PAE YACHTS

NORDHAVN 50

Owner's Manual

Hull No. 5025

OPHELIA

(Formerly Flat Earth)

Baltimore, MD

Builder

Pacific Asian Enterprises, Inc.
P.O. Box 874
Dana Point, California
92629

Designer

Pacific Asian Enterprises
Jeff Leishman, NA

TABLE OF CONTENTS

1.0 INTRODUCTION AND GENERAL INFORMATION

1.1 INTRODUCTION

This manual has been prepared to enable the owner to familiarize himself with his new yacht. In addition to basic operating instructions and suggestions for yacht care, detailed information for the boat's systems has been supplied.

It must be realized that an "expert" yachtsman or seaman is a product of years of training and practical experience and that this manual in itself is not intended as a substitute for this acquired knowledge. This manual along with equipment manufacturer's manuals does, however, present basic information concerning proper operation of this particular yacht and should be thoroughly read by the experienced yachtsman as well as by the novice.

For additional training in the proper operation of any vessel, the owner should address himself to publications on the subject and to programs offered by the United States Coast Guard.

Pacific Asian Enterprises, Inc. has made every effort to be accurate, however, we accept no responsibility for damage arising from misunderstanding of, or omission from, the contents of this manual. Also, we do not accept liability or be held liable for any personal injuries or damage occurring as a result of misuse, or badly maintained equipment.

We hope this manual and those of equipment manufacturers that have been provided to you will answer any questions which may arise regarding operation and maintenance of your vessel. If additional guidance is required, contact Pacific Asian Enterprises, Inc. directly. PAE wishes you many happy and safe nautical miles of cruising and we look forward to being of service to you in the future.

PLEASE KEEP THIS OWNER'S MANUAL IN A SECURE PLACE ON BOARD YOUR VESSEL.

1.2 OWNER'S RECORD & DETAILS

Owner's Name:_____

Address:_____

_____

_____

Telephone No:_____

_____

Boat Name:_____

USCG Hull I.D. No:_____
(H.I.N.)

Registration No:_____
(State or Country)

Port of Registry:_____

Hull/No:_____

Engine Model:_____

Engine S/N:_____

Engine Block S/N:_____

Engine Key No:_____

Transmission S/N:_____

Manufacturer:_____

Address:_____

_____

Contact Person:_____

Telephone No: _____

Fax No:_____

E-mail Address:_____

Delivery Date:_____

Delivery Location:_____

In the event of emergency, contact:

Name:_____

Address:_____

_____

_____

Telephone No:_____

Fax/E-mail:_____

It is important to fill out the owner's record in full and keep it with this owner's manual in a secure and accessible place.

1.3 NORDHAVN YACHTS LIMITED WARRANTY

VERY IMPORTANT MESSAGE TO OWNERS OF NEW BOATS: You have been provided with manufacturer's warranty cards for major equipment installed on your yacht. It is extremely important that these cards be filled out and returned to the manufacturer as soon as possible to establish proof of ownership and date of purchase. Failure to return these cards may invalidate any claim against defective or damaged parts.

1. This Limited Warranty is extended to the original purchaser of the yacht at retail, and is not extended to any subsequent purchaser of the yacht, nor is this Limited Warranty transferable. The obligations of Pacific Asian Enterprises, Inc. (hereinafter referred to as "PAE") under this Warranty shall be further limited if the yacht is used for hire or charter. If the yacht is used for hire or charter, PAE, in its sole discretion, shall determine whether or not the requested repair is covered by this Warranty or whether or not this Warranty has been voided due to abuse, misuse or neglect caused by the hire or charter of the yacht.

2. This Warranty applies to those components of the yacht manufactured by or built by PAE, or items which PAE has manufactured by various suppliers including hull, keel, mast, standing rigging, deck, interior bulkheads, rudder, rudder post, plumbing, wiring and electrical panel. Items not covered under this Warranty are: gel coat coloration, exterior finish of exterior hull below waterline, upholstery materials, minor cracking or checking of teak trim or teak decks and toe rail. Engines, pumps, winches, toilets and any items not specifically manufactured for or by PAE are covered by their own individual manufacturer's warranties. All original warranty registration and validation cards are provided to original buyer at delivery. All cards should immediately be filled out and signed as individually specified.

3. To validate the Warranty, the "Warranty Registration Card" must be mailed to Pacific Asian Enterprises, Inc., P.O. Box 874, Dana Point, CA 92629, as soon after the commissioning date as possible. In order to obtain performance of any Warranty obligation, the owner must report in writing, within 30 days of its discovery, any claim in respect of defects in material or workmanship to PAE, Inc. at Dana Point, CA. When reporting a claim, the owner must provide the following information: (a) full details of the problem, (b) model and hull number of the yacht on which the claim is being made, (c) full name and address of the owner, (d) location of the yacht, (e) date of commissioning.

3A. Upon determination by PAE that the defect is warrantable, PAE will effect or authorize repairs. PAE may require that the yacht or defective parts be returned to the PAE or an authorized agent of PAE. PAE neither assumes nor authorizes any person to assume for PAE any liability or expense in the replacing of parts or corrections of defects in the yacht within Warranty period, except when such expenses are authorized in advance and in writing by PAE.

If Warranted components are repaired or replaced under terms hereof, the terms of this Limited Warranty shall cover such component for a period of 90 days from the date of repair or replacement or until the end of the original warranty period, whichever is later.

4. PAE accepts no responsibility for liability through the failure of any yacht or part, except to repair or replace the defective part. Obligations of PAE under this warranty are limited to claims that shall have been received by PAE within the warranty period, and which shall, to the satisfaction of PAE, be determined to have resulted from defective material or workmanship.

5. It is a condition of this Warranty that the yacht has been given reasonable care, and that the warranty claim has not resulted from accident, negligence, misuse or from unauthorized alterations by the original purchaser.

6. PAE reserves the right to improve its products through changes in design and material without obligation to incorporate such changes in yachts of prior manufacture.

7. The duration of the Limited Warranty protecting the fiberglass hull structure, excluding the deck and all fittings and attachments to the hull, shall be two (2) years from the date of commissioning. The Limited Warranty covering the other items as listed in paragraph 2 above shall be for one (1) year from the said date of commissioning.

All other implied warranties, including those of fitness and merchantability, shall continue for one (1) year from the said date of commissioning.

8. PAE shall not be responsible for any damage or defect that shall occur upon the unreasonable use of the yacht by the original purchaser after said purchaser has notice of any defect.

9. This Limited Warranty does not extend to any other damages that the original purchaser claims to have suffered by reasons of such defects.

10. PAE shall not be responsible for the cost of slip rent or storage or for loss of use of the vessel while approved warranty repairs are being carried out.

1.4 VESSEL SPECIFICATIONS

	US	Metric
LOA	50’ 6”	15.39m
LWL	44’ 5 1/2”	13.55m
Beam Overall	16’ 0”	4.88m
Beam at Waterline	14’ 5”	4.39m
Stack Height Above Water*	21’9”	6.63m
Draft	5’ 1 1/2”	1.56m
Area Above/Below WL Ratio:	2.3 : 1	
Displacement	55,932 lbs.	25,425 kg
Ballast	6,600 lbs.	3,000 kg
Fuel	1,320 gal.	4990 liters
Water	300 gal.	1,134 liters

* Maximum Nordhavn 50 height. Measured from the waterline to the top of the main engine exhaust stack, it does not take into account any other appendages.

1.5 NEGLIGENCE

LAW ENFORCEMENT

This section is intended only as an overview of some key laws and is by no means complete or comprehensive. It is the responsibility of the owner to familiarize himself with local laws.

A vessel underway, when hailed by a Coast Guard vessel, is required to heave to or maneuver in such a manner that permits a boarding officer to come aboard.

Other Federal, State and local law enforcement officials may board and examine the vessel whether it is numbered, unnumbered or documented. The Coast Guard may impose a civil penalty of up to $1,000 for failure to:

- Comply with numbering requirements;
- Comply with equipment requirements;
- Report a boating accident;
- Comply with other federal regulations

Failure to comply with the unified Inland Rules of the Road (Inland Navigation Rules Act of 1980) can result in a civil penalty of up to $5,000. It is compulsory to have this book on board if the vessel is over 39 feet. The book is obtainable from:

The Superintendent of Documents
US Government Printing Office
Washington, DC 20402

Tel: (202) 783-3238

Stock No: 050-012-002053 “Inland Rules of the Road”

Improper use of a radiotelephone is a criminal offense. The use of obscene, indecent or profane language during radio communications is punishable by a $10,000 fine, imprisonment for two years or both. Other penalties exist for misuse of a radio, such as improper use of Channel 16 VHF-FM.

Channel 16 is a calling and distress channel. It is not to be used for conversation or radio checks. Such traffic should be conducted on an authorized working channel.

Operating a vessel while intoxicated became a specific federal offense effective January 13, 1988. The final rule sets standards for determining when an individual is intoxicated. The BAC (Blood Alcohol Content) is .10% for operators of recreational vessels being used only for pleasure. Violators are subject to civil penalty not exceeding $1,000 or criminal penalty not to exceed $5,000, I year imprisonment, or both.

NEGLIGENT OPERATION of a vessel which endangers lives and property is prohibited by law. The Coast Guard may impose a civil penalty for negligent operation. GROSSLY NEGLIGENT is a criminal offense and an operator may be fined up to $5,000, imprisoned for 1 year, or both. Some examples of actions that may constitute negligent or grossly negligent operation are:

- Operating boat in a swimming area;
- Operating a boat while under the influence of alcohol or drugs;
- Excessive speed in the vicinity of other boats or in dangerous waters;

For further information, consult the “United States Coast Guard Information Pack”.

1.6 CONSTRUCTION

The design and construction of an ocean going yacht must gracefully blend structural integrity, comfort and performance. Incorporation of these qualities into the NORDHAVN 50 design and construction specifications, together with the excellent craftsmanship of the PAE team, has resulted in a craft that has been described by experts as “the finest ocean going yacht ever produced under 60 feet.”

The vessel construction plan contains a number of unique features which are consistent with its quality. The following descriptions of the vessel structural components highlights these features.

LAMINATES

Structural laminations consisting of fiber glass mat and woven roving are carefully hand cut and laid up entirely by hand. Each layered area is hand rolled and “squeegeed” to remove all excess resin and air pockets keeping the weight down and most efficiently producing the proper glass to resin ratio for maximum strength.

HULL

The hull is laid up in a set of highly polished molds bolted together. The outer skin starts with a isophthalic gel coat applied by a mechanical spray system. For superior blister resistance, the gel coat is backed up by a layer of surface mat laminated in vinyl ester resin. The isophthalic vinyl ester resin is evenly distributed to achieve a very resin rich mix for excellent filament saturation and then hand rolled and squeegeed. This proven outer skin application is crucial to the prevention of osmotic blisters. Addition of alternate plies of fiber glass mat and woven roving bound in resin form the hull shell. Hull strength fore and aft is provided by the woven roving and the mat provides strength through thickness. The polyester resin ties this reinforcement matrix together into a solid and rigid laminate. Additional laminates are successively applied in the lower strakes to further reinforce and enhance rigidity and strength in these high load areas.

Further hull rigidity is provided by five (5) longitudinal stringers, port and starboard, and multiple transverse floors attached to the hull from stem to stern. The longitudinal stringers are evenly spaced along the port and starboard sides and consist of a polyurethane foam core attached to the hull with alternating layers of fiber glass mat and woven roving. The transverse floors are installed near the keel and consist of a ¾ inch marine ply core with alternating layers of fiber glass mat and woven roving. The floors are attached to the hull with alternating layers of fiber glass mat and woven roving.

Hull thickness is in excess of 0.79 inches at the lower strakes and the entire stem, from 3' 8" above the water line to station 2 has two added laminates of mat and woven roving.

KEEL

The keel is laid up along with the hull with added overlapping laminate layers from the lower strakes resulting in a bottom thickness of over 1.0 inch. For stability, 6,600 pounds of lead ballast is placed between transverse floors from just forward of station 2 to station 5 and sealed with laminate layers of mat and woven roving. Limber holes are provided in the transverse floors from the forward stations to allow drainage to the engine room bilge between stations 8 and 9. Polyurethane foam is added to the keel from at stations not provided with ballast or tanks and sealed with mat and woven roving.

DECK

The main deck is a continuous fiberglass laminate structure from stem to stern, including the front and sides of the salon and wheel house. The main deck consists of ¾ inch thick end grain balsa core and alternating layers of mat and woven roving and an external layer of gel coat that results in a thickness of over 1.62 inches. The deck is supported by interior bulkhead laminate structures and reinforced with longitudinal stringers between bulkheads consisting of a 2 inch thick foam core overlapped with alternating layers of mat and woven roving. All horizontal walking surfaces are finished with a fine diamond patterned non-skid surface.

HULL TO DECK JOINT

The vital hull to deck joint is engineered with an overlapping double flange bedded in a high tensile polyurethane adhesive. The foredeck to hull joint flanges are fastened together with 3/8 inch bolts with backing washer and lock washers and covered with a 1 inch teak cap fastened to the overlapping flanges with self tapping screws and plugged with teak bungs. The joint is sealed on the inside with 3 alternating layers of mat and woven roving. The aft deck to hull joint flanges are fastened with self tapping screws and covered with a 1 inch teak cap fastened to the overlapping flanges with self tapping flat head screws and plugged with a teak bung. The resulting bulwark "box" section formed, dramatically affords superior structural rigidity and, though expensive and difficult to achieve, is one of the most watertight connections available in current production technology.

SALON AND PILOT HOUSE STRUCTURE

The salon, pilot house, and Portuguese bridge sides are molded together with the main deck and consist of a ¾ inch thick cross-linked foam/termanto core with alternating layers of mat and woven roving and a gel coat finish. The salon and

pilot house roof consists of a 1 inch end grain balsa core with alternating layers of mat and woven roving and gel coat finish for an overall thickness of 1.62 inches. The salon sides are reinforced with vertical stringers and the salon overhead and pilot house roof are reinforced with longitudinal stringers. The stringers consist of a 2 inch thick foam core overlapped with alternating layers of mat and woven roving. The salon and pilot house roofs are fastened to the sides from the inside with self tapping screws and bedded in high tensile polyurethane adhesive. The joint is sealed with 3 layers of mat and woven roving.

DECK FITTINGS

All deck fittings are stainless steel and are thru-bolted onto backing plates and liberally sealed with a pliable polyurethane sealant to prevent leakage. The backing plate on the underside of the deck provides a firm foundation to withstand the loading that may be exerted on the fitting. Lifeline stanchions are thru-bolted with backing plates to the vertical bulwarks to prevent water from seeping through the bolt holes.

THRU HULL FITTINGS

All thru hull fittings are bronze with bronze ball valve bodies and integral stainless steel balls and teflon seats and are thru-bolted onto backing plates and liberally sealed with pliable polyurethane sealant to prevent leakage. The fittings are connected to the bonding system using #6 AWG bonding wire using bolted connections.

2.0 VESSEL ENGINEERING AND SERVICE SYSTEMS

The NORDHAVN 50 has been designed and engineered to provide the owner with a vessel of uncompromised quality, comfort, efficiency and reliability. The equipment and components included in the engineering and service systems described in this section reflect this design philosophy.

The following sections are intended to provide the owner a description of the vessel's systems and basic instructions for their operation and, where applicable, care and maintenance. The instructions, however, are not to be interpreted as binding or all encompassing. The owner, with time and operating experience, will undoubtedly develop habits and intuitive skills that may depart from any suggested instructions provided herein.

Further, the owner has been provided with maintenance and operation manuals for all equipment and components included in these systems. These manuals supercede any instructions included in this manual and the owner must be thoroughly acquainted with their contents.

2.1 PROPULSION SYSTEM

The NORDHAVN 50 standard propulsion system includes main and auxiliary drive trains each consisting of a diesel engine and integral transmission, engine cooling and exhaust systems, shaft coupling, stuffing box, stern bearing, propeller shaft, propeller and engine instrumentation and controls. A description of these components and the engine controls is included in this section.

2.1.1 Main Propulsion

1) **Main Engine**. Main propulsion is provided by a direct (straight) drive **ALASKA DIESEL ELECTRIC, INC. LUGGER Model No. L6108A** turbo-charged, after-cooled diesel engine mounted on the boat centerline by four (4) engine mounts on engine beds integral to the vessel hull. The engine is directly cooled by a closed fresh water loop which rejects heat to a raw water (sea water) loop. Both loops are equipped with engine driven water pumps. The closed fresh water loop pump circulates fresh water through the engine and lube oil and gear oil coolers and a raw water heat exchanger. The raw water pump draws sea water from port and starboard thru hull connections and strainers to the engine raw water heat exchanger and discharges through the engine wet exhaust system back to the sea. In addition, a portion of the raw water flow is utilized to cool the hydraulic fluid in the Stabilizer System. The engine oil cooler is made of stainless steel with thermostatic temperature control and the gear oil cooler is made of stainless steel. The engine starter operates at 24 VDC and is powered by two 12 volt batteries connected in series. Additional engine driven accessories include a fuel oil pump, a lube oil pump, a 24V/40A engine starting alternator, a 12V/270A power alternator, and a hydraulic pump for the vessel stabilizers (see Section 2.9 – STABILIZER SYSTEM). The engine is connected to the bonding system using #6 AWG bonding wire bolted to the engine block (see Section 2.16 – BONDING SYSTEM).

   LUGGER L6108A vital characteristics are as follows:

Cylinders:	Inline 6, Turbo Charged
Rated Horsepower:	300 BHP @ 2300 Continuous Duty
Fuel Consumption:	2.8 gallons/hr @ 1400 RPM
Crankcase Capacity:	24.8 quarts
Fresh Water Capacity:	4.5 gallons
Fresh Water Flowrate:	67 gpm @ 2300 RPM
Air Consumption Rate:	575 cfm @ 2300 RPM

   For additional engine characteristics and information consult the LUGGER manufacturer's instruction and technical manual.

2) **Wet Exhaust System**. The diesel engine utilizes a 5 inch wet type exhaust system comprised of piping, expansion joint bellows, muffler, and exhaust hoses. The hot exhaust gases exit the engine via an insulated line to a wet muffler in the aft end of the engine room. The raw water exiting the main engine fresh water cooler is combined with the hot engine exhaust gas just prior to entering the muffler. The raw water cools the exhaust gas as the mixture enters the muffler and then exits the vessel through the port side transom. The exhaust system is essentially maintenance free, however, periodic inspections should be made to ensure the insulated portion at the exit of the engine is still intact and adequately covers the piping.

3) **Transmission**. The standard transmission (gear box) used on the LUGGER engine is a **ZF MARINE Type ZF280** with a 3.0 to 1 reduction gear. When viewed from the stern, the direction of rotation of the propeller is counter-clockwise.

4) **Shaft Coupling & Alignment**. A Walter clamp fit shaft coupling is used off the back of the ZF transmission to couple the transmission and the 2.25 inch diameter stainless steel propeller shaft. The coupling bolts, clamps and pins should be periodically checked for tightness particularly during the first 25 hours of operation and following maintenance and alignment of the coupling.

   Alignment of the propeller shaft and engine should be performed after the vessel is launched and has had some time afloat. Each time the vessel is hauled and launched the alignment should be rechecked. If vibration is present or there is any noticeable movement of the shaft or stuffing box, the alignment should be checked.

   WARNING: The forward end of the propeller shaft is supported solely at the transmission coupling. When uncoupled, if the coupling locating rings are not engaged, the shaft coupling half should drop slightly below the transmission coupling half due to the weight of the unsupported end and the shaft clearance in the stern tube. Prior to engaging the coupling locating rings, it is important that the operator confirm that the shaft is reasonably centered in the stern tube. This is accomplished by lifting the shaft up and down and moving it side to side and verifying that the shaft moves in each direction relative to the engaged position of the locating rings.

   To align the propeller shaft and engine, remove all bolts from the coupling flange and force the coupling halves slightly apart to break the coupling loose. After the flanges are separated, slide the shaft forward so the locating rings are engaged. Insert a feeler gauge between the coupling flanges at 90 degree angles around the circumference to check that the clearance is even. If it is noted that the flanges are out of alignment by over .003”, alignment is

necessary. Horizontal alignment adjustment is performed by loosening the engine mounts and moving the engine in the desired direction. Vertical adjustment is performed by raising or lowering the engine using the engine mount jack-screws. If vibration is present after proper alignment, the propeller is possibly out of balance or the shaft is bent. A bent shaft or damaged propeller requires the service of a professional propeller shaft service.

5) **Stuffing Box & Adjustment**. A standard bronze stuffing box utilizing 5/8" packing is installed on the propeller shaft to minimize sea water leakage into the boat. The stuffing box assembly consists of a gland housing fixed to the vessel shaft hull penetration and an adjustable gland follower inserted in the gland housing. Packing rings, usually three per assembly, are inserted in the gland housing and are compressed against the shaft by tightening the gland follower. The stuffing box assembly requires a small in-leakage of sea water to prevent shaft overheating and/or scoring. Frequent inspections and periodic adjustment of the assembly are required to ensure the correct leak-off is present. Adjustment is made by either tightening or loosening the nuts on the packing gland follower until the correct leak-off is obtained. It is important to tighten the adjustment nuts evenly so as not to cock the packing gland follower in the gland housing. A properly adjusted stuffing box is indicated by a steady leak off of 1 drip per second while running and slightly less dripping of 1 drip every 3 seconds after shutdown. If, after adjustment, excessive leaking is present, new packing may be needed.

WARNING: The stuffing box leak off has been adjusted during the commissioning of the boat. However, it is important to inspect the stuffing box for over heating on a regular basis. The stuffing box while running should be cool enough to hold your hand on it without discomfort. If excessive heating is present, the packing gland follower must be backed off and the packing rings loosened. This will allow more water through which cools the stuffing box and propeller shaft. If overheating persists, use 7/16" packing instead of the 5/8" specified above.

To replace the packing, remove the locking and adjustment nuts and back the gland follower away from the stuffing box. Using a packing puller or screwdriver remove the old packing, noting the number or packing rings removed. Wipe the shaft and stuffing box with a clean rag to remove any residual packing material. The new packing rings are formed by wrapping the material around the shaft and cutting the rings ends on matching angles to the dimension of the shaft circumference. The packing rings are then inserted into the stuffing box with the angled cut staggered for each successive ring. The gland follower is slid back into position in the stuffing box and the adjustment evenly tightened until the leak off is minimized. After adjusting the stuffing box or after packing replacement, the unit must be carefully monitored for the first

hour of hard running to ensure there is no overheating. Excessive leak-off will require further tightening of the adjustment nuts.

6) **Stern Bearing**. A rubber cutlass bearing at the shaft hull penetration is provided and is held in place with set screws located forward of the propeller. The bearing is essentially maintenance free but has a limited service life. It is quite normal for the cutlass bearing to be replaced on a seasonal basis. In addition, operating the vessel in shallow water may shorten the service life due to the abrasive properties of sand and debris typically present in coastal waters. In all cases, the bearing should be checked at each haul out and inspected for wear and evaluated for further use. Replacement of the bearing requires removal of the propeller and can easily be accomplished by any boat yard.

7) **Propeller Shaft**. The propeller shaft is 2.25 inch stainless steel **AQUAMET 17** and is tapered at the propeller end with a standard SAE taper. The coupling is keyed, drilled for the coupling pin and dimpled for the set screws. Shaft removal requires disassembling the propeller, steering tiller and rudder stop and swinging the rudder to either side. The shaft can be pulled aft through a deck plate opening on the rudder body

8) **Propeller**. The fixed blade propeller is a standard 4 blade bronze, 34 inches in diameter with a 22 inch pitch. Propeller rotation is to the left or counter clockwise when viewed from the stern. The propeller is secured with a nut and castle nut. The castle nut is secured by a large cotter pin. A **SPURS** line cutter is installed on the shaft just forward of the propeller. The propeller can be removed with a prop puller and by deflecting the rudder. Continuity for galvanic protection is through the shaft brush bolted to the bonding system.

9) **Engine Mounts and Stringers**. The engine mounting beds are formed of hard wood stringers with a heavy lamination of fiberglass. On top of the wood and under the fiberglass lamination, there is a stainless steel flat bar which is drilled and tapped to accommodate the stainless steel bolts which hold down the engine mounts. Any adjustment of alignment is done by either moving the engine vertically by adjusting the nuts on the vertical stud of the engine mount or horizontally by backing off the mounting bolts which go into the engine stringers and moving the engine mounts horizontally on their slotted holes.

10) **Engine Control Stations**. Control stations for the main propulsion engine are located in the **pilot house and the fly bridge**. The main propulsion engine control station in the pilot house is the primary control station for the vessel. The fly bridge control station can be enabled at the fly bridge controller. In addition, both control stations are equipped with a bow thruster controller for operation of this component (see Section 2.10 – HYDRAULICS SYSTEM).

- **Pilot House Control Station.** The main propulsion engine control station in the pilot house is the primary control station for the vessel.

  The pilot house station consists of a **MATHERS MMC** electronic controller powered by a **MATHERS 585CE MicroCommander Control System** capable of integral throttle and forward and astern movement control and a **LUGGER Deluxe Instrument Panel** with a key locked ignition switch. The Mathers controller is located on the main console to the starboard side of the helm and the instrument panel is located on the vertical console forward of the helm. Power to the Mathers MicroCommander Control System is by a fused circuit and relay directly connected to the 12 VDC bus behind the 12 VDC SERVICE panel on the port side of the pilot house console.

  Main Engine Instrument Panel. The instrument panel consists of the following: dial gauges for engine rpm, engine oil pressure, water temperature, alternator voltage, engine operating hours, exhaust temperature, turbo boost pressure, and gear pressure; an audio alarm with alarm status lights for high water temperature and low lube oil pressure; a 4 position keyed ignition switch; an engine stop pushbutton; and a toggle switch for a panel back light.

  Turning the ignition key to RUN (one position clockwise from the vertical lockout position) enables the flybridge station to take control and start and control the main engine. Engine starting at the pilot house station is performed by turning the ignition key clockwise to the full right START position. The switch returns to the RUN position when the key is released. Engine shutdown is accomplished by depressing the STOP pushbutton (see System Operation).

  Mathers MicroCommander Controller. The three position, single lever MATHERS controller operates both the engine transmission/gear box for the forward and astern directions and the engine throttle. The control head has three detents; ASTERN, NEUTRAL and AHEAD. The vertical position of the controller corresponds to NEUTRAL and idle RPM of the engine. Control head lever movement of 15 degrees to the AHEAD or ASTERN detent will command Ahead or Astern clutch engagement while the engine remains at idle RPM. Further movement of the control head lever in either direction will increase the engine RPM in proportion to the control head lever position. The lever can also control the engine speed only by depressing and holding the pushbutton switch on the front of the controller head and moving the lever forward.

  When DC power is first supplied to the MicroCommander System (key switch in the RUN position), the MATHERS 585CE Control Module, located in the engine room on the forward bulkhead, initializes by positioning the

engine throttle lever to idle and the transmission lever to NEUTRAL. A low repetition tone occurs at each station indicating the system has initialized and that no remote station has taken command. The red light on each controller head will flash.

Accept command at either station by positioning the controller head lever into the NEUTRAL position and depressing the pushbutton on the front of the controller head. The red light on the controller head will become solid indicating this station is in command and the low repetition tone will cease.

Each remote station is independent making only one station able to take command at a time. A solid light on the controller head indicates the station in command. To transfer command to the other station while underway, leave the controller head lever at the last commanded position. At the receiving station, move the controller head lever into the NEUTRAL detent position and press the pushbutton on the controller head. The operator has one second after the light becomes solid to position the controller head lever to the approximate position the previous station's lever was set. A smooth transfer of command will take place without interruption of speed.

To use the station for adjusting the engine RPM only, depress and hold the controller pushbutton and move the lever forward. The red indicating light will flash indicating the controller mode is for adjusting the engine speed only. To return to full control mode, move the lever to the NEUTRAL detent position. The red light will turn solid indicating normal control.

Fly Bridge Control Station. For main engine control and piloting, the fly bridge control console is equipped with a single lever MATHERS controller with functions identical to the pilot house, a LUGGER instrument panel and pushbutton for the boat horn. The instrument panel consists of the following: dial gauges for engine rpm, oil pressure, and water temperature; an audio alarm with alarm status lights for high water temperature and low lube oil pressure; and start and stop pushbuttons. When enabled from the master control station in the pilot house (key switch to the ON position), the main engine can be started and stopped at this control station.

2.1.2 Auxiliary (Wing) Propulsion.

1) **Wing Engine.** Auxiliary propulsion is provided by a V-drive **YANMAR Model No. 3JH3E** naturally aspirated diesel engine mounted aft of the main engine and to the port side of hull centerline. The engine and attached V-drive transmission mounting is by four engine mounts on engine beds integral to the vessel hull. Engine cooling is provided by a fresh water loop and a raw (sea) water loop with a heat exchanger common to each water system. Water in

each loop is circulated by separate engine driven water pumps. The fresh water pump loop circulates cooling water to the engine block and then through the heat exchanger where heat is rejected to the raw water loop. The raw water loop cools the wing engine coolers, and the engine exhaust piping. Raw water is drawn thru hoses from a through hull connection and sea strainer by the wing engine raw water pump and is discharged through the engine fresh water and lube oil coolers and wing engine exhaust hoses back to the sea. Additional engine driven accessories include a fuel oil pump, a lube oil pump, and 80 amp AC generator for charging the generator/wing engine shared starting battery. The engine is connected to the bonding system using #6 AWG bonding wire bolted to the engine block.

YANMAR 3JH3ME vital characteristics are as follows:

Cylinders:	4 In-line, naturally aspirated
Rated Horsepower:	36 BHP @ 3650 RPM Continuous Duty 40 BHP @ 3800 RPM One Hour Duty
Direction of Rotation:	Counter-clockwise Viewed From Stern
Crankcase Capacity:	5.5 liters

For additional engine characteristics and information consult the YANMAR manufacturer's instruction and technical manual.

2) **Exhaust System**. The wing engine employs a wet exhaust system and is cooled by the wing engine raw water cooling loop. The raw water flow is mixed with the hot exhaust gas as it exits the exhaust manifold and enters a muffler mounted just forward of the engine. The mixture is then discharged overboard through a common discharge line.

3) **Transmission.** The wing engine transmission is a **ZF MARINE Model ZF15 MIV** V-drive type with a 2.99 to 1 gear reduction. When viewed from the stern the direction of rotation is clockwise (shaft propeller). Oil capacity is 0.8 liters (SAE 20/30 HD).

4) **Stuffing Box & Adjustment.** The stuffing box for the wing engine drive shaft is a standard bonze model similar to the main engine (refer to the main engine stuffing box for adjustment and repacking). The wing engine utilizes 7/16" packing material, however if this results in overheating, use 3/8" packing.

5) **Stern Bearing.** The wing engine drive shaft is equipped with a rubber cutlass stern bearing encased in a housing supported by a strut attached to the hull. The strut is necessary to support the propeller due to the extended length of the drive shaft beyond the hull penetration. The shaft extension is required in order for the propeller to clear the vessel hull. The bearing is essentially maintenance free but has a limited service life and should be checked at each haul out and replaced when necessary. Replacement of the bearing requires

removal of the propeller and can easily be accomplished by a competent boat yard.

6) **Propeller Shaft.** The propeller shaft is 1-1/4 inch in diameter fabricated from 304 stainless steel and is tapered at the propeller end with a standard SAE taper. The coupling is keyed, drilled for the coupling pin and dimpled for the set screws. A collar zinc anode is installed on the shaft just forward of the propeller.

7) **Propeller**. The wing engine propeller is a two blade, bronze **MARTEC, MK II** Explorer, folding blade type with a 18 inch diameter and a 13 inch pitch. When the wing engine is not running, the two propeller blades fold together to minimize the drag force on the vessel. When the wing engine is in operation and turning the propeller shaft, the propeller blades are positioned by centrifugal force to drive the vessel. The propeller is secured with a nut and castle nut. The castle nut is secured by a large cotter pin. The propeller can be removed with a prop puller. The engine is connected to the bonding system using # 8 AWG wire.

8) **Engine Mounting Beds and Stringers**. Refer to Section 2.1.1.10) for a description of the engine mounting beds and stringers.

9) **Engine Control Station.** The control station for the wing engine is in the pilot house and consists of dual **MORSE Model DC push/pull T-handle** controllers and a **YANMAR Type B** control panel with a key locked ignition switch. The Morse controllers are located on the lower face of the pilot house console starboard side and the instrument panel is located on the lower console face to the port side of the helm.

   Control Panel. The control panel consists of the following: dial gauges for engine rpm/engine hours, lube oil pressure, and cooling water temperature; alarm windows for low oil pressure, high cooling water temperature, and charging voltage, and engine operating hours; a 4 position keyed ignition switch; an engine stop pushbutton; an illumination toggle switch for turning on the control panel lamps; and a buzzer-off switch

   The ignition switch positions are GLOW – OFF – ON – START. Engine starting is performed by turning the ignition key clockwise from the vertical OFF position to the full clockwise START position. When released, the key will automatically move to the ON position. Engine shutdown is accomplished by turning the key to the vertical OFF position and depressing the engine STOP pushbutton.

   Engine Controllers. The dual T-handle Morse controllers operate both the engine gear box and engine throttle. The top handle is a three position gear shift and the lower handle controls engine speed. The fully inserted position of

the gear shift handle engages the FORWARD gears and the fully withdrawn position engages the ASTERN gears. The intermediate position places the gears in NEUTRAL. Full insertion of the engine speed T-handle brings the engine RPM to idle and pulling the handle out increases the engine speed.

2.1.3 Main and Auxiliary Propulsion System Operation.

CAUTION: In the event of a fire in the engine room that results in the automatic actuation of the FIREBOY fire suppression system, the main engine, wing engine, generator and engine room blowers will automatically shutdown and the LPG solenoid valve close. Restart of these components is inhibited until the FIREBOY override switch is positioned properly. Refer to Section 2.12 – FIRE SUPPRESSION SYSTEM.

IMPORTANT NOTE TO BOAT OPERATORS: In the event the FIREBOY Engine Shutdown System is actuated in the absence of an engine room fire, to restart the engines and blowers the operator should first place the FIREBOY indicator switch in the OVERRIDE position and check the status of the circuit fuse behind the 12 VDC SERVICE panel. If the fuse is intact and the engines and blower still do not start, the FIREBOY ES5000-01 relay module may be faulty. In this event, to restart the engines and blower access the relay module inside the pilot house console and install a wire jumper across each pair of NORMALLY CLOSED and COMMON terminals that have wires attached and disconnect the wire lead on each of the NORMALLY OPEN terminals located on the relay module. The module terminals are clearly marked **NC, NO and C** to indicate the type of relay contact. This action will bypass the FIREBOY relay module for the respective engine and blower starting system. For the disconnected wire, wrap the metallic terminal lug on the end of the wire with tape to prevent it from making contact with the relay module terminals.

1) **Main Engine Starting.** Prior to operating the main engine, the operator must read the LUGGER Operation and Maintenance Manual and follow the guidelines for starting and operation. The following are routine steps for normal safe starting:

   - Verify the water level in the expansion tank is about 1 ¾ in below the filler cap when the engine is cold.

   - Verify the oil level is at the correct level (dipstick is re-marked to account for the engine mounting angle). Use SAE-30W Single Viscosity or SAE 15-40W Multi-Viscosity oils. Refer to the LUGGER manual.

   - Verify the 24V ENGINE BATTERY EMERGENCY SHUTOFF switch is in the NORMALLY ON position. The switch is located in the engine room on the lower face of the port side bench. This switch must always be left in

the ON position when the engine is running to prevent damage to the starting battery charging alternator.

- Check the oil level in the transmission. Methods may vary from gear box to gear box. Refer to the gear manufacturer's owners manual for instructions.

- Verify the fuel oil system is aligned to draw and return to the same fuel oil tank and the supply line is filled and primed (see Section 2.2 – FUEL OIL SYSTEM).

- Clean the sea water inlet strainers and then open the sea water cooling inlet valves. **The inlet valves and strainers are located inside the port and starboard benches in the engine room.**

- Verify the MATHERS controller levers at the pilot house and fly bridge control stations are in the vertical (neutral) position.

  IMPORTANT NOTE: Failure of the main engine to start may be caused by a failed power supply fuse/relay to the Mathers Engine Control System or actuation of the FIREBOY Engine Shutdown System (Refer to Section 2.12). Refer to the Mathers operator's manual for additional trouble shooting guidelines.

- Insert the ignition key at the pilot house LUGGER engine control panel and turn the key switch to the first position (RUN) and check the voltage meter. For starting, the voltmeter should not read below 24 volts.

- **If starting the engine from the pilot house control station**, insert the ignition key and turn clockwise to the ON position, assume control by depressing the pushbutton on the front of the MATHERS controller and then turn the key to the clockwise to the START position. Release the ignition key after the engine has started. **NOTE:** The Mathers control system alarm will sound when the key is turned to the ON position. This is normal and the alarm will be silenced when command has been taken by depressing the Mathers controller pushbutton. In addition, the engine key switch will not start the engine until command has been established.

OR,

- **If starting the engine from the fly bridge**, insert the ignition key at the pilot house LUGGER control panel and turn the key to the first (RUN) position. Assume command at the fly bridge station by depressing the touch pad control pushbutton on the MATHERS controller and then depress the START pushbutton. Release the pushbutton after the engine has started.

- Do not crank the starter for more than 10 seconds consecutively. If the engine fails to start with the first attempt, be sure the starter has stopped completely before re-engaging. Continued failure to start may require priming the fuel supply line.

  WARNING: The main engine utilizes a wet exhaust system. If the engine does not start after a cumulative total of 30 seconds cranking, remove the drain plug in the bottom of the muffler in order to drain the accumulated water preventing the accidental flooding of the engine. Replace the plug after the muffler is drained.

- Check oil pressure as soon as the engine has started. Oil pressure should be above 15 psi. The engine must never be run if oil pressure is below 15 psi.

- Check the voltmeter. Voltage reading should be between 24 and 26 volts.

- Water temperature should not rise over 205 degrees F. Shut down engine immediately if water temperature is over 205 degrees F.

- Engine speed for continuous duty is 2300 RPM. Recommended speed for long distance cruising is 1400 RPM.

- Observe instrument panel gauges often for satisfactory engine operating conditions. High cooling water temperature and low lube oil pressure (both factory set) will initiate an audible alarm and illuminate the affected status light.

2) **Main Engine Shutdown.** Shutting down the main engine is straight forward and very simple and can be performed from either control station as noted by the following:

   - Place the MATHERS controllers in the vertical (neutral) position and allow the engine to run for a 3-5 minute cooldown period.

   - While observing the engine speed indicator, depress the STOP pushbutton and turn the ignition key at the pilot house instrument panel to the vertical STOP position.

   - Verify that the engine does not restart.

3) **Auxiliary Wing Engine Starting.** The wing engine should be operated periodically to maintain internal parts lubricated and to verify its operability. If the wing engine has not been operated for an extended period of time, the YANMAR owner's manual should be consulted for additional precautions on engine starting. Routine starts of the wing engine is accomplished by the following suggested steps:

- Verify the engine oil level is at the upper limit of the dipstick. USE ONLY SAE 15W40 CD oil.

- Verify the transmission oil level is at the upper limit of the dipstick. USE ONLY SAE 30 transmission fluid.

- Verify the cooling water level in the engine overflow tank is above the lower limit. The overflow tank is mounted on the port bulkhead just forward of the engine.

- Clean the sea water inlet strainer and then open the sea water cooling thru hull inlet valve. **The inlet valve and strainer are located below the deck plates aft of the main engine on the wing engine side of the bilge cavity.**

- Verify the fuel oil system is aligned to draw from and return to the wing engine local fuel day tank. Fill the wing engine local fuel day tank as required (see Section 2.2).

- Verify the GEN/WING ENGINE BATTERY EMERGENCY SHUTOFF switch is in the NORMALLY ON position. The switch is located in the engine room on the lower vertical face of the port side bench. This switch must always be left in the ON position when the engine is running to prevent damage to the starting battery charging alternator.

- Verify that the transmission control handle for the wing engine MORSE controller is in the neutral position.

- Move the throttle control handle to the full speed position and return back to idle.

- Insert the ignition key in the YANMAR instrument panel and turn the key to the ON position. If the alarm buzzer sounds and the alarm lamps come on, the alarm devices are normal.

  WARNING: Do not hold the start button on for more than 10 seconds at a time. If the engine does not start the first time, wait 10 seconds before trying again. After the engine has started, do not turn the key off. Alarm devices will not work when the key is off.

WARNING: The wing engine utilizes a wet exhaust system. If the engine does not start after a cumulative total of 30 seconds cranking, remove the drain plug in the bottom of the muffler in order to drain the accumulated water preventing the accidental flooding of the engine. Replace the plug after the muffler is drained.

- Start the engine by turning the ignition key to the START position and release the ignition key when the engine starts. The alarm buzzer should stop and the alarm lights go out.

- Allow the engine to warm at idling speed for a 3-5 minute period to allow the lube oil system to lubricate all parts of the engine. Check the instrument panel to verify there are no alarms present. If the engine alarms persist, shut the engine down and investigate.

- Before shifting gears, be sure to lower the engine RPM to 1000 or less.

- Do not shift abruptly from FORWARD to REVERSE or vice versa. When changing between FORWARD and REVERSE, lower the engine speed to 1000 RPM, bring to NEUTRAL and pause before slowly shifting to the desired position.

- Frequently check the control panel for alarm indication and if the alarm buzzer sounds, lower the speed immediately, check the warning lights, and stop the engine for repairs.

- When operating the engine at low speeds for long periods of time, race the engine once every 2 hours by placing the engine in neutral and accelerate from the low speed to high speed (3400-3600 RPM) and back for 5 cycles. This is done to clean out carbon from the cylinders and the fuel injection valves. Neglecting to race the engine will result in poor exhaust color and reduce engine performance.

4) **Auxiliary Wing Engine Shutdown**. Stop the engine in accordance with the following steps:

- If operating at low engine speeds (less than 3400 RPM), race the engine per the above prior to stopping the engine.

- Lower the engine speed to 1000 RPM, shift the gears to NEUTRAL, and allow the engine to cool down for 5 minutes.

- With the ignition key still in the “ON” position, depress the stop button until the engine stops completely. If the button is released early, the engine may continue running.

- Turn the key switch counterclockwise to the vertical STOP position.

- Close the isolation valve at the raw water cooling through hull connection (optional).

2.1.4 Engine Inspection and Maintenance. With proper care, the LUGGER and YANMAR diesel engines will provide extended and dependable operation for many years. Minimum daily inspections should be routinely conducted to insure normal vessel propulsion system operation. Of particular importance is to inspect for water, oil and exhaust leaks, irregular noises, abnormal or excessive vibration, loose or improperly tightened fittings, clamps and bolts, proper stuffing box leak-off and temperature and normal engine cooling water temperature and lube oil pressure.

Periodic preventative maintenance requirements are extensive and are detailed in the LUGGER and YANMAR owner's manuals. The owner is advised to be thoroughly familiar with these requirements and establish a schedule for conducting these activities.

2.2 FUEL OIL SYSTEM

NOTE: Fuel oil, fuel and diesel oil are interchangeable terms for this section.

The Fuel Oil System is designed to provide filtered and water free diesel fuel to the main propulsion engine, wing engine, and the boat's diesel generator. When any of these engines is in service, fuel oil is drawn from a fuel oil tank and in line filter/water separator by the operating engine's integral fuel pump. Excess fuel oil not required by the engine is returned to the in service fuel tank. The fuel oil system also includes a fuel transfer loop for transferring fuel between tanks. The system consists of tanks, a transfer pump, filters/water separators, valve manifolds, associated hoses and fittings, and electrical power supplies, switches, and wiring.

2.2.1 System Components and Installation

1) **Tanks.** The boat is equipped with four (4) fuel storage tanks and a small day tank for the wing engine.

   The four fuel storage tanks are fabricated of reinforced fiberglass with a combined capacity of approximately 1320 gallons. Two, large tanks, each with a capacity of approximately 535 gallons, are located in the engine room against the port and starboard sides of the hull. Two, small tanks, each with a capacity of approximately 125 gallons, are located in the lazarette port and starboard sides. Each tank has a top mounted, metallic inspection plate bolted to the fiberglass top. The inspection plate on the forward, engine room tanks is equipped with hose connections for a vent and fuel return line from the diesel engines. The inspection plate for the aft tanks is equipped with a hose connection for the fuel return line. Access to each inspection plate is provided by removable hatches located in the dining salon (large tanks) and inside the lazarette (aft tanks). The tanks are finished in red gel coat for easy identification. Each tank inspection plate is bolted to the bonding/grounding system using #6 AWG bonding wire.

   Additional connections for each tank are provided for fuel oil supply to the diesel engines, fuel oil transfer between tanks, and tank filling. The fuel oil supply and transfer connections have isolation valves and are attached to the bottom of each tank to permit maximum utilization of the contents of each tank. Separate deck fill connections for each tank are located on the inboard transom bulwark port and starboard sides. Each tank deck fill is equipped with a screwed cap flush with the transom and is engraved with the word "DIESEL" on the connection face plate. A vent outlet for each tank is located on the exterior of the salon aft bulkhead. Each deck fill fitting is tied to the bonding/grounding system using #6 AWG bonding wire.

2) **Pump.** The fuel oil system contains one pump primarily used to consolidate and transfer fuel between tanks and to supply fuel to the wing engine day tank. A secondary but important use of this pump is to prime the engine fuel supply lines when required. The fuel transfer pump is a **WALBRO Model 4 Diaphragm Pump**, rated at 60 gph and 4 psig. It is powered by the FUEL TRANSFER PUMP circuit breaker on the 12 VDC SERVICE panel. A red light on the panel will be lit when the pump is running. As a precaution, a timer is included in the control circuit to automatically stop the fuel transfer pump thereby minimizing the possibility of overflowing a tank. The fuel transfer pump circuit breaker must be in the "ON" position and the timer set in order for the pump to run. The fuel transfer pump is mounted in the engine room under the bench on the starboard side. The timer is mounted on the vertical face of the bench near the pump.

3) **Filters/Water Separators.** The fuel oil system contains a total of four (4) diesel fuel filter/water separators to filter the fuel and remove water before entering the operating diesel engine and to filter the fuel being transferred between tanks. The filter/water separators are mounted on the engine room starboard bulkhead. In addition, the main engine filter is equipped with a water sensor and pilot house water alarm panel.

   Main Engine Filter/Water Separator and Water Detection Kit. The supply line to the main propulsion engine is equipped with a duplex type **RACOR Diesel Fuel Filter/Water Separator, Model 75/900 FGX**, rated at 180 gph and 28.5 inches Hg vacuum utilizing a 2 micron filter cartridge. The filter assembly consists of two filter/cartridge bowls each capable of 90 gph, a **RACOR Water Detection Kit Model RK30056**, a four-way valve and a pressure gauge**.** The water detection kit consists of a model RK21069 water sensor installed on the right bowl and a model RK20726 water detection panel mounted on the pilot house overhead console dash. Power to the detection kit is by a fused circuit from the 12 VDC bus. The fused circuit also supplies the bilge alarms, water tank level indicators and the holding tank level monitor. The four-way valve can be positioned for fuel flow through the LEFT BOWL – RIGHT BOWL – BOTH BOWLS or BOWLS OFF (no fuel flow). Valve handle position indication for the desired flow path is clearly labeled on the valve body. The pressure gauge indicates the vacuum pressure on the outlet side of the separator unit. When the gauge indicates a reading between 6-10 inches of mercury, the separator cartridges should be changed. A high vacuum pressure reading can also indicate that the supply line may be partially obstructed. Water that is separated will accumulate in the bottom of the bowl and can be visually observed through the clear glass housing. A bleed valve is provided at the bottom of each bowl to remove this water.

   OPERATING REQUIREMENT: Single bowl operation is generally employed when operating at the recommended main engine long distance cruising

speed (1400 RPM). Dual bowl operation **MAY** be required at higher engine speeds depending on the condition of the filter cartridge. Filter cartridge change-out of one bowl can be accomplished with the opposite bowl in service but may require the engine speed to be reduced during the change process.

After a filter cartridge has been changed it is advised that the filter housing be filled to the brim with fresh diesel fuel before replacing the lid. This minimizes air introduced into the system and may eliminate the need to bleed the engine supply line. **NOTE: Filling the filter bowls can be performed using the Fuel Transfer Pump by discharging to the Fuel Supply Manifold – see PRIMING below.**

Wing Engine Filter/Water Separator. The fuel supply line to the wing engine contains a single **YANMAR Filter/Water Separator Model 4230-0100** with a rating of 50 gph, 28.5 in. Hg. Max working pressure with a 10 micron filter cartridge. The filter assembly consists of a single bowl and cartridge. Filter change-out can only be performed when the engine is shutdown. The housing of this filter unit is similar to the duplex type and the same bleed and filter replacement procedures as described above are applicable to this unit.

Generator Filter/Water Separator. The fuel supply to the generator engine is a **RACOR Diesel Fuel Filter/Water Separator, Model 500FG**, with a rating of 50 gph, 28.5 in. Hg. Max working pressure with a 2 micron filter cartridge. The filter assembly consists of a single bowl and cartridge. Filter change-out can only be performed when the engine is shutdown. The housing of this filter unit is similar to the duplex type and the same bleed and filter replacement procedures as described above are applicable to this unit.

Transfer Pump Filter/Water Separator. The fuel supply line to the fuel transfer line on the suction side of the fuel transfer pump contains a **RACOR Diesel Fuel Filter/Water Separator, Model 900FG,** with a rating of 90 gph, 28.5 in. Hg. Max working pressure with a 30 micron filter cartridge. The filter assembly consists of a single bowl and cartridge. Filter change-out can only be performed when the fuel transfer pump is shutdown. The housing of this filter unit is similar to the duplex type and the same bleed and filter replacement procedures as described above are applicable to this unit.

4) **Level Instrumentation**. The engine room fuel tanks are equipped with a side mounted, self reading level sight glass tube with integral isolation valves and calibrated capacity scale. The lower visible level of the sight glass corresponds to a scale reading of approximately **50 gallons and the upper visible level corresponds to a scale reading of approximately 425 gallons**. The sight glass assemblies are readily accessible in the forward end of the engine room and are recessed in the side bulkhead behind a protective plastic cover. The sight glasses gauges are the most accurate and reliable method of measuring the fuel level. There is a metallic protective channel over

the glass tube, however, if impacted hard enough the channel will give way and the glass tube can break. The small aft tanks are not equipped with level indication. **NOTE:** The upper reading of the sight glass tube capacity scale does not indicate the entire tank volume. This feature must be considered during vessel refueling.

CAUTION: LEAKING FUEL IS A FIRE AND EXPLOSION HAZARD. FAILURE OF THE DIESEL FUEL TANK LEVEL GAUGE GLASS TUBE WILL PRESENT SUCH HAZARDS. IN ADDITION, SIGHT GLASS FAILURE WILL CAUSE AN UNCONTROLLED RELEASE OF FUEL TO THE ENGINE ROOM BILGE AND OVERBOARD VIA THE BILGE PUMP SYSTEM AND MAY SUBJECT THE OWNER TO HEAVY FINES. IT IS STRONGLY ADVISED THAT THE UPPER AND LOWER SIGHT GLASS ISOLATION VALVES BE KEPT CLOSED AND ONLY OPENED WHEN CHECKING THE DIESEL FUEL LEVEL.

5) **Accessories.** In addition to the above components, the fuel oil system is equipped with the following accessories.

Timer. One (1) timer, **INTERMATIC**, 0-60 minutes is installed in the fuel transfer pump control circuit as a precaution to limit the operation of the fuel transfer pump during transfer operations. The fuel transfer pump can only be started when the FUEL TRANSFER PUMP circuit breaker at the 12 VDC SERVICE panel is in the “ON” position and the timer is set to the desired time. The pump will stop when either the circuit breaker is turned OFF or the timer advances to the zero setting.

Manifolds. Three (3) manifolds each equipped with ball valves, fittings and hoses are provided with one manifold in each of the engine supply, tank return and fuel transfer loops. The **supply and return manifolds** are mounted end to end mid way in the engine room on the starboard bulkhead below the fuel filter/water separators. The **transfer manifold** is mounted on the starboard side under the bench. The fuel supply and return manifolds each contain lines and isolation valves to the four fuel tanks, the main engine, wing engine and generator and the fuel transfer pump. The fuel transfer manifold contains lines and isolation valves from each fuel tank and to the fuel transfer pump. For operator convenience, each valve is identified with the source and/or destination for each line. In addition, the isolation valves on the supply and return manifolds are arranged in a mirror image of each other to facilitate system alignment.

2.2.2 System Operations

1) Fueling and System Priming.

CAUTION: Fueling the boat is a critical operation and requires constant vigilance and the strict observance of safety precautions. Boat activity should be limited to those specifically required to monitor tank level and for the observance of leaks and tank overfilling. Portable fire extinguishers should be close at-hand along with clean-up material. Smoking, cooking or any other spark or flame producing activity along with operation of laundry equipment should not be allowed on board for the duration of the fueling activity.

System Fueling. Filling each of the fuel oil storage tanks is accomplished by the following procedure:

VERY IMPORTANT NOTE: It is unlawful to discharge or spill fuel oil in coastal waters. Violation will result in fines levied against the owner. The fill connections for the vessel are on the transom and very susceptible to overflowing if the filling rate and tank level are not carefully attended. The refueling process must be performed in a deliberate and methodical manner. Of particular importance is to avoid using a high speed pump at the fuel dispenser facility.

REMINDER: The aft fuel tanks are not equipped with level gauges. After medium to long voyages, the fuel in these tanks has, most likely, been consumed or transferred to the forward tanks to improve the vessel trim. In these cases, refueling these tanks will require approximately 125 gallons in each tank.

- If the level in the forward (engine room) fuel oil storage tank is initially below the lower visible range of the tank level sight glass, remove the appropriate deck fill cap then commence filling the tank while monitoring the tank level sight glass. If the level in the fuel oil tank is within the visible range of the level sight glass, skip the first two steps.

- Stop filling the tank when the fuel oil level is firmly within the visible range of the sight glass.

- Using the tank level sight glass capacity scale, record the approximate amount of fuel, in gallons, in the tank and record the reading of the dockside fuel dispenser meter.

- Subtract the value of the tank scale reading determined above from 535 gallons and record. This is the **approximate amount of additional** fuel required to completely fill the tank.

- Add the value of additional fuel required to the dockside fuel dispenser meter recorded above. This is the **approximate reading of the meter** that will completely fill the tank.

- Re-start or commence filling the appropriate fuel tank until the desired level as indicated by the level sight glass is attained or until the approximate amount of additional fuel, as determined above, is added.

  NOTE: The values determined above are approximate. A safe practice is to listen to the sound at the fill spout and also at the vent opening. When the sound changes or the vent begins to gurgle due to the foam in a tank reaching the vent fitting, a tank is nearing capacity. After the foam dissipates, more fuel can be introduced, <u>WITH CARE</u>, until a tank is filled. Due to the possibility of temperature changes that may cause the fuel to expand, a safe practice is to NOT fill the tank to its rated capacity.

- Upon completion of the fueling activity for each tank, the deck fill cap should be firmly tightened to preclude the possibility of sea water intrusion. It is suggested that a thin coating of petroleum jelly be applied to the cap threads to enhance a water tight seal and to allow easy removal.

System Priming. Priming the system will be typically required after various maintenance activities such as filter cartridge replacement, tank inspection and engine maintenance or anytime air is introduced into the fuel supply manifold or supply lines. System priming is accomplished using the fuel transfer pump by taking suction from a tank via the fuel transfer manifold and discharging to the engine fuel supply lines via the fuel supply manifold. The following steps are typical for performing this function:

- With the fuel transfer pump not running, **CLOSE** all valves at the fuel oil supply manifold.

- At the fuel oil return manifold, **CLOSE** the valve from the fuel transfer pump discharge.

- Align the fuel transfer pump to take suction from a fuel oil tank by **OPENING** the appropriate valves AT the tank and the corresponding tank valve AT the fuel transfer manifold.

- At the fuel oil supply manifold **OPEN** the valve from the fuel transfer pump. The system is now aligned to transfer fuel oil from the selected tank to the fuel oil supply manifold.

- Turn **ON** the FUEL TRANSFER PUMP circuit breaker at the 12 VDC SERVICE panel.

  IMPORTANT NOTE: When using the following step for refilling the main engine and generator RACOR filter bowls with the lids off, <u>BE SURE</u> to stop the pump by advancing the timer switch to zero when the level is just at or below the filter bowl rim.

- **START** the fuel transfer pump by advancing the timer switch from the zero position. At this time the pump will start supplying fuel at a noticeable rapid pumping rate and will begin to slow down as the fuel oil supply manifold fills with fuel.

- When the pumping rate has slowed to one or two pulses per second, individually prime the lines from the supply manifold to the main engine, and generator by individually **OPENING and CLOSING** each valve at the supply manifold. For these cases, the pumping rate of the fuel transfer pump will slow down as each line is filled and pressurized. If the timer zeroes out before each line is sufficiently primed, restart the pump by advancing the timer as before.

- Vent the fuel connection at the main engine and generator. Refer to the engine manufacturer's instructions.

- When all lines have been satisfactorily filled and primed, **STOP** the fuel transfer pump by manually advancing the timer to the zero setting, **CLOSE** the fuel transfer pump discharge valve at the supply manifold, and **TURN OFF** the FUEL TRANSFER PUMP circuit breaker at the 12 VDC SERVICE panel.

- Realign the fuel oil system for normal operation, as required.

2) Normal Underway Operation.

WARNING: (1) For simplifying the management of fuel inventory and boat trim, it is suggested that only one fuel tank be in service at a time. Multiple tank operation may result in uneven draw down and confusion in determining fuel burn rate and adjustment of boat trim. (2) A return flow path to the same supply tank must be provided at all times. Failure to provide a return flow path could result in damage to the diesel engine by over injecting fuel to the engine cylinders.

During normal underway operation, the main propulsion engine (or wing engine) and generator diesel engines are running and the Fuel Oil System is providing fuel to each operating engine. In this operating configuration, fuel is supplied by gravity from one fuel tank to the operating engines via the supply

manifold assembly and excess fuel is returned to the same storage tank via the return manifold. The idle storage tanks are isolated by closing the respective valves at the supply and return manifolds. Suggested system valve alignments typical for each fuel oil tank are as follows:

NOTE: The recommended operating configuration is to draw from either the port or starboard forward engine room fuel tank. When there is sufficient room available in the tank, the contents of the aft tank can be transferred to the forward tank.

- **OPEN** the fuel tank supply line isolation valve located just inside the bulkhead access opening at the tank.

- At the supply manifold **OPEN** the fuel tank supply line isolation valve for the corresponding tank.

- At the fuel supply manifold **OPEN** the fuel oil supply isolation valves to the main engine and generator.

- At the fuel return manifold **OPEN** the return valves from the main engine and generator.

- **OPEN** the valve at the fuel return manifold to the selected fuel oil tank.

- **CLOSE** all other valves at the fuel supply and return manifolds.

- The Fuel Oil System is now aligned for service from the selected fuel storage tank.

  NOTE: To switch fuel tanks, be sure to open the valves to and from the new fuel tank at the fuel supply and return manifolds BEFORE closing the valves of the operating or near empty tank.

3) Tank Management.

As fuel is consumed, careful vigilance of the in service fuel tank level is required so as NOT to lower the level below the bottom of the supply line and introduce air into the engine supply line. Switching tanks is accomplished by first valving in the supply and return lines of the new tank, establishing flow and then valving out the near empty tank (see previous section). The operator is encouraged to perform this function when there is sufficient fuel capacity left in the in service tank (preferably before the fuel oil level in the level sight glass reaches the lower visibility limit) so as to not lower the tank level below the bottom of the supply line before the switching operation is completed.

As fuel is consumed, the decrease in weight will affect the boat trim. The relatively simply process of switching fuel tanks at periodic intervals before either tank is empty will effectively minimize deviations from even keel operation.

4) Fuel Transfer and Water Removal.

Fuel Transfer. Transferring fuel between tanks while underway is generally performed to consolidate fuel, maintaining boat trim, and polishing fuel that might be dirty. Switching tanks is performed before the in service tank is empty to prevent introducing air into the supply lines to the running engines. After a full tank has been placed in service and operating for a reasonable period of time and its available free volume has been determined, the remaining contents of the spent tank can be transferred or consolidated to the in service tank. It is imperative that the operator ensure that the in service tank has sufficient free volume to accommodate the consolidated fuel.

The transfer operation is performed using the fuel transfer pump by lining up the pump to take suction from the spent tank (to be drained) at the transfer manifold and discharging to the return manifold which is already lined up to return to the in service tank (to be filled). In this operating configuration, the transfer pump is operated until the spent tank is completely empty. Transfer pump operation drawing from an empty tank will not damage the pump. In addition, the pump will automatically stop when the control circuit timer times out. The following steps are typical for performing this function:

- With the fuel transfer pump not running, **CLOSE** all valves at the fuel oil transfer manifold.
- At the fuel supply manifold, **CLOSE** the valve from the fuel transfer pump discharge (this valve is normally closed).
- Align the fuel transfer pump to take suction from the fuel tank to be drained by **OPENING** the appropriate valves AT the tank to the transfer manifold and the corresponding tank valve AT the fuel transfer manifold.
- **TURN ON** the FUEL TRANSFER PUMP circuit breaker at the 12 VDC SERVICE panel.
- **START** the fuel transfer pump by advancing the timer switch from the zero position.
- At the fuel return manifold, **OPEN** the valve from the fuel transfer pump.

NOTE: When underway, the valves from the fuel return manifold to the return tank are already open. If not underway, open the valves to the receiving tank at the fuel return manifold AND at the receiving tank.

- Continue pumping until the fuel transfer pump starts pumping at a rapid rate indicating no flow (empty tank).

- **STOP** the fuel transfer pump by manually advancing the timer switch to the zero setting then turn **OFF** the FUEL TRANSFER PUMP circuit breaker at the 12 VDC SERVICE panel.

- At the fuel transfer manifold, **CLOSE** the valve to the fuel transfer pump.

- At the fuel return manifold, **CLOSE** the valve from the fuel transfer pump.

Water Removal. During normal operation, the temperature of the fuel in the return line will be hotter than the supply as a result of the diesel engine pumping action. Over time, the temperature of the fuel in the tank and the air space above the level will increase. As the temperature increases, condensation of the water vapor present in the air will result due to the fuel tanks close proximity to the hull and cold sea water. The heavier water will settle below the fuel to the bottom of the tank and into fuel oil supply manifold and/or fuel transfer manifold. The water will then be drawn into the fuel filter/water separator and accumulate at the bottom of the filter bowl. The main engine right filter bowl is equipped with a water sensor that will actuate an alarm panel on the pilot house overhead console dash, however, daily inspection of the fuel filter/water separator bowls for the presence of accumulated water should be a standard practice. Water removal from the filter/water separator bowls is simply accomplished by opening the drain cock at the bottom of the bowl and draining the water to a container or thru a tube to the bilge.

2.3 USED OIL/NEW LUBE OIL SYSTEM

The Used Oil/New Lube Oil System is designed to permit changing and disposing the lube oil in the main and wing propulsion engines and the diesel generator. The system consists of a transfer pump with integral manifold common to the engine crankcases, valves, hoses, a control switch, and wiring. Each of the engine crankcases is provided with a line routed to the pump/manifold. Isolation valves for each line are installed at the pump/manifold. For changing oil, the transfer pump is equipped with a reversible (direction) motor and is capable of taking suction from or discharging to the manifold. The line to the main engine also includes a three-way valve at the engine to enable the engine transmission to be drained and filled.

2.3.1 System Components and Installation

1) **Pump.** The system contains one reversible oil change pump and integral manifold capable of transferring new and used lube oil to and from the engine crankcases. The oil change pump is a **REVERSO Oil Change System by Nautical Ventures, Model OP-703.** The oil change pump is powered by the OIL CHANGE PUMP circuit breaker on the 12 VDC SERVICE panel.

   Pumping direction is controlled by a three position toggle switch mounted on the pump motor enclosure. The switch positions are labeled DRAIN-MID-FILL. The location of the pump is on the hull centerline below the engine room deck plate just forward of the aft bulkhead

2) **Manifold.** The oil change pump integral manifold is equipped with ball valves, fittings and hoses to each of the engine crankcases and to a local discharge/suction.

3) **Three-Way Valve.** The line from the main engine to the oil change pump includes a three-way valve at the aft end of the main engine starboard side to permit draining and filling the main engine crankcase and the engine gear box.

2.3.2 System Operations

The Used Oil/New Lube Oil system is normally in a standby condition and is placed in operation as needed. In this condition, the system configuration is for the OIL CHANGE PUMP circuit breaker at the 12 VDC SERVICE panel to be in the OFF position and the toggle switch on the oil change pump body to be in the MID (OFF) position. Changing the lube oil from any of the diesel engines and main engine gear box requires that the engine crankcase first be drained then refilled. For draining an engine crankcase, the oil change pump discharge is equipped with a hose only and requires a portable container to be placed in the vicinity of the oil change pump to receive the used oil. Conversely, for adding new

lube oil, the oil change pump requires an oil filled portable container from which to take suction by placing the provided hose into the new oil. Changing the oil from any of the engine crankcases requires the following common actions:

- Turn **OFF** the OIL CHANGE PUMP circuit breaker at the 12 VDC SERVICE panel and position and the local toggle switch on the oil change pump to the **MID** position.

- Place an empty container of suitable capacity at the oil pump discharge hose. It is advisable to secure the end of the hose to the container so that is does not inadvertently discharge oil outside the container.

- **OPEN** the valve at the engine crankcase to the oil change pump (if equipped). For the main engine gear box, position the three-way valve at the engine to the gear box direction.

- Remove the oil fill cap or dipstick at the engine (or main engine gear box)

- At the oil change pump manifold, **OPEN** the valve from the engine crankcase. The valves are clearly marked for this function.

  WARNING: The crankcase capacity of the main propulsion engine is over 24 quarts. It may be necessary to stop and start the oil change pump several times in order to empty the local container of the used oil.

- Turn **ON** the OIL CHANGE PUMP circuit breaker at the 12 VDC SERVICE panel then start the pump by positioning the toggle switch in the **DRAIN** position.

- Continue operation of the oil change pump until the discharge flow of oil has stopped and then **STOP** the pump by positioning the toggle switch to the **MID** position.

- To refill the engine crankcase, place the oil change pump hose in a clean container and fill the container with oil. It may be necessary to periodically add oil to the container during the filling process.

- **START** the oil change pump by positioning the toggle switch in the **FILL** position.

- When the required amount of oil has been added, **STOP** the oil change pump by positioning the toggle switch to the **MID (OFF)** position.

- **CLOSE** the manifold valves, replace the oil cap/dipstick and turn **OFF** the OIL CHANGE PUMP circuit breaker at the 12 VDC SERVICE panel.

2.4 FRESH WATER SYSTEM

NOTE: For clarity, the discussion of the Fresh Water System is presented in Fresh Water Supply and Fresh Water Makeup portions.

2.4.1 Fresh Water Supply System Components and Installation

The fresh water supply portion is designed to provide a continuous, pressurized supply of hot and cold potable water for consumption, bathing, cooking, laundry, toilet flushing, and general cleaning purposes.

Fresh water is drawn from either of three (3) non-pressurized storage tanks and distributed to user stations in hot and/or cold loops throughout the vessel. The water pressure in the user end of the system is maintained by a fresh water supply pump operating in conjunction with a pressurization/accumulator tank. Water expended from the user stations drains overboard by gravity with the exception of the head toilets and shower drains. Water from these facilities is pumped overboard by the TOILET FLUSHING/HOLDING TANK SYSTEM (Section 2.5) and the SHOWER DRAINS/SUMP SYSTEM (Section 2.6).

The fresh water supply portion of the system consists of three (3) water tanks totaling approximately 350 gallons, a pressure water pump, a 20 gallon hot water heater, a pressurization/accumulator tank, level instrumentation, a supply manifold, plumbing fixtures such as hose bibs, wash basins, sinks and shower faucets, and the necessary hoses, control switches and wiring.

1) Tanks.

Fresh Water Tanks. Three (3) fresh water tanks constructed of reinforced fiber glass are provided with a combined capacity of approximately 350 gallons. The forward tank (approximately 100 gallons) is mounted below the guest staterooms, the mid tank (approximately 160 gallons) is located below the master stateroom sole, and the aft tank (approximately 80 gallons) is located below the main engine. Each tank is equipped with a top mounted inspection plate. Access to the inspection plate is available by a removable hatch cover located in each stateroom and the engine room. The tanks are finished in blue gel coat to distinguish them from the red fuel oil tanks.

The inspection plate is made of stainless steel and bolted to the tank for easy removal. Each plate is equipped with separate connections and hoses for supplying water to the fresh water pump, venting to the outside, remote tank level indication, and a dipstick. The top of each tank also has a fill line from a deck connection. The supply lines from each tank are routed to a manifold in the engine room equipped with isolation valves for each tank. A single line from the manifold is routed to the fresh water pump inlet connection. Standpipes are provided inside each tank for the fresh water pump suction line

and the level indication sensing line and extend to within an inch from the bottom of the tank. The deck fill for the forward fresh water tank is on the foredeck port side. The amidships tank deck fill is located on the port stairs to the boat deck, and the aft tank deck fill is located on the starboard side walkway. Each deck fill is marked “WATER” for easy recognition. The tank inspection plates and deck fill connections are bolted to the bonding/grounding system using #6 AWG bonding wire.

Accumulator/Pressurization Tank. The accumulator/pressurization tank functions as a pulsation damper for the fresh water system and absorbs pressure spikes that may be caused by the starting and stopping of the system pressure water pump. The 1 gallon volume of the accumulator tank maintains the system pressure during light system use thus minimizing the service duty of the pressure water pump. The tank is a **GROCO PST-1** bladder type accumulator rated for 200 degrees and a maximum working pressure of 100 psi with a bladder pre-charge of 20 psi. A bicycle type valve is provided on the top of the tank for adjusting the bladder pressure as desired. The accumulator is mounted on the engine room forward bulkhead starboard side.

2) **Pump and Strainer.** The fresh water pump provides fresh water for all system uses and maintains system pressure on demand from the user station and/or accumulator tank. The pump is a variable flow rate **JABSCO SENSOR MAX 17 Water Pump** with a full rated capacity of 4.5 gpm. The pump features variable speed control, solid state pressure sensor and nearly silent operation with no cycling. System pressure is controlled by motor speed and the pump speeds up as demand increases. The pump is powered by the FRESH WATER PUMP circuit breaker/control switch on the 12 VDC SERVICE panel. When the circuit breaker/control switch is in the ON position, the pump will automatically start and self adjust the flow rate to maintain a system pressure of approximately 40 psi. The pump will stop when there is no water demand. A red status light on the 12 VDC SERVICE panel will be illuminated when the pump is running. The inlet to the pump is equipped with a **SHURFLOW In-line** strainer attached to the pump inlet. The strainer consists of a stainless steel mesh cylinder enclosed in a plastic container screwed to a metallic cap. The strainer screen is removable for cleaning. The pump and strainer are mounted below the engine room starboard bench aft of the forward bulkhead.

3) **Hot Water Heater**. Hot water for the fresh water system is provided by a 20 gallon **TORRID Marine Water Heater Model MV 20** equipped with a 1500 watt heating element for electric power and an internal heat exchanger for using engine heat when underway. In the electrical mode, the heater element is powered by the WATER HEATER circuit breaker on the SHIP 240 VAC bus (120/240 VAC 60HZ SERVICE panel). Water outlet temperature is thermostatically controlled at approximately 140 degrees F. In the heat exchanger mode, the hot water heater receives hot circulating water from the

main engine fresh water cooling loop. The hot water heater is located below the master stateroom berth.

4) **Level Instrumentation.** Level indication for the fresh water tanks is provided by a **WEMA Tank-Level Indication System.** The system consists of a level sensor/sending unit mounted on the top of each of the fresh water tanks and a level indication panel shared by all tank level sensors. The panel is mounted on the forward bulkhead in the master stateroom head and consists of a dial indicator gauge, seven (7) position selector switch, ON/OFF knob, and a red POWER ON light. The dial gauge indicates tank level in one-quarter full increments. A tank level reading is obtained by turning the power on and selecting position 1, 2, or 3 corresponding to the forward, amidships and aft fresh water tanks, respectively. The level indication system is powered by a fused circuit from the 12 VDC bus behind the 12 VDC SERVICE panel. The fused circuit also supplies the fuel system water detector, bilge alarms, and the holding tank level monitor.

5) **Fresh Water Manifold.** Water supply lines from the three fresh water tanks are routed to a manifold assembly located below the starboard bench in the forward end of the engine room. The outlet of the manifold is routed to the inlet of the fresh water pump/strainer mounted adjacent to the manifold. In addition to the lines from the fresh water tanks, the manifold has a valve connection for the fresh water makeup from the water maker. The manifold inlet valves allow the fresh water pump to draw from one or more of the fresh water tanks.

2.4.2 System Operations

1) **Fresh Water Tank Filling.** Prior to any voyage, it should be a standard practice to fill the fresh water tanks if this service is available. The fresh water tank deck fills are located on the port foredeck, port side stairs to the boat deck, and on the starboard side walkway. Each deck fill is marked WATER on the faceplate. The tanks are filled one at a time. During the filling process, the WEMA level indicator located in the master stateroom head should be monitored by selecting the applicable selector position as follows:

   - **WEMA Position #1 – Forward Tank**
   - **WEMA Position #2 – Amidships Tank**
   - **WEMA Position #3 – Aft Tank**

   WARNING: The accuracy of the WEMA Tank-Level Indication dial gauge is to the nearest quarter full increment and should not be relied upon for exact level in the tank. During filling , when the gauge reads three quarters full, slow the filling rate so as not to overpressurize the fresh water tank.

NOTE: During filling, some pounding may be heard as the tanks expands with the weight of the water. This is normal and does not indicate problems with the tank.

Upon the completion of tank filling, the deck fill cap should be firmly tightened to preclude the possibility of sea water intrusion. It is suggested that a thin coating of petroleum jelly be applied to the cap threads to enhance a water tight seal and to allow easy removal for filling.

2) Normal System Operation.

NOTE: If the fresh water pump is in continuous operation when water demand is low, the system may have a leak, an open outlet, or a faulty pressure switch and an inspection of the system should be performed.

The fresh water system normal operating configuration is the pump lined up to take suction from one of the fresh water tanks and to discharge to the system. The selected valve at the suction manifold is open and the FRESH WATER PUMP circuit breaker at the 12 VDC SERVICE panel is in the ON position.

When there is no water demand at the system outlets (no water flow) the pump pressure sensor stops the variable speed motor when the system pressure reaches approximately 40 psig. As water demand increases, the pump in conjunction with the accumulator tank self adjusts motor speed to meet the water demand while maintaining the system pressure at 40 psig. The pump and accumulator operating combination results in a smooth and near constant system pressure with no pressure spikes.

3) Hot Water Heater Operation. Two (2) modes of supplying hot water utilizing the hot water heater are available.

- Electric Mode
- Main Engine Heating Mode

The Electric Mode utilizes the electrical heating coil integral to the hot water heater. The Main Engine Heating Mode utilizes the main engine closed cooling water system to transfer heat to the heat exchanger integral to the hot water heater unit.

WARNING: Energizing the hot water heater electrical heating element with the heater empty or partially filled will severely damage and most likely destroy the heating element.

Electric Mode. Operation of the hot water heater in the Electric Mode can be employed when docked and 240 VAC 60 HZ shore power is available or when the generator is in operation. For this mode, the heater electrical heating element is energized from shore power or the generator by closing the WATER HEATER circuit breaker on the SHIP 240 VAC bus. The hot water heating element will automatically turn off when the water temperature reaches 140 degrees F. Prior to energizing the hot water heater perform the following actions to verify that the hot water loop is filled:

- Verify that the pressure water pump is in operation and the fresh water system is pressurized.

- Starting at the berthing compartment head slowly open the hot water faucets to the showers and wash basin one faucet at a time to expel any entrapped air. Close the faucet when water a steady stream of water is flowing.

- Repeat the previous step for the galley sink (system high point)

- TURN ON the WATER HEATER circuit breaker on the SHIP 240 VAC bus to energize the hot water heater electrical heating element.

Main Engine Heating Mode. Operation of the hot water heater in the Main Engine Heating Mode is normally performed when underway with the main engine running. The hot water heater integral heat exchanger will transfer heat from the main engine fresh water cooling loop.

CAUTION: Extended coolant circulation through the heater may result in excessively hot water of up to 180 degrees F. Use care when dispensing water so as not to be scalded.

- TURN OFF the WATER HEATER circuit breaker on the SHIP 240 VAC panel bus to de-energize the hot water electrical heating element.

- Slowly crack open the hot water supply valve from the main engine closed cooling water system to the hot water heater to fill/pressurize the heating loop. The supply and return valves are located on the port side of the main engine forward end.

  WARNING: It is a good practice to inspect the hot water heater and piping to look for any signs of water leakage. System leakage left undetected will result in draining the main engine fresh water cooling system resulting in engine overheating and forced shutdown.

- Fully open the hot water supply valve then open the hot water return valve from the hot water heater to the main engine cooling system. The hot water heater is now in operation in the Main Engine Heating Mode.

2.4.3 Fresh Water Makeup System Components and Installation

The Fresh Water Makeup System (WATERMAKER) will be a future addition. Inlet and outlet thru-hull connections, an inlet strainer and power supply have been provided to accommodate this assembly.

2.4.4 Maintenance

1) **Fresh Water Supply System**. The components included in the fresh water supply system portion are designed and sized to provide long service and require little routine maintenance.

   - Inspect hoses, fittings and components on a regular basis taking note of undue wear caused by rubbing and for leakage.

   - Continuous fresh water pump operation may be indicative of a faulty pressure switch that should be replaced.

   - Periodically inspect the fresh water pump inlet strainer and clean as required.

2) **Fresh Water Makeup Water System**. **FUTURE ADDITION**

2.5 TOILET FLUSHING/HOLDING TANK SYSTEM

The Toilet Flushing/Holding Tank System is designed to provide personnel toilet service, waste holdup and waste removal capability in a sanitary, odor free and comfortable environment. Private toilet facilities are provided for the owner's and guest staterooms. The system operates on a vacuum principle where waste matter is evacuated at a low pressure from the toilet bowls and discharged directly overboard or to a holding tank. The holding tank stores the waste matter until such time that it can be discharged overboard or evacuated by a port disposal facility. The system consists of individual toilets and vacuum generator assemblies and pumps, a Y type directional valve for each toilet, a shared holding tank, electric and manual overboard discharge pumps, holding tank vent filter, and associated piping, electrical power supplies, switches and wiring.

2.5.1 System Components and Installation

1) **Toilet Assemblies.** The master and guest heads are each equipped with a **SEALAND VACU-FLUSH Toilet Assembly** that discharges to a holding tank or overboard via separate discharge hoses. Each assembly consists of a toilet bowl with flushing water supply and discharge valves, side-mounted foot-operated flushing pedal, and a **SEALAND VACUUM GENERATOR Model VG12**. The vacuum generator includes a SEALAND S-Series pump mounted on a highly impervious polyethylene vacuum tank and a pre-set pressure differential switch that turns the pump on and off to maintain the proper vacuum level in the tank. The toilet bowl and vacuum generator are connected to each other by odor proof hose.

   Flushing water is supplied by the fresh water system and includes a valve integral to the toilet bowl that is linked to a side mounted foot operated pedal. The pedal, when depressed, has the dual function of opening the toilet bowl flush outlet valve and opening the water supply valve to rinse and replenish the bowl with a small amount of fresh water. Lifting the foot pedal opens the fresh water supply valve to add more water if desired. The foot pedal is spring loaded to return to the neutral position (outlet and makeup water valves closed) from either the depressed or lifted position when the pedal is released. It is important to maintain a minimum water level in the toilet bowl for sanitary purposes and to enhance the sealing capability of the rubber seated flush valve. The vacuum generator for the master stateroom head is located below the steps from the pilot house and can be accessed by lifting two hinged steps near the bottom of the steps. The vacuum generator for the guest stateroom head is located under the starboard guest stateroom berth. The guest and master vacuum generator pump motors are individually powered by separate circuit breakers on the 12 VDC SERVICE panel labeled FWD HEAD and AFT HEAD & TANK GAUGE, respectively.

The discharge line of each vacuum generator assembly is equipped with a **JABSCO Y-type** manual valve that can be positioned to route waste material to a holding tank or directly overboard. The Y-valve for the master head toilet is located inside the locker forward of the toilet bowl. The Y-valve for the guest head toilet is under the starboard guest stateroom berth. The valve body is embossed with arrows to indicate the flow direction for each valve position. In addition each discharge line is labeled to indicate the correct direction.

2) **Pumps.** The system contains two (2) additional pumps, an electric and a manual holding tank discharge pump. The pumps are connected in series and draw from the holding tank and discharge directly overboard via a shared connection.

   Holding Tank Discharge Pump – Electric. The electric discharge pump is a **SEALAND Vacuum Pump Model T12VDC**. The pump is powered and started by the HOLDING TANK PUMP circuit breaker on the 12 VDC SERVICE panel. The pump is located under the port guest stateroom berth. The overboard discharge valve is located inside the locker forward of the aft (master) toilet.

   Manual Holding Tank Discharge Pump. The manually operated holding tank discharge pump is a **MUNSTER-SIMMS Engineering, Inc MK V** bellows type pump and is located under the forward stairs from the pilot house. The pump is operated by inserting the provided pump handle through a slotted hole in the face of the lower step and stroking the pump handle in an up and down direction. The overboard discharge valve is shared by the electric discharge pump and is located inside the locker forward of the aft (master) toilet.

3) **Holding Tank and Level Monitor.** A single reinforced fiber glass holding tank, shared by each toilet assembly, is provided to receive and temporarily store raw waste matter discharged from the vacuum generators. Waste matter from each toilet is routed via the respective Y-valve through odor proof hoses into the top of the holding tank through a bolted inspection plate which also contains two discharge lines and a vent line. The tank holds approximately 50 gallons and is located below the sole in the passageway at the foot of the stairs to the pilot house. In addition to the holding tank pump discharge line the tank is equipped with a line to a deck connection for emptying the tank to a dockside evacuation facility. The deck connection is located on the starboard foredeck and with an engraved faceplate labeled “WASTE”. The holding tank is finished in black gel coat for easy identification. The inspection plate is accessible by a removable hatch in the passageway.

   Level Monitoring Panel. The holding tank level is monitored by a **SEALAND TANKWATCH 4 Level Monitor System** consisting of a three probe assembly of varying lengths with attached floats that are connected to a switch housing and an indicating panel installed on the master head forward bulkhead. The

probes are inserted in the top of the holding tank with the switch housing exposed for easy access. The switches are actuated when the tank level lifts the respective float. The indicator panel has four (4) status lights; **GREEN for EMPTY, YELLOW for LOW, AMBER for MID, and RED for FULL**. A status light will be lit when the corresponding tank level is reached. The level monitoring panel is powered by a fused circuit connected to the 12 VDC bus behind the 12 VDC SERVICE panel. The fused circuit also supplies the fuel system water detector, bilge alarms, and water tank level indicators.

4) **Holding Tank Vent Filter.** The holding tank vent line is equipped with a **SEALAND TANK VENT FILTER Model 310002** that contains odor-removing filter materials encased in the filter cartridge**.** The filter is located behind a removable panel on the forward bulkhead in the master stateroom head. The filter cartridge is good for an entire season and is equipped with hose adaptors for easy replacement.

2.5.2 System Operations.

1) **Normal Underway and In-Port Service.** Operation of the system requires the Fresh Water System to be in service and the system pressurized. The following steps are required to place the system in operation (refer to the system drawing at the end of this section):

For UNDERWAY service,

- Place the Fresh Water System in service (Section 2.4).

  WARNING: When discharging overboard, the overboard discharge valves <u>MUST</u> be positioned in the <u>OPEN</u> position before the vacuum generator pumps are started. Operating the pump with the valve closed pressurizes the downstream piping and may cause the pump's integral duck bill check valve rubber flapper to be positioned in the opposite direction. Should this occur, pump disassembly will be required to reposition the flapper.

- Open the master toilet overboard discharge valve. The valve is located inside the cabinet under the sink. **NOTE: Coast Guard regulations require this valve to be closed while in port**.

- Position the master head toilet discharge Y-valve to the **SEA** (overboard) direction. The valve is located inside the locker forward of the toilet. **NOTE: Position the valve to discharge to the holding tank if operating in coastal waters subject to waste discharge restrictions.**

- Position the guest head toilet discharge Y-valve to the **SEA** (overboard) direction. The valve is located under the starboard guest stateroom berth. **NOTE: Position the valve to discharge to the holding tank if operating in coastal waters subject to waste discharge restrictions.**

- Open the guest toilet overboard discharge valve. The valve is located inside the lower locker under the guest stateroom settee. **NOTE: Coast Guard regulations require this valve to be closed while in port**.

- Turn **ON** the FWD HEAD and AFT HEAD & TANK GAUGE circuit breakers located on the 12 VDC SERVICE panel. These breakers are normally left in the ON position.

  NOTE: At this time, the respective vacuum generator pump will automatically start and discharge any waste material overboard. The pump continues to operate evacuating the upstream piping and vacuum generator assembly tank until the vacuum is re-established then shuts off. When a toilet is flushed, the above cycle is repeated.

- Flush the toilet by depressing the foot pedal lever on the side of the toilet. The discharge valve will open and draw the waste matter into the vacuum generator tank. The vacuum generator pump will start and discharge the waste matter overboard.

- When the toilet is emptied, release the foot pedal. The pump will continue to run until vacuum is re-established in the vacuum generator tank then will shut off. To add additional water to the toilet bowl, lift the foot pedal and then release when desired level is achieved.

For IN PORT service,

WARNING: Overboard discharging of raw sewage in most ports is strictly prohibited and can result in severe fines levied against the owner. U.S. Coast Guard Regulations require that the toilet and holding tank overboard discharge valves be closed while in port.

- Position the master head toilet discharge Y-valve to the **TANK** direction. The valve is located inside the locker forward of the toilet.

- Close the master toilet overboard discharge valve. The valve is located inside the cabinet under the sink. **NOTE: Coast Guard regulations require this valve to be closed while in port**.

- Position the guest head toilet discharge Y-valve to the **TANK** direction. The valve is located under the starboard guest stateroom berth.

- Close the guest toilet overboard discharge valve. The valve is located under the starboard guest stateroom berth. **NOTE: Coast Guard regulations require this valve to be closed while in port**.

- Turn **ON** the FWD HEAD and AFT HEAD & TANK GAUGE circuit breakers located on the 12 VDC SERVICE panel. These breakers are normally left in the ON position.

  NOTE: At this time, the respective vacuum generator pump will automatically start and discharge any waste material to the holding tank. The pump continues to operate evacuating the upstream piping and vacuum generator assembly tank until the vacuum is re-established then shuts off. When a toilet is flushed, the above cycle is repeated.

- Flush the toilet by depressing the foot pedal lever on the side of the toilet. The discharge valve will open and draw the waste matter into the vacuum generator tank. The vacuum generator pump will start and discharge the waste matter to the holding tank.

- When the toilet is emptied, release the foot pedal. The pump will continue to run until vacuum is re-established in the vacuum generator tank then will shut off. To add additional water to the toilet bowl, lift the foot pedal and then release when desired level is achieved.

2) Holding Tank Discharging Operations. Discharging the holding tank is performed by employing the motor operated discharge pump or backup hand operated pump when underway or by utilizing a dockside evacuation facility in port. For emptying the tank in port, a deck connection marked WASTE is provided on the starboard side Portuguese bridge to accommodate the dockside pump out facility. Emptying the holding tank overboard using the motor driven vacuum pump or backup hand pump is performed by the following steps:

IMPORTANT NOTES:

(1) The discharge line from the holding tank discharge pump has an installed isolation valve at the hull penetration. This valve <u>MUST</u> be positioned in the <u>OPEN</u> position before the electric pump is started. Operating the pump with the valve closed pressurizes the downstream piping and may cause the pump's integral check valve rubber flapper to be positioned in the opposite direction.

Should this occur, the unpleasant task of pump disassembly will be required to reposition the flapper.

(2) Discharging the holding tank is independent of toilet flushing and can be performed with the heads in operation and the holding tank at any level.

- Open the holding tank overboard discharge valve **located inside the locker forward of the master stateroom toilet**.

- **If utilizing the motor driven vacuum pump**, start the pump by turning **ON** the HOLDING TANK PUMP circuit breaker/control switch on the 12 VDC SERVICE panel. **NOTE:** The vacuum pump does not stop automatically thus vigilance at the TANKWATCH 4 Monitor Panel is required to stop the pump when the tank indicates empty – GREEN light ON, all other lights OFF. Continued operation of the vacuum pump for a brief period once the tank is empty will not damage the pump, however dry operation should be minimized.

- When the GREEN light on the TANKWATCH 4 Monitor is **ON**, stop the pump by turning **OFF** the HOLDING TANK PUMP circuit breaker/control switch on the 12 VDC SERVICE panel.

- **If utilizing the backup hand operated holding tank pump,** insert the pump lever in the slot provided on the face of the lower step from the pilot house to the staterooms, commence stroking the lever in an up and down motion, and monitor the TANKWATCH 4 panel as before. **NOTE**: It may take several strokes to prime the pump. Experience has shown that short rapid strokes are the most effective when priming this type of pump.

2.5.3 Maintenance. Experience has shown the system components to be reliable and require little maintenance. Removal and cleaning of the Tankwatch level monitor switch assembly may be required to ensure the floats are free to move on the switch probes. Consult the manufacturers manual for maintenance requirements and trouble shooting instructions.

RECOMMENDATION: The vessel toilet flushing system is designed to operate using a minimal amount of flushing water. Operating in this fashion MAY result in waste matter being “stranded” in the discharge line from the toilet to the inlet of the holding tank. To help minimize the possibility of waste matter buildup, an extended periodic flushing of each toilet using 3-5 gallons per toilet is recommended to maintain a clog-free discharge line and holding tank. Flushing in this manner should be performed, as a minimum, prior to entering coastal waters or a port where discharge restrictions are enforced.

2.6 SHOWER DRAINS/SUMP SYSTEM

The shower stalls for both of the vessel heads are individually equipped with a water collection basin just below the shower grating. Drainage capability for basins is provided by the shower drains/sump system. A locally controlled sump pump is provided for each shower that draws from the associated basin and discharges the water overboard. The overboard opening is above the water line and the discharge line is equipped with an anti-siphon loop. The system consists of sump pumps, strainers, and associated hoses, fittings and electrical power supplies, switches, and wiring.

2.6.1 System Components and Installation

1) **Pumps**. The shower drains/sump system contains two (2) **WHALE GULPER Model 220** rated at 3.3 gpm. Both of these pumps are powered by the SHOWER SUMP PUMPS circuit breaker located on the 12 VDC SERVICE panel. The pumps are individually operated by a toggle switch mounted on a panel in the shower stall. The panel also has a red indicating light that is lit when the pump is running. The sump pump and overboard discharge valve for the guest stateroom shower are located below the guest head sole (forward bilge) and is accessible by a removable cover in the head. The sump pump and overboard discharge valve for the master stateroom head are located inside the head cabinet under the sink. Each discharge is shared with the sink overboard drain.

2.6.2 System Operations

Operation of the shower drains/sump system is simple and straightforward. Both shower sump pumps are ready for operation by **OPENING** the overboard thru-hull valves (see PUMPS above) and turning **ON** the shared SHOWER SUMP PUMPS circuit breaker on the 12 VDC SERVICE panel. This circuit breaker is generally left in the ON (closed) position. Shower drain pump start and stop is performed by utilizing the locally mounted toggle switch.

These pumps are designed to briefly run dry and the pump can be turned on prior to showering before water drains to the pump suction and left operating for a short time after the collection basin is drained. However, to avoid the possibility of undue pump wear, it is advisable to minimize dry operation by starting the pump after the shower faucets are turned on and stopping the pump when the shower basin is free of standing water.

The shower drain to the basin underneath the grating (when equipped) is designed to prevent soap and debris from entering and clogging the small diameter drain line. It is necessary to occasionally lift the shower grate and clear the perforated drain cover plate.

2.7 BILGE PUMP SYSTEM

The NORDHAVN 50 Bilge Pump System is designed to automatically and/or manually discharge water that may accumulate at the lowest point inside the vessel by either in-leakage of sea water or from various fresh water drains. The lowest point or main bilge is in the engine room. All forward and aft compartments are equipped with limber holes in the transverse decks to allow drainage to the engine room bilge. The bilge pump system consists of a normal electric pump, a high water electric submersible pump, a manually operated backup pump, level switches for pump starting, engine room bilge bilge high level alarm and level switch, associated hoses and fittings, and electrical power supplies, circuit breakers and wiring. In addition, the compartment below the forward guest head (forward bilge) is equipped with a level switch that will actuate a pilot house alarm.

2.7.1 System Components and Installation

1) **Pumps**. Two (2) electrical bilge pumps, one normal and one high water, and one (1) manual backup pump are provided for the bilge pump system. The pumps feature an excellent design, durability, and ability to pump water with the higher head pressures encountered with the deep sump of the NORDHAVN. The control circuit for the electric bilge pumps contain separate level switches to automatically start and stop its respective pump when operating in the auto mode.

   Normal Bilge Pump. The normal pump is a WHALE GULPER Model 220 with a rated capacity 3.3 gpm. The pump draws water from deepest part of the bilge aft of the main engine via a suction hose and discharges overboard via a thru-hull valve in the aft end of the lazarette starboard side. The pump is powered by the BILGE PUMP circuit breaker switch on the 12 VDC SERVICE panel and can be operated both manually or in automatic by a two position toggle type selector switch labeled AUTO/MANUAL. Both switches are located on the 12 VDC SERVICE panel. A red status light adjacent to the AUTO/MANUAL switch will be illuminated when the pump is running. The pump, when operating in AUTO, is automatically started and stopped by its respective level switch (see below). The pump is located in the lazarette under the deck plate to the starboard side of boat centerline.

   High Water Bilge Pump and Alarm Panel. The high water bilge pump is a **RULE Model 14A Submersible Pump** rated at 3700 gph. The pump is powered by the HIGH WATER BILGE PUMP circuit breaker on the 12 VDC SERVICE panel via an **AQUALARM Bilge Pump Panel Model #20042** located on the pilot house overhead console dash. The alarm panel features include an audio alarm, red light, AUTO-OFF-MAN switch, green ON light and fuse holder. The pump is mounted on a platform above the bottom of the bilge aft of the main engine at an elevation above the normal pump inlet hose.

When operating in AUTO, the pump will start by actuation of its respective level switch (see below) if the water level rise exceeds the capacity of the normal bilge pump or if the normal pump is unavailable. The overboard discharge valve is located in the lazarette on the starboard side transom.

Manual Backup Bilge Pump. In addition to the motor driven bilge pumps, a hand operated **EDSON, Model 638AL** manual bilge pump is provided as a emergency backup to the electric pumps. The Edson is a high capacity commercial pump which is capable of pumping large volumes of water along with solid material. The manual bilge pump is located in the aft end of the lazarette port side and is accessed for operation from the cockpit by removing a screwed deck cover plate. The pump draws from the deepest part of the engine room bilge and discharges to a thru-hull valve in the lazarette port side.

2) **Pump Level Switches.** The normal and high water electric bilge pumps are each equipped with a dedicated level switch to start and stop the pump when operating in the AUTO mode.

   Level Switch – Normal Bilge Pump. The level switch for the normal bilge pump is a **RULE ECO Pneumatic Type Switch**. The switch uses changes in air pressure created by rising bilge water to activate the pump. The switch assembly consists of a sealed housing mounted under the lazarette deck plates adjacent to the pump and a sensing tube routed to the deep end of the engine room bilge cavity. Rising bilge level compresses the air in the sensing tube actuating the pump.

   Level Switch – High Water Bilge Pump. The level switch for the high water bilge pump is an **AQUALARM Smart Pump Switch Model 20048** float type switch. The switch consists of a cylindrical plastic housing that encases a float, non-magnetic stainless steel sensor tube and wiring. The bottom of the housing is perforated so that water can enter the housing and lift the float. The sensor tube is equipped with magnetically controlled reed switches that open and close as the float rises and falls on the tube thereby actuating the pump start/stop and high level alarm reed switches. The switch housing is mounted on the platform in the bilge adjacent to the submersible high water bilge pump. The switch will start the high water pump if the normal pump fails or if the leakage rate into the bilge exceeds the capacity of the normal pump.

3) **High Water Alarm Panels and Level Switches.** In addition to the pump start/stop switches the engine room and forward bilge compartment below the forward head are equipped with a separate high level switches that actuate dedicated high water alarm panels in the pilot house. The high level switches are **RULE-A-MATIC Float Type Model #35**. The engine room switch is mounted on the raised platform in the bilge cavity aft of the main engine adjacent to the high water bilge pump. The forward bilge switch is mounted on the floor of the bilge compartment. When actuated, the switches will actuate

its respective **RULE High Water Bilge Alarm Gauge Model 33AL** mounted on the pilot house overhead console dash. Each alarm gauge also includes a red lamp that illuminates when actuated. The level switch and alarm panel are powered by a fused circuit directly connected to the 12 VDC bus behind the 12 VDC SERVICE panel. The fused circuit also supplies the fuel system water detector, water tank indicators and the holding tank level monitor.

2.7.2 System Operations

1) **Automatic Operation.** Automatic operation of the bilge pump system is simple and straightforward and is the normal operating configuration. The pumps are placed in automatic by the following steps:

- Open the normal bilge pump, high water bilge pump, and emergency backup pump overboard discharge valves. The valves are located as follows:

  Normal Bilge Pump – lazarette starboard side
  High Water Bilge Pump – lazarette starboard side transom
  Manual Backup Pump – lazarette port side tramsp,

- Place the BILGE PUMP toggle switch located on the 12 VDC SERVICE panel in the **AUTO** position.

- Place the toggle switch at the HIGH WATER BILGE ALARM panel on the pilot house overhead console dash in the **AUTO** position

- **TURN ON** the BILGE PUMP and HIGH WATER BILGE PUMP circuit breakers on the 12 VDC SERVICE panel.

- The bilge pumps are now in service in the automatic mode.

- With the bilge pumps in the automatic operating configuration, the normal bilge pump will auto start when the water level actuates the switch. When running, a red status light on the 12 VDC SERVICE panel adjacent to the AUTO/MANUAL toggle switch will be lit. If the water level rise exceeds the capacity of the normal bilge pump, the high water bilge pump will automatically start and actuate the audio alarm when the water level reaches the set point of the high water bilge pump level switch. In this event, both pumps will operate simultaneously. As the water level drops, the level switches will stop its respective bilge pump and extinguish the red status light and silence the alarm.

  It is particularly important that the bilge pumps be left in the above automatic configuration when the boat is left unattended. It is also recommended that the automatic actuation of the pumps be tested

periodically to verify operability. This can be done using a garden hose and filling the bilge sufficiently to the level actuation point. Failure of the level switch to actuate may require replacement of the switch.

2) Manual Operation.

WARNING: Manual operation of the electric bilge pumps bypasses the automatic stop feature of the pumps. When manually operating a bilge pump, constant monitoring of the bilge level is required. Do not leave a running pump unattended.

- Open the normal bilge pump, high water bilge pump, and emergency backup pump overboard discharge valves. The valves are located as follows:

  Normal Bilge Pump – lazarette starboard side
  High Water Bilge Pump – lazarette starboard side transom
  Manual Backup Pump – lazarette port side transom

- Turn **OFF** the BILGE PUMP and HIGH WATER BILGE PUMP circuit breakers on the 12 VDC SERVICE panel.

- Position the BILGE PUMP toggle switch on the 12 VDC SERVICE panel to **MANUAL**.

- Position the toggle switch at the HIGH WATER BILGE ALARM panel on the pilot house overhead console dash to **MAN**.

- Start the normal bilge pump by closing the BILGE PUMP circuit breaker on the 12 VDC SERVICE panel and then visually monitor the level in the bilge.

- If the level in the bilge continues to rise with the normal bilge pump in operation and backs up in the forward bilge, start the high water bilge pump by closing the HIGH WATER BILGE PUMP circuit breaker on the 12 VDC SERVICE panel.

- If the normal bilge pump AND the high water bilge pump are BOTH running and the level in the bilge is decreasing, stop the high water bilge pump when the pump loses suction by turning off the HIGH WATER BILGE PUMP circuit breaker on the 12 VDC SERVICE panel. Start and stop the backup pump as required per the above.

- If the normal bilge pump ONLY is in operation and the level in the bilge is decreasing, stop the pump when the level is near the bottom of the bilge by turning off the BILGE PUMP circuit breaker on the 12 VDC SERVICE panel. Then, start and stop the normal bilge pump as required.

3) **Manual Backup Pump Operation**. Manual backup operation of the bilge pump system is performed by utilizing the EDSON hand operated bilge pump. When necessary, the EDSON hand pump is operated by opening the overboard discharge valve in the lazarette port side, remove the screwed deck plate cover in the cockpit port side, insert the pump lever handle in the top of the pump, and stroke the pump lever as required. **NOTE:** It may take up to 50 strokes to prime the pump and establish flow. Experience has shown that short, rapid strokes are the most effective for priming the pump and establishing flow.

2.7.3 Maintenance.

If the bilge is flooded with a significant amount of diesel fuel, it is recommended that the bilge pump lines and pump be flushed with clean water and bilge cleaner.

2.8 STEERING SYSTEM

Steering control for the NORDHAVN 50 is from either the pilot house or fly bridge and is provided by a self contained hydro-mechanical system. The system is powered by rotation of the pilot house or fly bridge steering wheel which pumps hydraulic fluid thru copper tubing to one of two ports on a single slave cylinder connected to a linkage arm attached to the rudder post. System valves and connecting tubing/hoses and manifolds are arranged so that rotating the steering wheel in the desired direction moves the rudder in the corresponding direction. Mechanical rudder locks are provided to limit the rudder position angle to approximately 30 degrees in both the port and starboard directions. In addition, the vessel is equipped for emergency operation using a tiller bar to manually operate the rudder in the unlikely event the hydraulic system is not available.

In addition to the primary steering system, maneuvering control is provided by the bow thruster. Refer to Section 2.10 – ANCHOR WINDLASS AND BOW THRUSTER for a description of this component.

2.8.1 System Components & Installation.

1) **Hydraulic Steering Unit**. The hydraulic steering system for the NORDHAVN 50 is a pressurized system made by **HYNAUTIC Marine Systems and Products, Inc.** and consists of the following items: Model H-42 helm pumps mounted on the pilot house and fly bridge helm shafts; a Model R-06 hydraulic fluid reservoir mounted inside the pilot house console; a Model MSV-21 relief valve mounted in the lazerette on the aft bulkhead; a Model K-3-B single slave cylinder located in the lazarette on the steering bracket; and a linkage arm assembly connected to the rudder post in the lazarette. High pressure tubing and hoses direct hydraulic fluid to the slave cylinder from the hydraulic steering pumps. A bypass valve is installed at the slave cylinder that bypasses the slave cylinder when using the emergency tiller.

   The steering pump is attached to the helm shaft and turning the 24” diameter helm wheel pumps hydraulic fluid to the corresponding side of the slave cylinder which drives the rudder linkage in the desired direction. Reversing the direction of the helm wheel redirects the hydraulic fluid to the opposite side of the slave cylinder moving the linkage arm and rudder in the opposite direction. When operating correctly, the wheel will require approximately 6.2 full turns from right rudder lock to left lock. The operation should be smooth and positive.

2) **Rudder.** The rudder assembly consists of a ½" thick 304 stainless steel plate core with lightening holes attached on one edge by 2 ¼" diameter stainless steel rudder stock which forms the post of the rudder. The plate and post portion of the assembly is encapsulated by a molded and shaped reinforced fiber glass shell.

The rudder is mounted on the vessel centerline directly astern of the main propulsion propeller with the lower rudder post extension fitted into a two piece bronze carrier shoe. The main piece of the rudder carrier shoe is bolted to the hull. The aft piece is removable so that the rudder can be removed. The upper rudder post extension penetrates the hull into the lazarette and through a collar bearing attached to a stainless steel bracket. The hull penetration is equipped with a cutlass bearing and a bronze stuffing box above the cutlass bearing. The hydraulic steering system linkage is clamped to the rudder post above the collar bearing. The collar bearing prevents lateral movement of the upper rudder post.

The emergency rudder tiller is mounted in lazarette and when necessary is inserted over the upper end of the rudder post. A removable deck plate cover in the cockpit is provided for tiller access to the top of the rudder post.

2.8.2 Steering System Operations

1) **Adding Fluid and System Bleeding.** It is extremely important that the steering system be properly and totally purged of air for proper operation. The procedure is explained in the Hynautic steering system manual but several important points are repeated here. Use Hynautic steering oil or light viscosity oil that meets the aircraft hydraulic fluid spec Mil-H-5606, such as Texaco #15, Exxon Univis J-13, Castrol AWH-15, Castrol Aero-585-B, or Shell Tellus 15. Heavier oils, such as automatic transmission oil Type A or Dextron II, may be used but will cause harder steering.

Adding Fluid. If there is any indication of air in the steering system, it may be necessary to first add fluid before bleeding the steering system. **The fluid level in the reservoir should be at least half full as indicated on the reservoir sight glasses.** The following steps provide guidance for adding fluid:

- Depressurize the air pressure in the reservoir through the bicycle tire-type air valve on top of the reservoir.
- Remove the fill plug on the top of the reservoir.
- Add clean hydraulic fluid to the reservoir to the half to two-thirds full mark and replace the fill plug.

- Using a tire type air pump, slowly re-pressurize the reservoir through the air valve to 20-30 psi as indicated on the reservoir pressure gauge.

System Bleeding. The steering system is purged of air and checked for leaks before delivery. System filling and purging as a result of major repairs where the system is drained of fluid may require the assistance of a competent technician. The following purging steps is a process by which the pilot house helm and autopilot are sequentially operated to pump oil into the hydraulic lines, displacing the air-infiltrated oil out through the relief valve and into the reservoir where the air separates from the oil. Oil from the bottom of the pressurized reservoir is then fed back to the helm pumps and autopilot pump through the supply line as needed.

- Verify the system pressure at the reservoir gauge behind the control console is 20-30 psi.

- Check for oil leaks at the hose connections at the pilot house and fly bridge helm pumps, the reservoir, and the relief valve and tighten as necessary.

- Go to the lazarette and inspect the hose connections at the slave cylinder and the autopilot pump and tighten as necessary.

- Open the bypass valve at the slave cylinder. This will allow the helm to be rotated freely.

- Go to the pilot house helm and slowly turn (2 to 3 sec/rev) 60 times in one direction. Repeat this for the fly bridge helm.

- Start the autopilot pump and manually direct the autopilot in the same direction as the previous step and allow it to run for 1 to 2 minutes.

- Check the reservoir pressure and oil level. If the oil level is below the half full mark, exhaust the air pressure through the air valve, remove the oil fill plug, refill to the half to two-thirds mark, and replace the fill plug. Re-pressurize to 20-30 psi.

- Go to the helm and turn the wheel slowly 60 turns in the opposite direction. Repeat this for the fly bridge helm.

- Start the autopilot pump and manually direct the autopilot in the same direction as the previous step and allow it to run for 1 to 2 minutes.

- Check the reservoir pressure and oil level and adjust as before.

- Close the slave cylinder bypass valve.

- Go to the pilot house helm and turn in one direction until a hardover is felt.

- While counting the number of wheel revolutions, turn the wheel in the opposite direction until a hardover is felt.

- Go to the fly bridge helm and turn in one direction until a hardover is felt.

- While counting the number of wheel revolutions, turn the wheel in the opposite direction until a hardover is felt.

- Verification of a complete purge is accomplished if the number of turns is within one-half turn of 6.2 turns hardover to hardover. If the number of turns exceeds this amount, repeat this procedure.

- If the number of turns is correct, check the reservoir for fluid level and pressure. Leave the reservoir one-half to two-thirds full and at 20-30 psi.

2) Emergency Tiller Use.

In the unlikely event of a steering system failure, the boat is equipped with an emergency tiller stowed in the lazarette. In order to use the emergency tiller, the bypass valve on the steering system manifold in the lazarette must be open which allows the fluid within the slave cylinder to bypass the steering wheel pump. If the steering failure is a result of a faulty steering pump or the loss of hydraulic fluid, the bypass valve will allow the rudder to swing without much resistance. If the failure is a result of a failed slave cylinder and the opening of the bypass valve does not free the rudder, it may be necessary to uncouple the slave cylinder from the rudder arm. The emergency tiller is constructed of stainless steel and can be used with the lazerette hatch open or closed. A deck plate is provided for use when the hatch is closed.

3) Rudder Removal

Removal of the rudder or replacement of the rudder post cutlass bearing should not be necessary as a part of normal maintenance. The cutlass bearing is subject to very little wear and it should last for many years. To remove the rudder, the steering linkage arm is unbolted and removed, the set screw backed out of the inner race of the bearing, and the packing gland follower backed off from the stuffing box. The rudder is then rigged for support and the bronze rudder shoe unbolted and removed from the keel. The rudder will then drop downward and clear of the hull. With the rudder removed, the cutlass bearing can be removed and replaced. Rudder assembly is performed

by reversing the above sequence. During re-assembly, replace the stuffing box packing material using 7/16” packing material.

Maintenance of the rudder bearing at the steering arm linkage is minimal and requires pumping with a water proof grease at least once a year.

2.9 STABILIZER SYSTEM

To optimize personnel comfort and vessel operating efficiency, the NORDHAVN 50 design incorporates an effective and reliable **NAIAD MARINE SYSTEMS Model 252 Fin Type Stabilizer System**. The stabilizers minimize the tendency for the boat to roll when operating in moderate to heavy seas. The system is a completely automatic hydro-mechanical system utilizing gyroscopic controlled actuators that rotate the angle of fins installed on both sides of the hull to counter the boat's tendency to roll. As soon as the vessel begins to roll, the sensitive turbine-driven hydro-mechanical gyroscope responds to the rate of movement by applying a calibrated amount of corrective angle to the fins. The fins operate in rotational unison, either clockwise or counterclockwise. The pressure of the water running past the angled fins produces exactly the desired amount of lift force required to generate an equal and opposite righting moment to reduce or neutralize the roll.

The NAIAD Model 252 stabilizer system utilizes any SAE 10W-40 oil as the hydraulic medium and consists of a vane pump, a pressure filter assembly, two fin actuator assemblies, a fluid conditioner assembly with integral hydro-mechanical gyroscope, a control switch assembly, and interconnecting plumbing and wiring.

2.9.1 System Components and Installation

1) **Fluid Conditioner and Gyroscope Assembly.** The fluid conditioner and gyroscope assembly is the main controlling device for the stabilizer system. The assembly includes a reservoir (10 quarts capacity) and low-level warning switch, a heat exchanger for cooling the hydraulic fluid, a pressure relief valve set at 1250 psi for maintaining system pressure, a system pressure gauge, an electrical solenoid valve for controlling the modes of operation, and passages and orifices for controlling the hydraulic system. The hydraulically driven gyroscope assembly senses the roll rate of the boat and converts this input to a fully proportional hydraulic pressure signal. The produced signal is received by a servo valve at each fin actuator which responds by positioning the fin to the proper angle. The fin movement ceases when the gyroscope control no longer senses vessel roll in that direction and the fins then begin to return to the neutral position in anticipation of the impending roll tendency in the opposite direction. Cooling of the hydraulic fluid is provided by the main engine raw water cooling pump. A portion of the main engine raw water cooling flow is diverted to the heat exchanger integral to the fluid conditioner and is then discharged overboard.

   The fluid conditioner, gyroscope assembly and pressure filter assembly are mounted on the port side of the engine room just aft of the forward bulkhead. The cooling water overboard thru-hull valve is in the forward end of the engine room port side.

2) **Pump**. The stabilizer system utilizes a NAIAD supplied fixed displacement hydraulic vane pump mounted to the forward power takeoff of the main propulsion engine. The pump is in operation when the main engine is running and delivers hydraulic oil to the pressure filter assembly at a pressure of approximately 1000 psig.

3) **Fin and Actuator Assemblies.** The port and starboard fin and actuator assemblies are installed amidships and mounted perpendicular to the hull with the fin extremities within the vessel's beam and draft to eliminate docking and shallow water navigation problems. The fins have an area of 7.5 square feet and are constructed of high-density foam encased in a heavy fiberglass shell. These materials surround a stainless steel insert which mates with the precision taper stainless steel shaft extending from the actuator assembly. This construction provides a rugged fin yet allows the structure to yield to severe impact, such as may be experienced during grounding.

   The NAIAD model 252 actuator assemblies consists of a strong housing into which are assembled a pair of heavy-duty roller bearings and a heat treated stainless steel shaft. A double acting hydraulic cylinder and splined torque arm deliver power to rotate the shaft and fin in response to pressurized oil from a precision servo valve. The servo valve is fully modulated by a differential hydraulic pressure signal from the gyroscope roll sensing device. A simple mechanical lock provides a means for securing the fins in their neutral position when the stabilizer will not be used for extended periods, or for maintenance. Double shaft seals prevent entry of seawater into the bearings. Grease inside the actuator lubricates the tapered roller bearings which support the actuator shaft. The NAIAD actuators are located in the engine room port and starboard sides just aft of the forward bulkhead.

4) **Pressure Filter Assembly**. Hydraulic fluid flow from the pump is directed to a housing containing a fine 3 micron pressure filter. The filter is considerably oversized to allow for years of service. The assembly includes a dirt alarm which indicates when it is necessary to change the element.

5) **Control Panel Assemblies.** NAIAD stabilizer control panels are located on the pilot house and fly bridge consoles. The panels are powered by the STABILIZERS circuit breaker on the 12 VDC SERVICE panel.

   Pilot House Control Panel. The pilot house panel is the master control panel and includes the following items: a three-position **STABILIZER** rocker switch that provides power to the solenoids of the three-position directional valve on the fluid conditioner assembly; port and starboard fin position indicators; red pushbutton warning lights to indicate a low level and high temperature in the reservoir respectively (PUSH to TEST); and.a two position **LOCATION** rocker switch for transferring control to the fly bridge panel. The **STABILIZER** switch

positions are **CENTER, OFF and ON**. With the control switch positioned to CENTER, the system is hydraulically pressurized and holds the fins in their centered position. With the control switch positioned to ON, the system and gyro circuits are energized and the fins respond to roll motion. In the OFF, position the system is de-energized and fluid delivered by the hydraulic pump is returned to the reservoir at low pressure. The **LOCATION** switch positions are **MAIN and AUX**. With the switch positioned to MAIN, control of the stabilizers is from the pilot house. With the switch positioned to AUX, control is from the pilot house.

Fly Bridge Control Panel. The fly bridge panel includes***:*** a two position **STABILIZER** rocker switch labeled CENTER and ON and red pushbutton warning lights to indicate a low level and high temperature in the reservoir respectively (PUSH to TEST). In the ON position, the system and gyro circuits are energized and the fins respond to roll motion. In the CENTER position, the system is hydraulically pressurized and holds the fins in their centered position. The red warning light is illuminated for both low level and high temperature in the fluid reservoir.

2.9.2 Stabilizer Operation

1) Starting the System.

- Verify that the mechanical locking pins are removed from the stabilizer actuators – if installed – and are properly stowed. **IMPORTANT NOTE: Operating the stabilizer with the pins installed may cause severe damage to the actuators.**

- Open the hydraulic fluid cooling water overboard discharge valve located in the forward end of the engine room port side. This valve can be left in the open position.

- Start the main engine.

- Place the stabilizer control panel operating switch in the OFF position.

- Energize the stabilizer control panel operating switches by closing the STABILIZERS breaker on the 12 VDC SERVICE panel bus.

- Position the pilot house MAIN/AUX control switch in the **MAIN** position.

- Place the pilot house control panel operating switch in the **ON** position and verify that the system and gyro pressure gauges indicate appropriate hydraulic pressure.

NOTE: An abnormally high gyro pressure usually indicates that the system is cold. Low system and gyro pressure is normal when the pump is running at low rpm such as when engines are idling. Lack of system pressure may indicate an electrical disconnection at the solenoid valve, a relief valve malfunction, or loss of pump prime.

- **To shift control to the fly bridge**, position the pilot house MAIN/AUX control switch in the **AUX** position then position the fly bridge control switch to **ON**.

2) Use of Operating Switch Positions.

ON - This switch position commands the system to operation mode. The NAIAD stabilizer system will automatically respond in proportion to varying sea conditions and hull speeds by continuously angling its fins to a greater or lesser degree according to sea conditions. Maximum roll reduction performance is achieved with minimal effort, power consumption, and fin drag. Most owners leave the system in this mode at all times while underway.

WARNING: Do not switch to ON while at cruising or higher speed because a momentary list may occur before the gyroscope attains its operating speed.

OFF - This switch position commands the system and gyro to depressurize. Use this position when the vessel is secured to conserve battery drain through the solenoid valve.

WARNING: Do not use this position when underway unless the mechanical actuator lock pins are engaged to hold the fins centered.

CENTER - This switch position commands the system to be hydraulically pressurized and the fins to be locked in their neutral position. In this mode the gyroscope remains depressurized. Always use this mode while maneuvering, especially astern. This position is often used when leaving port to warm the system prior to the ON mode.

WARNING: Be sure to switch control panel to CENTER mode before maneuvering, especially astern.

3) Securing the System.

- At the NAIAD Control Panel place the fins in the CENTER position.

- Stop the main engine per section 2.1.

- **For anchoring the boat**, if the boat is at anchor longer than 24 hours OR in rough anchorage waters, the stabilizer locking pins should be installed. An alternative to installing the locking pins is to periodically start the main engine, place the stabilizers in operation in the CENTERED position and then secure the system.

  IMPORTANT NOTE: It is strongly suggested that a "LOCKING PINS INSTALLED" tag be placed on the stabilizer controller whenever the pins are installed as a reminder to remove the pins. Operating the stabilizer with the pins installed may cause severe damage to the actuators.

2.9.3 Maintenance

The NAIAD stabilizer system is designed to function for many years with minimal attention. As with any new precision equipment, malfunctions sometimes appear during the first few weeks of operation. Generally these relate to oil leaks, system contamination, or gyro calibration. Routine maintenance may be performed by the owner or local mechanic. Service problems, however, should be referred to the nearest NAIAD representative or the NAIAD factory for consultation.

The routine maintenance activities listed below are topical and the indicated frequency for conducting these activities is minimal. Consult the NAIAD owner's manual for details regarding these maintenance activities.

1) **Oil Level.** Maintain reservoir level near the mid to three-quarter level mark (cold). Use a quality SAE 10W-40 multigrade oil. Change reservoir oil every three years or after 4000 hours of use.

2) **Bonding** (yearly). Check the actuators to be sure they are properly attached to the vessel's electrical bonding system.

3) **Oil Filter** (yearly). Check the condition of the filter with the system pressurized. If it is approaching the red area, replace the filter.

4) **Oil Leaks** (yearly). Check for oil leakage around pumps, gyro, fluid conditioner, reservoir and filter.

5) **Actuators** (yearly). Check for evidence of oil leaks at the hydraulic cylinder rod, feedback and around the actuator casting. Check the torque of the eight ½ inch mounting bolts to 50 foot-pounds. With a pressure oiler, direct a stream of oil into the trunnion areas above and below the cylinders and between the torque arm and the cylinder rod end.

6) **Fluid Conditioner** (yearly). Check the mounting is securely attached to the bulkhead. Check for watertight connections (170 degree maximum temperature) and system pressure (1000 psig not to exceed 1250 psig).

7) **Gyroscope** (yearly). Check the following for normal operation:

- **Pressure** – 300 to 700 psig (500 normal) with the system ON and warmed to 120 – 140 degrees
- **Coast Down** – With the system ON and warm, stop the main engine and listen to the gyro as it coasts down. It should emit a high-pitched whine without any gravely rumble. Any sound other than a high-pitched whine may indicate the gyro orifice is plugged or out of position. A grinding sound may require replacement.

8) **Hoses** (yearly). Check the system hoses for chafing and overall wear.

9) **System Checks** (yearly). Check the following for normal operation:

- **Centering check**. With the system in CENTER mode and warm, check alignment of the center mark on the actuator torque arm with the middle of three projections on the cover. Alignment should be within one mark.
- **Gyro centering check**. Repeat the above with system ON and warm. Slow movement each side of center usually indicates slight wave motion.
- **Actuator movement check**. If the vessel can be rolled at the slip or under way, an inch or two of actuator response should be apparent both actuators moving clockwise to starboard and counterclockwise to port.

10) **Lower Seals.** Replace the actuator seals every three years or 4000 hours of operation or at any convenient time the vessel is hauled out of water. This interval should be shortened if the actuator shafts are not regularly cycled (at least bimonthly).

2.10 ANCHOR WINDLASS AND BOW THRUSTER SYSTEM

The Anchor Windlass and Bow Thruster Systems are installed to assist with anchoring and close quarter maneuvering like docking. The system consists of motorized anchor windlass and bow thruster assemblies, controllers, and associated wiring.

2.10.1 System Components and Installation

1) **Anchor Windlass.** The electric motor driven anchor windlass is a **MAXWELL Model VWC 3500** vertical capstan windlass rated for a maximum pull of 3500 lbs and a 3/8" High Test chain . The installation is designed for dual direction operation using a 24 VDC motor powered from the main engine 24 volt alternator and main engine 24V starting batteries. A PUSH/PULL type power disconnect switch is provided to isolate the windlass motor from its 24 VDC alternator and battery power supply. The disconnect switch is located on the forward side of the master stateroom berth. The windlass capstan is located on the bow deck and the motor is below deck in the chain locker. The windlass design features integral chainpipe and stripper aligned for jam free operation providing automatic feed of chain to and from the locker.

2) **Anchor Windlass Controls.** Operation of the windlass can be performed using locally (bow) mounted MAXWELL UP and DOWN foot switches or either one of a MAXWELL panel type controller mounted on the pilothouse and fly bridge consoles. The local footswitches mounted on the bow deck are Maxwell heavy duty weather resistant switches with anchor chain direction clearly indicated on the switch hinged covers. The pilot house and fly bridge panels consist of a single UP/DOWN toggle switch and a red power supply indicating light. Anchor up and down directions are clearly indicated on the controller face. Power to the control panels and foot switches is from the WINDLASS circuit breaker located on the 24 VDC SERVICE bus included on the 12 VDC SERVICE panel. For safety and positive control of the anchor movement, the UP and DOWN switches at each control station are spring loaded to return to a neutral position when released. The capstan is also capable of manual (non-motorized) operation by disengaging or loosening the clutch using the provided winch handle (see Operation, Section 2.10.2).

3) **Bow Thruster Assembly.** The bow thruster assembly provides vessel maneuvering ability for docking, undocking and other situations where added vessel control is desired. The electric motor driven bow thruster is a **TRAC 10" Model** supplied by **AMERICAN BOW THRUSTER.** The thruster assembly features a dual 10" propeller designed for dual direction operation by a single speed, 10 hp, 24 VDC motor powered from the 24 volt alternator on the main engine and main engine starting batteries. The motor is energized by an ON/OFF type power disconnect switch located on the forward side of the

master stateroom berth. The location of the bow thruster motor is in the forward bilge compartment under the guest head. Access to the compartment is by a removable hatch cover in the head. An oil filled header tank is provided at the bow thruster to maintain positive fluid pressure inside the thruster gearbox to prevent sea water intrusion. Although rare, the most probable source of a leak is through the thruster shaft seals**.** The location of the bow thruster header tank is inside the guest head sink cabinet.

WARNING: The fluid in the header tank should be monitored on a regular basis and must be kept half full. ABT recommends using Chevron Delo Gear Lubricant SAE 80-90. An equivalent SAE 80-90 gear lubricant is permitted if the Chevron product is not readily available.

4) **Bow Thruster Controllers**. Operation of the bow thruster is from either the pilot house or fly bridge control console by using an ABT Thruster Control Station panel at each station. The panels consist of a joy-stick type lever and ON and OFF touch pad switches. Power to the controllers is from the BOW THRUSTER circuit breaker located on the 24 VDC SERVICE bus included on the 12 VDC SERVICE panel. Depressing the ON touch pad switch at either location enables **BOTH** controllers and illuminates the POWER ON light on each controller. Depressing the OFF touch pad at either station disables both controllers. The joy-stick is normally in a vertical or neutral position corresponding to an idle thruster motor. Positioning AND maintaining the joy-stick left or right from the neutral position starts the constant speed motor to move the bow in the corresponding direction as the joy-stick lever. The momentary joy-stick lever when released will spring back to the neutral (vertical) position stopping the motor.

2.10.2 Anchor Windlass and Bow Thruster System Operation. Operation of the anchor windlass and bow thruster is straightforward and relatively simple and requires very little preparation. The following sections illustrate the required minimal actions.

REMINDER: **Both the anchor windlass and bow thruster use a large amount of electricity. The operator is advised to run the main engine when either component is to be used so the engine 24 volt alternator provides power to the units instead of draining the main engine starting batteries. When the main engine is not running, the boat generator and the 24 volt battery charger should be used to power either component.**

1) **Anchor Windlass Operation.** When use of the anchor windlass is not required or anticipated, it is recommended that the disconnect switch on the forward side of the master stateroom berth be left in the OFF position. This will prevent inadvertent operation of the windlass assembly. Operation requires the following actions:

CAUTION: The anchor windlass is a very powerful piece of equipment and misuse by untrained personnel, particularly from the bow control station, can result in injury. All personnel unfamiliar with its operation should stand clear of the bow during anchoring maneuvers.

RECOMMENDATION: Mark the anchor chain at 20 feet and 6 feet to enable the operator to judge when the anchor is almost up. Going gently the last few feet of retrieving will prevent the anchor from "flying up" over the roller, banging tight, and putting excessive load onto the roller, windlass, and foredeck.

- **With the main engine running**, TURN ON the anchor windlass disconnect switch by depressing the red push button (PUSH = ON) at the windlass panel disconnect switch on the forward side of the master stateroom berth.

- TURN ON the WINDLASS circuit breaker on the 24 VDC SERVICE panel bus. The sub panel is located on the lower right corner of the 12 VDC SERVICE panel on the pilot house console face. The red "power on" light on the windlass controllers will be lit.

- Lower or raise the bow anchor by depressing the DOWN or UP foot switch located at the bow or by positioning the toggle switch on the pilot house or fly bridge controller to DOWN or UP. The control switches at each location must be held in the desired position. Releasing the switches will stop anchor movement and hold the anchor in a static position. **NOTE**: Manually lowering of the bow anchor without the motor can be accomplished but is generally used in tight anchorages or an emergency situation, where a fast dump is required. The windlass is also equipped with an emergency crank facility for manually raising the anchor. Refer to the MAXWELL Instruction manual for details on each of these operations.

  SUGGESTION: To avoid overloading and wear and tear, it is suggested that once an anchor is set on the bottom, tie the chain off using a bridle, cleat, or other method of securing the chain so that you can "unload" the windlass.

- When operation of the anchor windlass is no longer required position the windlass disconnect switch in the master stateroom to OFF (PULL = OFF).

- TURN OFF the WINDLASS circuit breaker on the 24 VDC SERVICE panel.

2) **Bow Thruster Operation**. When use of the bow thruster is not required or anticipated, it is recommended that the disconnect switch in the master stateroom be left in the OFF position. This will prevent inadvertent operation of the thruster assembly. Operation requires the following actions:

- **With the main engine running**, TURN ON the bow thruster disconnect switch at the bow thruster panel on the forward side of the master stateroom berth.

- TURN ON the BOW THRUSTER circuit breaker on the 24 VDC SERVICE sub panel bus. The bus is located on the lower right corner of the 12 VDC SERVICE panel on the pilot house console.

- Depress the ON touch pad switch on the Thruster Control Station panel on the pilot house **OR** fly bridge console. The GREEN light will illuminate at each panel indicating thruster control is available.

  WARNING: The MAXIMUM continuous running time is 3 minutes followed immediately by 15 minutes rest before the next use. The operator is advised to make brief, pulsing type movements with the bow thruster when maneuvering in locations where space is limited so as not to potentially damage the vessel by excess movement.

- Initiate operation of the bow thruster by positioning AND holding the controller joy-stick lever in the desired direction the bow is to be moved.

  IMPORTANT NOTE: Avoid simultaneous operation of the bow thruster from the pilot house and fly bridge control panels. Conflicting demands may cause damage to the bow thruster assembly and uncontrolled movement of the vessel.

- When operation of the bow thruster is no longer required depress the STOP touch pad switch on either thruster control station panel. The POWER OFF light will illuminate at each controller.

- TURN OFF the disconnect switch in the master stateroom.

- TURN OFF the BOW THRUSTER circuit breaker on the 24 VDC SERVICE panel.

2.10.3 Anchor Windlass and Bow Thruster System Maintenance. Once placed in service, the MAXWELL anchor windlass and the TRAC bow thruster will provide years of service with minimal attention. Service problems, however, should be referred to the nearest Maxwell or ABT representative or the respective factory for consultation. The routine maintenance activities listed below are topical and the indicated frequency for conducting these activities is minimal. Consult the

applicable owner's manual for additional requirements and details regarding maintenance activities.

1) **Anchor Windlass.** Refer to the MAXWELL Instruction Manual for drawings and specific instructions on windlass disassembly.

   - Prior to Season - the above deck components should be removed and greased and the oil level in the gearbox topped off as necessary. The under-deck components should be sprayed with CRC 3097 "Long Life".

     Recommended Lubricants:

Gearbox Oil:	SAE 90, e.g. Shell Omala 320, Castrol Alpha SP 320
Mainshaft & Bearing:	Marine grease, lithium based or lithium complex based, e.g. Duckhams "Keenol"; Castrol LMX. Do not used soap based grease.
Above Deck Components:	CRC 3097

   - Bi-Monthly throughout the Season – grease the main bearing.

   - Six monthly and/or End of Season – repeat the "Prior to Season" items above.

   - Above deck components – clean the windlass with a cloth damp with Kerosene (paraffin). Spray preferably with CRC 3097 "Long Life" or alternatively, CRC6-66 or WD40. Polish off with clean non-fluffy cloth.

2) **Bow Thruster.**

   - Thruster Motor Header Tanks. Periodically Insure oil level is at least half full. Use ONLY Chevron Delo Gear Lubricant SAE 80-90, or equivalent.

   - Thruster Motor Shaft Seals. Inspect shaft seals at every haul-out and replace as required.

   - Check the quality of the oil in the head tank line to the thruster and drain if necessary. The oil drain plug under the anode copper joint at the bottom of the leg housing should be changed.

- Frequently check the condition of the anode at the bottom of the leg housing and replace if necessary (the anode should be changed every year as a minimum).

- Coat the leg and propellers with antifouling paint. Do not paint the anode.

- Periodically check for obstructions, such as fishing line, in the propellers.

2.11 AIR CONDITIONING & HEATING SYSTEM, ENGINE ROOM VENTILATION SYSTEM, AND HEAD EXHAUST SYSTEM

The **Air Conditioning & Heating System** is comprised of four (4) independently operated, thermostatically controlled, air recirculation loops each consisting of a compressor assembly and fan coil assembly (air handler), connecting ducting, tubing, controllers and wiring. The compressors operate on a R-22 refrigerant cycle and are capable of providing both cool and heated air. Separate loops are provided for the following areas: pilot house; salon; master stateroom; and guest staterooms. A sea water pump shared by all the air conditioning units is provided for cooling the air conditioner condensers. Separate power supplies for each air conditioning unit and the shared cooling water pump are provided by circuit breakers from the 120/240 AC SERVICE panel AIR CONDITIONING bus.

The **Engine Room Ventilation System** provides outside ambient air to the engine room for equipment cooling and diesel engine combustion air. The system is comprised of two (2) exhaust blowers.

The **Head Exhaust System** provides a small fan in the master stateroom head to remove moisture laden air and odors from the head. The forward guest head is not equipped with an exhaust fan.

2.11.1 Air Conditioning & Heating System Components and Installation

1) **Compressor and Air Handler Assemblies**. The compressor assemblies are **CRUISAIR Direct Expansion Condensing Units Type F Models** and operate on a refrigerant cycle in either a cooling or heating mode. Each assembly includes a dependable reciprocating compressor, a copper nickel condenser, reversing valve, refrigerant receiver and other electrical and mechanical components on a single chassis with rubber, vibration-isolating mounts. The air handler units are **CRUISAIR Direct Expansion Cooling/Heating Units Model EHBO**. These units consist of an evaporator coil, refrigerant line connections, condensate drain pan and a high-efficiency squirrel-cage blower which pulls air across the evaporator coils. The four (4) compressor assemblies are located on the port and starboard sides of the lazarette and the air handler/fan coil assemblies are located in or near the compartments served by their respective compressor (see below). In the cooling mode, pressurized R-22 from the compressor assembly is transformed to a cool gas at the air handler expansion valve then enters the air handler cooling coils. A fan draws air from the served compartment and discharges across the coils thereby cooling the air. The cool, “conditioned” air is then discharged back to the compartment. The R-22 gas returns to the compressor and is re-pressurized and cooled to a liquid by the sea water thus completing the cycle. In the heating mode, the cycle is reversed and the R-22 passing

through the air handler coils is warmer than the ambient temperature thus heating the desired area. Data for each air conditioner assembly is as follows:

Pilot House.

Compressor:	Model:	FN12C-P
	Capacity:	12,000 BTU, 6.7 amps
	Location:	Lazarette, stbd side
Air Handler:	Model:	EHBO12C
	Capacity:	12,000 BTU, 1.6 amps, 1.5 kW heat
	Location:	Inside pilot house settee, inboard side

Salon.

Compressor:	Model:	FN24C-P
	Capacity:	24,000 BTU, 8.6 amps
	Location:	Lazarette, port side
Air Handler:	Model:	EHBO24C
	Capacity:	24,000 BTU, 3.0 amps, 2.0 kW heat
	Location:	Beneath settee, port side

Master Stateroom.

Compressor:	Model:	FN10C-P
	Capacity:	10,000 BTU, 6.0 amps
	Location:	Lazarette, port side
Air Handler:	Model:	EBO10C
	Capacity:	10,000 BTU, 1.5 amps, 1.5 kW heat
	Location:	Inside pilot house settee, outboard side

Guest Stateroom:

Compressor:	Model:	FN10C-P
	Capacity:	10,000 BTU, 6.0 amps
	Location:	Lazarette, stbd side
Air Handler:	Model:	EBO10C
	Capacity:	10,000 BTU, 1.5 amps, 1.5 kW heat
	Location:	Inside stairs cabinet, stbd side

2) **Cooling Water Pump**. The air conditioning cooling water pump is a **CRUISAIR Model P1500BXT** centrifugal type with a capacity of approximately 1500 gph. The pump takes suction from the sea through a strainer, delivers flow to each of the air conditioner unit compressors via a manifold, and discharges overboard via individual lines. The pump is powered by the PUMP circuit breaker on the 120/240 AC SERVICE panel AIR CONDITIONING panel. Pump start is controlled by a pump start relay panel that automatically

starts the pump when any of the compressors is started. The pump, inlet valve, strainer, and discharge manifold are located in the lazarette just aft of the forward bulkhead port side. The overboard discharge valves from the air compressor assemblies is via two thru-hulls in the lazarette one each on the port and starboard sides aft.

3) **Temperature Controllers.** Each of the air conditioner units is provided with a **CRUISAIR Temperature Controller, Model SMXir** conveniently wall mounted within the area service by the loop. The controllers provide the capability to operate in either an automatic or a manual mode. Specifically designed for the marine environment, the SMXir features a plastic housing, sealed membrane keypad, and electronics with anticorrosion coating. The SMXir displays the space temperature and setpoint in a large, easy to read display and is also used to give information on operating parameters and fault code warnings. The controller microprocessor is supplied with factory settings that may be changed with user-programmable commands to fine-tune the system for personal preference. Programmable features include:

   - AC line voltage calibration
   - Temperature calibration
   - Compressor restart time delay
   - Continuous or intermittent fan operation
   - Low and high fan speed adjustment
   - Compressor response differential
   - Fahrenheit or Celsius temperature display

4) **Pump Start Relay**. The air conditioning cooling water pump is automatically started and stopped by a **CRUISAIR Model PR 8X-4C Pump Relay**. When any of the air conditioner units is started, the relay is actuated to start the cooling water pump. When more than one unit is running, the cooling water pump will continue to run until all of the units are stopped by its respective controller. The relay panel is mounted on the lazarette forward bulkhead above the air conditioning cooling water pump.

2.11.2 Air Conditioning & Heating System Operation

Normal operation for the air conditioning & heating system requires the generator to be in service (underway) or shore power. When required, operation of the air conditioner unit(s) for each space is performed by using the SMXir temperature controller by turning the controller ON and selecting the desired setpoint. The operator can select cooling only, heating only, or automatic changeover between cooling and heating. Fan speed is automatically controlled, or can be manually set. Instructions for the operation of the system are quite extensive and are thoroughly explained in the CRUISAIR SMXir instruction manual. The operator should read and be thoroughly knowledgeable with the CRUISAIR manual before operating the system. Additional instructions for routine operation are as follows:

- Start the boat generator (see Section 2.14).

- Verify the cleanliness and/or clean the sea strainer to the air conditioning cooling pump. The strainer is located in the lazarette on the forward bulkhead port side

- Open the air conditioning cooling pump suction thru-hull connection located under the center deck plate in the lazarette.

- Open the discharge thru-hull connections for the pilot house, salon, master and guest staterooms air conditioner units. The two discharge thru-hull connections are located outboard of the air conditioner compressors in the lazarette. These valves are normally left in the OPEN position.

- TURN ON the following circuit breakers at the 120/240 VAC 60HZ panel AIR CONDITIONING bus:

  A/C PILOT HOUSE
  A/C SALON
  MASTER CABIN
  GUEST A/C CABIN
  A/C PUMP.

- For the desired compartment, open the coverage door on the SMXir controller and depress the ON touch pad button and then depress the COOL (for cooling) or HEAT (for heating) touch pad button.

- **For AUXILIARY heating utilizing the electrical heating strip integral to the air handler**, depress the HEAT pushbutton a second time. The HEAT led will slow flash indicating the auxiliary heating strip ONLY is in operation.

- Increase or decrease the desired temperature setpoint at the SMXir controller by depressing the UP or DOWN touch pad until the desired temperature is indicated on the controller digital display window. The air conditioner unit(s) will start and start to control the specified temperature.

- To shutdown the air conditioner(s) for a specific zone/space, depress the OFF touch pad at the applicable SMXir controller(s). TURN OFF the circuit breaker(s) for the A/C unit(s).

2.11.3 Engine Room Ventilation System Components and Installation

1) **Engine Room Exhaust Blowers**. The two engine room exhaust blowers are **DAYTON, Model 4C846**, squirrel cage fans with a rated capacity of approximately 200 cfm. The fans draw air from the engine room air space thereby inducing outside air into the engine room through louvered vents on the starboard and aft sides of the salon and discharge to the outside through the engine room side vents. The fans are operated by the ENGINE ROOM BLOWERS circuit breaker on the 120VAC INVERTER panel.

   Operation of the fans induce outside air into the engine room to maintain a fresh environment by removing hot, stale air, cool operating equipment, provide combustion air for the diesel engines, and to establish a slight negative pressure in the engine room compartment relative to the other boat compartments. This negative pressure prevents undesirable engine room odors from escaping into personnel occupied spaces.

2.11.4 Engine Room Ventilation System Operation.

CAUTION: Actuation of the engine room FIREBOY fire suppression system energizes a switch that will automatically stop the main propulsion engine, wing engine, generator and the engine room blowers and close the LPG solenoid valve. This feature is provided to prohibit the introduction of outside air and combustible LPG into the compartment. Refer to Section 2.12 – FIRE SUPPRESSION SYSTEM.

Operation of the engine room blowers while underway is not mandatory but is generally employed to ensure a suitable environment for equipment protection and personnel comfort. If practical, the engine room temperature should be kept under 120 degrees F. For personnel comfort, the blowers should be placed in operation for the anticipated length of time the engine room is to be occupied.

The engine room exhaust blowers are simultaneously started by turning ON the ENGINE ROOM BLOWERS circuit breaker switch on the 120 VAC INVERTER. Turning OFF the circuit breaker stops the blowers.

2.11.5 Head Exhaust Fan Installation and Operation.

1) **Head Exhaust Fan Installation**. One (1) exhaust blower/fan is installed in the aft master stateroom shower stall to remove moisture laden air and odors from the head and shower. The fan is a **DAYTON, Model 2C646** rated for continuous duty. The fan is powered by the AFT HEAD & TANK GAUGE on the 12 VDC SERVICE panel. A timer switch mounted on the inboard bulkhead above the toilet is used to start and stop the fan.

The forward guest head is well ventilated by a hatch to the outside and is not equipped with an exhaust fan.

2) **Head Exhaust Fan Operation.** Operation of the head exhaust fan requires the AFT HEAD & TANK GAUGE circuit breaker at the main 12 VDC SERVICE panel to be in the ON position. Fan start and stop is performed using the locally mounted timer switch.

2.12 FIRE SUPPRESSION SYSTEM

CAUTION: Shipboard fire is one of the most serious events that can be encountered at sea. Constant vigilance and actions to eliminate potential fire hazards is an absolute must when operating a boat. Of particular importance is the necessity of repairing fuel leaks, storing combustible materials such as paints, oily rags and chemicals in fireproof containers, and controlling spark or flame producing activities in areas containing combustible materials.

Fire protection aboard the NORDHAVN is provided by a combination of portable fire extinguishers for the normally occupied spaces and a self actuated fire suppression system for the engine room compartment.

The self actuated fire suppression system for the normally UNOCCUPIED engine room utilizes a pressurized extinguisher bottle that contains environmentally friendly FE-241 extinguishing agent to suppress an engine room fire. In the event of a fire, the extinguisher automatically releases non-combustible, non-fire supporting gaseous FE-241 extinguishing agent to flood the engine room air space displacing oxygen thus putting the fire out. In addition to the self-actuation feature of the FIREBOY systems, the extinguisher is equipped with a remote, manual actuation handle for rapid deployment.

The normally occupied spaces are equipped with standard portable fire extinguishers in areas where fire hazards are most probable. For these spaces, fire detection and combative action is dependent upon the vigilance of on board personnel. Personnel on board must be thoroughly familiar with these locations and the operation of the fire extinguishers.

For added fire protection, all current carrying cables and wires in the NORDHAVN electrical circuits are protected by circuit breakers or fuses sized below the cable/wire amperage rating. However, it is prudent to provide portable extinguishers in, or adjacent to, areas containing electrical components such as the battery and inverter installations.

2.12.1 Fire Suppression System Components and Installation

CAUTION: The FIREBOY Automatic Fire Extinguisher when used improperly or tampered with can be hazardous to personnel. It is important that the owner thoroughly read and understand the Fireboy Owner's Manual before servicing or removing this device.

1) **Engine Room Self Actuating Fire Extinguisher.** The self actuating fire extinguisher for the engine room is a **XINTEX SAFETY SYSTEMS, FIREBOY Clean Agent Fire Extinguisher, Model MA2-900** supplied by Consolidated Marine Products of Grand Rapids, MI. The unit is U.S. Coast Guard Approved in accordance with DOT-E-10180. The MA2-900 contains approximately 30 lbs of FE-241 extinguishing agent pressurized to 200 psig and is rated for fire protection coverage for a volume of approximately 900 cubic feet. The red, vertically mounted, cylindrical extinguisher bottle is installed on the port side bulkhead in the engine room just forward of the wing engine.

2) **System Readiness Indicator & Engine Shutdown Switch.** The FIREBOY engine shutdown system consists of a **FIREBOY Model ES5000-01 Engine Shutdown Relay Module** and a panel mounted **System Status Indicator and Override Switch**. The system is actuated by a pressure switch mounted at the top of the engine room FIREBOY extinguisher that closes when the extinguishing agent is released. The relay module when actuated by the pressure switch, shuts down the main and wing propulsion engines, generator and engine room exhaust blowers and closes the LPG solenoid valve. The relay module is mounted inside the pilot house console forward of the helm. System readiness is indicated on a FIREBOY system indicator and override switch mounted on the pilothouse console. The system indicator has GREEN and RED status lights to indicate the CHARGED and DISCHARGED condition of the extinguisher, respectively. The indicator is also equipped with a two position toggle switch for NORMAL and OVERRIDE operation. The **OVERRIDE position allows restart of the engines and blower** subsequent to actuation of the extinguisher. The FIREBOY system is connected directly to the 12 VDC bus behind the 12VDC SERVICE panel by a fused circuit and is always energized.

   IMPORTANT NOTE: In the event the FIREBOY Engine Shutdown System is actuated in the absence of an engine room fire, to restart the engines and blower the operator should first place the indicator switch in the OVERRIDE position and check the status of the circuit fuse behind the 12VDC SERVICE panel. If the fuse is intact and the engines and blower still do not start, the FIREBOY relay module may be faulty. In this event, to restart the engines and blower access the relay module and install a wire jumper across each pair of NORMALLY CLOSED and COMMON terminals that have wires attached and disconnect the wire lead on each of the NORMALLY OPEN terminals located on the relay module. The module terminals are clearly marked **NC, NO and C** to indicate the type of relay contact. This action will bypass the FIREBOY relay module for the respective engine and blower starting system. For the disconnected wire, wrap the metallic terminal lug on the end of the wire with tape to prevent it from making contact with the relay module terminals.

3) **Manual Actuation Cable.** The FIREBOY extinguisher actuating mechanism is equipped with a cable routed to a location outside of the compartment. The cable end is equipped with a pull ring and retaining pin to manually release the FIREBOY extinguishing agent in the event a fire is visually detected prior to self actuating. The manual actuation location is inside the master stateroom aft closet port side. To manually actuate the bottle, remove the safety pin and pull the ring and cable.

2.12.2 Fire Suppression System Operation.

1) **Actuation**. The self actuating FIREBOY fire suppression system is a passive system and requires no personnel action to suppress a fire. The pressurized FE-241 extinguishing agent is prevented from escaping by a release mechanism at the container nozzle designed to actuate at a temperature above 175 degrees. In the ready state, the FIREBOY Engine Shutdown System indicator toggle switch is in the NORMAL position with the green status light illuminated.

   In the event of a fire in the engine room, the accompanying rise in air temperature actuates the release mechanism causing the FE-241 extinguishing agent to be released into the compartment. The release mechanism will simultaneously actuate the engine shutdown switch system to stop the running engines and exhaust blower. The rapid depressurization of the released FE-241 changes it from a liquid to a gas flooding the compartment and extinguishing the fire. Subsequent to actuation, the red light on the Fireboy system status indicator will be illuminated and alarm initiated.

   NOTE: In addition to the self-actuation feature of the system, a remotely installed, manual pull cable actuator is provided inside the master stateroom aft closet port side. To actuate the FIREBOY system, remove the safety pin and pull the handle.

   CAUTION: DO NOT OPEN OR ENTER THE ENGINE ROOM COMPARTMENT IMMEDIATELY. Keep the compartment closed for a period of time sufficient to allow the FE-241 agent to "soak" all areas of the space. This allows cooling of hot metals. Premature opening of the compartment allows an in-rushing of oxygen and could result in the fire being re-ignited.

2) **Recovery.** Recovery from a fire should be conducted in a deliberate and methodical manner. The following are suggested actions that should be considered:

   CAUTION: FIREBOY FE-241 SYSTEMS ARE INTENDED TO BE USED IN NORMALLY UNOCCUPIED AREAS. FE-241 IS TOXIC IF INHALED IN LARGE QUANTITIES AND WILL DISPLACE OXYGEN. IN

ADDITION, TOXIC BY-PRODUCTS OF FE-241 AND CERTAIN MATERIALS MAY RESULT FROM A FIRE. Refer to the FIREBOY Manual for additional information regarding the use, limitations and hazards associated with FE-241 extinguishing agent.

CAUTION: Do not attempt to restart the diesel engines or engine room intake or exhaust blowers until it has been determined that the fire is completely extinguished. Such action will introduce oxygen into the engine room and potentially re-ignite the fire.

- Subsequent to a fire, it is important to determine that the fire has been extinguished. This may be accomplished by touching the door to the engine room with the BACK of your hand. Continue this action until the door temperature stabilizes or cools to ambient conditions.

  CAUTION: When opening the compartment for inspection, have hand held fire extinguishers at hand and ready.

- Being careful not to enter the engine room and in as short a time frame as possible, open the door and observe the condition of the space. A dark smoky room would indicate a diesel oil, lube oil or hydraulic fluid fire. A white smoke or clear room would indicate an electrical fire and the main electrical panel should be checked to see if any breaker has tripped. Close the door so as not to allow fumes and FE-241 gas to escape.

- **If the fire in the engine room has been determined to be completely extinguished,** start the engine room exhaust blower. Do not start the main engine, wing engine or generator at this time.

- Allow the blower to operate for at least 30 minutes to clear the room of residual FE-241 extinguishing agent, fumes, smoke and other gases.

- Enter the room and conduct an inspection to determine the cause of the fire.

2.12.3 Maintaining the Fire Suppression System.

1) **Daily Inspection.** Inspect the pressure gauge on the top of the extinguisher and the system integrity on a daily basis. The gauge indicator should be in the “green” zone and the release mechanism intact.

2) **Every 6 months.** Remove the Fireboy extinguisher and weigh the complete unit less the mounting brackets. If the weight is below that shown on the nameplate inspect for leaks and return to the factory for recharging.

Recharging of the extinguisher is possible providing the loss of FE-241 extinguishing agent is not due to fire.

Refer to the FIREBOY Owner's Manual for additional instructions on the installation, operation and care of the FIREBOY Suppression System.

2.13 BOAT DAVIT

The NORDHAVN 50 is provided with a hydraulic-electric davit hoist mounted on the boat deck. The davit is primarily used to lower and raise the boat dinghy.

2.13.1 Components and Installation.

1) **Boat Davit**. The boat davit is a hydraulic-electric **ARITEX Model HSC-600S**. The 10 foot boom and pyramid base are fabricated from highly polished stainless steel. The davit in the boom down (horizontal) position is rated for a pull of 1300 lbs and is powered by a hydraulic-electric motor operator and capable of 350 degree power rotation. Power to the electric motor is from the DAVIT circuit breaker on the SHIP 240 VAC bus on the 120/240 AC SERVICE panel. The hydraulic-electric motor supplies hydraulic fluid in high pressure braided hoses to a winch inside the davit frame that operates the 3/8" hoist wire. The davit electric and hydraulic pump package is located in the davit pyramid base enclosure.

2) **Davit Controller**. The davit is controlled by a six (6) pushbutton local controller with a 15 foot length cable extension equipped with a multi-pin connection plug. The controller connector plugs into a covered multi pin receptacle on the rotating end of the davit boom. "U" and "D" pushbuttons are provided for boom and hoist up and down movement and "L" and "R" pushbuttons are provided for boom left and right movement. Each of the pushbuttons is spring loaded to return to a neutral position when released. Boom and hoist movement stops when the applied pushbutton is released.

2.13.2 Boat Davit Operations. Operation of the boat davit is straightforward and relatively simple and requires little preparation. The following are minimum actions required to launch and retrieve the boat dinghy:

CAUTION – VERY IMPORTANT: DAVIT OPERATION INVOLVES LIFTING AND RETRIEVING HEAVY LOADS ONTO AND OFF YOUR YACHT. ALL SAFETY PROCEDURES SHOULD BE PRACTICED ON A REGULAR BASIS TO ENSURE TROUBLE FREE OPERATION. OF PARTICULAR IMPORTANCE IS TO MAINTAIN THE DAVIT CABLE FREE OF KINKS, CORROSION AND FRAYED WIRES THAT REDUCE THE LOAD RATING OF THE CABLE. AT NO TIME SHOULD PERSONNEL BE ALLOWED TO PASS OR STAND DIRECTLY UNDER A SUSPENDED LOAD. REFER TO THE ARITEX OWNERS MANUAL FOR A MINIMUN LIST OF SAFETY CONCERNS TO KEEP IN MIND BEFORE AND DURING THE OPERATION OF THE DAVIT SYSTEM.

- Before using the system, check the cable to make sure that it is not frayed and is in the groove on the roller in the nose.

- TURN ON the DAVIT circuit breaker on the SHIP 240 VAC bus.

- Remove the controller plug connector cover on the davit frame and plug in the hand held controller..

- Detach the davit from its tie down. The davit idle position is down or stowed.

- Using the controller UP pushbutton, raise the boom to the desired position.

- Using the controller LEFT or RIGHT pushbutton, swing the davit boom over the dinghy. Extend the nose as required so that the davit hook is centered over the dinghy.

- Use the winch DOWN pushbutton on the controller to let out enough cable to reach the lifting harness or bar on the dinghy. ALWAYS KEEP TENSION ON THE CABLE TO PREVENT LOOSE LOOPS FROM FORMING ON THE DRUM OF THE WINCH.

- Release the tie downs on the dinghy then use the winch IN pushbutton to raise it high enough to clear the boat railing. Remember to position the boom so the load can be lifted straight up and is not pulled sideways.

- Using the LEFT or RIGHT pushbutton swing the davit boom until the dinghy is in the launching position. It is easier to swing the system with the load than to try to swing the load with the davit.

- When the dinghy is clear of the rail and stabilized use the winch OUT pushbutton to lower it onto the water.

- After the dinghy is on the water and secured to the yacht have someone board the dinghy and release the davit hook.

- Reel in the cable using the IN pushbutton, then using the LEFT or RIGHT pushbutton swing the davit back to its resting position and lower the boom using the DOWN pushbutton back to the down position and attach the davit to its tie down.

- Place the davit controller in the storage location inside the davit frame and replace the hand hole cover.

- Turn OFF the DAVIT circuit breaker at the 240 VAC SHIP panel. **NOTE:** Always leave the DAVIT circuit breaker in the OFF position when not in use to avoid inadvertent operation.

- To retrieve the dinghy the launching process is reversed.

2.13.3 Maintenance

Once placed in service, the ARITEX davit with proper servicing will provide years of service. The following are standard **BUT NOT EXCLUSIVE** maintenance activities that should be followed for care of these components. Consult the ARITEX manufacturer's manual for detailed requirements. Service problems should be referred to the nearest ARITEX representative or the factory for consultation.

- Inspect all cables, hydraulic hoses and fittings often. Replace at the first signs of excessive wear or corrosion.

- Annual maintenance requires the removal of the bearing trim ring. Pump grease into the bearing until it is observed oozing past the grease seal.

- Inspect the davit and its components regularly for signs of damage or non-functioning parts. Repair or replace as necessary. Inspect the luffing pins and the luffing pin set-screws for centering and tightness. Adjust as necessary.

- Service the hydraulic system annually. Servicing should include verifying the condition of the hydraulic fluid. If the fluid appears dirty or discolored, or is milky with water contamination, it should be replaced. Use a quality 10W hydraulic oil.

- Inspect the hydraulic lines and fittings for leaks periodically for weeping oil. Do not over tighten the fittings.

2.14 ELECTRICAL GENERATION SYSTEM

The NORDHAVN 50 Electrical Generation System is designed to accommodate all on board machinery by providing electrical power at voltage levels of 240 VAC, 120 VAC, 24 VDC, and 12 VDC.

The vessel generator output of 12kW at 240 VAC and 50 amps, can generally provide sufficient power during normal underway operation for the entire electrical distribution system at all voltage levels. When the generator is operating, all other sources of electrical power are in a float or backup operating condition to the generator.

The main propulsion engine is equipped with two alternators. One alternator, rated at 24 VDC and 40 amps, provides sufficient power to operate the anchor windlass and bow thruster and to charge the main engine starting batteries. Supplementary 24 VDC power is also provided to the 24 volt components by a 120VAC to 24 VDC battery charger and two 12 VDC batteries wired in series.

The second main engine alternator with its set point of 14.2 VDC and a rating of 12 VDC and an output total of 270 amps is sufficient for the DC distribution system. The 12 VDC alternator also backfeeds an inverter that inverts the DC output to 120 VAC 60HZ for the components that utilize 120 VAC power.

The 12 VDC house battery bank also provides power to the DC distribution system and backfeeds the inverter which inverts the output to 120 VAC power. The battery bank generally operates in a supplementary or backup mode to the main engine 12 VDC alternator depending on the load. The 12 volt house battery bank can also provide power when the main engine and generator are not running.

In port, dual 240 VAC 60HZ and one 120 VAC 60HZ shore power connections are provided for supplying the vessel with 240 VAC service from a shore power facility. The connections are located inside a locker on the foredeck bulwark port side. One 240 VAC connection and the 120 VAC connection are input to a 120/240 VAC to 240 VAC (output) isolation transformer rated at 12 KVA. The second 240 VAC connection is a dedicated supply to the air conditioning components only.

Refer to the drawings at the end of Section 2.15 for AC and DC system components and layout.

2.14.1 Diesel Generator – 240 VAC.

1) **Engine & Generator.** The diesel generator set is a **LUGGER Model M843N** engine with a close coupled **NORTHERN LIGHTS 12 kW Model PX-312K1** generator both manufactured by **ALASKA DIESEL ELECTRIC, INC**. The set is mounted in the engine room on the starboard side aft. The engine is cooled by a closed fresh water loop with engine mounted expansion tank and attached engine driven fresh water pump. The pump circulates fresh water through the engine and lube oil coolers to a heat exchanger where engine heat is rejected to the sea/raw water. Raw water is drawn from the sea chest by an engine driven pump through the fresh water heat exchanger and is discharged through a wet exhaust system to overboard. Additional engine driven accessories include a fuel oil pump, a lube oil pump, and a 12V/40A alternator. The engine is connected to the bonding system using #6 AWG bonding wire bolted to the engine block.

   The Northern Lights generator rating of 12 KW, 240 VAC, 60HZ and 50 amps is sufficient to provide all necessary electrical power for the expected loading under normal usage.

   Northern Lights generator vital characteristics are as follows:

Engine:	Model:	M843N
	Cylinders:	3 in-line
	Rated Flywheel HP:	20.1 @ 1800 RPM
	Oil Capacity:	5.8 quarts
	Approx. Coolant Cap:	1.1 gallon
	Raw Water Pump Cap:	9.0 gpm
	Approx. FL Fuel Rate:	1.2 gph @ 1800 RPM
	Air Consumption:	39.6 cfm @ 1800 RPM
Generator:	Model:	PX-312K1
	KW Rating:	12 kW
	Rated RPM/Frequency:	1800/60Hz
	240 VAC Amperage:	50 amps

   For additional engine and generator characteristics and information consult the Northern Lights instruction and technical manual.

2) **Engine Exhaust System.** The exhaust system for the generator is a wet type utilizing raw water as the coolant and a GEN-SEP gas and water separator to separate the exhaust gas and the raw water before it exits the boat. Raw water exiting the fresh water heat exchanger is mixed with and cools the engine exhaust gases before entering into a wet muffler. The gas/water mixture from the wet muffler is routed to the GEN-SEP separator where the mixture is separated. The cool exhaust gas is discharged thru the hull above

the water line and the raw water is discharged below the water line. Both thru-hull discharge lines are on the starboard side transom in the lazarette.

3) **Generator Control Panel.** The control panel for the generator is a **NORTHERN LIGHTS Series 3** generator control panel. The panel consists of oil pressure and engine coolant temperature gauges, a DC voltmeter, engine hour meter, an engine preheat switch, and an engine start-stop switch. The panel is located on the pilot house lower console vertical face port side.

2.14.2 Diesel Generator Operation. When underway, operation of the diesel generator is required when any of the components specifically designed to receive power from the generator is required to be operated or when the total electrical load is exceeds the capacity of the main engine alternator and house battery bank. In addition, it may be necessary to operate the generator to recharge the house batteries via the inverter after prolonged usage. In port, operation of the generator should only be required in the absence of adequate shore power facilities.

IMPORTANT NOTE: In the event of a fire in the engine room that results in the automatic actuation of the FIREBOY fire suppression system, the main engine, wing engine, generator and engine room blowers will automatically shutdown and the LPG solenoid valve close. Restart of these components is inhibited until the FIREBOY override switch is positioned properly. Refer to Section 2.12 – FIRE SUPPRESSION SYSTEM.

1) **Diesel Generator Starting.** Starting the diesel generator can be performed at the remote control panel in the pilot house per the following steps:

- **FILL** the water level in the engine expansion tank to about 1 in below the filler cap when the engine is cold.

- **CHECK** to see that the engine oil level is in the waffled area of the dipstick. Never allow the oil level to go below this area. Use SAE 30W or SAE 15-40W (refer to Northern Lights Operator's Manual).

- **CHECK** to see that the fuel supply and return lines are properly aligned to the operating fuel tank (refer to Section 2.2 – FUEL OIL SYSTEM).

- **CLEAN** the generator raw water inlet strainer then **OPEN** the raw water supply valve at the thru hull. The thru-hull connection and strainer are located below the deck plates aft of the main engine on the generator side of the bilge cavity.

- **TURN ON** the GEN/WING ENGINE BATTERY EMERGENCY SHUTOFF switch. The battery switch must always be kept ON while the engine is

running to prevent the possibility of damaging the engine alternator. The switch is located on a panel mounted at the engine room entry port side.

- To start the generator hold the Preheat switch in the ON position for 10 seconds before starting a cold engine. This is not necessary if the engine is already warm.

- While holding the Preheat switch in the ON position, push the Engine Control switch to START. As soon as the engine starts, release both switches. Do not crank the starter for more than 10 seconds. If the engine fails to start the first time be sure the starter has stopped before re-engaging. Continued failure to start may require priming the fuel supply line. Refer to Section 2.2 for priming the system.

  WARNING: The generator utilizes a wet exhaust system. If the engine does not start after a cumulative total of 30 seconds cranking, remove the drain plug in the bottom of the muffler in order to drain the accumulated water preventing the accidental flooding of the engine. Replace the plug after the muffler is drained.

- Allow the engine to run unloaded for a three to five minute warm-up period before applying electrical load.

- Check operating gauges at the control panel often. Oil pressure must be above 15 psi. The DC voltmeter should read between 11 and 15 and the water temperature must be below 200 degrees F. Turn off the engine if the temperature rises above 205 degrees F. Refer to the Northern Lights owner's manual for additional instructions.

2) Stopping the Generator.

- Remove the electrical load from the generator.

- Run the engine for a 3 to 5 minute cool down period.

- Hold the Engine Control Switch to the STOP position until the engine comes to a complete stop.

2.14.3 24 VDC Main Engine Alternator, 24 VDC Battery Charger and 24 VDC Starting Batteries & Operation.

1) 24V Alternator. The main engine is equipped with a LEECE-NEVILLE 24VDC alternator with a rated capacity of 40 amps. When the main engine is running, the alternator maintains two (2) main engine starting batteries fully

charged and is available to power the anchor windlass and bow thruster 24V motors.

2) **Battery Charger – 120VAC to 24VDC.** A 120VAC to 24VDC battery charger is also provided as a backup to the main engine 24VDC alternator. The battery charger is a **C-CHARGER Marine Electronic Battery Charger 24VDC Model 93-24105E-A by CHARLES MARINE PRODUCTS**. The charger is powered by the 24V CHARGER circuit breaker on the 120 VAC INVERTER bus. The battery charger circuit breaker is normally left in the OFF position when underway. The battery charger is mounted under the inboard end of the master stateroom berth.

3) **24V Starting Batteries – Main Engine**. Two (2) **LIFELINE AMG type, size 8D** batteries rated at 12 VDC and 200 amp-hours each are provided for starting the main engine. The two batteries are each 12 volts wired in series for a combined 24 volts and are used to start the main engine and backup the main engine 24V alternator. The batteries are located under the sole of the master stateroom and can be isolated from the main engine starting alternator by a normally ON (closed) disconnect switch located on a panel mounted on the port side of the engine room entry. The disconnect switch is labeled 24V ENGINE BATTERY EMERGENCY SHUTOFF. See 2.14.6 for additional information on AGM batteries.

2.14.4 12 VDC Main Engine Alternator & Operation. The main engine is equipped with a **12 VDC LEECE-NEVILLE alternator, Model AOO14867JB** rated at 270 amps. The alternator is set to deliver at 14.2 VDC in order to preferentially deliver power to the DC distribution system over the house battery bank when the diesel generator is not running.

When the main engine is running and supplying the vessel electrical load, the engine alternator will maintain the 12 VDC house load as well as maintaining the house batteries fully charged. The alternator also backfeeds the TRACE inverter which converts the output to 120 VAC for the 120 VAC INVERTER bus. As more system load is demanded from the alternator, the system voltage will drop until the voltage of the house battery bank is reached at which time the battery bank will deliver power to supplement the alternator. The operating time in this configuration is limited to the ampere-hour rating of the batteries. At this time, it may be necessary to either start a generator or shed the load on the system in order to recharge the batteries.

2.14.5 12 VDC Wing Engine Alternator & Operation. The wing engine is equipped with a smaller alternator rated at 12V/80 amps. The alternator is normally aligned to maintain the generator/wing engine starting battery fully charged. When operating the wing engine in place of the main engine, the alternator can be aligned to supply the boat 12 VDC system and backfeed the inverter to provide

120 VAC 60HZ power to the 120 VAC INVERTER bus. Refer to Section 2.15 for a further description of this operating mode.

2.14.6 12 VDC House Batteries and Operation. The house battery bank consists of **four (4) LIFELINE Absorbed Glass Mat (AGM) type, size 8D** batteries rated for 12 VDC and approximately 255 Amp-hours each. The batteries are connected in parallel for a total rating of approximately 1030 amp-hours of service. AGM batteries require less charging time than conventional batteries, they have low self-discharge and they are maintenance free. The completely sealed, valve regulated design eliminates acid spills and terminal corrosion. AMG batteries are safer than conventional flooded batteries, as the chance of explosion or acid spray is reduced. The batteries are designed to carry the DC system load and the 120 VAC load for a limited period of time when no other power source is available or necessary. The batteries are located inside fiberglass enclosures in the lazarette port and starboard sides with two batteries in each enclosure. Two (2) normally closed (ON) battery disconnect switches are provided in the lazarette – one each for a battery pair – to isolate the associated batteries in order to replace a battery, if required. When operating on battery power alone (see above), careful attention must be observed to monitor the state of the batteries and the elapsed time of their use.

2.14.7 Generator/Wing Engine Starting Battery & Operation. In addition to the house batteries, an additional **LIFELINE AGM** battery is provided for starting the generator and wing engine. The battery is a size 4D rated at approximately 215 amp-hours and is located aft of the generator.

2.14.8 Shore Power Connections. In port, dual 240 VAC 60HZ and one 120 VAC 60HZ shore power connections are provided for supplying the vessel with electrical service from a shore power facility. The connections are located inside a locker on the foredeck bulwark port side. One 240 VAC connection and the 120 VAC connection each labeled SHIPS SERVICE, are input to a 120/240 VAC to 240 VAC (output) isolation transformer rated at 12 KVA via a SHORE SERVICE select switch. The second 240 VAC connection labeled AIR CONDITIONING is a dedicated shore power supply to the air conditioning components only. Each 240 VAC connection are protected by a 50 amp circuit breaker. The 120 VAC connection is protected by a 30 amp circuit breaker. The shore power circuit breakers are inside the upper port side cabinet in the port guest stateroom. Refer to Section 2.15 for operation of the boat electrical system utilizing these shore power connections.

2.15 ELECTRICAL DISTRIBUTION SYSTEM

The NORDHAVN 50 electrical distribution system provides AC and DC electrical power service from two complete and conveniently centralized distribution panels located on the vertical faces of the pilot house console port and starboard sides.

AC power for machinery, personnel comfort and living conveniences is supplied at 240 and 120 voltage levels from the 120/240 AC SERVICE distribution panel.

DC power for components and functions vital to vessel operation and safety and for boat services is supplied at 12 volts from the 12 VDC SERVICE distribution panel. 24 VDC power is supplied to specific components directly from the main engine 24 volt alternator, a 24 volt battery charger, and from a sub-panel labeled 24 VDC SERVICE located on the lower right hand corner of the 12 VDC SERVICE panel.

2.15.1 AC Service Distribution System

The AC SERVICE distribution system provides all 240 VAC and 120 VAC power from the 120/240 AC SERVICE distribution panel located on the lower face of the pilot house console on the starboard side of the helm. The panel is divided into panel buses arranged according to voltage levels and are labeled as follows: AIR CONDITIONING 240 VAC; SHIP 240 VAC; and INVERTER 120 VAC. The distribution panel is bottom hinged and equipped with top mounted marine locks. Access to the rear of the panel and the interior of the electrical cabinet is possible by depressing the lock pushbuttons and tilting the panel face forward.

The air conditioners, davit and laundry and galley appliances that operate at a high voltage level receive electrical power from the 240 VAC 60 HZ panel buses.

Galley appliances, engine room lights, the main engine starting battery charger, and electrical outlets that operate at a medium voltage level receive electrical power from the 120 VAC 60 HZ INVERTER panel bus.

1) **SHIP 240 VAC Bus.** The SHIP 240 VAC panel includes components that can only be powered by the boat generator or the 240 VAC and 120 VAC SHIPS SERVICE shore power connections. The following loads are included through individual circuit breakers:

    - Washer/Dryer
    - Davit
    - Water Heater
    - Oven

The panel is equipped with the meters for voltage and amperage, and circuit breakers for the above loads. The panel front, meters, and circuit breakers are engraved to identify the name and component description for each item.

2) **AIR CONDITIONING 240 VAC Bus.** The AIR CONDITIONING 240 VAC bus is dedicated to supplying 240 VAC power to the vessel air conditioning components. The bus can be powered by the boat generator, the SHIPS SERVICE shore power connections – 240 VAC or 120 VAC – and the dedicated AIR CONDITIONING shore power connection. The following loads are included through individual circuit breakers:

   - Pilot House
   - Salon
   - Guest Cabin
   - Master Cabin
   - Pump

   The panel is equipped with the meters for voltage and amperage and circuit breakers for the above loads. The panel front, meters, and circuit breakers are engraved to identify the name and component description for each item.

3) **INVERTER 120 VAC Bus.** This bus provides 120 VAC 60HZ power through individual breakers to the following loads:

   - Outlets Fwd
   - Outlets Amidship
   - Outlets Galley
   - Outlets Salon
   - Outlets Pilot House
   - Outlets Ext. and Laz
   - Engine Room Lights
   - 24V Charger
   - TV/Stereo
   - Dishwasher
   - Cook Top
   - Galley Reefer/Freezer
   - Galley Small Reefer
   - P.H. Deep Freezer
   - Trash Compactor
   - Microwave
   - Garbage Disposal
   - Computer
   - Engine Room Blowers

   The panel is equipped with meters for voltage and amperage and circuit breakers for the above loads. The panel front, meters, and circuit breakers are engraved to identify the name and component description for each item.

4) **AC Panel Selector Switches**. In addition to the above buses, the panel is equipped with three (3) selector switches labeled SHORE SERVICE, SHIP SERVICE and AIR CON SERVICE, respectively. The switches enable the operator to select 240 VAC 60HZ or 120 VAC 60HZ power from a shore power facility and 240 VAC 60HZ from the vessel generator. The switches are mounted on the bottom of the 120/240 AC SERVICE panel. **NOTE**: 120 VAC

shore power is stepped up to 240 VAC by an isolation transformer – see below.

SHORE SERVICE Selector Switch. The SHORE SERVICE switch is a three position switch to enable the operator to select the available shore power voltage connection – 240 VAC or 120 VAC. The switch positions are OFF – 240 VAC – 120VAC.

SHIPS SERVICE Selector Switch. The SHIPS SERVICE switch is a three position switch that routes 240 VAC power from the generator or shore power to the entire electrical distribution system. The switch positions are OFF – SHIP – SHORE.

AIR CON SERVICE Selector Switch. The AIR CON SERVICE switch is a three position switch that routes 240 VAC power from the generator (via the SHIPS SERVICE selector switch) or the 240 VAC AIR CONDITIONING shore power connection to the AIR CONDITIONING 240 VAC bus **ONLY**. The switch positions are OFF – SHIP – SHORE.

5) **120 VAC Inverter.** One (1) **TRACE SW 2512 Pure Sine Wave Inverter/Battery Charger** rated at 2.5 kW is provided. The inverter is mounted on the forward bulkhead in the lazarette starboard side. The inverter control panel is located on the pilot house overhead dash. The inverter performs the following functions:

   - Transfer 120 VAC power from the 240 VAC 60HZ Service system (via a balancing transformer – see below) to the inverter supplied components that utilize 120 VAC power
   - Convert 120 VAC power to 12 VDC power for the DC Service system
   - Invert 12 VDC power from the main engine alternator/house battery bank to 120 VAC 60 HZ to power inverter supplied components
   - Charge the 12 VDC house batteries when the generator is running or on shore power

   The inverter operates in either a TRANSFER MODE or INVERT MODE.

   Transfer Mode. The inverter operates in the transfer mode when AC power is provided by either the generator or shore power. In this mode, 240 VAC power from the generator or SHIPS SERVICE shore power connection is routed to the SHIPS SERVICE select switch. The output of the switch is routed to a 240 VAC to 120 VAC balancing transformer that directs 120 VAC to the input of the inverter. The inverter transfers the incoming 120 VAC power to the 120 VAC 60HZ INVERTER bus. In addition, the inverter converts the incoming 120 VAC 60HZ power to 12 VDC for the DC Service System.

Invert Mode. The inverter operates in the invert mode when the boat is underway and AC power from the generator or shore power is not available or required. In this mode, the electrical load is carried by the main engine alternator and the house battery bank. The inverter receives the 12 VDC output from the alternator/house battery bank and inverts the DC to 120 VAC.

IMPORTANT NOTE: The required battery charging settings for the TRACE inverter have been adjusted by PAE technicians during commissioning of the boat. The setting values are as follows:

- **Bulk volts 14.2**
- **Float volts 13.2**
- **Adsorption time 5 hours**

These values <u>MUST</u> be reset if the inverter loses DC power or is manually reset to TRACE factory default values. Refer to the MENU SYSTEM section of the TRACE Owner's Manual for instructions.

7) **120/240 VAC 60HZ to 240 VAC 60HZ Isolation Transformer**. One (1) **OLSUN ELECTRICS CORP., Model GS 12YY-0 Marine Isolation Power Transformer** rated at 12 KVA is provided for receiving/converting either the 240 VAC 60HZ SHIPS SERVICE or 120 VAC 60HZ SHIPS SERVICE shore power inputs and delivering a 240 VAC 60HZ output. The transformer is located inside the pilot house console forward of the helm. In addition to stepping up the voltage from the 120 VAC shore power connection, the transformer isolates the shore power grounding system from the ships grounding system.

8) **240 VAC to 120 VAC Transformer**. One (1) **OLSUN ELECTRICS CORP., Model GS7.5HD-2 Power (Balancing) Transformer** rated at 7.5 KVA is provided for stepping down the 240 VAC generator and ships service shore power voltage to 120 VAC for input to the Trace inverter. The transformer is located inside the pilot house console forward of the 120/240 AC SERVICE panel.

2.15.2 AC Distribution System Operation. The design versatility of the NORDHAVN 50 AC Distribution System enables the boat operator to provide power to all vessel components by utilizing a combination of the boat generator, main engine alternators, wing engine alternator, house battery bank, and shore power. The following modes of operation describe this capability.

1) **Boat Generator Power.** This is the mode of operation when the vessel is underway, at anchor or when shore power is not available AND 240 VAC power is required. Operation in this mode is limited to the 12kW (50 amps) rating of the boat generator. When underway, the output of the main engine 12 volt power alternator and the house battery bank are backing up the

generator for the inverter bus and the 12 VDC SYSTEM. The following system alignment is typical for this mode of operation (refer to the AC Electrical System Diagram at the end of this section):

- Start the boat generator (see Section 2.14)

- Place the SHIPS SERVICE selector switch in the **SHIP** position (the switch is located at the bottom of the 120/240 AC SERVICE panel). This position routes 240 VAC power from the generator to the SHIP 240 VAC bus, the AIR CON SERVICE selector switch, and 120 VAC power to the inverter. **NOTE**: The inverter transfers 120 VAC power to the 120 VAC INVERTER bus and supplies 12VDC power to the 12 VDC SERVICE panel.

- Place the AIR CON SERVICE selector switch in the **SHIP** position. This position routes 240 VAC generator power via the SHIPS SERVICE selector switch to the AIR CONDITIONING 240 VAC bus.

- Place the inverter in operation.

- In this configuration, ALL electrical components can be supplied power by turning ON the applicable circuit breaker on the AC Electrical Distribution panel and the 12 VDC SERVICE panel (see operating requirements for each component prior to supplying power). When underway, the output of the main engine power alternator and the house battery bank are backing up the generator for the inverter bus and the 12 VDC System. **REMINDER**: The total electrical load in this operating configuration is limited to the capacity of the generator – 12 kW.

2) Shore Power. Operation of the AC Distribution System when power is provided by a shore facility is dependent on the extent of the available 240 or 120 VAC power supply.

Dual Shore Power Connections – 240 VAC. When dual 240 VAC 60HZ connections are available, the 240 VAC SHIP and 240 VAC AIR CONDITIONING buses can be connected to its own shore power supply inlet using two separate power cords. This configuration provides the maximum shore power available to the vessel with a **50 amps limitation to each** bus by the shore power circuit breakers. Operation of the AC Distribution System in this mode requires the following actions:

- Connect the 240 VAC 60 HZ shore power connections to the boat 240 VAC SHIPS SERVICE and 240 VAC AIR CONDITIONING shore power inlets and turn ON the shore power circuit breakers. The shore power circuit breakers are located in the guest stateroom upper cabinet port side. The circuit breakers are normally left in the ON position.

- Place the SHORE SERVICE selector switch in the **240 VAC** position. This position routes the 240 VAC shore power to the SHIP SERVICE selector switch via the 12 kva isolation transformer.

- Place the SHIPS SERVICE selector switch in the **SHORE** position. This position routes 240 VAC 60HZ shore power to the SHIP 240 VAC bus, the AIR CON SERVICE selector switch, and 120 VAC power to the inverter. **NOTE**: The inverter transfers 120 VAC power to the 120 VAC INVERTER bus and supplies 12VDC power to the 12 VDC SERVICE panel.

- Place the AIR CON SERVICE selector switch in the **SHORE** position. This position routes 240 VAC 60HZ from the AIR CONDITIONING shore power connection directly to the 240 VAC AIR CONDITIONING bus.

- Place the inverter in operation.

- In this configuration, ALL electrical components can be supplied power by closing the applicable circuit breaker on the AC Electrical Distribution panel and the 12 VDC SERVICE panel (see operating requirements for each component prior to supplying power). **REMINDER:** The electrical power from each shore power connection is limited to 50 amps.

Single Shore Power Connection – 240 VAC. When only one 240 VAC 60HZ shore power connection is available or if power is limited by amperage, the power is brought it to the SHIP 240 VAC bus via the SHIPS SERVICE shore power inlet connection. In this configuration, the total amperage available to the vessel is **limited to 50 amps – TOTAL** by the boat shore power circuit breaker. Careful use of the vessel services must be observed so as not to exceed this amperage limitation. Operation of the AC Distribution System in this mode requires the following actions:

- Connect the 240 VAC 60 HZ shore power connection to the boat SHIPS SERVICE 240 VAC shore power inlet and close the shore power circuit breaker. The shore power circuit breaker is located in the guest stateroom upper cabinet port side. The circuit breaker is normally left in the ON position.

- Place the SHORE SERVICE selector switch in the **240 VAC** position. This position routes the 240 VAC shore power to the SHIP SERVICE selector switch via the 12 kva isolation transformer.

- Place the SHIPS SERVICE selector switch in the **SHORE** position. This position routes 240 VAC 60HZ shore power to the SHIP 240 VAC bus, the AIR CON SERVICE selector switch, and 120 VAC power to the

inverter. **NOTE**: The inverter transfers 120 VAC power to the 120 VAC INVERTER bus and supplies 12VDC power to the 12 VDC SERVICE panel.

- Place the AIR CON SERVICE selector switch in the **SHIP** position. This position routes 240 VAC 60HZ shore power via the SHIPS SERVICE selector switch to the 240 VAC AIR CONDITIONING bus.

- Place the inverter in operation.

- In this configuration, ALL electrical components can be supplied power by closing the applicable circuit breaker on the AC Electrical Distribution panel and the 12 VDC SERVICE panel (see operating requirements for each component prior to supplying power).

NOTE: If the load on the boat exceeds the available shore power supply, i.e. all air conditioner units in operation, the vessel generator can be started and utilized to supplement the shore power. For this case, the shore connection is typically made to the AIR CONDITIONING 240 VAC bus and the AIR CON SERVICE selector switch positioned to SHORE. The boat generator supplies the SHIP 240 VAC bus with the SHIPS SERVICE selector switch positioned to SHIP.

Single Shore Power Connection – 120 VAC. When the only available shore power connection is 120 VAC 60HZ, the power is brought in to the SHIPS SERVICE 240 VAC bus via a 120 VAC 60HZ SHIPS SERVICE shore power inlet connection. In this configuration, the total amperage at 240 VAC available to the vessel is **approximately 15 amps** by the boat shore power circuit breaker. Only those items required to be continuously operated should be in operation. These items include refrigeration, lighting, and 12 VDC System components such as the bilge pumps, fresh water pump, toilet flushing, and DC lighting. Air conditioning components and other high voltage appliances will generally require the generator to be placed in service as required. Operation of the AC Distribution System in this mode requires the following actions:

- Connect the 120 VAC 60 HZ shore power connection to the boat 120 VAC SHIPS SERVICE shore power inlet and close the shore power circuit breaker. The shore power circuit breaker is located in the guest stateroom upper cabinet port side. The circuit breaker is normally left in the ON position.

- Place the SHORE SERVICE switch in the **120 VAC** position. This position routes the 120 VAC 60HZ shore power source to the SHIPS SERVICE selector switch via the 12 kva isolation transformer. **NOTE**:

The 12 kva isolation transformer steps up the 120 VAC input to a 240 VAC output.

- Place the SHIPS SERVICE selector switch in the **SHORE** position. This position routes 240 VAC power from the 120 VAC shore power connection to the SHIPS 240 VAC bus, the AIR CON SERVICE selector switch, and 120 VAC power to the inverter. **NOTE**: The inverter transfers 120 VAC power to the INVERTER 120 VAC bus and supplies 12VDC power to the 12 VDC SERVICE panel.

- Place the AIR CON SERVICE switch in the **OFF** position. This position isolates the AIR CONDITIONING 240 VAC bus. **NOTE:** If the air conditioners and/or water heater are required, the boat generator will most likely require operation.

- Place the inverter in operation.

- In this configuration, **ONLY VITAL** electrical components can be supplied power by closing the applicable circuit breaker on the AC Electrical Distribution panel and the 12 VDC SERVICE panel (see operating requirements for each component prior to supplying power).

NOTE: If the load on the boat exceeds the available shore power supply, the vessel generator requires operation.

3) **Main Engine/House Battery Power**. Operation of the 120 VAC INVERTER bus in the AC Distribution System when neither the generator nor shore power is available can be performed by utilizing the main propulsion engine 12V alternator when the engine is running or the house battery bank. In this configuration, 12VDC power from the main propulsion engine alternator or the house battery bank is back fed to the inverter which inverts the output to 120VAC 60HZ to power the INVERTER 120 VAC loads as described above.

   NOTE: When operating in this mode, the power available from the main engine alternator is approximately 1.6 kW (13.3 amps @ 120 VAC). If the electrical load exceeds this amount, the additional power will be provided by the house battery bank up to the maximum rating of the inverter of 2.5kW. Careful administration of the electrical load is necessary to insure that the house battery bank is not excessively discharged. Prolonged operation in this mode will require starting the generator to charge the house batteries or to shed the electrical load.

4) **Wing Engine Power.** When the wing engine is operating in place of the main engine, the wing engine 12 VDC alternator can provide power to the INVERTER 120 VAC bus of the AC Distribution System by paralleling the alternator output with the 12 VDC System bus. This requires closing the

normally open GEN/WING ENGINE BATTERY PARALLEL selector switch on the STARTING BATTERY SWITCH panel (see DC Distribution System below).

NOTE: When operating in this mode, the power available from the wing engine alternator is less than 1000 watts (approximately 8 amps @ 120 VAC). If the electrical load exceeds this amount, the additional power will be provided by the house battery bank. If operating in this mode, use of non-vital electrical loads should be avoided.

2.15.3 DC Service Distribution System.

The DC Service Distribution System provides 12 VDC and 24 VDC power for vessel components and services. The more extensive 12 VDC system includes components for boat navigation and safety and components for house services. The 24 VDC system is limited to providing power to the bow thruster and anchor windlass and the main engine electrical system. The distribution of power for each system is from a centralized panel located on the pilot house console.

In addition, a separate Starting Battery Switch Panel, with three selector switches, is provided in the system for the following functions:

- connect the main engine 24 volt alternator to the main engine starting batteries and bow thruster and anchor windlass motors;
- connect the generator and wing engine alternators to their shared starting battery and isolated from the 12 VDC system;
- connect the generator and wing engine shared starting battery and alternator with the 12 VDC system.

1) **12 VDC System.** The 12 VDC System provides power for components and services that require a continuous and reliable power supply and for maintaining the house battery bank fully charged. The sources of 12 VDC power include the following:

    - Inverter when the generator is operating or the boat is on shore power;
    - main engine (or wing engine) 12 volt alternator when the main engine is running;
    - 12 VDC house battery bank when no outside source or generating components are in service.

    The 12 VDC power from these sources provide a continuous supply of power to the 12 VDC SERVICE electrical distribution panel located on the vertical face of the pilot house console. **NOTE**: The DC service distribution system, using the house battery bank, also back feeds the inverter which inverts the

12VDC input to 120 VAC 60HZ to provide power to the INVERTER 120 VAC bus. Refer to 2.15.2.

12 VDC SERVICE Panel (pilot house console). The panel provides 12 vdc power through individual circuit breakers to the following system loads:

- Cabin Lights Guest
- Cabin Lights Master
- Cabin Lights Salon
- Cabin Lights Pilot House
- Cabin Lights Galley
- Engine Room Lights
- Interior Courtesy Lights
- Exterior Courtesy Lights
- Exterior Lights
- Fans
- Fwd Head
- Aft Head & Tank Gauge
- Fresh Water Pump
- Shower Sump Pumps
- High Water Bilge Pump
- Bilge Pump
- Radar 1
- Radar 2
- Depth Sounder
- NavNet/Flybridge
- GPS 1
- NavNet/Fax
- Auto Pilot 1
- Auto Pilot 2
- VHF Radio
- VHF Radio
- Stereo
- Sat. Phone
- Wind Speed
- TracVision/Sat TV
-
-
- Navigation Lights
- Anchor Light
- Search Light
- Fuel Transfer Pump
- Oil Change Pump
- Salt Water Wash Pump
- Holding Tank Pump
- Water Maker
- Boat Deck Light
- Aft Deck Light
- Fly Bridge Lights
- Accessories Panel
- 12 V Outlets
- LPG
- Stabilizers

The panel front is equipped with the following items: meters for battery voltage (house), amps out (12 VDC system), engine alternator amps and net amps; two momentary battery test toggle switches for the House and Generator starting batteries; and circuit breakers for the above loads. The front of the panel is engraved to identify the panel name, meter label, toggle switch description, and component description for each circuit breaker.

The net amps ammeter indicates the power (current flow) **FROM or TO** the house battery bank. A negative reading indicates current flow FROM the battery bank (battery discharging) and a positive reading indicates current flow TO the battery bank (battery charging). The test toggle switches are provided to check the charged state of the house and generator/wing starting batteries. By positioning and holding the toggle, the voltage of the selected battery can be observed on the panel voltmeter.

2) 24 VDC System. The 24 VDC System provides power for the bow thruster and anchor windlass and for maintaining the main engine starting batteries fully charged. The sources of 24 VDC power include the following:

- main engine 24 volt alternator when the main engine is running;
- 24V battery charger when the generator is running or the vessel is on shore power;

- 24 VDC main engine starting batteries when no outside source or generating components are in service

The 24 VDC power from these sources provide power to the 24 VDC SERVICE distribution sub-panel located on the 12 VDC SERVICE panel.

24 VDC SERVICE Bus. The bus provides 24VDC power through individual circuit breakers to the following system loads:

- Bow Thruster
- Windlass

The sub-panel bus is located in the lower right hand side of the 12 VDC SERVICE panel and is equipped with labeled circuit breakers for the above loads.

3) **Starting Battery Switch Panel**. The Starting Battery Switch Panel mounted on the lower face of the engine room port side bench is equipped with three (3) ON/OFF selector switches. The function of each switch is as follows:

- **24V Engine Battery Emergency Shutoff Switch (Normally ON)**. This switch connects the main engine 24V alternator to the main engine starting batteries to maintain the batteries fully charged. This switch mist be ON whenever the engine is running to charge the batteries and prevent damaging the engine alternator.

- **Gen/Wing Engine Battery Emergency Shutoff Switch (Normally ON).** This switch connects the generator and wing engine alternators to the generator/wing shared starting battery to maintain the battery fully charged. This switch must be ON whenever the generator and wing engine are running to charge the battery and prevent damaging the engine alternator.

- **Gen/Wing Engine Emergency Battery Parallel Switch (Normally OFF).** This switch, when closed, connects the generator/wing engine shared starting battery with the 12 VDC System power sources. In the event the generator/wing engine starting battery is fully discharged (dead), closing this switch will provide 12 VDC power from the main engine 12 volt alternator or the house battery bank in order to start the engines. This switch, when closed, also provides 12 VDC power from the engine alternator to the 12 VDC system.

2.15.4 DC Distribution System Operation

1) **Boat Generator Power.** With the boat generator in operation and the main engine not running, the 12 VDC distribution system receives power from the inverter and is backed up by the house battery bank. In this configuration the GEN/WING ENGINE BATTERY EMERGENCY selector switch on the Starting Battery Switch Panel should be in the closed (ON) position and the GEN/WING ENGINE BATTERY EMERGENCY PARALLEL switch in the open (OFF) position. This configuration will provide 12 VDC power to all components, maintain the house batteries charged, and isolate the generator and wing engine starting battery from the 12 VDC power sources. This configuration also provides 24 VDC power via the 24V CHARGER circuit breaker on the INVERTER 120 VAC bus to maintain the main engine starting batteries fully charged and to power the bow thruster and anchor windlass motors. This is the normal mode of operation when the vessel is at anchor or when shore power is not available and components that require generator power are to be used.

   With the boat generator and the main engine in operation, the 12 VDC distribution system receives power from the inverter with a backup from the main engine 12 volt alternator and the house battery bank. In this operating condition, battery switches are in the same configuration as above. This is the normal mode of operation when the vessel is underway and components that require generator power are to be used.

2) **Shore Power.** When power is provided by a shore facility, the DC Distribution System receives power through the inverter and is backed-up by the house battery bank. In this operating condition, the battery switches are in their normal positions as above. This configuration will provide DC power to all components and maintain the house batteries charged and the main engine and generator/wing engine starting batteries isolated and in a charged state.

3) **Main Engine Power**. With the main engine in operation only, the DC Distribution System receives power from the main engine 12 volt alternator and backup power from the house battery bank. The battery switches on Starting Battery Switch Panel are in their normal position as above. In this configuration, the main engine 12V alternator provides 12 VDC power to all components and maintains the house battery bank fully charged. The main engine 12V alternator also back feeds the inverter which inverts the 12V input to 120 VAC for the INVERTER loads as described previously. This is the normal mode of operation when the vessel is underway and 120 VAC power to all components is not required.

   WARNING: The capacity of the main engine alternator is 130 amps and the total load on the DC and 120 VAC systems should be controlled so as not to exceed this capacity.

NOTE: In this configuration, the main engine 24V alternator also maintains the main engine starting batteries fully charged and provides power to the bow thruster and anchor windlass motors. The 24V CHARGER circuit breaker on the INVERTER 120 VAC bus should be in the OFF position.

4) **Wing Engine Power.** With the wing engine running in place of the main engine, the 12VDC Distribution System can receive power from the wing engine 12V alternator by closing the GEN/WING ENGINE BATTERY EMERGENCY PARALLEL switch on the Starting Battery Switch Panel. In this configuration, the power available to the 12 VDC is limited to the 80 amp rating of the wing engine alternator. This operating configuration should be limited to emergency situations when all sources of 12 VDC power are not available.

5) **House Battery Power.** With all sources of external power and onboard generation not in service or not available, the DC Distribution System receives power from the house batteries only. In this configuration, the house battery bank stored energy provides 12 VDC power to all components and back feeds the inverter which inverts the 12V input to 120 VAC to power the INVERTER 120 VAC bus. The switches at the Starting Battery Switch Panel in their normal positions will prevent the generator/wing starting battery from back-feeding the 12 VDC and 120 VAC systems. This is the normal mode of operation when the vessel is anchored or docked and a limited amount of 120 VAC power is required. This condition can also be encountered underway as a result of a loss of fuel to the main engine and the generator.

WARNING: While on house battery power only, the available amperage is limited to the house battery bank rating of approximately 1020 amp hours. Careful attention to the amount of power expended is required so as not to leave the batteries in an excessively discharged state.

2.16 BONDING SYSTEM

For the NORDHAVN 50, protection against galvanic corrosion of components and fittings that directly or indirectly come in contact with the sea, and to a lesser extent corrosion by electrolysis, is provided by a bonding system. In addition, the bonding system is also used as a common ground for the vessel electrical and electronic equipment and systems.

The bonding system consists of #6 AWG wires that run fore and aft on either side of the hull. The wires are connected at three locations to embedded through hull terminals fitted with externally mounted, sacrificial, 4" x 8" x 1 1/2'' thick zinc anode plates. The mounting for the zinc plates are recessed in the hull so that the zinc plates are flush with the hull contour. The locations of the zincs are on the port and starboards sides of the hull approximately mid way in the engine room and on the transom just below the waterline.

Inside the hull, all metallic parts and thru hull fittings touching water including the main and wing engine blocks are connected together with #6 AWG and branched off the fore and aft wires. The #6 wire is tinned copper stranded wire and all connections are made using bolted lugs. The wire ends at each bolted connection are sealed using shrink wrap tubing. The bonding wire is wrapped in green colored insulation for easy identification.

In addition to the zinc plates attached to the hull, external components attached to or protruding through the hull that are susceptible to galvanic corrosion are equipped with sacrificial, zinc anode plates or shapes for added protection. These zincs can generally be replaced with the boat in the water (except as noted). The locations are as follows:

- Wing engine shaft forward of the propeller; CANADA, CMX4, 1 1/4" Collar Anode (or equivalent)
- Bow Thruster hub (refer to the manufacturer's manual)

The life expectancy of these zinc anodes is dependant on boat usage and environmental conditions such as water temperature and mineral content. As a minimum, the zincs should be inspected quarterly and replaced if more than 50% eroded. In most cases, zincs should be replaced at every boat haul-out. All of the above zinc anodes can be purchased from Pacific Asian Enterprises.

NOTE: In addition to the externally mounted zinc anodes, equipment installed inside the vessel that utilize sea water cooling will generally be equipped with zinc anodes that will require periodic inspection and replacement. These include, but are not limited to, heat exchangers on engine cooling systems and air conditioner compressors. The boat operator must consult the manual provided by the manufacturer of these and other products for specific galvanic protection requirements.

2.17 LIGHTING SYSTEM

The NORDHAVN 50 lighting system is designed to provide a safe, well lighted environment in both the occupied interior spaces and exterior passageways as well as navigational lights conforming to USCG requirements for Inland Navigation and International Rules. The system utilizes a 12 VDC lighting system for standard navigational, interior, and exterior light fixtures. In addition, the engine room is equipped with a 120 VAC lighting circuit for enhanced illumination to conduct maintenance and repairs.

2.17.1 Interior and Exterior Lighting. Interior lighting in all occupied spaces consists of overhead lighting fixtures, bulkhead mounted courtesy light fixtures and courtesy light fixtures for stairways. Chart and reading light fixtures are provided in the pilot house. Overhead and courtesy lighting for the boat exterior is provided in the cockpit, passageway, boat deck, and stairways.

The typical lighting fixtures and models are as follows:

- Main lighting through interior are recessed incandescent lights with wall switches
- Bulkhead reading lights: AAA 00950
- Engine room lights: recessed incandescent #552 Ramco
- Exterior dome lights: AAA 00552 with stainless steel faces
- Interior dome lights: GUEST #8071-12-B
- Courtesy lights: AAA 00144
- Hanging locker lights: AAA 00532 with stainless steel faces

Power for the interior and exterior 12 volt light fixtures is provided by well labeled circuit breakers on the 12 VDC SERVICE panel located on the pilot house console.

2.17.2 Navigation Lights. The navigation lighting system consists of port and starboard sidelights, stern light, masthead light and anchor light and are in conformance with USCG requirements for Inland Navigation and International Rules. The sidelights are mounted on the outside bulkheads of the Portuguese bridge, the stern light is mounted on the aft bulkhead of the upper deck and the masthead and anchor light are mounted on the mast.

The navigation lights are HELLA and PERKO with models as follows:

- Port (10 pt. Red) – HELLA #62209
- Starboard (10 pt. Green) – HELLA #62210
- Stern (12 pt. White) – HELLA #62208

- Masthead (20 pt. White) - PERKO Model 110 000 BLK
- Anchor (32 pt. White) - PERKO Model 112 BOO PLB

The sidelights, stern and masthead lights are powered from a control switch/circuit breaker on the 12 VDC SERVICE panel in the pilot house labeled NAVIGATION LIGHTS. The anchor light is powered from the same panel by a control switch/circuit breaker labeled ANCHOR LIGHT.

2.18 ELECTRONIC SYSTEMS

Electronic components for the NORDHAVN 50 are non standard and are generally specified, purchased and installed according to owner preference. Due to the complexity of these components, the owner is advised to consult the manufacturer's manuals for operating, maintenance and trouble shooting instructions. The following are typical electronic components utilized:

- Radar
- Auto Pilot
- Global Positioning System (GPS)
- SAT Phone
- Speed/Temp/Depth Sounder
- SSB
- VHF
- Weather Fax
- Computer

Power to these components can be provided by separate circuit breakers on the 12 VDC SERVICE panel in the pilot house.

2.19 GALLEY SYSTEMS

Components for cooking, refrigeration, freezer, microwave, dishwasher, garbage disposal and trash compaction are provided by the Galley Systems and are typically owner specified. The following items are typically included in the galley systems

- **Stove** (see below)
- **Oven** (see below)
- **Refrigerator**
- **Galley Freezer**
- **Pilot House Freezer**
- **Microwave Oven**
- **Trash Compactor**
- **Garbage Disposal**

The above components are purchased for 120 VAC service and receive their power from the INVERTER 120VAC bus on the 120/240 AC SERVICE panel by separate circuit breakers. These components are grouped so that operation of each can be powered from the main engine alternator and the house batteries through the inverter. When operating these components from these power sources, however, selective operation of each is required so as not to exceed the capacity of the inverter.

Stove/Oven. The THERMADOR Professional Model stove/oven utilizes propane gas for the stove top burners and 240 VAC power for the oven. **The oven requires the generator to be operating or shore power**. The appliance is equipped with an exhaust fan, overhead light, and electronic ignition and gas detection/alarm system. Two (2) 30 lb. DOT approved aluminum propane bottles, one in service and one in reserve, are provided and installed in a vented, self draining locker located in the cockpit aft bulwark port side. The locker is completely sealed from the interior of the boat and is in compliance with all ABYC and USCG regulations. Access to the locker interior is via doors installed flush with the bulwark.

The bottles are connected to a manual three-way valve, pressure regulator, and a XINTEX S-2ALP electric solenoid valve. The solenoid valve is remotely opened from a XINTEX S-2A Propane Fume Detector/Automatic Valve Control panel mounted on the face of the sink cabinet. The panel consists of four (4) pushbuttons, four (4) indicating lights and an audio alarm. The pushbuttons are as follows: PRESS VALVE ON/OFF that opens and closes the propane bottle solenoid valve; SENSOR 1 TEST; SENSOR 2 TEST; and ALARM SILENCE. The indicating lights left to right are as follows: GREEN for VALVE ON; GREEN=OK, RED=DANGER (for sensor 1); GREEN=OK, RED=DANGER (for sensor 2); and AMBER=FAULT. The RED DANGER light will illuminate and an audio alarm will sound in the presence of propane gas.

Electrical power to the stove top control valve/detector panel is from the LPG SYSTEM circuit breaker on the 12 VDC SERVICE panel. The stove top fan, light and ignition system is powered by the COOK TOP circuit breaker on 120 VAC INVERTER panel bus.

The following steps are required to operate the stove/oven:

IMPORTANT NOTE: Actuation of the engine room FIREBOY fire suppression system energizes a relay module that will automatically close the LPG solenoid valve inside the LPG locker. This prevents the possible introduction of combustible LPG in the fire zone. Refer to Section 2.12 – FIRE PROTECTION SYSTEM.

- **If oven use is required, START** the generator (or if on shore power) and **TURN ON** the OVEN circuit breaker on the SHIP 240 VAC panel bus.

- Position the three-way valve to the desired LPG bottle on the connected hose upstream of the pressure regulator. The valve is located in the propane locker in the cockpit.

- **OPEN** the shutoff valve on the selected bottle. A pressure gauge is provided on the inlet side of the three-way valve to indicate gas pressure in the bottle.

- **TURN ON** the COOK TOP circuit breaker on the 120 VAC INVERTER panel bus.

- **TURN ON** the LPG SYSTEM circuit breaker on the 12 VDC SERVICE panel. The stove top control panel and the propane sensor will be in service.

- Check that the GREEN power ON indicating light is lit on the STOVE TOP propane fume detector panel.

- Depress the VALVE ON pushbutton at the STOVE TOP detector panel and check that the GREEN VALVE ON light is ON. The LPG solenoid valve will open to admit LPG to the stove top burners.

- Operate the stove in accordance with the manufacturer's manual.

CAUTION: If the RED DANGER light illuminates at the detector panel depress the VALVE ON pushbutton at the STOVE TOP detector panel to close the remote solenoid valve, TURN OFF the LPG SYSTEM circuit breaker at the 12 VDC SERVICE panel, and inspect the system to look for loose connections and worn hoses and repair as required.

- **When the stove and oven are no longer required**, depress the VALVE ON pushbutton on the stove detector panel and check that the GREEN VALVE ON light is OFF.

- **TURN OFF** the LPG SYSTEM circuit breaker at the 12 VDC SERVICE panel and check that the GREEN POWER ON light is OFF. This will reduce the possibility of introducing propane gas into the vessel interior.

- **TURN OFF** the COOK TOP circuit breaker on the 120 VAC INVERTER panel bus.

- **TURN OFF** the OVEN circuit breaker on the SHIP 240 VAC panel bus and stop the generator (if not required).

  RECOMMENDATION: If the stove/oven is not expected to be utilized for an extended period of time, close the manual valves on the top of each propane bottle.

2.20 LAUNDRY SYSTEM

The Laundry System consists of a combination clothes washer and dryer and are typically owner specified. The clothes washer is capable of heating its supplied water and is provided with a cold water line only. The shutoff valve is located behind a removable panel forward of the master head toilet. Gray water is discharged directly overboard.

The washer is installed in the master stateroom starboard side cabinet and the dryer is installed in the outboard cabinet on the stairway from the pilot house to the staterooms. Both units utilize 240 VAC power from the 240 VAC 60 HZ bus of the 120/240 AC SERVICE panel from a shared circuit breaker labeled WASHER/DRYER. Operation of these components requires the generator to be in service or shore power.

.

2.21 ACCESSORY SYSTEMS/COMPONENTS

Accessory systems/components are included in the NORDHAVN 50 design to accommodate the following functions: saltwater deck wash, pilot house windshield wipers, boat compass, boat horn, searchlight and 120VAC Outlets.

2.21.1 Saltwater Deck Wash. The saltwater deck wash system consists of a pump taking suction from a thru hull and strainer and discharging to outlets on the bow and cockpit. The system is a **SHURFLO Baitmaster Washdown Pump** rated at 3.6 gpm. The kit is equipped with a pump and built-in auto shutoff switch. The system operates between 15 psi (pump start) and 40 psi (pump stop) and is powered by the SALT WATER WASH PUMP circuit breaker on the 12 VDC SERVICE panel. With the breaker in the ON position, the pump will automatically start when the outlets are open. The pump, strainer and thru hull connection are located in the engine room forward alcove starboard side under the shelf plates. The pump discharge is equipped with a **GROCO PST-1** accumulator tank mounted on the engine room forward bulkhead adjacent to the identical fresh water accumulator. In addition, fresh water hose bibs are installed on the bow and cockpit for freshwater cleaning.

2.21.2 Windshield Wipers. The front pilot house windshields are equipped with **ROCA Heavy Duty Wiper Motors Model RC525991 with EXALTO IMW HD Pantograph Arms Model EX2108**. The wiper motors feature 2-Speed w/Park capability. The wiper blades are 15” and 11” EXALTO made Model EX2173 and EX2170, respectively. The wiper motors are individually operated from console mounted switches that receive their power from the 12 VDC SERVICE panel by a circuit breaker labeled WINDSHIELD WIPERS.

2.21.3 Boat Compass. The boat compasses are a RITCHIE Powerdamp Plus magnetic compass mounted on the horizontal section of the pilot house and fly bridge consoles in line with the boat steering wheel. The pilot house compass is equipped with a back light that is operated by a toggle switch that is powered from the 12 VDC SERVICE panel by a circuit breaker labeled ACCESSORIES PANEL.

2.21.4 Boat Horn. The boat horn is a 12 VDC AFI model ABT-D part #10106 and is sounded by a push button from the pilot house, fly bridge and cockpit control stations. Power to horn is from the 12 VDC SERVICE panel by a circuit breaker labeled ACCESSORIES PANEL.

2.21.5 120 VAC Outlets. Double and single 120 volt wall outlets are provided in convenient locations throughout the boat for use with standard appliances and electrical equipment. Outlets in the galley and heads are equipped with ground fault interrupter devices (GFI). The outlets are powered by the TRACE INVERTER from four (4) circuit breakers on the INVERTER OUTLETS side of the 120 VAC 60HZ panel by well labeled circuit breakers.

3.0 HULL AND DECK CARE

The NORDHAVN 50 is constructed with the finest materials and processes available for a production ocean going yacht. Once it leaves the factory, however, the exposed surfaces are subject to use and environmental conditions which ultimately leads to degradation. Naturally occurring factors involved in the degradation process include sunlight, heat, water, marine life and pollutants the combination of which can lead to fading and breakdown of the exterior surfaces of the vessel. It is essential that these exterior surfaces receive periodic care and maintenance. The following are minimum activities that, when performed in a timely and correct manner, will enhance the preservation of your yacht.

3.1 Below the Water Line Care

Bottom Paint. All submerged surfaces of the boat are factory coated with a high grade bottom paint suitable for most sea water environments. The combination of the paint coating and the isophthalic vinyl ester resin in the gel coat and outer layers of fiberglass mat and woven roving provide a tight barrier to water intrusion and prevention of osmotic blisters.

If the applied coating is degraded by normal wear or impact, sanding, sandblasting or other types of abrasives including chemical etchants or paint removers, it must be re-applied at the earliest convenience. It is strongly advised that any repairs or coating re-applications be undertaken by qualified and properly trained personnel with a paint product suitable for the expected operating environment.

Marine Growth. It is extremely important to keep the bottom of the yacht as free from marine growth as possible. To allow marine growth to build up will not only affect the performance, but also interfere with the thru hull fittings. The growth of marine life will vary depending on the waters where the yacht is kept.

It is advisable to check below the waterline every month and, if necessary, wipe the bottom and propeller with a towel. Remove all stains on the waterline which might accumulate from harbor pollution by using an approved cleaner/degreaser.

Monthly checks should include cleaning the waterline, thru-hulls, rudder, keel, shaft, and propeller and inspection of the zincs.

When the vessel is lifted, check the following items:

- The condition of the main and wing propeller, shaft, rudder, and skeg.
- Replace zinc anodes as necessary
- Operation of the sea valves
- Rudder stock shoe

- Main and wing engine shaft cutlass bearing
- Stuffing boxes for the propeller shafts and rudder stock

Anti-fouling Paint. The bottom of the boat receives a coating of anti-fouling paint just prior to leaving the factory. Re-application of the anti-fouling coating will be dependent on the operating conditions of the boat. An inspection of the boat bottom at each haul-out should be made by a qualified individual to determine if re-application is necessary.

The yacht should not be out of the water with a new application for more than 60 days or per the manufacturer's specifications. The climate conditions for the application of anti-foul bottom paint must be dry. Do not apply while the hull is damp, wet or in wet weather conditions.

3.2 Above The Water Line Care

General Cleaning. To help maintain a good exterior above the water line, wash with fresh soapy water and a cloth. A mild liquid detergent or one approved for fiber glass finishes is recommended. Hose down with fresh water giving special attention to rinsing off salt water and salt residue on all expose surfaces, allow to dry, then apply a good marine wax. This operation should be carried out at least twice a season. Do not use any abrasive cleaning agents or materials on the gel coat, particularly steel wool, and always wash all detergents off thoroughly. Small pieces of steel wool will break off and cause rust stains wherever they remain. Other notable precautions are as follows:

- Be careful when using an electric buffing machine as this can easily "burn" the gel coat.
- Do not wax the non-skid or any other horizontal surface on which people walk as it will make the surface slippery and hazardous.
- Avoid use of acetone cleaner. Acetone is extremely flammable and will harm gel coat surfaces.
- Persistent smudges can usually be removed from fiberglass surfaces with a polishing compound.
- Repairing small scratches, chips and gouges in colored surface gel coat can be repaired with minimum effort by carefully following the directions in any fiberglass repair and care book.
- Fittings and hardware should be cleaned with a lubricant such as WD-40, LPS 1 or 2 or CRC and periodically polished with a metal cleaner chrome polisher.

Exterior Teak Wood. Exterior teak use is limited and is protected with varnish. Wash frequently to remove salt water and salt residue in the same manner as the gel coat deck and hull. Re-apply varnish as necessary.

4.0 MAINTENANCE

This section provides minimum guidelines and instructions for incidental maintenance and are presented in a form that can be used as a check list if desired. The items listed, as applicable, and time intervals are for suggestion only, however, the more frequently the vessel is being used, the more often these items should be performed.

As mentioned above, these are only guidelines and they are recommended to be used in conjunction with the periodic maintenance requirements for the equipment installed on the yacht. These requirements are found in their respective Manufacturer's Manuals. Most of these manuals also have a troubleshooting section that is helpful in making repairs. The owner should read these Manufacturer's Manuals carefully to become more familiar with their operation and maintenance procedures. Should you have questions concerning maintenance, please contact PAE for assistance.

Boat Hauling. The NORDHAVN 50 rigid hull structure presents few restrictions on boat hauling. The center of gravity of the vessel is slightly aft of amidships (station 5). Hauling the boat should be performed with lifting slings forward and aft of the boat midpoint and with the boat level fore and aft. DO NOT place the lifting slings on the aft carrier shoe, at the fin stabilizer location, and on any vessel appurtenances.

4.1 Monthly

Interior

( ) 1. Inspect all compartments and storage lockers for signs of water leakage or other anomalies.

( ) 2. Inspect portholes, hatches, and doors for proper operation.

( ) 3. Check all portable fire extinguishers for full charge.

( ) 4. Inspect toilets for leaks and proper operation.

( ) 5. Inspect all faucets and shower mixing valves for leaks and proper operation. Remove any debris from faucet aerators.

Exterior

( ) 1. Inspect and clean exterior fiberglass, non-skid, wood finish, and glass.

( ) 2. Inspect all lockers for proper stowage.

( ) 3. Inspect all hardware, fixtures, fasteners and covers for free operation.

( ) 4. Inspect all deck fills for tightness.

( ) 5. Inspect deck drains for pluggage.

( ) 6. Inspect below water line surfaces and zincs.

Mechanical & Electrical

( ) 1. Inspect all sump pumps, bilge pumps, and emergency bilge pump.

a. Remove any debris from pickup or strainer.
b. Check operation of float switches.
c. Check electrical connection for corrosion and tightness.
d. Check operation of pump in auto and manual.
e. Check all hoses and hose connection for signs of leaks.

( ) 2. Inspect hand bilge pumps.

a. Check operation, hoses and connections for leaks.
b. Remove any debris from pickup.

( ) 3. Check all through hull valves for operation and bonding connections.

( ) 4. Inspect and clean raw water strainers.

( ) 5. Inspect main engine shaft stuffing box for correct leak-off.

( ) 6. Inspect engine and generator exhaust hoses/piping, clamps, tubing, mufflers and risers for leakage and excessive heat.

( ) 7. Check engine mounting bolts for tightness.

( ) 8. Inspect main and generator engines.

a. Check all hose connections for possible leaks.
b. Check all electrical connections for corrosion and tightness.
c. Check engines for signs of fuel, water, and oil leaks.

( ) 9. Inspect all fuel lines, hoses flare nuts, valves, fittings, and filters for signs of leaks.

( ) 10. Inspect toilet flushing lines, pump, holding tank, discharge lines for leaks.

( ) 11. Inspect all water lines, lines, hoses, valves, fittings and filters.

( ) 12. Inspect water pumps for proper operation.

( ) 13. Inspect hot water heater and relief valve for proper operation.

( ) 14. Inspect heating and air conditioning system (when equipped).

a. Check lines, compressor and condensing units, fittings for leaks.
b. Check all electrical connections for corrosion and tightness.
c. Check operation of sea water pump.
d. Check operation of air conditioning fans.

( ) 15. Inspect operation of engine room exhaust fans.

( ) 16. Inspect stabilizer system.

a. Check pump, hoses, conditioner and actuators for oil leakage.
b. Check reservoir for oil level.

( ) 16. Inspect bow thruster, anchor winch and emergency bilge system.

a. Check pump, hoses, reservoir, valves for oil leakage.
b. Check reservoir level.
c. Check thrusters head tank oil level.

( ) 17. Inspect steering system lines, tubing, fittings, manifold, helm, and slave cylinder for leaks.

( ) 18. Inspect rudder seal for leakage.

( ) 19. Inspect reverse osmosis water maker for leaks and operation.

( ) 20. Inspect all batteries. Check cables and connections.

( ) 21. Inspect all electrical wires for signs of chafing.

( ) 22. Check operation of all interior, exterior and navigational lighting.

4.2 Semi-Annual

( ) 1. Perform Monthly maintenance activities.

( ) 2. Weigh the engine room fire extinguisher cylinder. See manufacturer's manual for specific instructions.

( ) 3. Perform additional engine maintenance per the manufacturer.

( ) 4. Perform additional bow thruster maintenance per the manufacturer.

( ) 5. Perform additional stabilizer maintenance per the manufacturer.

( ) 6. Perform additional reverse osmosis water maker maintenance per the manufacturer.

4.3 Annual Maintenance

( ) 1. Perform Monthly and Semi-Annual maintenance activities.

( ) 2. Perform annual boat haul out and conduct survey.

( ) 3. Perform additional engine maintenance per the manufacturer.

( ) 4. Perform additional bow thruster maintenance per the manufacturer.

( ) 5. Perform additional stabilizer maintenance per the manufacturer.

( ) 6. Perform additional reverse osmosis water maker maintenance per the manufacturer.

( ) 7. Inspect fuel oil tanks and remove sediment as required.

( ) 8. Inspect fresh water tank and remove sediment as required.

5.0 CHECK LISTS

This section is intended to provide a list of helpful suggestions that should be considered prior to getting underway. The list is not all encompassing and additional precautions and considerations will be developed with time and experience.

5.1 Pre-Start Check List

( ) 1. Main/wing engine and generator coolant levels, no leaks.

( ) 2. Main/wing engine and generator oil levels, no leaks.

( ) 3. Drain water from fuel filters.

( ) 4. Fuel level in tanks.

( ) 5. Fuel manifold, select tank.

( ) 6. Fresh water tank topped off.

( ) 7. Sea chest strainers clean and isolation valves open to wing engine, generator, air conditioning pump, and water maker.

( ) 8. Main shaft stuffing boxes correct leak off.

( ) 9. Rudder shaft seal leakage.

( ) 10. Bilge pumps in operation.

( ) 11. Bilge level in engine roon.

( ) 12. Steering system operable in both directions.

( ) 13. Stabilizers conditioner oil level.

( ) 14. Stabilizers controller energized and in CENTER.

( ) 15. Bow thruster head tanks oil level.

( ) 16. Fireboy bottle charged/toggle in NORMAL. Portable extinguishers posted.

( ) 17. Main and generator battery switches in NORMAL

( ) 18. House battery switches ON.

( ) 19. Thru-hull valves open.

( ) 20. Navigation and anchor lights.

( ) 21. Horn, windshield wipers, pilot house lights.

( ) 22. Electronics energized.

( ) 23. Deck lockers stowed.

( ) 24. Loose articles stowed.

5.2 Post Starting and Underway Check List

( ) 1. Engine room visual inspection for fuel, water, oil, or exhaust leaks

( ) 2. Engine and generator outlets to be checked for water discharge.

( ) 3. Engine shaft stuffing box for excessive leakage and temperature rise.

( ) 4. Rudder shaft seal for leakage.

( ) 5. Electrical panel for battery charging status and house loads.

5.3 Thru – Hull Layout Drawings

Thru – hull intake and discharge connections on the NORDHAVN 50 are generally placed in the vicinity of the installed equipment that requires the connection. The following drawings provide the standard port and starboard thru-hull layout, service description and compartment location.