and potential damage. 90-865612080 FEBRUARY 2009 Page 9D-13 Preliminary Electronic Release Power-assisted Steering 4. Remove the shipping cap and immediately connect the hydraulic line to the fitting on the steering cylinder hydraulic block as shown. Repeat for the other line. Ensure that the hydraulic lines are routed over the wiring harness and connector. abc a -Low-pressure return line b -High-pressure supply line c -Hydraulic block 31874 40291abc Diesel model a -High-pressure supply line b -Low-pressure return line c - Hydraulic manifold 5. Tighten the hydraulic line fittings to specification. Description Nm lb�in. lb�ft Low-pressure hydraulic return line fitting 34 � 25 High-pressure hydraulic line fitting 54 � 40 Connecting the Axius Steering Cylinder Clevis NOTE:Ensure that the engine is aligned before proceeding. 1. Lubricate the Axius steering cylinder clevis, steering lever bushing, and clevis pin. Page 9D-14 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering Tube Ref No. Description Where Used Part No. 34 Steering cylinder clevis, Special Lubricant 101 steering lever bushing, and 92-802865Q02 clevis pin 2. Pivot the steering cylinder and adjust the steering lever position as needed. Insert the clevis pin through the clevis and steering lever. abc 31924 a -Steering arm b -Clevis c -Clevis pin 3. Align and install the tab washer over the clevis pin as shown. 4. Install and tighten the clevis pin bolt to specification. Description Nm lb�in. lb�ft Clevis pin bolt 5.4 48 � 5. Bend one washer tab against a corresponding flat on the clevis pin bolt head. acdb 32389 a -Tab washer c -Clevis pin bolt b -Clevis pin d -Bent tab Power Steering Pump�Gasoline Models Power Steering Pump Replacement IMPORTANT: Prior to replacing the power steering pump for contamination or low pressure issues, contact Mercury MerCruiser Customer Service to make arrangements to have a Technical Account Manager (TAM) present to assist with initial startup and system filtration immediately following power steering pump replacement. The TAM will have the special filtration equipment necessary to properly filter the system to avoid additional damage or malfunction. Failure to have the TAM filter the system following pump replacement can cause additional system damage and possibly void the warranty. 90-865612080 FEBRUARY 2009 Page 9D-15 Preliminary Electronic Release Power-assisted Steering Axius Power Steering Pump Pulley�Removal NOTE:The power-assisted steering pump pulley may be removed and installed while thepower-assisted steering pump assembly remains mounted to the engine. ! WARNING Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components. ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. 1. Disconnect both battery cables from the battery. 2. Remove the serpentine belt from the power steering pulley. See Section 9B Maintenance for the appropriate engine. 3. Install the pulley removal tool on the end of the power-assisted steering pulley and the shaft. Power-Assisted Steering Pump Pulley Kent Moore J-25034-C Remover 4. While holding the pulley removal tool with a suitable wrench, turn the threaded bolt until the power-assisted steering pulley is removed. a b 39791 a -Tool b -Pully shaft Axius Power Steering Pump Pulley�Installation Install the power steering pump pulley using the pulley pusher installer. 1. Thread the stud from the pulley pusher installer completely into the power steering pump shaft. Pulley Pusher Installer 91-93656A1 2. Lubricate the power steering pump shaft. Page 9D-16 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering Tube Ref No. Description Where Used Part No. 114 Power Trim and Steering Fluid Power-assisted steering pump 92-858074K01 shaft 3. Place the power steering pulley on the power steering pump shaft. 4. Place the spacer on the pulley. 5. Place the spacer and the bearing over the pulley pusher installer stud, so the spacer is against the pulley. 6. Thread the pulley pusher installer nut onto the pulley pusher installer shaft. NOTE:The spacer is designed to center the bearing on the tool and press the pulley flush with the end of the shaft. Use the additional spacer for installation on the 496 cid Axiusmodels. 7. Thread the pulley pusher installer shaft and nut onto the pulley pusher installer stud (threaded into the power-assisted steering pump shaft). 8. Turn the pulley pusher installer nut until the face of the power-assisted steering pulley is even with the edge of the power-assisted steering shaft on 350 and 377 cid Axius models, or 1.8 mm (0.07 in.) past the face of the shaft on 496 cid Axius models. f38037bacde Saginaw pump shown, tool order the same a -Pulley pusher installer stud d -Pulley pusher installer nut b -Pulley pusher installer spacer e -Pulley pusher installer shaft c -Pulley pusher installer bearing f -Power-assisted steering pump pulley ab 39792 496 cid models only a -Face of shaft b -Face of pulley 90-865612080 FEBRUARY 2009 Page 9D-17 Preliminary Electronic Release Power-assisted Steering Axius Power Steering Pump�Removal ! WARNING Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components. ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. 1. Disconnect both battery cables from the battery. 2. Remove the serpentine belt from the power steering pulley. See Section 9B Maintenance for the appropriate engine. NOTICE Discharge of oil, coolant, or other engine/drive fluids into the environment is restricted by law. Use caution not to spill oil, coolant, or other fluids into the environment when using or servicing your boat. Be aware of the local restrictions governing the disposal or recycling of waste, and contain and dispose of fluids as required. 3. Drain the fluid from the power steering pump assembly: a. Allow the fluid to cool. Remove the power steering reservoir cap and dipstick. b. Note the locations of the hoses and remove the power steering hoses from the power steering pump. c. Drain fluid into a suitable container and dispose of properly. 39793a b c 496 cid Axius models a -High pressure hose b -Low pressure hose c -Return hose Page 9D-18 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering a bc 39794 350 and 377 cid Axius models a -High pressure hose b -Low pressure hose c -Return hose (not visible) 4. Remove the power steering pump pulley. See Axius Power Steering Pump Pulley� Removal 5. Remove the bolts and nuts from the power-assisted steering pump and front mounting brackets. 39798a b 496 cid models a -Front mount bolts (not visible) b -Power steering pulley a b 39797 350 and 377 cid Axius models a -Front mount bolt b -Front mount bolt 90-865612080 FEBRUARY 2009 Page 9D-19 Preliminary Electronic Release Power-assisted Steering 6. Remove the bolts and nuts from the power-assisted steering pump and rear mounting brackets. 39795 496 cid Axius models 39796 350 and 377 cid Axius models 7. Remove the power-assisted steering pump from the mounting brackets. It may be necessary to loosen or remove the front or rear power steering bracket to remove the power steering pump. Axius Power Steering Pump�Installation IMPORTANT: Do not cross-thread or overtighten the hose fittings. 1. Place the power steering pump on the mounting brackets. Tighten or replace the bracket if removed or loosened earlier. Page 9D-20 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering 2. Install and tighten the front mounting bolts and nuts to specification. 39798ab 496 cid Axius models a -Front mount bolts (not visible) b -Power steering pulley ab39797 350 and 377 cid Axius models a -Front mount bolts (not visible) b -Power steering pulley Description Nm lb-in. Power-assisted steering pump bolt and nut to mounting brackets 41 � 3. Install and tighten the rear mounting bolts and nuts to specification. lb-ft 30 39795 496 cid Axius models 90-865612080 FEBRUARY 2009 Page 9D-21 Preliminary Electronic Release Power-assisted Steering 39796 350 and 377 cid Axius models Description Nm lb-in. lb-ft Power-assisted steering pump bolt and nut to mounting brackets 41 � 30 4. Install the power steering hoses, using new O-rings, to the power steering pump assembly. Tighten the hose fittings. 39793abc 496 cid Axius models a -High pressure hose b -Low pressure hose c -Return hose abc 39794 350 and 377 cid Axius models a -High pressure hose b -Low pressure hose c -Return hose (not visible) Page 9D-22 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering Description Nm lb-in. lb-ft All power-assisted steering hose fittings 31 � 23 5. Install the power steering pump pulley. See Axius Power Steering Pump Pulley� Installation. 6. Install the serpentine belt. See Section 9B Maintenance. IMPORTANT: Do not turn the engine over or fill the power steering pump without a Technical Account Manager (TAM) present to assist with initial startup and system filtration immediately following power steering pump replacement. The TAM will need to use special filtration equipment necessary to properly filter the system to avoid additional damage or malfunction. Failure to have the TAM fill and filter the system following pump replacement can cause additional system damage and possibly void the warranty. Power Steering Pump�Diesel Models Power Steering Pump Replacement�Diesel Models IMPORTANT: Cummins MerCruiser Diesel is committed to providing premium service for the Axius product. In order to meet our customers' expectation, CMD has introduced Marine Repair Logistics (MRL). Contact MRL for any Axius specific non-scheduled maintenance repair. In the USA, please contact our Toll free Number 1-866-549-6458 . For International access, please call +1-843-329-5735. Marine Repair Logistics will be the liaison between the customer and the Service Location. The MRL team will ensure customer satisfaction by locating Certified Service locations for supporting the Axis product. Once the call is made into MRL, we will work with the Service Location to develop a customer support plan to insure the repair is completed in a minimum amount of time. The Importance of Clean Fluid The Axius power steering system operates with tight tolerances and high fluid pressure. Clean fluid fluid is essential for proper functioning and system longevity. Particles as small as 3 microns can cause system failure and the loss of vessel control. Maintain a high level of cleanliness all times, particularly when the Axius steering hydraulic system is exposed to the atmosphere for service. Minimize the time fluid containers or the hydraulic system is open to the environment. Carefully clean all components before service. If there is any possibility that the system has been contaminated during a repair, change the fluid. Refer to Section 9D: Changing the Power-assisted Steering Fluid. Crankshaft Pulley Removal IMPORTANT: The power steering pump stretch-belt is not reusable. Replace if removed. 1. Remove and discard the power-assisted steering pump stretch-belt. 90-865612080 FEBRUARY 2009 Page 9D-23 Preliminary Electronic Release Power-assisted Steering 2. Remove the six bolts retaining the six groove power steering belt pulley to the crankshaft dampener. ab40307 a -Stretch-belt b -Crankshaft power steering drive pulley 3. Remove the power steering pulley from the crankshaft pulley. Crankshaft Pulley Installation 1. Clean the mating surfaces of the power steering pulley and crankshaft dampener. 2. Align the screw holes and mount the power steering pulley on the crankshaft dampener. 3. Install the six retaining bolts and tighten to specification. ab40307 a -Stretch-belt b -Crankshaft power steering drive pulley Description Nm lb-in. lb-ft Power steering pulley bolts 35 � 26 Power Steering Pump Removal NOTE:The power steering pump is a non-serviceable item. If the pump has failed, installa new pump and return the core. Page 9D-24 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. 1. Disconnect battery power at the battery. 2. Remove and discard the power steering stretch-belt. Refer to Section 9B: Diesel Models�Drive Belts. 3. With a suitable puller, remove the power steering pump pulley. 4. Position oil absorbing cloths under the pump to catch any spilled fluid. 5. Disconnect each hydraulic hose separately and cap both the hose and pump fittings before proceeding to the next hose. a b c 40309 a -Case drain outlet b -Supply inlet c -High-pressure outlet 6. Remove the nut attaching the pump retaining stud to the rear bracket. ab c a 40310 a -Rear bracket screws b -Rear bracket c -Pump retaining stud nut 7. Remove the two screws attaching the rear pump bracket to the engine. 90-865612080 FEBRUARY 2009 Page 9D-25 Preliminary Electronic Release Power-assisted Steering 8. Remove the two screws that pass through the front mounting flange of the pump into the front mounting bracket. 40312a b c c a -Upper screw b -Lower screw c -Pump bracket 9. Remove the power steering pump form the engine. Cleaning and Inspection The Axius power steering pump moves the fluid at very high pressures. Use caution around the hoses of an operating pump. Do not loosen or attempt to remove hoses with the pump operating. The pump is a non-serviceable item. Install a new pump and return the core. Refer to Section 9D, Remove and Install of this manual Pump Installation 1. Position oil absorbing cloths under the pump mounting area to catch any spilled fluid. 2. Install the power steering pump high and low-pressure hydraulic fittings into the pump. a b c 40315 a -High-pressure outlet fitting b -Pump case drain c -Low-pressure inlet fitting 3. Install service caps to seal the high and low-pressure hydraulic fittings. NOTE:During power steering pump assembly and filling, use a protected work surface toprotect the pump from damage. 4. Turn the pump on it's face and fill the pump with fluid through the case drain. Page 9D-26 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering Tube Ref No. Description Where Used Part No. 28 Dexron III Automatic Power steering pump Obtain Locally 5. Install the case drain fitting into the power steering pump. 6. Install a service cap to seal the pump case drain fitting 7. Position the power steering pump on the bracket. 8. Install the two screws that pass through the front mounting flange of the pump into the front mounting bracket. Do not tighten. 40312abcc a -Upper screw b -Lower screw c -Pump bracket 9. Position the rear bracket. 10. Install the nut attaching the pump retaining stud to the rear bracket. Do not tighten. abca 40310 a -Rear bracket screws b -Rear bracket c -Pump retaining stud nut 11. Install the two screws attaching the rear pump bracket to the engine. Do not tighten. 12. Tighten the pump attaching nut and screws to specification. Description Nm lb-in. lb-ft Pump attaching nut 44 � 32 Pump attaching screws 60 � 44 13. Tighten the rear bracket screws to specification. 90-865612080 FEBRUARY 2009 Page 9D-27 Preliminary Electronic Release Power-assisted Steering Description Nm lb-in. lb-ft Rear bracket screws 44 � 32 IMPORTANT: When properly installed, the power steering pump pulley will be flush with the end of the pump shaft with the grooved hub facing out. 14. Clean the power steering pump shaft and the inner hub of the pulley. 15. With a suitable pulley installer, press the power steering pump pulley onto the pump shaft. a b 40323 a -Pulley b -Installer 16. Connect each hydraulic hose separately. Do not remove the service caps until just prior to making each connection. Refer to Section 9D: Power-assisted Steering� Hydraulic Line Connections. a b c 40309 a -Case drain outlet b -Supply inlet c -High-pressure outlet 17. Install a new power steering stretch-belt. Refer to Section 9B: Diesel Models�Drive Belts. ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. 18. Check the power steering fluid level. Fill as required. Refer to Section 9B: Maintenance�Steering Fluid. Page 9D-28 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Power-assisted Steering 19. Connect battery power at the battery. 20. Provide cooling water to all seawater pickups. 21. Start the engine and check the Axius steering system for leaks. 22. If a leak is observed, immediately stop the engine and correct. 23. Allow the engine to reach operating temperature. 24. Check the Axius steering system for leaks. 25. Check the power steering fluid level. Fill as required. Refer to Section 9B: Maintenance�Steering Fluid. 90-865612080 FEBRUARY 2009 Page 9D-29 Preliminary Electronic Release Power-assisted Steering Notes: Page 9D-30 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Electrical Important Information Section 9E - Electrical Table of Contents Axius Electrical System�Gasoline Models.....9E-2 Axius Helm System Architecture Diagram� Gasoline Models.....................................9E-2 Axius Electrical System�Diesel Models.........9E-4 Axius Helm System Architecture Diagram� Diesel Models...9E-4 Wiring Guidelines..9E-5 Wiring Guidelines for Electrical Boat Accessories..9E-6 Harness Installation Guidelines...............9E-6 Component Identification...............................9E-6 90-865612080 FEBRUARY 2009 Page 9E-1 Preliminary Electronic Release 9 E Electrical Axius Electrical System�Gasoline Models Axius Helm System Architecture Diagram�Gasoline Models 12345678991010111213141516171718192021222324255322311 -Helm tilt mechanism 2 -Electric steering helm motor 3 -Joystick 4 -Electronic Remote Control (ERC) lever with DTS trackpad 5 -Key switches Page 9E-2 90-865612080 FEBRUARY 2009 Preliminary Electronic Release6 -Axius helm harness 7 -Driver power harness from 20A circuit breaker Electrical Notes: 90-865612080 FEBRUARY 2009 Page 9E-3 Preliminary Electronic Release Preliminary Electronic Release Electrical Page 9E-4 90-865612080 FEBRUARY 2009 Axius Electrical System�Diesel Models Axius Helm System Architecture Diagram�Diesel Models 1 10 11 12 13 15 14 16 17 18 19 2 21 22 20 24 23 25 26 27 28 29 3 30 4 5 6 7 8 40 9 31 32 33 34 35 37 36 38 39 1 2 3 6 7 8 11 15 16 37207 5 42 41 43 44 22 45 46 Electrical 1 - Vessel sensor harness 2 - Shift actuator 3 - Trim pump 4 - Genset (optional) 5 -Vessel sensor extension harness (optional) 6 - TVM extension harness 7 - Axius steering cylinder assembly 8 - Bravo Three sterndrive 9 - Port vessel interface panel 10 -Starboard vessel interface panel 11 -T-harness 12 -Starboard helm clean power harness 13 -Port engine 14 -Starboard engine 15 -Helm extension harness 16 -Helm harness 17 -Port CCM 18 -Starboard CCM 19 -Port main power relay 20 -Starboard main power relay 21 -Port clean power connector (with jumper) 22 -Warning horn 23 -Starboard clean power connector 24 -Port engine key switch 25 -Starboard engine key switch 26 -Fire suppression breakout 27 -Start-stop switch 28 -E-stop switch 29 -Skyhook notification harness (optional) 30 -Electronic steering column assembly 31 -Electronic remote control (ERC) 32 -Joystick 33 -CAN V extension harness (optional) 34 -Smart junction box 35 -VesselView harness 36 -NEMA connectors 37 -Port Link gauges 38 -Starboard Link gauges 39 -VesselView 40 -USB extension harness 41 -Precision Pilot track pad 42 -DTS track pad (in ERC) 43 -Junction box 44 -Auto pilot module 45 -Navigation system Y-harness 46 -Navigation system components Wiring Guidelines IMPORTANT: Refer to the following precautions when working on or around the electrical harness, or when adding other electrical accessories, to avoid damage to the electrical system. � Do not tap accessories into the engine harness. � Do not puncture wires for testing (probing). � Do not reverse the battery leads. � Do not splice wires into the harness. � Do not attempt diagnostics without the proper, approved service tools. � Never attempt to connect, network, tie into, switch, sink source voltage or current from the wiring harnesses. � Never attempt to connect any type of communication or navigation equipment into the wiring harnessing other than at the designated connection point. � Always install boat accessory equipment using an appropriate power source connection, such as a fuse panel or junction box. � Never attempt to tap directly into any of the electrical wiring harnesses for a source of power. 90-865612080 FEBRUARY 2009 Page 9E-5 Preliminary Electronic Release Electrical Wiring Guidelines for Electrical Boat Accessories IMPORTANT: Do not connect boat accessories to ignition key switch circuits. Use a separate, switched 12-volt source for wiring boat accessories. Splicing or connecting accessories to the ignition key switch circuits could cause an open circuit at the fuse or overload circuits, causing intermittent or complete loss of operation. Harness Installation Guidelines � Ensure the total length of installed CAN V harnessing is less than 70 m (229 ft. 8 in.). Locate an appropriate path for routing the harness connections to their installation points. � Inspect the routing path to ensure that surfaces are free of any sharp edges or burrs that could cut the harness. � Fasten and support the harness with clamps or cable ties along the routing path. A clamp or cable tie must be used within 25.4 cm (10 in.) of any connection and every 45.8 cm (18 in.) along the routing path. � Ensure that all connections are tight. � Seal all unused connectors with weather caps. � Route the harness at least 1 m (3 ft. 3 in.) from any EMC device such as VHF radio and radar equipment. Component Identification 32001 VesselView (Simulated screen) 31059 CCM Page 9E-6 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Electrical 39438abc Vessel interface panel (VIP) a -24-Pin vessel sensor harness connector b -40-Pin engine to VIP connector c -14-Pin helm extension harness to VIP connector 31059 Auto pilot module (APM) 90-865612080 FEBRUARY 2009 Page 9E-7 Preliminary Electronic Release Electrical The APM is standard equipment for diesel models, optional with Axius Premier equipped MerCruiser models. acfgibdeh33034j Smart J-Box a -Smart junction box b -Port SmartCraft display c -SmartCraft display multi-ignition (maximum 5 A) d -Starboard SmartCraft display e -LED lamp (six total) f -Starboard engine g -VesselView multi-ignition h -CAN V i -Multi-ignition j -Port engine Standard junction box 31075 Page 9E-8 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Electrical 35941 Integrated helm panel (optional) 31110 Inertial measurement unit (IMU) abc40095 Example helm layout a -Electronic steering wheel b -Electronic remote control with DTS trackpad c -Joystick 90-865612080 FEBRUARY 2009 Page 9E-9 Preliminary Electronic Release Electrical 40100 CMD Precision Pilot track pad MerCruiser Axius Premier track pad (optional) Page 9E-10 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom Important Information Section 9F - Transom Table of Contents Axius Steering Arm...9F-3 Gimbal Ring Assembly Removal.............9F-3 Gimbal Ring Lower Swivel Pin Bushing Replacement...9F-6 Gimbal Housing Swivel Shaft Bushing And Seal Replacement...9F-8 Gimbal Ring Assembly Installation and Alignment...9F-11 Axius Power Steering Actuator Components ....9F-17 Axius Power Steering Actuator Component Identification..9F-17 Position Sensor Guard...........................9F-18 Wiring Harness.......................................9F-20 Pivot Bushings.....................................9F-24 Hydraulic Manifold Fitting O-Rings�Gasoline Models..9F-24 Hydraulic Manifold Fittings O-Rings�Diesel Models..9F-26 Power Steering Actuator Sensors.................9F-30 Position Sensor.....................................9F-30 Pressure Sensor...................................9F-32 Temperature Transducer.......................9F-34 Other Power Steering Actuator Electronics....9F-36 Thrust Vector Module............................9F-36 Hydraulic Valve Coils............................9F-39 Relay...9F-42 CAN Terminal Resistor..........................9F-45 90-865612080 FEBRUARY 2009 Page 9F-1 Preliminary Electronic Release 9 F Transom Removes the upper swivel shaft on gimbal rings. Slide Hammer 91-34569A 1 Aids in the removal of various engine components. Use with 6761 puller jaws. Bushing/bearing/seal driver 91-43578A1 Installs the transom assembly bushings, bearings, and seals. 10484 Expanding Rod Snap-On CG45-4 Aids in the removal of the upper swivel shaft lower bearing in 17771 the gimbal housing. Use with Snap-On Collet (CG45-15). Collet Snap-On CG45-15 Aids in the removal of the upper swivel shaft lower bearing in the gimbal housing. Use with Snap-On Expanding Rod 10774 (CG-45-4). Collet Snap-On CG40A-6 Aids in the removal of gears or bearings; use with expanding rod. 12534 Expanding rod Snap-On CG40-4 Aids in the removal of gears and bearings; use with collet. 12538 10678 Lubricant, Sealant, Adhesives Tube Ref No. Description 7 Loctite 271 Threadlocker 28 Dexron III Automatic 130 Sealer Kit, Two Part Epoxy Special Tools Puller head Where Used Part No. Swivel shaft seal 92-809819 O-ring Obtain Locally Lower swivel pin 92-65150 1 91-63616T Page 9F-2 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom Axius Steering Arm Gimbal Ring Assembly Removal 1. Loosen the U-bolt nuts. a 16575 a -U-bolt nuts 2. Loosen clamping bolt and nut on the steering lever. ab 13576 Engine and transom assembly removed a -Wrench on clamping bolt b -Wrench on nut 90-865612080 FEBRUARY 2009 Page 9F-3 Preliminary Electronic Release Transom 3. Remove the upper swivel shaft locking nut. ab 16577 Standard steering arm shown, Axius similar a -Upper swivel shaft locking nut b -Wrench 4. Remove the cotter pin from the lower swivel pin. a a -Cotter pin 5. Remove the lower swivel pin. a 16578 a 16579 a -Lower swivel pin Page 9F-4 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 6. Remove the washer. a 16580 a -Washer 7. Remove the upper swivel shaft from the gimbal ring using the slide hammer puller and puller head tools. abbccaa 16581 a -Slide hammer puller b -Upper swivel shaft c -Puller head tool Puller head 91-63616T Slide Hammer 91-34569A 1 90-865612080 FEBRUARY 2009 Page 9F-5 Preliminary Electronic Release Transom 8. Remove the large ID washer, steering lever, small ID washer, and locknut. dcba 17907 a -Locknut b -Small ID washer c -Steering lever d -Washer 9. Remove the gimbal ring. GIMBAL RING ASSEMBLY INSPECTION 1. Inspect the painted surfaces and bushings on the gimbal ring. 2. Inspect the upper swivel shaft threads for damage, corrosion and rust. 3. Inspect the lower swivel pin for nicks. 4. Replace any excessively worn or damaged parts. 5. Replace the cotter pin. Gimbal Ring Lower Swivel Pin Bushing Replacement IMPORTANT: Be careful not to damage the gimbal ring bore with the mandrel when removing the bushing. 1. Place a suitable mandrel on the lower swivel pin bushing of the gimbal ring. 2. Use a hammer to tap on the mandrel until the bushing is completely removed. 17905dabc a -Gimbal ring c -Hammer b -Suitable mandrel d -Lower swivel pin 3. Inspect the bore for cleanliness and damage before installing the bushing of the lower swivel pin. 4. Replace the gimbal ring if the bore is damaged. 5. Install a new bushing on the lower swivel pin: Page 9F-6 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom a. Thread the hinge pin tool into the driver. ab 16608 a -Hinge pin b -Driver Bushing/bearing/seal driver 91-43578A1 b. Apply sealer to the outside surface of the bushing onto the lower swivel pin. Tube Ref No. Description Where Used Part No. 130 Sealer Kit, Two Part Epoxy Lower swivel pin 92-65150 1 c. Place the lower swivel pin bushing over the hinge pin tool. NOTE:Use only one of the following procedures: d. Press the bushing of the lower swivel pin into gimbal ring. abc a -Press b -Bushing/bearing/seal driver d 16610 c -Bushing d -Bushing installed 90-865612080 FEBRUARY 2009 Page 9F-7 Preliminary Electronic Release Transom e. Drive the lower swivel pin bushing into the gimbal ring using a hammer. abc 17906 a -Hammer c -Bushing b -Bushing/bearing/seal driver Gimbal Housing Swivel Shaft Bushing And Seal Replacement 1. Remove the swivel shaft seal and the lower swivel shaft bushing from the gimbal housing using the bushing removal tool with the slide hammer tool. aa 17895 a -Bushing removal tool (expanding rod and collet) Expanding Rod Snap-On CG45-4 Collet Snap-On CG45-15 Slide hammer 91-34569A 1 2. Remove the upper swivel shaft bushing from the gimbal housing using the bushing removal tool. aa 17895 a -Bushing removal tool (expanding rod and collet) Page 9F-8 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom Collet Snap-On CG40A-6 Expanding rod Snap-On CG40-4 3. Install new swivel shaft bushings and seal: abc 16615 Swivel shaft bushing and seal replacement parts a -Swivel shaft seal c -Upper swivel shaft bushing b -Lower swivel shaft bushing 4. Install the upper swivel shaft bushing: a. Place the upper swivel shaft bushing on the bushing/bearing/seal driver tool. 16616ab a -Upper swivel shaft bushing b -Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Install upper swivel shaft bushing by tapping it in place with a hammer. ab 16617 a -Bushing/bearing/seal driver tool b -Hammer 90-865612080 FEBRUARY 2009 Page 9F-9 Preliminary Electronic Release Transom 5. Install the lower swivel shaft bushing: a. Place the lower swivel shaft bushing on the bushing/bearing/seal driver tool ab 16618 a -Lower swivel shaft bushing b -Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 b. Install lower swivel shaft bushing by tapping it in place with a hammer. ab 16617 a -Bushing/bearing/seal driver tool b -Hammer 6. Install the swivel shaft seal: a. Apply sealant to outside surface of swivel shaft seal. Tube Ref No. Description Where Used Part No. 7 Loctite 271 Threadlocker Swivel shaft seal 92-809819 Page 9F-10 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom b. Place seal on bushing/bearing/seal driver tool with lip facing the end of the tool with the smaller diameter. 16620abc a -Swivel shaft seal b -Seal lip c -Bushing/bearing/seal driver tool Bushing/bearing/seal driver 91-43578A1 c. Install the swivel shaft seal by tapping it in place with a hammer. ab 16617 a -Bushing/bearing/seal driver tool b -Hammer Gimbal Ring Assembly

Installation and Alignment 1. Align the gimbal ring hole in the lower swivel shaft with the hole in the gimbal housing. 2. Install the washer between the gimbal ring and the gimbal housing as shown. 90-865612080 FEBRUARY 2009 Page 9F-11 Preliminary Electronic Release Transom 3. Install the lower swivel pin. Align the lower swivel pin slot to face foreword and aft. aabcd 17982 a -Gimbal housing b -Gimbal ring c -Lower swivel pin d -Washer 4. Install the cotter pin through the gimbal housing and the lower swivel pin. 5. Bend the open end of the cotter pin in opposite directions to secure. NOTE:The cotter pin must be slightly bent to clear the gimbal ring ears. a ba 17981 a -Cotter pin b -Cotter pin ends bent 6. Place the following items into the cavity in the gimbal housing in this order: a. The washer with the large inner diameter b. The Axius steering lever c. The washer with the small inner diameter Page 9F-12 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom d. The locknut dcbaabcd 17985 Standard steering arm shown, Axius similar a -Locknut b -Small inner diameter washer c -Steering lever d -Large inner diameter washer 7. Install the upper swivel shaft through the gimbal ring and up through the washers, steering lever, and locknut. ab 40308 a -Upper swivel shaft b -Gimbal ring shaft bore 90-865612080 FEBRUARY 2009 Page 9F-13 Preliminary Electronic Release Transom 8. Hand-start the locknut on the upper swivel shaft threads. ab 17984 a -Hand starting nut b -Upper swivel shaft 9. Tighten the swivel shaft locknut until the the swivel shaft is completely pulled into the gimbal ring. ab 16577 Standard steering arm shown, Axius similar a -Locknut b -Wrench 10. Evenly tighten and torque the gimbal ring U-bolt locknuts. Description Nm lb. in. lb. ft. Gimbal ring locknuts for 3/8 in. U-bolt 72 � 53 Gimbal ring locknuts for 7/16 in. U-bolt 95 � 70 Page 9F-14 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 11. Loosen the locknut on the upper swivel shaft. ab 16577 Standard steering arm shown, Axius similar a -Locknut b -Wrench 12. Strike down on both the gimbal ring side supports using a synthane or plastic hammer. 13. Strike both sides of the gimbal ring side supports using a synthane or plastic hammer. IMPORTANT: You must reposition the gimbal ring by using a plastic hammer after each locknut adjustment to ensure proper measurement. 17989 Locations to strike when adjusting gimbal ring for alignment 90-865612080 FEBRUARY 2009 Page 9F-15 Preliminary Electronic Release Transom 14. Measure the clearance between the gimbal ring and the gimbal housing using a feeler gauge. abc 17988 a -Lower swivel pin b -Feeler gauge c -Washer Description Specification Clearance between lower swivel pin washer and gimbal housing mount 0.05�0.25 mm (0.002�0.010 in.) 15. If measurement is not within specification, repeat the procedure steps as listed until you obtain the proper measurement. a. Back off or tighten the locknut on the upper swivel shaft as necessary to achieve the specified clearance. b. Strike down on both of the gimbal ring side supports using a synthane or plastic hammer. c. Strike both sides of the gimbal ring side supports using a synthane or plastic hammer. d. Measure the clearance between the gimbal ring and the gimbal housing using a feeler gauge. Page 9F-16 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom Axius Power Steering Actuator Components Axius Power Steering Actuator Component Identification abcdeikfghjlmnoFront View a -Guard b -Relay (Main power) c -Sink valve d -Pressure sensor e -Pressure sensor f -Source valve g -Clevis h -Four-way valve 37100 i -Pressure sensor (pump) j -Temperature sensor k -Pressure sensor l -Harness m -Thrust vector module (TVM) n -Terminal resistors o -Position sensors ab40288 CMD actuator fitting location a -Low-pressure return line b -High-pressure supply line 90-865612080 FEBRUARY 2009 Page 9F-17 Preliminary Electronic Release Transom abcdefghi37203 Back View a -Clevis b -Pressure sensor c -Sink Valve d -14-pin connector e -Position Sensor f -Harness g -TVM h -Pressure sensor i Four-way valve Position Sensor Guard TEST PROCEDURE Visually inspect the guard for impact or damage that has caused the guard to become bent. Repair or replace the guard if it is bent, making contact with the position sensors, connectors, or the wiring harness. REMOVE 1. Remove and retain the four screws securing the guard. Note the location of the longer screw securing the relay and the location of the clamp holding the wiring harness. 37166 a -Screws b -Position sensors c -Guard abcFront Page 9F-18 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom abcd37101 Back a -Screws c -Position sensors b -Clamp d -Guard 2. Remove the guard from the power steering unit. 37102aabb a -Position sensor b -Connectors INSTALL 1. Align the guard to the power steering unit. 37103ab a -Bolt holes on power steering cylinder b -Guard 90-865612080 FEBRUARY 2009 Page 9F-19 Preliminary Electronic Release Transom 2. Install the four bolts securing the guard. Ensure that the longer bolt is securing the relay in the original location and that the clamp is securing the harness in the original location. 37166 a -Screws b -Position sensors c -Guard Front abc a b c d 37101 a -Screws b -Clamp Back c -Position sensors d -Guard Wiring Harness TEST PROCEDURE Use the Axius power steering harness wiring diagram in the MerCruiser Wiring Diagram Binder or refer to CMD Diagram 4082052 to trace the circuits of any failed subsystem. Check the continuity of the wires from connector to connector. If any wires are broken or are no longer providing reliable continuity, replace the harness. REMOVE 1. Remove the position sensor guard. Refer to Position Sensor Guard. Page 9F-20 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 2. Disconnect the harness from the components. 37094 Harness connection points 3. Remove the 14-pin connector from the bracket. abc37095 a -Nut b -Connector c -Bracket 4. Remove the cable ties and clamp from the power steering unit. abc a -Large cable tie b -Clamp c -Small cable tie 37098 90-865612080 FEBRUARY 2009 Page 9F-21 Preliminary Electronic Release Transom INSTALL 5. Remove the harness from the power steering unit. 1. Lay out the harness on the power steering unit. Ensure that the connectors will reach their intended components. 37099 2. Install the 14-pin connector to the bracket. abc37095a -Nut b -Connector c -Bracket 3. Connect the harness to the appropriate components. 37094 Harness connection points Page 9F-22 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom Note the following: � The primary position sensor is red and the secondary position sensor is green. � Route the temperature sensor connector behind the harness. � Route the harness behind lower pump pressure sensor. a a b c 37249 a -Harness b -Temperature sensor connector c -Lower pump pressure sensor 4. Install the position sensor guard. See Position Sensor Guard. 5. Install a new cable tie securing the harness to the power steering module. 37097a d c b a -Cable tie c -Left TVM connector b -Harness d -Right TVM connector 90-865612080 FEBRUARY 2009 Page 9F-23 Preliminary Electronic Release Transom 6. Install the clamp and cable tie to bottom of the power steering unit. a b c 37235 a -Power steering unit b -Clamp c -Cable tie Pivot Bushings INSPECTION Try to move the power steering unit while engaged and connected. Focus forces specifically around the pivot bolts. If movement is felt that is related to wear and excessive tolerances in the bushing, replace the bushings and the pivot bolts. REMOVAL 1. Remove the power steering actuator from the boat. Refer to Remove the Power Steering Actuator. 2. Using an appropriate tool, remove the pivot bushings. 37139a b Typical a -Power steering actuator b -Bushing INSTALLATION 1. Using a press or appropriate tool, install the busings into the power steering unit. 2. Install the power steering actuator into the boat. Refer to Axius Power Steering Cylinder Installation. Hydraulic Manifold Fitting O-Rings�Gasoline Models Removing the hydraulic hoses opens the hydraulic system to the environment. To reduce the potential for system contamination, maintain a clean working environment throughout this procedure. Page 9F-24 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom INSPECTION 1. Inspect the steering actuator for oil leaks around the hydraulic hose connections on the power steering actuator. 2. Inspect the fittings for nicks, cracks, burrs, or stripped threads that can cause damage to the O-rings or cause poor sealing. 3. If no damage is found, change the O-rings. 4. If damage is found, replace the hydraulic fitting. REMOVAL 1. Remove the appropriate hydraulic hose from the power steering actuator. 31874abc Gasoline models a -Low-pressure return line b -High-pressure supply line c -Hydraulic manifold 2. Remove the O-ring from the fitting and clean the fitting thoroughly. ab37142 Top view a -Fitting b -O-ring groove 90-865612080 FEBRUARY 2009 Page 9F-25 Preliminary Electronic Release Transom INSTALLATION 1. Install a new O-ring on the fitting. ab37138 a -Fitting b -O-ring 2. Lubricate the O-ring. Tube Ref No. Description Where Used Part No. Dexron III Automatic O-ring Obtain Locally 3. Install the fitting in the hydraulic manifold and tighten to specification. 28 Description Nm lb-in. lb-ft Fitting 34 � 25 4. Connect the hydraulic hose to the power steering unit. 31874abc a -Low-pressure return line b -High-pressure supply line c -Hydraulic block 5. Tighten the hydraulic line fittings to specification. Description Nm lb�in. lb�ft Low-pressure hydraulic return line fitting 34 � 25 High-pressure hydraulic line fitting 54 � 40 Hydraulic Manifold Fittings O-Rings�Diesel Models IMPORTANT: Maintain a clean working environment throughout this procedure. Page 9F-26 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom INSPECTION 1. Inspect the hoses and fittings for leaks. 2. Inspect the hoses and fittings for damage. 3. If leaks are observed, identify the cause and correct it. 4. Replace any damaged components. REMOVAL IMPORTANT: Do not move the steering actuator arm while the hydraulic system is open. NOTE:Usetwowrenchesonthehydrauliclinesandfittingstostabilizetheassemblyduring removal and installation. 1. Disconnect and cap the appropriate hydraulic hose from the fitting. 40291abc a -Low-pressure return hose b -High-pressure supply hose c -Hydraulic manifold 2. Remove the appropriate fitting from the power steering unit. abcc40293 High-pressure fitting a -Hose connection and seal b -Manifold connection c -O-rings 90-865612080 FEBRUARY 2009 Page 9F-27 Preliminary Electronic Release Transom 40292abcd Low-pressure fitting a -Hose connection and seal c -Sealing washer b -Elbow d -Nut INSTALLATION 1. Install a new O-ring or sealing washer on the fitting. abcc40293 High-pressure fitting a -Hose connection and seal b -Manifold connection c -O-rings 40292abcdLow-pressure fitting a -Hose connection and seal c -Sealing washer b -Elbow d -Nut 2. Lubricate the O-ring or sealing washer. Tube Ref No. Description Where Used Part No. 28 Dexron III Automatic O-ring Obtain Locally Page 9F-28 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 3. Install the fitting in the hydraulic manifold and tighten to specification. abcc40294 a -High-pressure fitting b -Low-pressure fitting c -Seal Description Fitting 4. Connect the hydraulic hose to the power steering unit. Nm 34 lb-in. � lb-ft 25 40291abc a -Low-pressure return hose b -High-pressure hose c -Hydraulic manifold 5. Tighten the hydraulic hose fitting to specification. Description Nm lb�in. lb�ft Low-pressure hydraulic return line fitting 34 � 25 High-pressure hydraulic line fitting 54 � 40 90-865612080 FEBRUARY 2009 Page 9F-29 Preliminary Electronic Release Transom Power Steering Actuator Sensors Position Sensor INSPECTION NOTE:Test each position sensor separately. 1. Connect a digital volt meter to the position sensor electrical terminals. 2. Set the digital volt meter to supply a 5 volt reference signal. 3. Record the digital volt meter readings in each position. a. Move the steering arm to the full in position. b. Move the steering arm to the centered position. c. Move the steering arm to the full out position. 4. Sensor voltage readings should fall within specification for each arm position. Arm Position Fully in Centered Fully out Primary position sensor .5 +/- 35 mv 2.5 +/- .5mv 4.5 +/- .35 mv Secondary position sensor 4.5 +/- .35 mv 2.5 +/- .5mv .5 +/- 35 mv 5. Replace any position sender exceeding specification. REMOVAL 1. Remove the guard. Refer to Position Sensor Guard. 2. Disconnect the harness from the appropriate position sensor. 37111a b c Primary position sensor shown, typical a -Primary (red) position sensor b -Connector c -Secondary (green) position sensor Page 9F-30 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 3. Remove the position sensor from the power steering unit. A gentle twisting motion may be necessary as it is being pulled out. 37112 Typical 4. Ensure that the rubber sleeve used as a vibration isolator extracts with the position sensor. 5. If the vibration isolator remains in the sensor bore extract it with an appropriate tool. INSTALLATION 1. Install the appropriate vibration isolator on the end of the position sensor. 2. Install the position sensor into the power steering unit. A gentle twisting motion may be necessary for the last 5-8 cm (2-3 in.) before thread engagement. 37170 Primary position sensor shown, typical 3. Tighten the position sensor to specification. Description Position sensor Nm 68 lb-in. � lb-ft 50 90-865612080 FEBRUARY 2009 Page 9F-31 Preliminary Electronic Release Transom 4. Connect and lock the sensor connector. 37111a b c Typical a -Primary (red) position sensor b -Connector c -Secondary (green) position sensor 5. Install the position sensor guard. Refer to Position Sensor Guard. 6. Contact Mercury MerCruiser Customer Service or Cummins MerCruiser Diesel to receive system initialization assistance from a Technical Accounts Manager. Pressure Sensor Removing the pressure sensor exposes the hydraulic system to potential contamination. Ensure that cleanliness is maintained throughout this procedure. There are four pressure sensors on the power steering unit. The procedure is the same for each. 37115 Pressure sensor locations Page 9F-32 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom REMOVAL 1. Disconnect the harness from the appropriate pressure sensor. ab37116 Typical a -Connector b -Pressure sensor 2. Remove the pressure sensor from the power steering unit. 37220ba Typical a -Pressure sensor b -Power steering unit INSTALLATION 1. Inspect the pressure sensor O-ring and replace if leaking or visibly damaged. 90-865612080 FEBRUARY 2009 Page 9F-33 Preliminary Electronic Release Transom 2. Install the pressure sensor in the power steering unit. 37220ba Typical a -Pressure sensor b -Power steering unit 3. Tighten the pressure sensor to specification. Description Nm lb-in. lb-ft Pressure sensor 23 � 17 4. Connect and lock the sensor connector. ab37116 Typical a -Connector b -Pressure sensor Temperature Transducer Removing the temperature transducer exposes the hydraulic system to potential contamination. Maintain a clean working environment throughout this procedure. REMOVE 1. Position oil absorbing mats below the steering actuator to catch any spilled fluid. Page 9F-34 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 2. Disconnect the harness from the temperature sensor. The connector may be tucked behind the harness near the TVM. 37118abc a -Temperature transducer b -Temperature transducer connector c -Pressure sensor 3. Remove the temperature transducer from the power steering unit. 37119 INSTALL 1. Install the temperature transducer in the power steering unit. 37119 2. Tighten the temperature transducer to specification. Description Nm lb-in. lb-ft Temperature transducer 16 � 12 90-865612080 FEBRUARY 2009 Page 9F-35 Preliminary Electronic Release Transom 3. Route the connector behind the harness. abcd37174 a -Harness c -Harness connector b -Temperature sensor connector d -Temperature transducer 4. Connect and lock the harness to the temperature transducer. 37118abc a -Temperature transducer b -Temperature transducer connector c -Pressure sensor 5. Check the fluid level after installation is complete. Refill the reservoir as necessary. Other Power Steering Actuator Electronics Thrust Vector Module REMOVAL ! CAUTION Disconnecting or connecting the battery cables in the incorrect order can cause injury from electrical shock or can damage the electrical system. Always disconnect the negative (-) battery cable first and connect it last. 1. Disconnect battery power at the battery. Page 9F-36 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 2. Disconnect the wiring harness connectors by depressing the locking tabs and gently pulling them away from the back of the TVM. 34487abc a -Wiring harness connectors b -TVM connections c -Locking tabs 3. Remove and retain the upper screw securing the TVM to the bracket and steering cylinder. 4. Remove and retain the two lower bolts and locknuts holding the TVM to the bottom of the bracket. Retain the bushings if they come out of the rubber isolation grommets. ab 34486 a -Upper screw b -Lower bolts and locknuts 5. Remove the thrust vector module from the bracket on the power steering unit. 37121 TVM bracket 90-865612080 FEBRUARY 2009 Page 9F-37 Preliminary Electronic Release Transom INSTALLATION 1. Ensure that the bushings are in place in the grommet, with the flange between the TVM and the bracket. 2. Install the upper screw securing the TVM to the bracket and steering cylinder. Tighten the screw to specification. ab 34486 a -Upper screw b -Lower bolts and locknuts Description Nm lb-in. lb-ft Upper screw 5 48 � 3. Ensure that the bushings are in place in the grommets, with the bushing flanges between the nut and the TVM. 4. Insert the bolts through the bushings and bracket. Reuse the nylon locknuts to secure the bolts to the bracket. Tighten the bolts to specification. Description Nm lb-in. lb-ft Lower bolts and locknuts 5 48 � 5. Connect the harness to the thrust vector module. Ensure the locking tabs are fully engaged. 34498ab a -Wiring harness connectors b -Locking tabs 6. Calibrate the system. For gasoline models, refer to the MerCruiser installation manual provided with this product. For diesel models, refer to the CMD Master Repair Manual (CMD PN 4022081). Page 9F-38 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom Hydraulic Valve Coils NOTE:Remove the hydraulic valve caps by hand. If the caps are too tight to loosen byhand, a 1 inch, 12-point socket may be used to loosen the cap. Do not damage the hydraulicvalve caps. abc37179 Hydraulic valves a -Sink valve b -Source valve c -Four-way valve REMOVAL 1. Disconnect the harness from the appropriate valve coil. abc37123 Source valve shown, typical a -Valve coil b -Valve coil connector c -Harness connector 90-865612080 FEBRUARY 2009 Page 9F-39 Preliminary Electronic Release Transom 2. Carefully remove the valve coil retaining cap. ab37126 Typical a -Valve coil b -Cap 3. Slide the coil off the valve. 37127 Typical 4. Remove and retain the O-ring from the valve coil. INSTALLATION 1. Install the O-ring on the recessed end of the valve coil. abc37251 Typical a -Valve coil b -O-ring c -Connector Page 9F-40 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 2. Slide the valve coil on the valve shaft. 37221 Typical 3. If needed, seat the O-ring in the recess of the valve coil. ab37128 Typical a -Valve coil b -O-ring 4. Install the retaining cap on the valve. Tighten securely without over tightening. ab37126 Typical a -Valve coil b -Cap 90-865612080 FEBRUARY 2009 Page 9F-41 Preliminary Electronic Release Transom 5. Connect and lock the valve coil connector. abc37123 Typical a -Valve coil b -Valve connector c -Harness connector Relay INSPECTION 6. Initialize the system. 1. Remove the relay from the power steering actuator. abc37223 a -Screw b -Relay c -Connector 2. Disconnect the harness from the relay. Page 9F-42 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 3. Identify the connectors on the relay. 37134abcde a -85 power d -86 Power b -87 Switch on e -87A Switch NC c -30 Common switch power 4. Put a 12V DC power source across connectors 85 and 86. 85868787A30abc36950 Shown with power off a -12V power source b -Relay c -Continuity tester 5. Check for continuity between 30 and 87. If no continuity is found, replace the relay. 6. If continuity is good, reinstall the relay. Refer to Install, below. 90-865612080 FEBRUARY 2009 Page 9F-43 Preliminary Electronic Release Transom REMOVE 1. Remove and retain the screw holding the relay to the power steering unit. abc37223 a -Screw holding relay b -Relay c -Connector INSTALL 2. Disconnect the harness from the relay. 1. Connect the harness to the relay. Do not lubricate the seal. cba37135 a -Connector b -Seal c -Relay Page 9F-44 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 2. Use the retained screw to install the relay to the power steering unit. abc37223 a -Screw holding relay b -Relay c -Connector CAN Terminal Resistor INSPECTION 1. Remove the connector from the CAN Terminal Resistor. ab37164 a -Terminal resistors b -Safety latch 2. Check the resistance between the contacts. 37222 Contacts CAN terminal resistor resistance specification Resistance Variance 120 ohms �10% ohms 3. If the resistance is greater than or less than the specifications, replace the CAN terminal resistor. 90-865612080 FEBRUARY 2009 Page 9F-45 Preliminary Electronic Release Transom REMOVAL 1. Remove the appropriate connector from the CAN terminal resistor, if needed. ab37164 a -CAN terminal resistor b -Harness connection 2. Use a suitable tool to compress the appropriate bayonet clips. Remove the appropriate termination resistor from the bracket. 34489abc Shown without Thrust Vector Module for clarity a -Tool b -Bayonet clips c -Bracket INSTALL 1. Connect the CAN terminal resistor to the bracket. Page 9F-46 90-865612080 FEBRUARY 2009 Preliminary Electronic Release Transom 2. Attach the appropriate connector from the CAN terminal resistor. ab37164 a -CAN terminal resistor b -Harness connection 90-865612080 FEBRUARY 2009 Page 9F-47 Preliminary Electronic Release Transom Notes: Page 9F-48 90-865612080 FEBRUARY 2009 Preliminary Electronic Release

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