ELECTRO-MOTIVE

M.I. 3600
*Rev. C

MAINTENANCE INSTRUCTION

MARINE UNIT INSTALLATION

INTRODUCTION

This publication contains general information and instructions applicable to installation, alignment, checkout, and operation of marine propulsion systems.

The material included is determined from the basic marine propulsion unit and common extra equipment. However, the appearance herein or absence of coverage for any particular system or component in no way implies that the equipment is or is not part of any specific purchase order. Wiring diagrams and installation drawings for specific units take precedence over information presented in this publication.

Additional information on installation, alignment, checkout, and operation may be obtained from an EMD Service Representative.

For specific equipment, it is advised that due consideration be given to the manufacturer's pamphlets and bulletins.

During alignment of the reduction gear and the engine, the vessel must be completely afloat at normal load displacement with the propeller shaft positioned in the center of the bearings.

GEAR TO PROPELLER SHAFT ALIGNMENT

Four different types of reduction gears are used for propulsion systems. The following instructions contain information applicable to installation and alignment of each type gear to the propeller.

FALK REDUCTION GEAR

1. Airflex clutches are shipped in an inflated condition. Deflate clutch by releasing air from the emergency air inlet Schrader valve.

2. Remove 3/4" pipe plug from top of air supply manifold.

3. Remove 1/2" pipe plug from inside the manifold which blocks normal air inlet passage.

4. Replace 3/4" pipe plug in the top of air supply manifold.

5. Remove the oil feed hose from the rear bearing housing of the ahead main pinion, and pour approximately one quart of gear case oil into bearing housing to lubricate air shaft pilot bushing.

6. Align the gear output shaft to the propeller shaft and perform gear tooth contact check as directed in the Falk maintenance manual. Final angular alignment limit for MR type gears is .005" max., and a concentricity limit of .005" TIR max.

WESTERN REDUCTION GEAR

Installation and alignment instructions and alignment limits are contained in the WESTERN maintenance manual supplied with each unit.

LUFKIN REDUCTION GEAR

Installation and alignment instructions and alignment limits are contained in the LUFKIN maintenance manual supplied with each unit.

*This bulletin is revised and supersedes previous issues of this number. Areas of change are indicated by vertical bars in the margins.

REINTJES REDUCTION GEAR

Installation and alignment instructions and alignment limits are contained in the REINTJES maintenance anual supplied with each unit.

ENGINE TO GEAR ALIGNMENT

The following instructions contain information for installation and alignment of the engine to Falk, Western, Lufkin, and Reintjes reduction gears, as applicable.

FALK REDUCTION GEAR

SINGLE PINION—SERIES M, MR (MODEL C) WITH THIN COUPLING DISC, AND MR WITH ENGINE BONDED RUBBER COUPLING

1. Place temporary support under aft clutch to approximate concentricity with drum.

2. Adjust clutch spacer axial position to obtain the "X" dimension, Fig. 1, between the forward edge of the ahead clutch drum and the aft face of the spacer nearest the bolt circle. Refer to the applicable engine and gear installation drawing for actual dimension.

3. Position engine to obtain "Y" dimension, Fig. 1, between the forward face of the spacer and the face of the engine coupling. Refer to the applicable engine and gear installation drawing for actual dimension.

4. Move clutch assembly aft enough to provide clearance for installation of the thin coupling disc or bonded rubber coupling and main drive coupling tube.

5. To avoid excessive distortion of the coupling disc or strain on rubber coupling elements when bolting the main drive coupling tube and coupling to the engine coupling, support the end of the tube with a sling from the engine or with temporary blocking.

6. Make a preliminary alignment by moving engine horizontally and vertically so the main drive coupling tube flange and clutch spacer can be mated without forcing or straining parts. Move the clutch assembly forward to engage the rabbet fit and tighten bolts between the main drive coupling tube and clutch spacer.

NOTE

When aligning main drive coupling tube, allowance must be made for the droop or sag of the ahead pinion shaft and clutch drum. Perfect concentricity between the engine and the ahead clutch drum is NOT GOOD ALIGNMENT.

7. Mount a dial indicator, Fig. 1, to indicate face runout between the ahead clutch gland and the

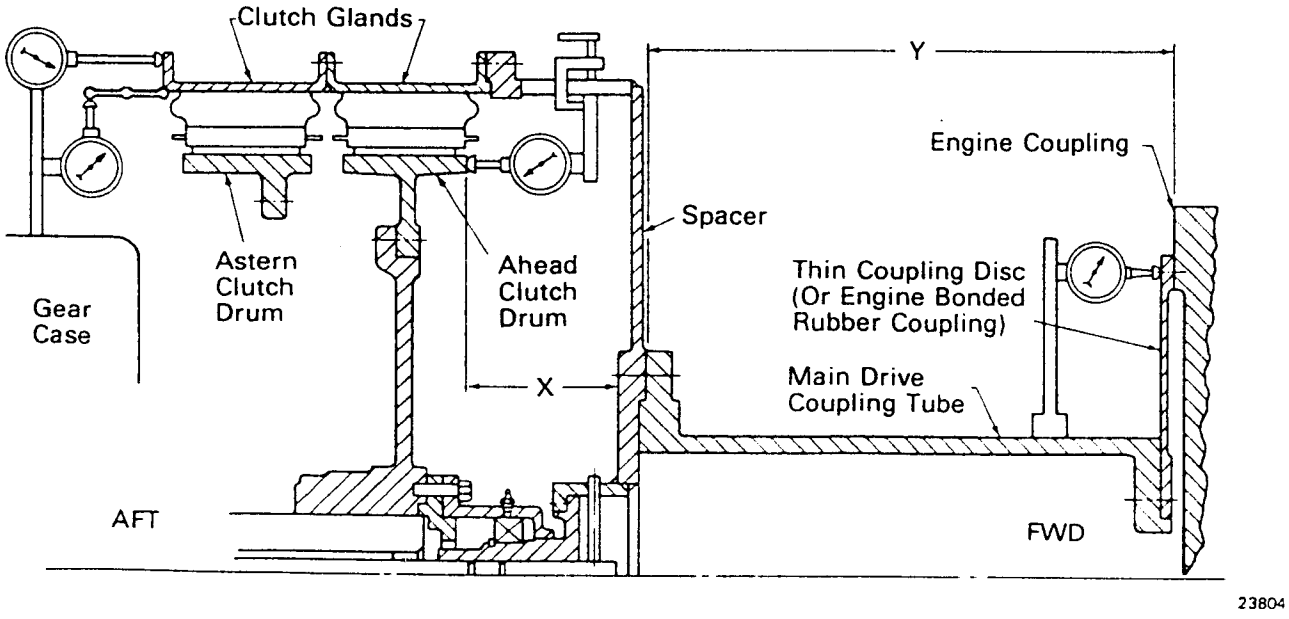

Fig.1 - Engine To Reduction Gear Alignment

face of the ahead clutch drum (TIR No. 1). Mount a second indicator from a rod inserted in the 1/4" P.T. hole in the main drive coupling tube, adjacent to the coupling disc, Fig. 1, to indicate face runout at the O.D. of the coupling disc, or at the outer member of the bonded rubber coupling, if so equipped (TIR No. 2).

8. With clutches deflated, rotate clutch gland and ahead clutch drum together taking readings every 90°. Make a full revolution of engine to center the bearings before taking readings. Adjust the aft engine mounts to get TIR No. 1 readings, per tables 1, 2, or 3, at the ahead clutch drum, bottom open, and sides equal within .005". Adjust the forward engine mounts to get TIR No. 2 readings, per tables 1, 2, or 3, at the engine coupling, top open, and sides equal within .005".

NOTE

Crankshaft thrust must be held in one direction during alignment.

MR UNIT SIZE	1226 1230 1626 1630 2430	1235 1635 2435 2440	3035 3040 3540	2448 3048 3548 4048 4548
TIR No. 1 (Open At Bottom)	.015" ±.002"	.019" ±.002"	.025" ±.002"	.030" ±.002"
TIR No. 2 (Open At Top)	.012" ±.002"	.012" ±.002"	.014" ±.002"	.014" ±.002"

Table 1 – Engine To Gear Alignment - Series MR Gear With Thin Coupling Disc

M UNIT CLUTCH SIZE	26 and 30	35 and 40	48
TIR No. 1 (Open At Bottom)	.015" ±.002"	.019" ±.002"	.024" ±.002"
TIR No. 2 (Open At Top)	.012" ±.002"	.012" ±.002"	.012" ±.002"

Table 2 – Engine To Gear Alignment - Series M Single And Double Pinion With Thin Coupling Disc

MR UNIT SIZE	1226 1230 1626 1630 2430	1235 1635 2435 2440	3035 3040 3540	2448 3048 3548 4048 4548
TIR No. 1 (Open At Bottom)	.016" ±.002"	.020" ±.002"	.027" ±.002"	.033" ±.002"
TIR No. 2 (Open At Top)	.010" ±.002"	.010" ±.002"	.014" ±.002"	.014" ±.002"

Table 3 – Engine To Gear Alignment - Series MR With Engine Bonded Rubber Coupling

9. Repeat Step 8 as necessary to obtain both required readings. Make full revolution of engine each time an adjustment is made in the engine mounting before taking readings. Secure engine to base with mounting bolts torqued to 455 ft-lbs, if using steel chocks.

   For other chocking materials, refer to manufacturer's recommendation. Make final indicator sweep to be certain alignment readings remain within tolerances, and record data.

10. Mount dial indicators on the gear case to run on the female pilot surface and the exposed aft flange face of the astern clutch, Fig. 1, and check the concentricity and runout. Total indicator readings should not exceed .015". If these values are exceeded, remove and disassemble glands and spacer to check for burrs, chips or other foreign matter which might interfere with proper assembly and concentric running of these elements. Check to ensure that clutch assembly is airtight after reassembling.

CAUTION

Any time the clutch spacer is unbolted or removed, the main drive coupling tube must be supported to prevent damage to the coupling disc.

DOUBLE PINION — SERIES M

1. Perform Steps 1 through 9 of the preceding single pinion procedure.

2. Mount dial indicators on the clutch flange to run on the female pilot surface and the exposed forward flange face of the clutch, Fig. 2. With clutch deflated, check the concentricity and runout by turning the clutch gland. Do NOT

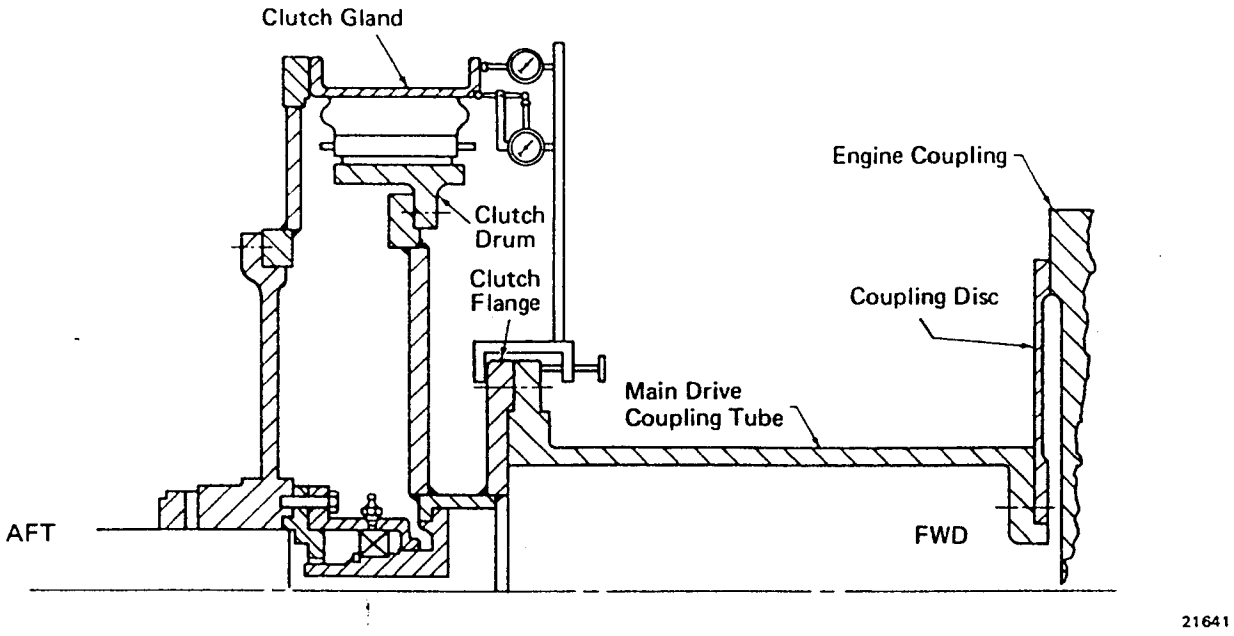

Fig.2 – Series M Double Pinion Alignment

turn the main drive coupling tube for this check. The total indicator reading must not exceed .015". If these values are exceeded, remove and disassemble gland to check for burrs, chips, or other foreign matter which might interfere with proper assembly and concentric running of these elements. Check to ensure that clutch assembly is airtight after reassembling.

CAUTION

During disasssembly, the main drive coupling tube must be supported to prevent damage to the coupling disc before clutch flange bolts are loosened.

CLOSE COUPLED FALK GEAR TO ENGINE OR CLOSE COUPLED FALK GEAR TO THROUGH SHAFT GENERATOR WITH CLUTCH PORTION MOUNTED ON GENERATOR HUB (SINGLE BEARING THROUGH SHAFT GENERATOR MOUNTED ON SKID WITH ENGINE)

Use Falk installation instructions titled "Engine to Gear Alignment for Engine Mounted Clutch (Model B)". These instructions are to be used when the clutch gland or drum is directly mounted to engine or generator. In either case, no pilot bearing is used in the reduction gear.

NOTE

Consult the installation drawing for the correct longitudinal position of the gear with respect to the engine or generator.

WESTERN REDUCTION GEAR WITH CLUTCH DRUM DIRECTLY MOUNTED TO ENGINE

1. Inflate the clutches or block the clutch glands and spacer (if provided) to position clutches in clutch drums.

2. Move engine toward gear until gear adapter/spacer mates with the engine coupling.

3. Bolt adapter/spacer to engine coupling and release clutch gland from clutch drum.

4. Check and correct longitudinal position of gear with respect to engine according to the installation drawing.

5. Mount two dial indicators on the clutch gland with followers riding on aft face and O.D. of clutch drum. On reverse reduction units, use the astern clutch gland and astern drum for dial indication.

6. With clutch gland and drum rotated together, position engine so that face and O.D. runout readings do not exceed .005" TIR.

LUFKIN REDUCTION GEAR WITH DRIVE LINE USING BONDED RUBBER COUPLING AND THOMAS COUPLING

After the gear to propeller shaft alignment is completed, per gear manufacturer's instructions, and the gear is securely positioned, the engine to reduction gear drive line is to be aligned as follows:

1. Attach bonded rubber coupling to engine coupling.

2. During alignment to gear, maintain engine crankshaft end play toward gear at all times to minimize effects of crankshaft thermal expansion on gear input shaft axial location.

3. Use Lufkin Marine Reduction Gear alignment procedures and data sheet supplied with unit to align engine to reduction gear.

4. Position engine so that face runout readings between inner and outer members of bonded rubber coupling do not exceed .005" TIR.

NOTE

Consult the installation drawings supplied for the correct longitudinal position of the gear with respect to the engine.

5. Secure engine to base with mounting bolts and chocks according to gear manufacturer's recommendations.

6. Make final indicator reading check to be certain alignment remains within tolerance.

NOTE

If in-service alignment checks show face runout readings between inner and outer members of coupling to be within a total indicator reading of .010", it is not necessary to disturb alignment. If readings exceed this limit, gear and engine should be realigned back to installation limits described above.

REINTJES REDUCTION GEAR

1. During alignment of engine to gear, maintain engine crankshaft end play toward the reduction gear to minimize the effect of crankshaft thermal expansion on the gear input shaft axial position.

2. Position engine to Vulkan coupling adapter so adapter mates with grooved pilot on the engine coupling without placing any strain on coupling rubber elements. Add or remove shims from the appropriate engine mounting pads to accomplish alignment.

3. Bolt Vulkan coupling adapter to engine coupling. Ensure that crankshaft has normal axial freedom and is not being restrained by the coupling.

4. With a rigid fixture attached to the gear end of the Vulkan coupling, mount dial indicators to read the O.D. runout and the face runout of the engine coupling.

5. Adjust the engine position so that, when the engine and coupling are rotated together, the face and O.D. runout readings do not exceed .004" TIR while holding the crankshaft end play one way during the indicator reading.

6. Secure engine to base with mounting bolts torqued to 455 ft-lbs, if using steel chocking. For other chocking materials, refer to manufacturer's recommendations.

7. Make final indicator sweep to be certain alignment readings remain within tolerances, and record data.

NOTE

If in-service alignment checks show face and O.D. runout within a total indicator reading of .010", it is not necessary to disturb alignment. If either reading exceeds this limit, gear and engine should be realigned back to installation limits described above.

GEAR AND ENGINE MOUNTED ON COMMON BASE

1. Align reduction gear mounted on common base to the propeller shaft as described in previous paragraphs. Alignment of the gear to the propeller shaft must be accomplished by shifting the base and not by shifting the gear on the base. The alignment procedures will be dependent on the type of gear used.

2. Check that jacking screws operate freely, and that mating surfaces are clean and smooth.

3. Upon completion of alignment of base mounted gear, secure the gear end of the base to the ship structure.

4. Check alignment of the engine to the gear and, if necessary, correct misalignment by shifting the engine end of the base horizontally or vertically as necessary.

5. If engine to gear alignment cannot be accomplished by shifting the engine base, final adjustments can be made by changing the position of the engine on the base by adding or removing engine mounting pad shims. Refer to applicable engine to gear alignment procedures for angular and concentricity alignment tolerances.

PIPING INSTALLATION

The installation and cleanliness of all piping external to the engine is the responsibility of the shipbuilder.

The following instructions must be followed to ensure that all engine systems are protected from damage by foreign material. The procedures will cover units equipped with and without accessory racks.

UNIT EQUIPPED WITH ACCESSORY RACK

1. Remove engine air intake filters and inspect filter housing and air ducts for damage and foreign material.

2. Install a temporary ~40 to 80 mesh screen at the junction of the return line from the fresh water cooler and the bypass piping. This screen will be used during dock trials to protect the engine cooling system from debris.

3. Blow out air supply piping to remove debris before connecting to air starting system strainer.

4. Check that the orifice is properly installed in the raw water system as shown on the Raw Water Piping schematic. Ensure that orifice is installed at the raw water cooler outlet.

5. Remove air box drain plugs. The method used to accomplish air box draining is determined by the shipbuilder to suit the installation.

6. Check alignment of raw water pump belt drive (if so equipped) as described in following paragraphs. Adjust drive belt tension in accordance with application drawing.

7. Check all external piping installed by shipbuilders for proper size and application.

UNIT WITHOUT ACCESSORY RACK

1. Remove engine air intake filters and inspect filter housing and air ducts for damage and foreign material.

2. Check for proper installation of piping to water temperature regulator valve. The regulator flanges are marked A, B & C. The A flange receives the water from the engine outlet, the B flange is the bypass to the lube oil cooler, and the C flange connects to the raw water, skin, or keel cooler.

3. Install a temporary 80 mesh screen between the ship piping and the "Y" pipe at the inlet to the water pumps. This screen will be used during dock trials to protect the engine cooling system from debris.

4. Flush lube oil system piping as follows:

   a. Open piping connection at lube oil strainer housing inlet.

   b. Remove lube oil filter and oil cooler bypass valves and install temporary connections.

   c. Close inlet and outlet valves at lube oil filter.

   d. Open connections at lube oil cooler inlet and outlet and blank off piping connections.

   e. Open piping at lube oil scavenging pump outlet connection and install flushing pump and external source of pickling acid to the piping connection.

   f. Flush lube oil piping until pickling solution is clean and free from foreign material at the strainer housing connection.

   g. Disconnect pickling source and connect source of *heated* lubricating oil.

   h. Flush piping until oil is clean and free from foreign material and is *completely flushed* of all traces of pickling fluid. Tap the pipes to loosen slag in the lines during the flushing operation.

   i. Remove oil source and flushing pump, then reconnect all piping connections.

5. Blow out air supply piping to remove debris before connecting to air starting system strainer.

6. Install an EMD furnished orifice in the engine cooling system at the engine outlet pipe, and in the raw water piping as shown on the Raw Water System schematic. Ensure that orifice is installed at the raw water cooler outlet.

7. Remove air box drain plugs. The method used to accomplish air box draining is determined by the shipbuilder to suit the installation.

8. Check alignment of raw water pump belt drive (if so equipped) as described in the following paragraphs. Adjust drive belt tension in accordance with application drawing.

9. Check all external piping installed by shipbuilders for proper size and application.

RAW WATER PUMP DRIVE ALIGNMENT

Belt drive raw water pumps supplied with marine engines are driven from a drive shaft coupled to the front end of the engine crankshaft with a sleeve type rubber coupling. The outer end of the drive shaft is carried in a pillow block pedestal bearing.

During installation of this equipment, it is important that the pump drive be checked for proper alignment on units received with accessory rack or as installed on units without accessory rack as follows:

1. With pump drive belt removed, mount dial indicator on coupling flange to read drive shaft angularity. Position indicator with plunger resting on shaft 2" from shoulder of the coupling, as shown in Fig. 3. Zero the indicator.

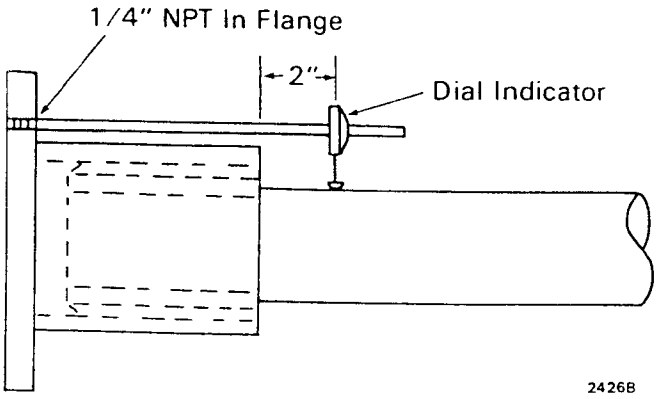

Fig.3 – Dial Indicator Positioning

2. Bar engine over one complete revolution and check indicator readings at each 90° interval. Position and shim pedestal bearing to obtain a total indicator reading (TIR) of 0.012" maximum.

3. Pull pedestal bearing out away from engine to remove axial clearance, then final tighten bearing mounting bolts. Recheck dial indicator readings to ensure they remain within limits.

4. After drive shaft is aligned, the pump sheave and both idler sheaves should be positioned parallel to each other in the same plane within 1/32".

5. Position drive sheave 0.080" ± 0.020" behind pump and idler sheaves to allow for crankshaft expansion which will bring drive sheave into alignment when engine is at operating temperature.

6. Secure sheave adjustments. Replace pump drive belt and adjust tension.

GOVERNOR AND CLUTCH CONTROLS

All control lines in the system will be fabricated from copper tubing. The use of teflon thread tape must be avoided to prevent plugging of small orifice openings with tape fragments.

Perform the following procedures to ensure proper operation of the governor and clutch controls.

1. Open all connections of the air control system and blow out lines with clean, dry air to prevent introduction of foreign material into control system equipment. Reconnect all air lines.

2. Check air system pressure level and adjust regulator if required.

3. Remove all dirt, metal chips, and foreign materials from the area around control head before attempting to operate system or make equipment adjustments.

4. Check governor speed control piping as follows:

   a. Remove speed line connection at the engineroom control head and install a pressure gauge in the head. Set control handle to FULL AHEAD position. Adjust control valve in head in accordance with manufacturer's recommendations for FULL AHEAD pressure as stated on the governor nameplate (usually 70 psi).

b. Place control handle to FULL ASTERN position. Gauge indication should be the same as FULL AHEAD.

c. Remove gauge from control head and reconnect speed control line.

d. Open governor control line at governor connection and install pressure gauge between the line and the governor. Set control handle to FULL AHEAD position and check gauge for steady FULL AHEAD pressure. If gauge does not indicate FULL AHEAD pressure, check all line connections for leaks, using a soap solution.

e. Place control handle to FULL ASTERN position and verify gauge indication.

f. Final speed control adjustments will be made during "Initial Engine Start" tests.

5. Repeat Step 4 for all other control stations.

6. Place engineroom control handle in the AHEAD position and check for 140 psi air pressure on the AHEAD pressure gauge mounted on the clutch control panel. Check that the AHEAD clutch shoes are contacting the drum. Repeat for the ASTERN clutch.

7. Repeat Step 6 for all other control stations.

8. Check for zero pressure indication on the AHEAD and ASTERN clutch gauges when the control handle is in the neutral position. Repeat for all other control stations.

9. Move clutch control handle from neutral to AHEAD position and check clutch inflation rate. Inflation from 0-140 psi should occur in 8-14 seconds. Repeat for the ASTERN clutch.

10. Adjust slip clutch controls as recommended by the manufacturer, if so equipped.

PRE-SERVICE ELECTRICAL INSPECTIONS

The settings of the alarm switches and control relays should be checked in accordance with the relay and switch setting chart contained in the applicable physical schematic diagram. It may be more convenient to check some of these settings during the initial engine start.

SHIP LOOSE ALARM CABINETS AND POWER CONTROL CABINETS

Prior to connection of ship's power to cabinets:

1. Visually inspect cabinet and external connections for obvious defects.

2. Connect ohmmeter between terminal 20 of the alarm cabinet and ground, as shown in Fig. 4. If the meter indicates a short circuit, one of the engine mounted switches or switch wiring is grounded. The most common ground is at the crankcase pressure detector, and occurs when the panel is wired to the switch mounting bolts instead of the switch contacts.

3. On multiple engine vessels with a common alarm siren, check that terminal 6 of each cabinet is wired to the same terminal of the siren.

Connection of ship's power:

1. Connect alarm cabinet to ship's power.

2. Turn power switch on, and check operation of the ALARM TEST switch and the LAMP TEST switch.

3. Energize each alarm to ensure that each circuit functions properly. Most alarms can be energized by mechanically opening the standard pressure or temperature alarm switches. The crankcase pressure detector can be qualified with its alarm circuit by drawing a vacuum on the vent on top of the device to open the switch. The low oil pressure circuit is energized by pulling out the low oil pressure switch plunger on the governor.

4. Check that the ALARM OFF switch functions properly on at least one of the alarms.

5. Connect power control cabinet to ship's power.

RACK MOUNTED ALARM CABINETS

1. Visually inspect cabinet for defects. Note customer connections to terminal boards.

2. Turn power switch ON and check operation of the alarm test switches.

3. Energize each alarm to ensure that each circuit functions properly. Most alarms can be energized by mechanically opening the standard pressure or temperature alarm switches. The crankcase pressure detector can be qualified with its alarm circuit by drawing a vacuum on the vent on top of the device to open the switch. The low oil pressure circuit is energized by pulling out the low oil pressure switch plunger on the governor.

4. Check that the alarm off or reset switch functions properly on at least one of the alarms or with each alarm if individual circuits have separate AX relay for silencing. See applicable schematic diagram.

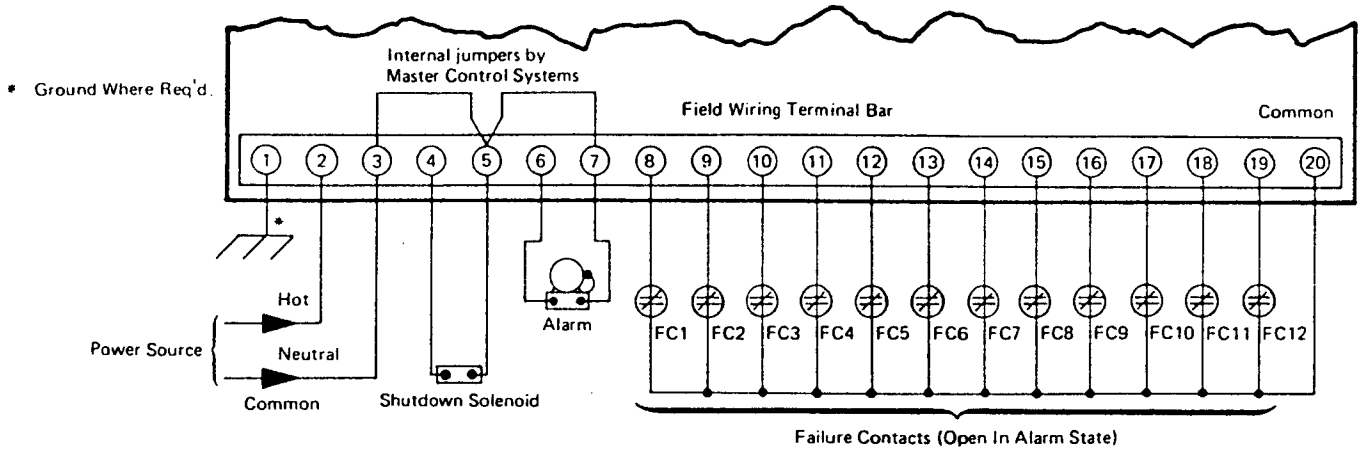

Fig.4 – Alarm Cabinet External Wiring

PYROMETER INSTALLATION

1. Mount the pyrometer to a vibration free structure.

2. Do not use copper wires to connect the thermocouples to the pyrometer. Use one No. 18 iron wire and one No. 18 constantan wire.

3. Connect the positive (white) wire to the positive terminal of the pyrometer, and the negative (red) wire to the negative terminal.

CAUTION

If it is necessary to check continuity of the circuits with an ohmmeter, be sure the circuit being checked is disconnected from the pyrometer. The battery voltage of this instrument will seriously damage the pyrometer.

4. Note that the indicator reads in the forward direction when the selector switch is set to any thermocouple position. If not, check the connections at both the thermocouple and pyrometer for proper polarity.

5. With the selector switch in the OFF position, the indicator should read a temperature corresponding to the cold end temperature which is the ambient temperature at the pyrometer terminals. If the reading is not correct, adjust the "cold end adjuster" screw until the pointer reads the correct cold end temperature.

NOTE

Never set the indicator pointer to the zero mark unless the cold end temperature actually is zero degrees.

ENGINE PRESTART

Perform the following procedures prior to engine start to ensure that the engine and associated equipment are in operating condition.

1. Check that injector control lever moves freely without binding, and rack stop is properly adjusted.

2. Check that overspeed trip lever is in the latched position.

3. Turn manual speed adjusting knob to minimum speed setting on PGA type governors.

4. Switch engine speed and clutch controls, to engineroom station, and place clutch control handle to neutral position.

5. Check that neither the forward nor reverse clutches are engaged.

6. Check that air box drains are open.

7. Remove oil filler hex plug from side of starting motor housing cover assembly, and fill reservoir with SAE 20W motor oil. Remove oil plug from pinion end of motor, and fill with SAE 20W motor oil. Pour two teaspoonfuls of engine oil into air inlet.

8. Fill air line lubricator with SAE 20W motor oil.

9. Fill engine cooling system to proper level as indicated by coolant sight glass. Add rust inhibitor to attain proper concentration as directed by Maintenance Instruction M.I. 1748, to prevent damage to cooling system.

10. Check that governor oil is at proper level. Add oil as necessary. Do not over-fill. Governor oil should meet specification of Maintenance Instruction M.I. 1764.

11. Fill reduction gear box to proper oil level, as directed by manufacturer's instructions.

12. Check oil filter element installation to ensure that elements are properly seated and that cover gasket is in place and is not damaged.

13. Check oil strainer housing for debris.

14. Install temporary 80 mesh lube oil strainers in strainer housing. The 80 mesh strainers will be used during dock trails to protect the engine oil system from residual debris in the lube oil piping after flushing.

    The temporary strainers can be fabricated as follows:

    a. Remove engine oil strainer assemblies from strainer housing.

    b. Remove screen assembly from strainer assembly.

    c. Wrap 80 mesh screening around the 40 mesh convolutes of the screen assembly, and secure firmly in place.

    d. Reinstall screen assemblies in strainer assemblies.

    e. Install strainer assemblies in strainer housing.

15. Fill engine oil pan until oil level is at FULL mark on the dipstick.

16. Fill lube oil strainer housing to overflow level.

17. On turbocharged engines, momentarily depress engine start switch to energize turbocharger soak back pump — do not start engine. Perform the following checks:

    a. Remove the rear oil pan handhole cover and confirm that oil is flowing from the rear gear train. If oil flow is not observed through the gear train, check soak back pump for proper rotation. Also check for a stuck check valve in the turbocharger oil filter head and the soak back oil filter head.

    b. Observe camshaft bearings. If lube oil flows from the camshaft bearings with the soak back pump running, and the engine shut down, inspect turbocharger lube oil filter outlet check valve for proper operation.

18. Prelube engine as directed in the Engine Maintenance Manual.

19. Open cylinder test valves and manually bar engine over one complete revolution. If fluid discharge is observed from any cylinder, find the cause, and make the necessary repairs prior to starting the engine.

20. Check that air starting pressure is 150 psi for 8 cylinder engines, and 200 psi for all other engines.

21. Check fuel supply, and prime fuel system.

22. Start engine in accordance with instructions contained in Operator's Manual.

INITIAL ENGINE START

After starting the engine for the first time, the following checks must be performed to ensure proper engine performance. A table of operating temperatures and pressures is provided at the end of this section for specific engine applications.

1. Remove ahead and astern clutch air lines from the four-way valve, and plug ports to prevent clutch action when control handle is actuated for final speed air control test, Step 20.

2. With engine at idle speed, check engine lube oil pressure. If pressure is not indicated on gauge within 30 seconds, shut engine down, and determine cause. Low oil pressure may be due to low oil level in engine oil pan or to air in the lube oil system, which may be corrected by venting the system.

3. Check coolant level and add coolant, if necessary.

4. Check engine cooling system and raw water pressure indicators to verify coolant flow.

5. Check that governor oil is at proper level. Add oil, if necessary. Do not overfill.

6. Open top deck covers and check for:

    a. Lube oil flow at all rocker arms and camshaft bearings.

    b. Fuel and water leaks.

c. Proper operation of valves, injectors, and rocker arms.

7. Check for proper injector rack operation and free movement of linkage by positioning injector rack to the increase fuel position at each cylinder. Proper operation is indicated by increased noise level during firing of the cylinder being tested.

8. Close engine top deck covers and shut down engine, using engine stop switch, after five minutes of operation.

9. On units with turbocharged engines, check that the turbocharger soak back pump is operating immediately after shutting down the engine.

10. Remove the oil pan handhole covers and perform a visual and "feel over" inspection of the main, connecting rod, and piston carrier bearings. Bearings that appear to be appreciably hotter than the others should be investigated to determine the cause of excessive heating.

11. Restart engine and repeat "feel over" inspection after 15 minutes of operation.

12. Restart engine and run at idle speed until temperature of water into the engine reaches a minimum of 120° F before increasing engine speed.

13. Slowly rotate governor manual speed control knob until rated engine speed is obtained.

14. Allow engine to operate at rated RPM until engine oil and coolant temperatures stabilize.

15. Use a handheld tachometer to measure engine RPM, and if necessary, adjust electric tachometer to agree with handheld tachometer.

16. Check fuel, coolant, and lube oil temperatures and pressure as listed in Tables 4, 5, and 6. If temperatures and pressures are not within limits, check the following items:

    a. High lube oil filter pressure and/or low main lube oil pump pressure may indicate that temporary screens installed in strainer housing require cleaning.

    b. Low water pump outlet pressure or high coolant temperature may be due to plugging of temporary screen.

    c. High pressure readings in the coolant or raw water system may require enlargement of the orifice plate opening in the applicable system. Low pressure indications may indicate too large an opening in the orifice plate.

17. On reduction gear oil coolers with raw water cooling, adjust cooler pressure drop by using an orifice or throttle valve to obtain value stated on Raw Water System schematic.

18. On reduction gear coolers with skin cooling, adjust cooler pressure drop by using an orifice or throttle valve to obtain value stated on Fresh Water System schematic.

19. Attach water filled manometer to oil pan dipstick tube and check crankcase suction with engine at rated RPM. Manometer reading must be 1/2" of water minimum.

NOTE

When making this check all top deck covers must be closed and firmly latched.

20. Slowly rotate governor manual speed knob until engine idle speed is obtained. With the clutch ports in the four-way valve plugged (see Step 1), move the engineroom control handle to full ahead speed. Check engine speed using a handheld tachometer. If necessary, adjust governor air pressure to obtain rated engine speed within +8, -0 RPM. Move control handle to neutral, and check that idle is within ± 4 RPM (usually 350 ± 4 RPM), check astern speed. Repeat for all control stations.

21. Slowly increase engine speed until overspeed trip is actuated. Overspeed should trip between 990 and 1045 RPM. Adjust overspeed trip as directed in the Engine Maintenance Manual, if necessary.

22. Remove temporary screens from lube oil strainer housing and coolant system.

23. Clean lube oil strainer housing.

24. Remove plugs from the four-way valve, and reconnect clutch air lines.

FINAL SHIP'S TRIAL

1. Prelube engine as directed in the Engine Maintenance Manual.

2. Fill lube oil strainer housing to overflow level.

3. Open cylinder test valves and manually bar engine over one complete revolution. If fluid discharge is observed from any cylinder, find the cause, and make the necessary repairs prior to starting the engine.

4. Start engine. The engine speed should not be increased above idle until the temperature of water into the engine reaches a minimum of 120° F.

5. Check lube oil and water levels.

6. With the engine at full load for a sufficient time to stabilize the lube oil and water temperatures, check that the temperatures, pressures and vacuums are within the values shown in TABLES 4, 5, 6, and 7.

	BLOWER ENGINE WITHOUT RACK	TURBO ENGINE WITHOUT RACK	BLOWER ENGINE WITH RACK	TURBO ENGINE WITH RACK
Fuel Pressure (Into Filter)	40-50 psi	40-50 psi	40-50 psi	40-50 psi
Lube Oil Pressure (At Governor)	40-70 psi	60-100 psi	40-70 psi	60-100 psi
Lube Oil Temperature* (Into Engine) (Out of Engine)	175°-200° F 195°-220° F	175°-195° F 195°-220° F	165°-200° F 185°-220° F	165°-195° F 185°-220° F
Water Temperature (Into Engine) (Out of Engine) (From Water Cooler To Lube Oil Cooler)	155°-170° F 165°-180° F	155°-170° F 165°-180° F	155°-170° F 165°-180° F 150°-165° F	155°-170° F 165°-180° F 150°-165° F

be oil temperatures given are with reduction gear coupled to engine – May be less with gear uncoupled.

	FRESH WATER PRESSURE RISE ACROSS PUMP		RAW WATER TEMPERATURE RISE ACROSS FRESH WATER COOLER (with rack)	
	BLOWER ENGINE	TURBO ENGINE	BLOWER ENGINE	TURBO ENGINE
8 Cylinder 12 Cylinder 16 Cylinder 20 Cylinder	36-42 psi 40-46 psi 38-44 psi	44-50 psi 44-50 psi 52-58 psi 52-58 psi	9°-13° F 7°-10° F 10°-13° F	8°-11° F 13°-16° F 15°-18° F 17°-21° F

Tables 4 and 5 – Operating Temperatures And Pressures

NOTE

To convert Fahrenheit to Celsius
Temperature (°F - 32) ÷ 1.8 = °C

For calculating temperature rise
1° Celsius = 1.8° Fahrenheit

	BELT DRIVEN RAW WATER PUMP (with or without rack)		ENGINE DRIVEN RAW WATER PUMP (without rack)	
	BLOWER ENGINE	TURBO ENGINE	BLOWER ENGINE	TURBO ENGINE
With Gear Cooler:				
8 Cylinder	35-1/2 - 37 psi	25-29 psi	39-43 psi	41-45 psi
12 Cylinder	25-29 psi	25-29 psi	41-45 psi	41-45 psi
16 Cylinder	25-29 psi	20-24 psi	41-45 psi	30-34 psi
20 Cylinder	-	20-24 psi	-	30-34 psi
Without Gear Cooler:				
8 Cylinder	36 - 37-1/2 psi	28-32 psi	44-48 psi	45-49 psi
12 Cylinder	28-32 psi	28-32 psi	45-49 psi	45-49 psi
16 Cylinder	28-32 psi	24-28 psi	45-49 psi	38-42 psi
20 Cylinder	-	24-28 psi	-	38-42 psi

Raw water inlet pressure (all units) - Min. 4 psi Vacuum.

Table 6 - Raw Water Pressure Rise Across Pump

	BLOWER ENGINES (Manometer tap at Siamese adapter)	TURBO ENGINES (Manometer tap at air Silencer box)
Remote Paper or Fiberglass Filters	15" H_2O	6" H_2O
Remote Oil Bath Filters	15" H_2O	8" H_2O

Table 7 - Maximum Air Inlet Depressions (Engines W/Remote Air Filters)

Turbo Engine Exhaust Back Pressure - 5" H_2O Max. (Manometer tap in exhaust duct).

Blower Engine Exhaust Back Pressure - 21" H_2O Max. (Manometer tap in ship's exhaust piping, immediately after engine exhaust manifold).

NOTE

1 inch = 25.4 millimeters
1 pound/sq. inch = .070 3 kilograms/sq. cm.
= 6.895 kilo Pascal (kPa)