MARINE RECREATIONAL HIGH OUTPUT PROPULSION UNITS B AND C SERIES INSTALLATION DIRECTIONS

INTRODUCTION

SPECIAL NOTES REGARDING THE INFORMATION CONTAINED IN THIS BULLETIN

This installation bulletin gives specific requirements regarding the installation of Cummins B and C Series Marine Engines. These requirements are necessary to maintain smooth and consistent engine operation. Failure to meet the requirements may result in premature engine wear and decreased reliability.

This bulletin is broken down by system. Each system contains the requirements necessary for maximum engine operation. The requirements are followed by text which gives RECOMMENDATIONS as a guide to possibly achieving the requirements. These recommendations are merely a roadmap to achieving the requirements. Other methods of achieving the requirements for engine installation may be followed.

Cummins Marine is providing this document to make the installation as easy and as simple as possible; however, this document is technical in nature and directed towards individuals and/or corporations capable of completing the requirements stated herein. Cummins Marine can offer professional assistance. Assistance can be provided by contacting your local Cummins Authorized distributor or dealer.

Supplemental information (such as Data Sheets, Data curves, Operation and Maintenance Manual, etc.) are required and are referenced in these directions.

NOTE: *Please consult the Operation and Maintenance manual for the proper start-up and maintenance procedures. Contact your local Cummins Marine Distributor for the specific performance curve/data sheet and the General Engine Data Sheet for your engine.*

SYMBOLS CONTAINED IN THIS DOCUMENT

This is a critically important point. When accompanied by the word "WARNING," this symbol indicate that there is a risk of personal injury or death.

This symbol is used to indicate a required caution. Failure to observe a caution could result in equipment damage or failure.

This symbol indicates a requirement for engine installation. Failure to comply with the requirement could void the engine warranty and could result in engine damage or failure.

NOTE: *A note provides additional helpful information.*

This symbol indicates that you should refer to the *Operation and Maintenance* Manual or some other document for further information.

This symbol indicates that you should consult your local Cummins Marine Distributor or Representative. You can find a listing of local sources in the Operations and Maintenance Manual, or consult your local yellow pages.

Additional materials needed for installation:

- Operation and Maintenance Manual
- Applicable Engine Installation Drawing
- Applicable Engine Performance Data Sheet
- Applicable General Engine Data Sheet

Cummins Marine does not have any liability, either express or implied, for the information contained herein.

NOTES:

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ENGINE MOUNTING/DRIVE SYSTEMS

REQUIREMENTS

! The mounting system should be constructed to provide a rigid supporting structure arrangement so as not to overstress the engine castings and drive system causing failure to the components.

! Four cylinder B Series engines must use a flexible mounting system.

! On flexible mounting systems, the vibration isolators must be installed parallel to the crankshaft centerline in both fore and aft and side to side directions.

! The engine must have sufficient space to prevent damage from physical contact between the engine components and adjoining structures during boat operation. The connecting systems must be designed to accommodate engine movement during boat operation.

! The static installation angle of the engine in a waterborne vessel must be between 0° and 12° nose up in a conventional setup and between 3° and 12° nose up in a vee-drive installation.

! The propeller shaft flange bore and face alignment must be within gear manufacturer's recommendation.

! The engine must reach maximum rated RPM under fully loaded vessel conditions.

! The engine must have sufficient crankshaft end clearance after installation of the marine gear or any accessory that imposes an axial load on the crankshaft.

INSTALLATION RECOMMENDATIONS

Engine Foundation

! The mounting system should be constructed to provide a rigid supporting structure arrangement so as not to overstress the engine castings and drive system causing failure to the components.

The stringer and bed system in a vessel is the single most important structural component. It should be designed to withstand the harshest environmental conditions without imposing damage to the rest of the vessel and propulsion system. In cases where the stringers and bed design are too flexible, stresses are imposed on the supporting structure of the engine causing these stresses to be transmitted into the engine.

The marine engine foundation must support the engine and marine gear without over stressing any engine and gear structure. Also, the engine foundation must transfer driveline thrust to the hull and hold proper alignment with the driveline components. In-line diesel engines require more rigid support structures due to the inherent design and engine movement. Engine and gear supports available from Cummins are recommended (see figure 1).

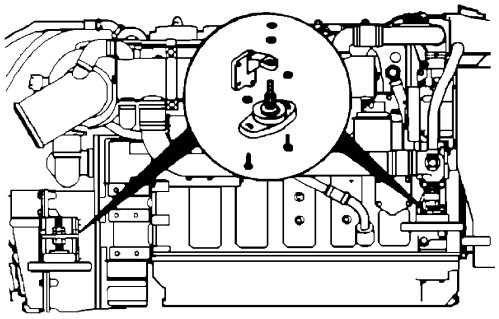


Figure 1: Engine and Gear Support Locations

The foundation primarily consists of the stringer sections and the engine bed (see figure 2).

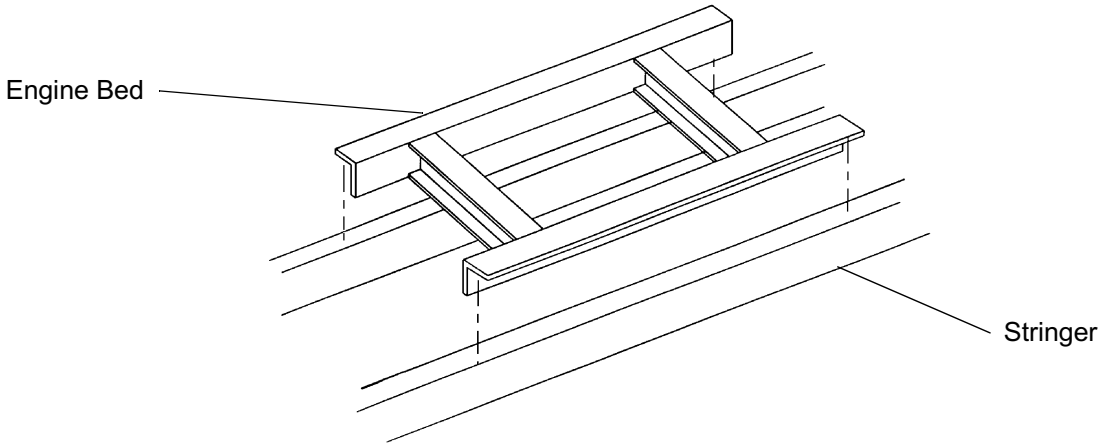


Figure 2: Typical Engine Foundation Arrangement

NOTE: *The design of the engine foundation should match the required engine installation angle. Special recommendations are made in the text regarding the alignment of the engine and the position of the isolators. It is important that these be considered in the design process.*

The longitudinal stringers usually run the length of the boat and support the engine and the marine transmission. The engine bed provides the attachment points for the engine and marine transmission to the stringer framework.

In some installations, cross bracing on the engine bed and stringers should be used to reduce lateral engine/support movement (see figure 3). This will assure that vessel structural deflections are not transmitted to engine castings and also limit the amount of lateral engine movement that is transferred to the hull causing vibration.

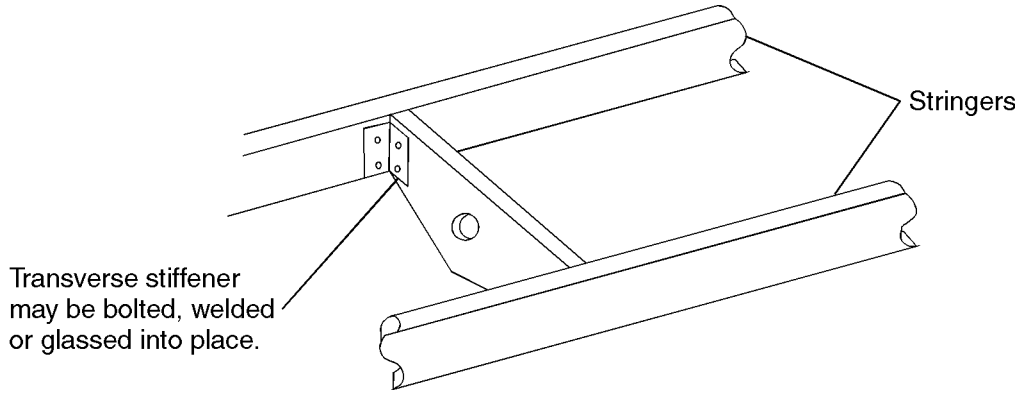


Figure 3: Typical Cross Bracing

Engine bed frames in steel hulls should be of welded steel construction. The frame should be welded in place.

If the supports are mounted on the side of the stringer, steel plates should be used under bolt heads (see figure 4).

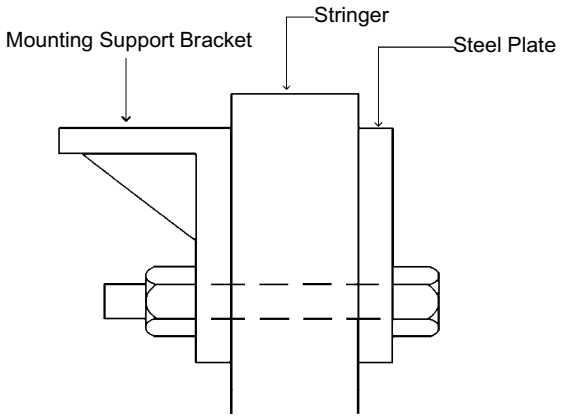


Figure 4: Stringer Cross Section

In fiberglass hulls, the engine bed can be molded into the boat. The bed should be built in a box section and filled with a material that is not affected by sea water, moisture, or oil. A welded steel or aluminum frame can also be used.

Solid Engine Mounting

NOTE: *Solid mounting the engine will increase the amount of resonance and vibration transmitted into the hull and drive system.*

Cummins Marine recommends the use of a flexible mounting system. If a solid engine mounting system is used, it is recommended that proper support brackets be used for solid mounting the engine and gear (see figure 5). Use the mounting pads on the marine gear (1) and rear of the engine (2) to absorb the propeller thrust

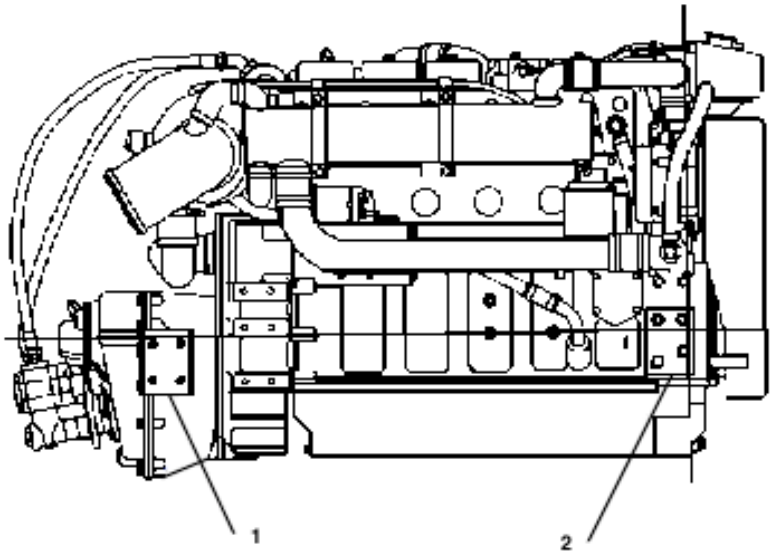


Figure 5: Engine Mounting Locations

Flexible Mounting Systems and Vibration Isolators

! Four cylinder B Series engines must use a flexible mounting system.

Transmitted vibration is the primary source of noise in a boat, so good isolation is the key to smooth and quiet operation.

With the use of flexible mounting systems, careful selection of vibration isolators is important. Rubber style isolators should not be used in tension unless specifically designed for that service. Figure 6 shows a typical vibration isolator.

Figure 6: Cummins Supplied Vibration Isolator

! On flexible mounted systems, the vibration isolators must be installed parallel to the crankshaft centerline in both fore and aft and side to side directions (see figure 7).

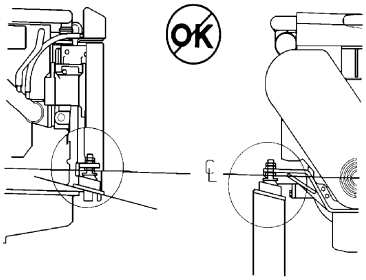


Figure 7: Isolators Must be Parallel to the Crankshaft Centerline Fore and Aft

The vibration isolators on flexible engine mounts must be installed parallel to the engine centerline to maintain uniform isolator compression. If the engine bed is not parallel to the engine centerline, wedges must be used under the isolators or mounts (see figure 8).

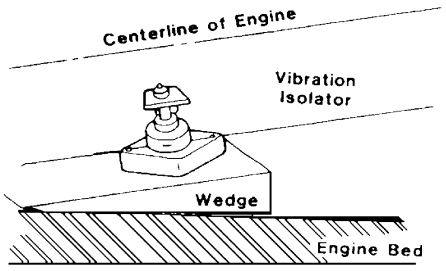


Figure 8: Wedge Isolators to Achieve Parallel Installation

Flexible mounts should be installed so that the mounting bolts do not excessively preload the flexible element. Check for adequate space around the snubber.

CAUTION: Failure to use proper support brackets and hardware could result in premature failure of the mounts, which could result in damage to the engine or vessel.

Flexible mounting systems are designed for multiple point engine mountings; mounts are used at the front of the engine and mounts are also used at the rear of the engine on the marine gear. Cummins Marine recommends the use of a flexible mounting system. If a solid engine mounting system is used, it is recommended that proper engine support brackets be used for solid mounting the engine and gear.

The engine should not be mounted with brackets off of the flywheel housing when using a direct mounted gear. The flywheel housing support (optionally available) is only recommended with remote mounted gears or jet drives.

Isolator Installation

Cummins Marine offers vibration isolators for marine engines. These mounts successfully reduce the amount of resonance normally transmitted from the engine to the boat hull. To gain full benefit from the use of these mounts, some precautions must be taken to ensure they are installed correctly. The engine bed or stringers in the vessel must be level and square with the engine installation to ensure a true surface for maximizing the isolator performance.

When installed on an engine, the engine support bracket should be sandwiched between the two hardened washers with the two smaller adjusting nuts on the bottom and the single larger adjusting nut on the top of the engine support bracket.

The vibration isolators must be installed parallel to the crankshaft centerline to maintain uniform isolator compression. You can use the oil pan flange as a reference to the crankshaft centerline. If the engine bed or stringer mounting system is not square, it must be leveled or wedges (shims) must be used under the isolators.

Assemble the Mounts to the Engine Support Brackets.

Position the mounts so that the engine support bracket is located in the center of the stud. This will allow for up or down adjustment when performing the engine alignment in the next step.

Lower the engine into place so that the four mount bases rest in the desired position. Do not remove the lifting hoist yet. Align the engine with the propeller shaft, and level the engine by using the lower adjusting nut. Do not move the lower adjusting nut without supporting the engine. This will prevent damage to the threads on the stud and nut.

Adjusting the Isolators

It is very important to equalize the weight of the engine and gear to the isolating mounts as much as possible. It is recognized that all situations cannot be equalized due to the engine installation angle. The bottom rubber snubber is also used as a load indicator, which is located between the casting and the stringer. When the isolator is properly loaded, the rubber snubber should be located approximately midway between the casting and the stringer, approximately 2-4 mm (1/8"). The rubber should not be in contact with the casting or the stringer. If it is touching the top of the casting, the mount is not loaded and will have reduced isolating capability. To apply load to the mount, turn the bottom adjusting nut so that it moves upward. If the snubber is touching the bottom of the casting, the mount is overloaded. To reduce load, turn the bottom adjusting nut so that it moves downward. Again, the rubber snubber location is dependent on installation angle and weight distribution. Based on these two factors, THE FRONT AND REAR SNUBBERS MAY NOT BE IN THE EXACT SAME LOCATION, BUT THE SIDE/SIDE MOUNTS SHOULD BE SIMILAR.

Be sure the mounts do not have any caster or camber to them. They should be parallel to the crankshaft center line, and they should not be canted in towards or out away from the engine. Check the inboard side snubber position. The rubber should be centered on both sides. If the rubber touches the top of the casting on one side and the bottom of the stringer on the other side, the mount is cocked or canted. There are slots in the base if inward or outward adjustment of the mount is necessary.

Loading the isolators may change the shaft flange alignment. Recheck alignment and repeat the process as necessary to ensure that the isolators are properly loaded and the engine is in alignment with the shaft.

If major adjustments are needed to achieve proper loading and alignment, it may be necessary to add shims or modify the engine bed to center the isolator studs on the engine support bracket. Full engagement of all the threads on the upper lock nut is mandatory.

Finally, the lower jam nut and the upper locking nut should be tightened to 355 to 445 N•m (80 to 100 ft lb).

! The engine must have sufficient space to prevent damage from physical contact between the engine components and adjoining structures during boat operation. The connecting systems must be designed to accommodate engine movement during boat operation.

The engine should be installed with sufficient clearance on all sides so that the allowable engine movement will not cause structural or component damage. Care should be taken to ensure that attaching systems are not damaged through engine movement.

Bending Moments

The engine must be installed so that the static bending moment at the point where the flywheel housing is attached to the engine does not exceed the maximum value shown on the Engine General Data Sheet.

For assistance in calculating bending moments, contact your Local Cummins Marine Certified Application Engineer, and reference Application Engineering Bulletin 21.36.

Engine Installation Angle

! The static installation angle of the engine in a waterborne vessel must be between 0° and 12° nose up in a conventional setup (see figure 9) and between 3° and 12° nose up in a vee-drive installation (see figure 10).

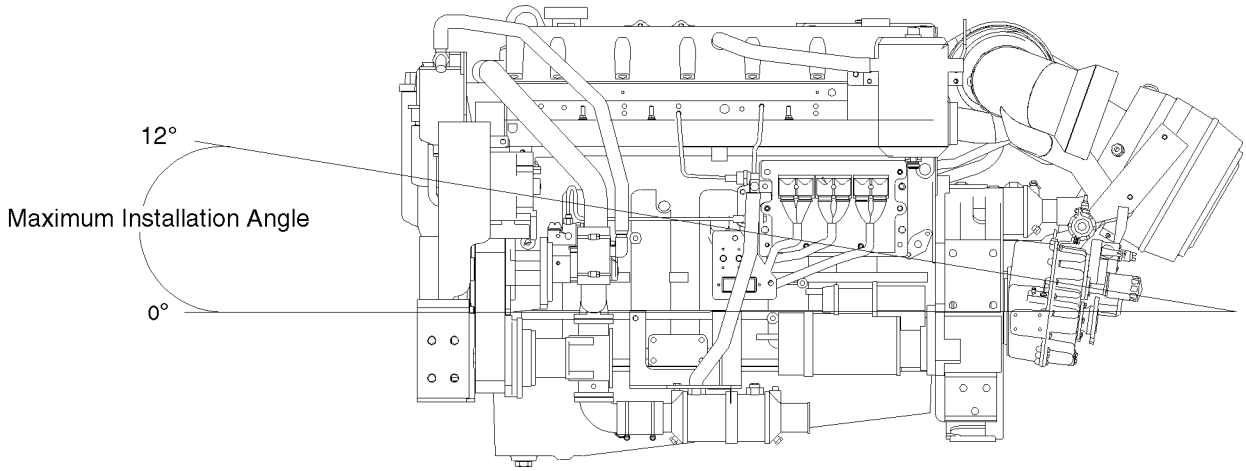


Figure 9: Maximum Installation Angle for Conventional Setup

For a conventional in-line setup, the engine should be installed as close to 0° as possible. There are several down angle gear choices available to keep the engine centerline low.

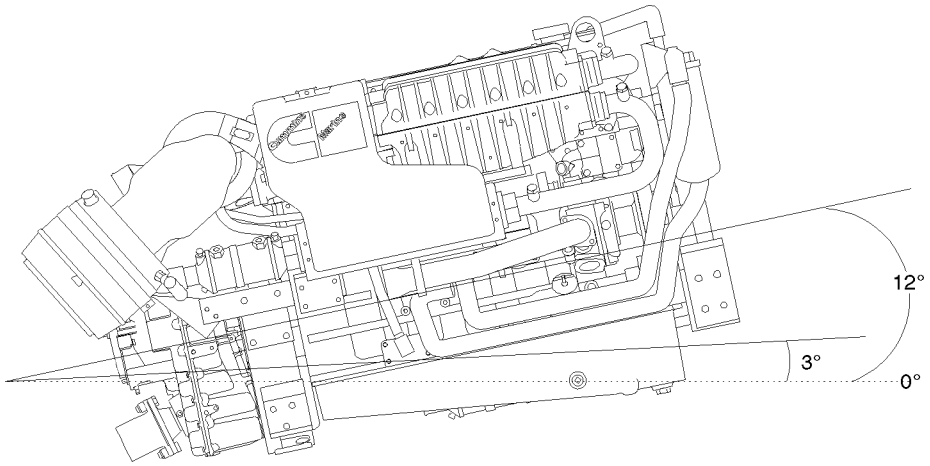


Figure 10: Installation Angle for Vee Drive Setup

The engine must be level or nose up during coolant fill and engine start-up so that the engine block and heads will completely fill with coolant. Operating an engine with the front down (see figure 11) will allow an air pocket to form at the rear of the cylinder head. This will cause localized overheating and possible engine damage. V-drive marine gears are available that allow the engine to be installed within the 3° to 12° nose up installation requirement. For V-drive installations, it is recommended that the engine be installed as close to the maximum 12° static installation angle as possible.

CAUTION: Operating an engine with the front down (see figure 11) will allow an air pocket to form at the rear of the cylinder head. This will cause localized overheating and possible engine damage.

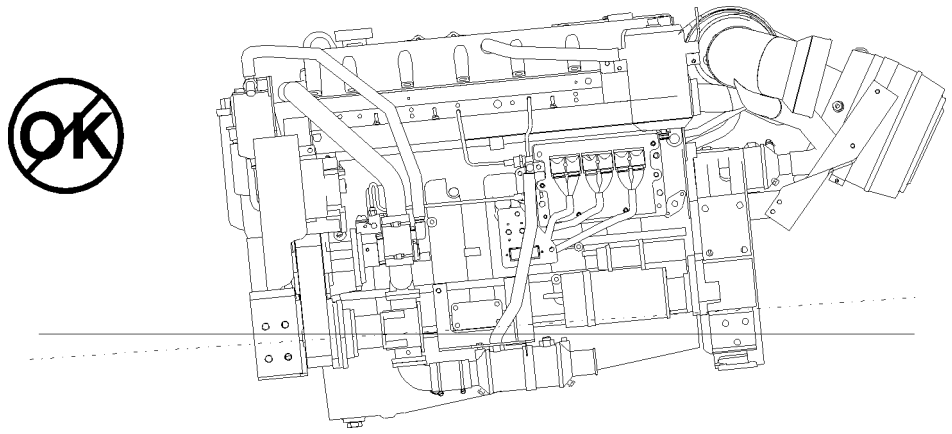


Figure 11: Nose Down Installation Causes Engine Overheating

***NOTE**: The front of an engine in a vee-drive installation faces the stern section of the vessel (see figure 12).*

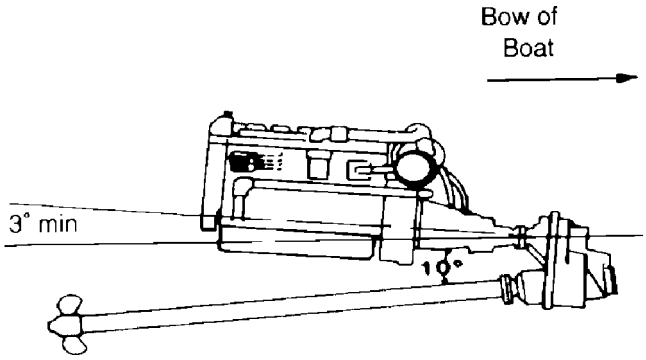


Figure 12: V-Drive Installation

V-drive marine gears are available that allow the engine to be installed within the 3° to 12° nose up installation requirement. For V-drive installations, it is recommended that the engine be installed as close to the maximum 12° static installation angle as possible.

Driveline

In order to isolate engine vibration and prevent it from being transferred to the hull through the propeller shaft, Cummins recommends that the distance from the marine gear output flange to the first fixed bearing be a minimum of 20 times the shaft diameter (see figure 13). If the distance is less than this, a flexible coupling may be necessary to absorb the engine vibration.

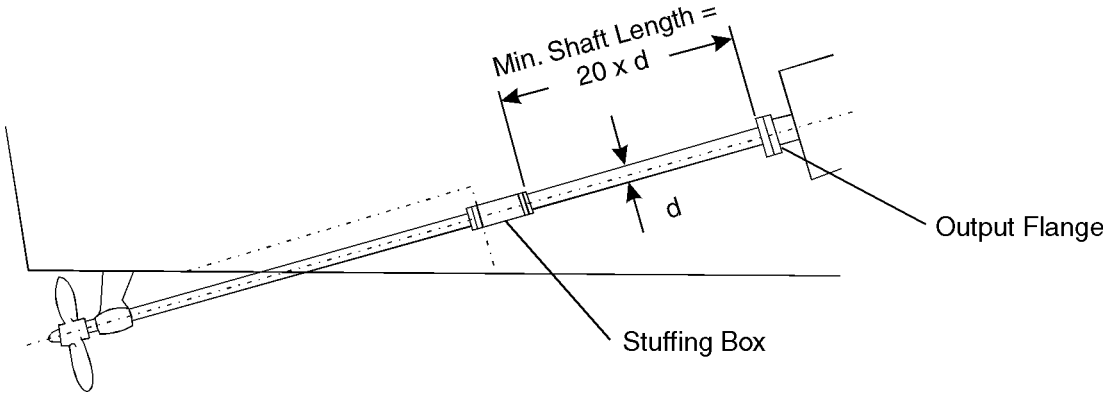


Figure 13: Driveline Vibration Isolation

Engine/Propeller Shaft Alignment

The alignment of the engine and marine transmission with the propeller shafting is essential to minimize vibration, noise, power loss, and stress in the driveline components.

There are many ways to align the engine and transmission. The method discussed here is only one way to accomplish the task. Please consult a trained professional for further assistance and advice.

On a solid mounted engine, temporary alignment is made with jacking screws (if available in the engine supports) or with temporary jacks and lifts (see figure 14). Caulking compound or shims are made to fit exactly between the engine mounts and the engine bed. With the engine aligned and mounting bolts installed, the jacking screws are backed off or the temporary jacks removed. On wood or soft engine beds, steel plates must be used under jacking screws to prevent damage to the engine bed.

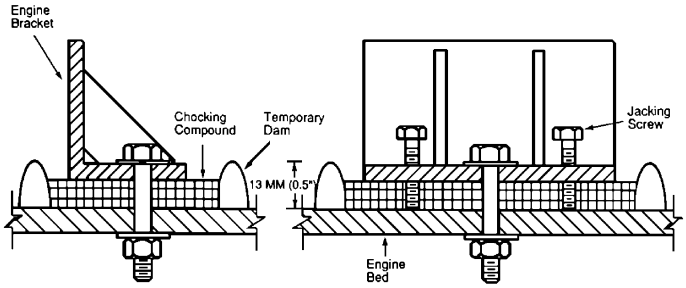


Figure 14: Jacking Screws

A flexibly mounted engine “moves” on the engine mounts. Therefore, the shafting connected to the marine gear output flange must be free to move with the engine. Most boat installations use a flexible stuffing box (1) and a single strut bearing (2) to support the propeller shafting while allowing for freedom of movement in the shafting (see figure 15).

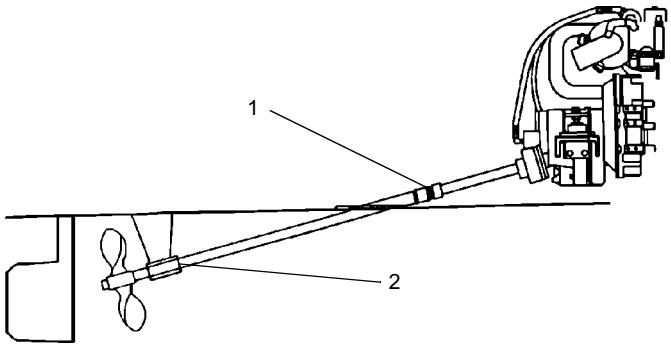


Figure 15: Propeller Shaft Support for a Flexibly Mounted Engine

On flexible mounted engines, the engine is aligned using the adjusting nuts on the vibration isolators. Isolator studs are not designed for major adjustments. Shimming should be used when additional height is needed. Flexible mounts without a height adjusting nut must be aligned by shimming under the mount.

! ***The propeller shaft flange bore and face alignment must be within gear manufacturer’s recommendation.***

While aligning the engine and gear, check both the propeller shaft flange bore and face. The bore alignment must be within the gear manufacturer’s recommendations to allow the propeller shaft flange and marine gear output flange to mate properly. The face alignment must be within the gear manufacturer’s recommendation when checked with a feeler gauge at the top, bottom, and each side of the flanges (see figure 16). Both fixed and flexible mounting arrangements must meet these specifications.

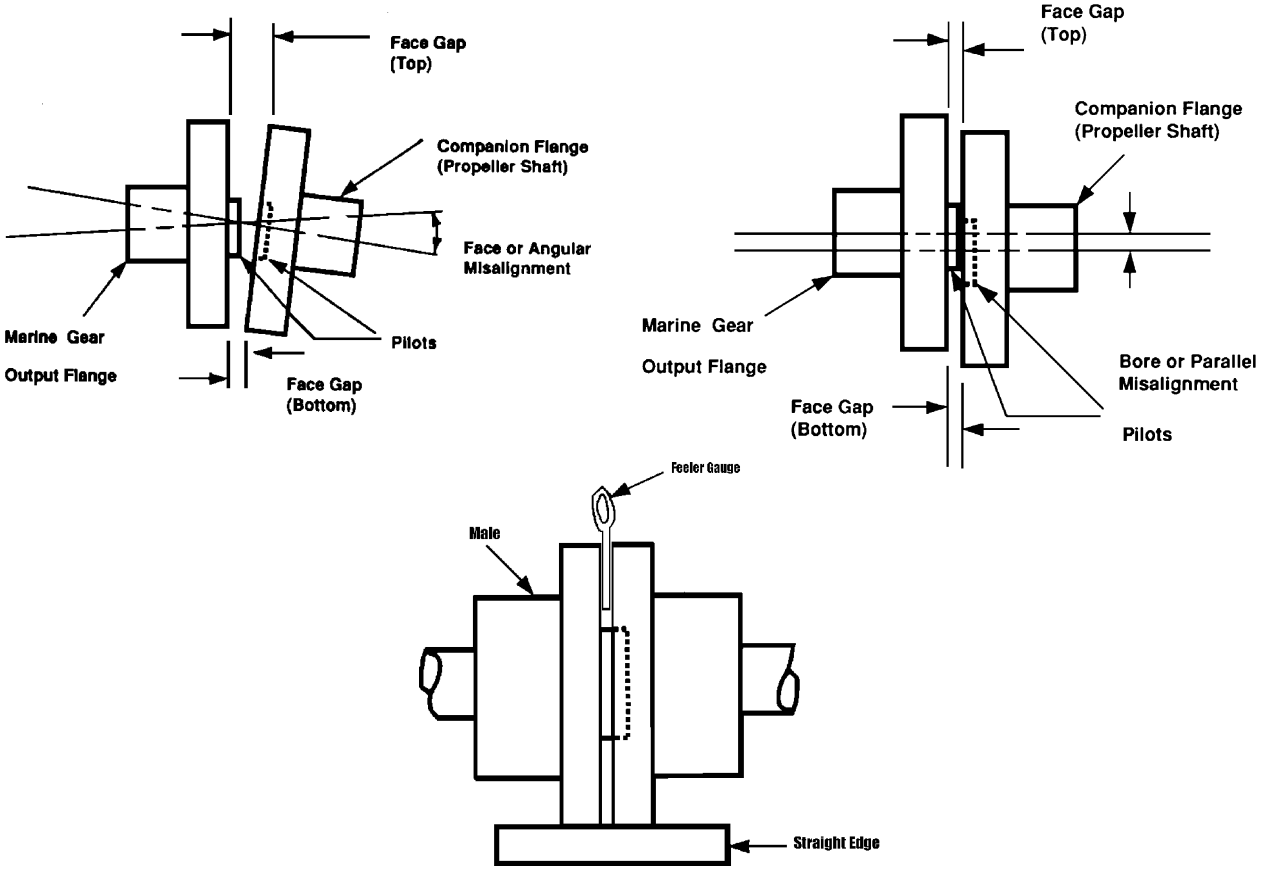


Figure 16: Flange Face and Bore Alignment

Final alignment should not be done until after the vessel is in the water and loaded to its normal operating condition. The alignment must be redone each time a flexible mounting system is disconnected from the propeller shaft. Annual alignment checks are recommended.

Propeller/Gear/Shafting Mounting

! ***The engine must reach maximum rated RPM under fully loaded vessel conditions.***

Final alignment should not be done until after the vessel is in the water and loaded to its normal operating condition. The alignment must be redone each time a flexible mounting system is disconnected from the propeller shaft. Annual alignment checks are recommended.

! ***The engine must reach maximum rated RPM under fully loaded vessel conditions.***

Proper propeller, gear, and shaft size are very important in ensuring performance and durability. Contact your local Cummins distributor or dealer for assistance in these matches.

! ***The engine must have sufficient crankshaft end clearance after installation of the marine gear or any accessory that imposes an axial load on the crankshaft.***

Without end clearance, the crankshaft will be turning in solid contact with the engine thrust bearing surface and will damage the thrust bearing and crankshaft. A simple test is to push the crankshaft vibration damper hub in until the crankshaft contacts the thrust bearing, then pull the crankshaft forward. Refer to the applicable Troubleshooting and Repair Manual and Application Engineering Bulletin 21.37 for additional information.

This movement should be checked before and after installation of marine gear or any engine driven accessory that imposes an axial load on the crankshaft to assure these components do not affect crankshaft end play (see figure 17). Proper installation of the marine gear is essential.

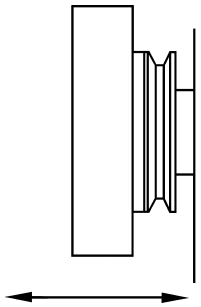


Figure 17: Crankshaft Endplay

Refer to the appropriate service manual for the proper procedure.

The engine should not be run without sufficient end clearance.

Propeller Rotation in Twin Engine Applications

Engine rotation is viewed from the front of the engine, looking at the engine damper. Propeller rotation is viewed from behind the boat, looking forward at the propeller. Therefore, a right hand rotation engine and a left hand rotation propeller are turning in the same direction.

The Cummins B and C Series marine engines are available in right hand rotation only. Twin engine installations should have the propellers turning in opposite directions. The typical recreational boat arrangement has the right hand (clockwise) turning propeller on the starboard (right) side of the boat and the left hand (counterclockwise) turning propeller on the port (left) side of the boat (see figure 18).

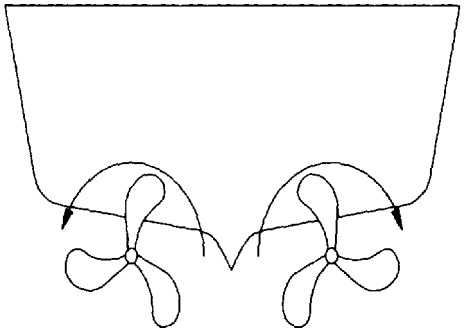


Figure 18: Twin Engine Propeller Rotation

The propeller rotation is determined by the marine gear. Some gears allow for full power in either direction of rotation. The rotation in forward is set at the marine gear. Gears that are designed for a specific direction of rotation must be installed on the proper side of the boat and cannot be used for long periods of time in reverse rotation or under heavy loads.

Propeller Tip Clearance

Adequate tip clearance is important for maximum propeller performance and for reduced vibration, noise, and cavitation (see figure 19). The tip clearance is specified by the builder. Inadequate tip clearance will result in excessive noise and vibration throughout the vessel. Please consult your local Cummins authorized Marine Certified Application Engineer for assistance.

$$\textit{Max allowable Propeller Diameter} = \frac{\text{Max Prop Swing w/o Tip Clearance}}{1+[2\ (\text{Tip Clearance Percentage}/100)]}$$

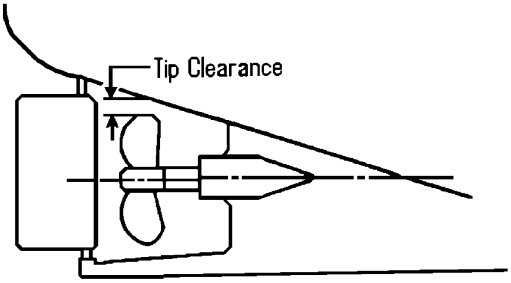


Figure 19: Propeller Tip Clearance Schematic and Formula

ENGINE DRIVEN ACCESSORIES

REQUIREMENTS

! Belt driven equipment must be held in alignment to a tolerance of 1 mm in 200 mm (1/16" in 12")

! Direct drive front power take-off arrangements must be within torsional limits. Some applications may require a torsional analysis.

! The total power taken off of the front of the crankshaft cannot exceed the capacity listed in the installation recommendations.

INSTALLATION RECOMMENDATIONS

Alternator Drive

Normally, the alternator is supplied mounted on the engine and driven from the front drive belt. Cummins does not recommend the use of non-specified alternators and components.

Belt Driven Accessories

! Belt driven equipment must be held in alignment to a tolerance of 1 mm in 200 mm (1/16" in 12") (see figure 20).

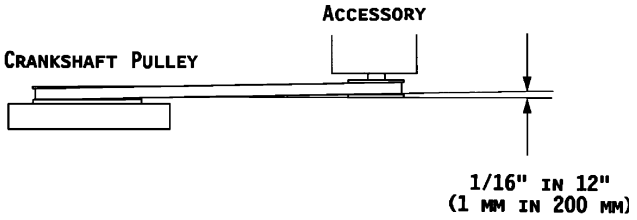


Figure 20: Belt Alignment

Misalignment between the belt driven equipment and the engine will result in bending forces on the shafts and can result in bearing or shaft failures.

New belts require a run-in period of 10 to 15 minutes under tension then retensioning. The run-in allows for the initial stretch. The retensioning will prevent the belt from jumping the pulley.

Cummins Marine does not supply engine driven accessories except for alternators. Cummins Marine provides a single and double groove pulley (with SAE 13 mm [1/2"] grooves) in addition to a front PTO (power take off) adapter. Additional pulley grooves or increasing the belt size may exceed the safe loading and is not recommended. Generally, the single groove pulley will drive up to 4 kW (5 HP) and the two groove pulley will drive up to 7.5 kW (10 HP).

In a flexible engine mounting situation, Cummins Marine recommends that belt driven accessories be mounted on the engine. It is not recommended that the accessories be mounted to the hull of a vessel. The relative motion of the engine and vessel can potentially cause the belt to slip or jump off of the pulley.

Brackets used to mount accessories should provide adequate strength to hold the static and dynamic load of the accessory.

The natural frequency of any engine mounted accessory must be outside of the operating range of the engine. Unless designed properly, operation in the engine natural frequency range may cause accessory bracket mounting or component failures.

Since engine driven accessories will experience fluctuations in load during normal operation, the rated load of the accessory should be multiplied by a design service factor when determining the load imposed on the engine by the accessory (see table 1).

Accessory Type	Design Service Factor
Bilge pumps and alternators	1.3
Air compressors	1.4
Hydraulic pumps	2

Table 1: Accessory Design Service Factor

For example, if an air compressor pulls a 20 HP rated load, use the design factors above to figure the design HP load (20 x 1.4 = 28 HP).

Acceptable torque limits for accessory loads are dependent upon the location of the accessory load with relation to the engine crankshaft. Accessory torque limits can be found in the figures 21 through 23. The diagrams and the equations are provided to obtain the maximum belt tension on the accessory drive in the specific location.

The following equation should be used to calculate these loads: $R = \frac{M}{X+D}$

where: R = side load reaction force (kg [lbs])

M = allowable moment from charts (N•m [in-lbs])

X = distance from centerline of #1 main bearing to Front Face Of Block (mm [in.])

D = distance from load to Front Face Of Block (mm [in.])

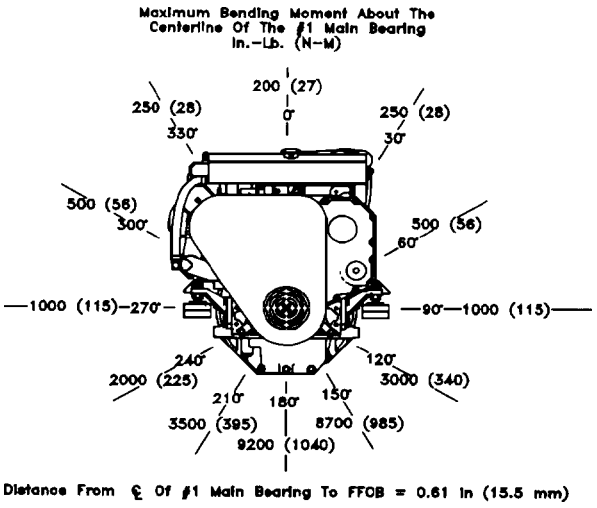


Figure 21: Torque Limit Calculation for 4-Cylinder B-Series Engine

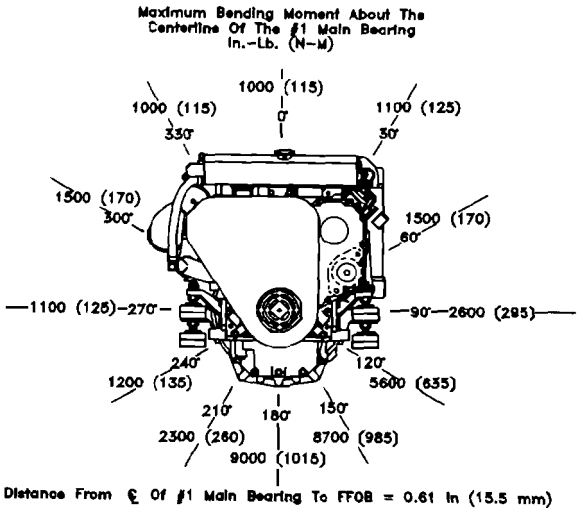


Figure 22: Torque Limit Calculation for 6-Cylinder B-Series Engine

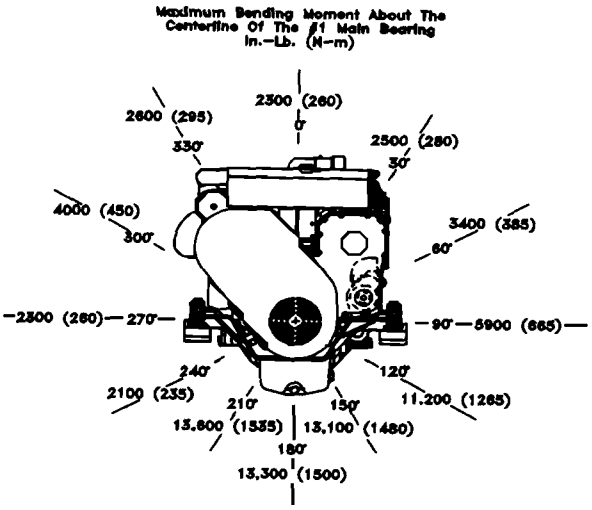


Figure 23: Torque Limit Calculation for C-Series Engine

If two or more accessories are being driven from a single multi-groove pulley, the accessories should be arranged to have opposing belt pulls so that the resulting force on the crankshaft is kept to a minimum (see figure 24).

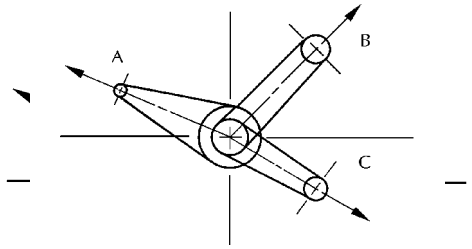


Figure 24: Belt Pull Arrangement for Multiple Accessories Driven from a Single Multi-Grove Pulley

Front Power Take-Off

! Direct drive front power take-off arrangements must be within torsional limits. Some applications may require a torsional analysis.

All direct driven equipment will have some effect on torsional vibration. Excessive torsional vibration in a system can result in excessive noise, gear failures, or in some cases, crankshaft or driven component failures.

In order to ensure the compatibility of the components in a particular application, Cummins recommends that a torsional analysis be done on the system prior to installation. The torsional compatibility of the system is the responsibility of the installer (ref. ISO 3046 part V-1978) and not Cummins Inc.

! The total power taken off of the front of the crankshaft cannot exceed the capacity listed in the installation recommendations.

The B and C series engines do not have provisions for front power take-off (FPTO) clutches. However, front drives may be used in the following circumstances; only if approved by Cummins Marine Engineering.

- On flexibly mounted engines, the drive must incorporate a flexible coupling on the front of the crankshaft that allows for the relative movement between the engine and the driven accessory.
- Total power from the front and rear of the engine combined cannot be greater than the total engine output (refer to your Marine Engine Performance Curve).

The total power from the front of the crank cannot be greater than that listed in table 2.

Engine Model	Torque Capacity	Power Capacity	Power Capacity
B-Series Marine	285 N•m (210 ft-lb)	29 kW@ 1200 RPM (38 HP@1200 RPM)	62kW@ 2600 RPM (84HP @ 2600 RPM)
C-Series Marine	569 N•m (420 ft-lb)	46 kW @ 1200 RPM (61 HP@ 1200 RPM)	95 kW @ 2500 RPM (128HP@2500 RPM)

Table 2: Total Crank Power

The engine must have sufficient crankshaft end clearance with FPTO installed. Reference crankshaft end clearance data located in the Engine Mounting Section of this bulletin.

Sea Water Pump/Direct Gear Drive

The sea water pump is mounted on the rear side of the front housing, below the fuel pump, and is gear driven from the front gear train (see figure 25). On keel cooled engines that do not need the sea water pump, this location may be used to drive another accessory. Up to 142 N•m (105 ft-lb) torque may be taken from this drive on the B or C Series marine engines.

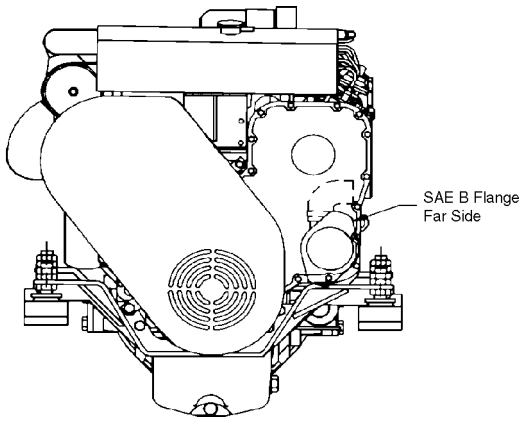


Figure 25: Sea Water Pump Mounting Location

Gear driven accessories must be properly supported to avoid damage to the gear housing. The maximum allowable bending moment at the sea water pump drive location is 14 N•m (10 ft-lb). Typically, accessories weighing 9 kg (20 lb) or less can be mounted without a support bracket. Heavier accessories must be supported with a bracket.

The gear drive ratios at the water pump location are shown in table 3.

Engines	Gear Drive Ratio
4B Series	0.97:1
6B Series	0.97:1
6C Series	1.13:1

Table 3: Gear Drive Ratios

The gear rotates in the same direction as the engine.

Mechanical Tachometer Drive

Drive provisions are optionally available for a 0.104" square drive (CAV fuel pump), a 0.156" tang drive (Nippondenso fuel pump) or a 0.187" (Bosch Fuel Pump) tang drive mechanical tachometer arrangement on the front of the engine gear cover (see figure 26). The load imposed on this drive by the tachometer and cable must not exceed 3 N•m (25 in.lb).

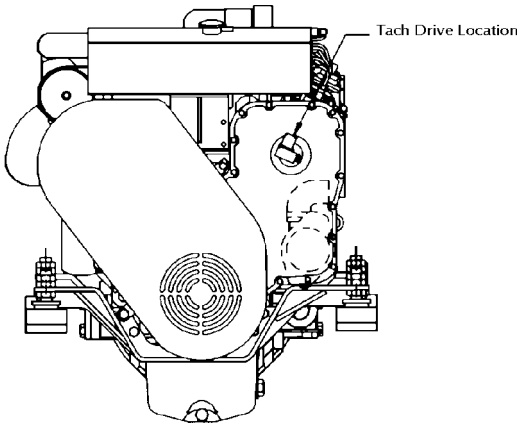


Figure 26: Tachometer Drive Location

Protective Guards

Cummins Marine recommends that any moving accessory have a protective guard.

Guards provided by Cummins must not be modified or taken off.

EXHAUST SYSTEM

REQUIREMENTS

! The exhaust system must be designed so it does not allow exhaust gasses to enter the air intake system.

! The exhaust system must be designed to prevent the entrance of water into the engine or turbo-charger whether it be from spray, rain, washing, or any other source.

! The exhaust system must be properly supported.

! Thermal insulation or guards must be installed on dry exhaust systems.

! Exhaust back pressure must not exceed 76 mm (3") Hg.

INSTALLATION RECOMMENDATIONS

Exhaust Systems

! The exhaust system must be designed so it does not allow exhaust gasses to enter the air intake system.

The exhaust system must carry the exhaust gas away from the engine outboard of the vessel and discharge it to the atmosphere without causing harm to the engine, vessel, or crew.

Wet Exhaust Systems

In a wet exhaust system, sea water from the engine sea water circuit (sea water pump, gear oil cooler, heat exchanger) is sprayed into the exhaust pipe (see figure 27), and the exhaust gas temperature drops low enough to allow the use of hard rubber hose, fiberglass tubing, or other corrosion resistant materials downstream of the water injection. Consult the hose or tubing manufacturer to determine the maximum allowable temperature.

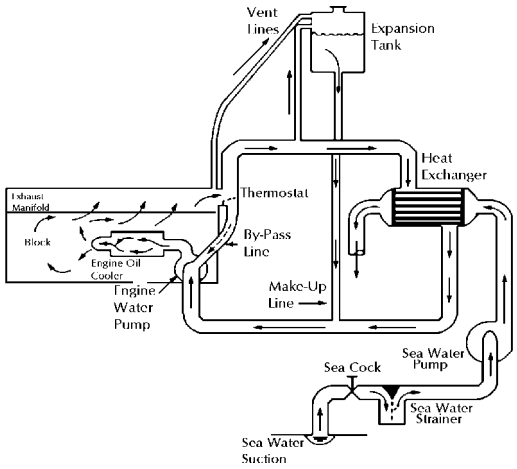


Figure 27: Typical Wet Exhaust System

Cummins uses a water-jacket type elbow with spray holes to direct the cooling water spray into the attached exhaust hose (see figure 28).

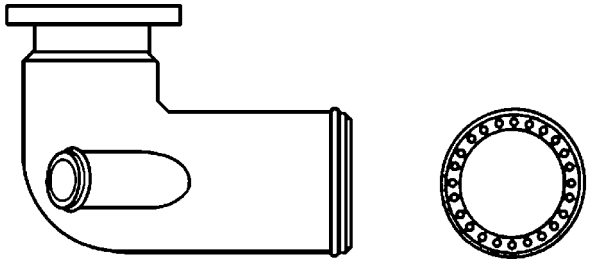


Figure 28: Typical Wet Exhaust Elbow

Caution: When using a non-Cummins Marine designed wet exhaust elbow, the external pressure drop in the sea water cooling loop must not exceed a 103 kPa (15 psi), and the temperature of the exhaust must not damage the exhaust piping material.

The size of the spray holes are critical. Too large holes will not allow water to spray and cool the exhaust hose. Too small holes will increase pressure and restrict water flow. Side discharge will not allow proper cooling for exhaust hose piping (see figure 29).

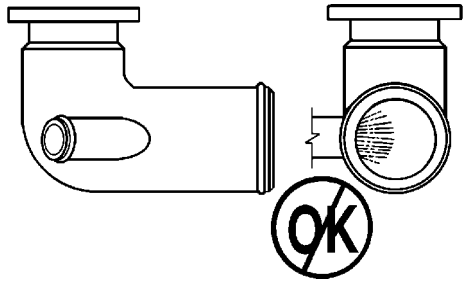
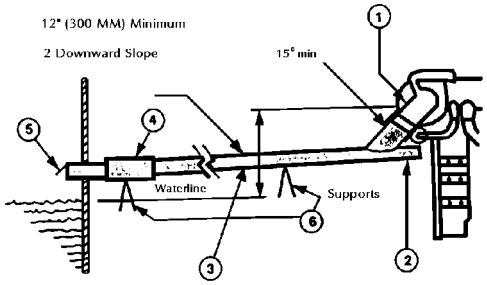


Figure 29: Ineffective Side Discharge Elbow

The exhaust system must be designed to prevent the entrance of water into the engine or turbocharger whether it be from spray, rain, washing, or any other source.

The exhaust system must be designed to prevent water from washing or spraying back into the engine. Cummins Marine recommends that the exhaust or turbocharger outlet (measured at the lowest point of the turbocharger exhaust) be at least 300 mm (12") above the vessel's loaded waterline.

To achieve the most efficient water flow, Cummins Marine recommends that the exhaust elbows or risers in wet exhaust systems be installed with a minimum down angle of 15° (see figure 30). It is also recommended that the exhaust pipe should have a continuous downward slope of at least 2° (35 mm per meter or 1/2" per foot of piping run) away from the engine.



1. Water Jacketed Exhaust Elbow
2. Surge Pipe
3. Exhaust Piping
4. Wet Muffler
5. Flapper Valve
6. Supports

Figure 30: Typical Wet Exhaust Configuration

On installations where the engine is positioned too low in the vessel to use normal exhaust pipe routing, an exhaust riser should be used to prevent water from entering the engine or turbocharger (see figure 31). An exhaust riser routes the exhaust above the engine before injecting sea water into the exhaust pipe. The added height of the exhaust riser provides protection against water washing back into the engine. Cummins recommends that the lowest point of the exhaust riser water injection be 300 mm (12") above loaded water line.

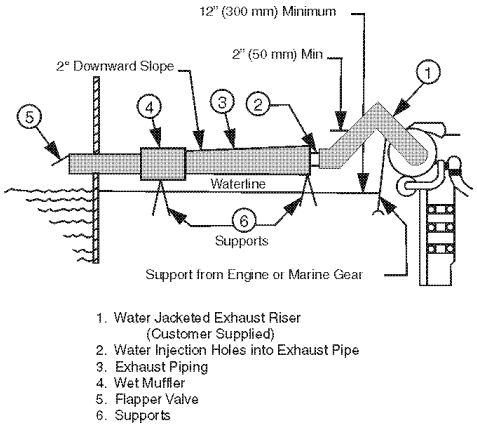


Figure 31: Typical Wet Exhaust Configuration with Riser

Cummins Marine recommends that a water lift muffler not be used as a means for preventing water flow back into the engine. A waterlift muffler should be intended for use as a noise suppression device only. If the engine exhaust outlet is below the waterline and a waterlift muffler is used, then the system must incorporate a siphon break vent line at the highest point in the sea water system. The highest point in the sea water system must be above the loaded waterline of the vessel to prevent the waterlift muffler and engine from filling due to seepage past the sea water impeller. In these installations, Cummins Marine recommends that the waterlift muffler be placed 300 mm (12") below the lowest point of the engine exhaust discharge (turbocharger exhaust) (see figure 32).

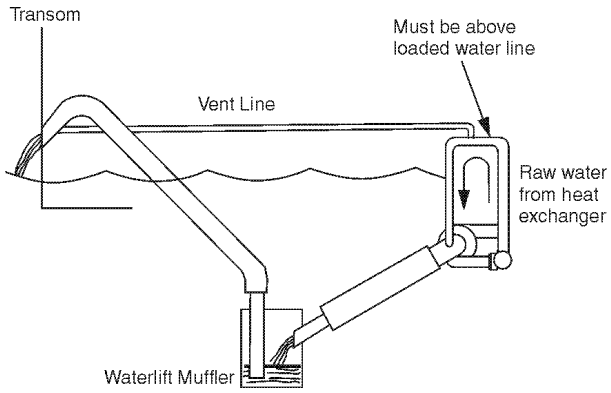


Figure 32: Typical Exhaust for Engine Below Loaded Water Line

! The exhaust system must be properly supported.

The exhaust components attached to the engine are designed to support short sections of piping, but not major exhaust system components or piping.

Water cooled exhaust risers should be supported if their developed lengths exceeds 500 mm (20").

Neither the engine or turbocharger can support the weight of the exhaust piping. Any exhaust components connected to the turbocharger must be supported (see figure 33).

Caution: Failure to support the exhaust system will cause the turbocharger to fail.

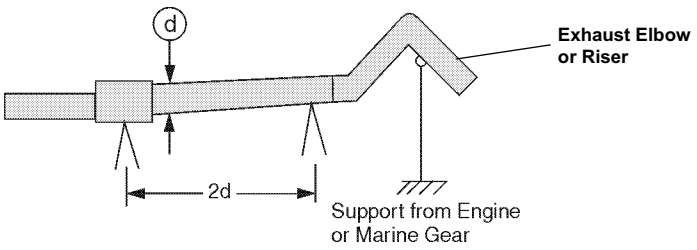


Figure 33: Recommend Exhaust Support Spacing

The maximum distance between the supports in the exhaust piping in a wet system should be approximately 2 times the diameter.

The maximum bending moments that can be imposed on any engine component is shown in table 4.

Engine Component	Maximum Bending Moment	Maximum Unsupported Length of Exhaust Pipe
Exhaust Manifold Flange	48 N•m (35 lb-ft)	2.1 m (7')
Turbocharger Flange	27 N•m (20 lb-ft)	1.2 m (4')
Turbocharger Flange (with supported exch. elbow)	170 N•m (125 lb-ft)	4.5 m (15')

Table 4: Maximum Bending Moments

Dry Exhaust Systems

! The exhaust system must be designed to prevent the entrance of water into the engine or turbocharger whether it be from spray, rain, washing, or any other source (see figure 34 and figure 35).

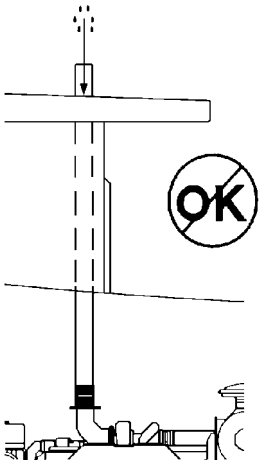


Figure 34: Improper Dry Exhaust Design

In dry exhaust systems, this can be accomplished by using 45° or greater bends at the top of the piping.

Condensation traps and drains can be used to help keep moisture and water out of the engine (see figure 35).

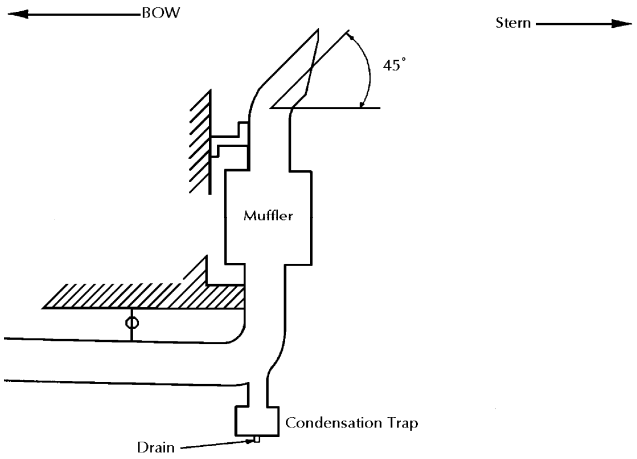


Figure 35: Proper Dry Exhaust Design

In a dry exhaust system, Cummins recommends the use of one or more flexible sections at the engine exhaust outlet or turbocharger outlet to prevent the thermal growth and vibration in the exhaust piping from overstressing the engine or turbocharger. The flexible section should be installed in a position that allows it to “flex” and “compress” with the motion of the engine and thermal growth of the exhaust piping (see figure 36). Cummins offers flexible connections that are appropriate for some applications.

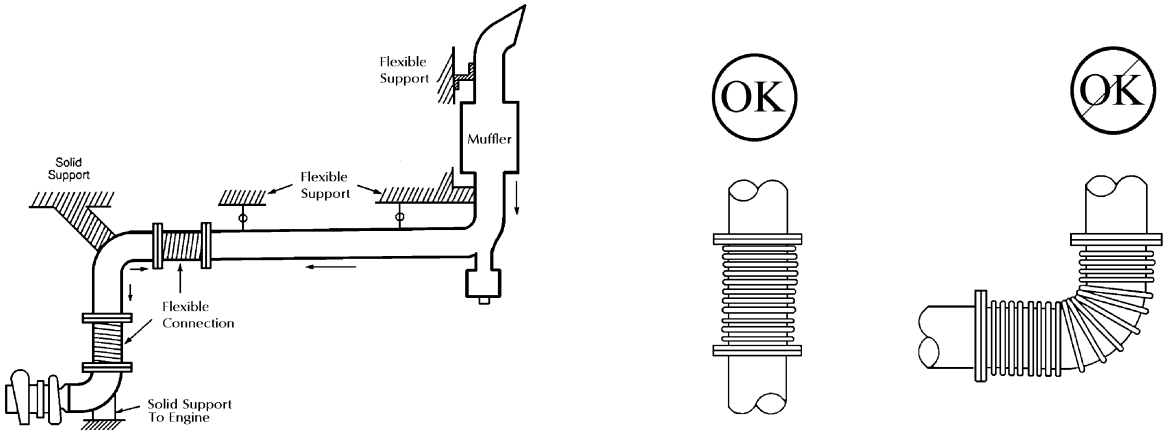


Figure 36: Proper Use of Flexible Connectors

Caution: Cummins recommends that dry exhaust piping never be installed near combustible material. The heat load of the dry exhaust component could exceed the specifications of the surrounding material causing fire, injury, or damage.

! Thermal insulation or guards must be installed on dry exhaust systems (see figure 37).

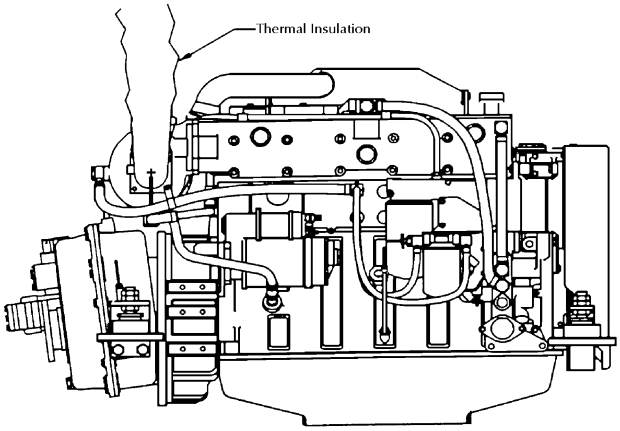


Figure 37: Typical Insulated Dry Exhaust

WARNING: In order to prevent personal injury from contact with a hot surface, to protect the vessel from the possibility of fire, and to maintain reasonable engine room temperatures, thermal insulation or guards are required on ALL parts of a dry exhaust system.

Exhaust Back Pressure

! The exhaust back pressure must not exceed 76 mm (3") Hg.

The exhaust back pressure restriction will vary depending upon the exhaust system design. The maximum exhaust back pressure must not exceed is 76 mm (3”) Hg. A 1/8" NPT tap is provided in the exhaust elbows supplied by Cummins Engine to check exhaust back pressure. If readings are not recorded from this position, individual results may vary. On systems that are not Cummins supplied, a provision should be placed in the riser at the same approximate position as elbows supplied by Cummins.

Any bends in the exhaust system should be made as smooth as possible (see figure 38). To keep the exhaust backpressure within specifications, minimize the number of bends and, use the recommended pipe size.

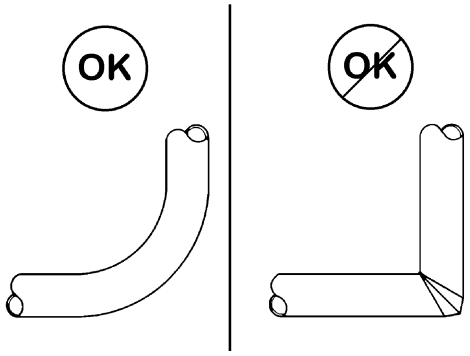


Figure 38: Proper and Improper Exhaust Pipe Bends

Cummins offers water injection elbows on turbocharged marine engines sized for 90 mm (3.5"), 100 mm (4"), 125 mm (5"), 150 mm (6"), and 200 mm (8") ID exhaust hose. Water injection elbows are not available for naturally aspirated engines. Some systems can require larger hose diameters to meet the backpressure requirements.

The suggested minimum size is listed in table 5.

	Recommended Minimum Diameter*	
Engine Model	**Wet**	**Dry**
4B3.9-M	75 mm (3.0")	75mm (3.0")
4BT3.9M	90 mm (3.5")	75mm (3.0")
4BTA3.9M	125 mm (5.0")	75mm (3.0")
6B5.9M	75 mm (3.0")	75mm (3.0")
6BT5.9M	100 mm (4.0")	75mm (3.0")
6BTA5.9M (Jacket Water After cooled)	125 mm (5.0")	90mm (3.5")
6BTA5.9M (Sea Water Afte Cooled)	150 mm (6.0")	90mm (3.5")
6CTA8.3M	200 mm (8.0")	125mm (5.0")
* Exhaust diameter must be sized properaly for back pressure. Back pressure must not exceed the limit listed in the General Engine Data Sheet		

Table 5: Recommended Minimum Exhaust Diameter.

HEAT EXCHANGER/COOLING SYSTEM

REQUIREMENTS

! Sea water aftercooled engines may not be keel cooled.

! The engine cooling system must be treated with an ethylene glycol/water or propylene glycol/water solution and/or DCA-4 per Cummins Marine Operation and Maintenance Manual.

! The maximum sea water pressure at the outlet of the sea water pump must not exceed 103 kPa (15 psi). Refer to the installation diagram for your engine for the measurement location.

! Four cylinder B Series marine engines require a coolant recovery bottle.

! Remote mounted expansion tanks must be mounted above the highest point in the cooling system circuit (water heater circuit, cabin heater circuit, etc.)

! Coolant system vent lines must not be teed together.

! The sea water inlet restriction must not exceed 125 mm (5") Hg.

! A sea water strainer or scoop with a maximum hole diameter of 1.4 mm (1/16") must be used.

INSTALLATION RECOMMENDATIONS

Engine Coolant and Engine Water Circuit

! Sea water aftercooled engines may not be keel cooled.

Sea water aftercooled engines are designed to cool the intake air low enough for efficient engine combustion and performance. Keel cooling aftercooled engines will result in high intake manifold temperatures causing a decrease in engine performance and engine life.

Cummins heat exchanger cooled marine engines have closed cooling systems. In a closed loop system, fresh water coolant mixture is used to cool the engine. The heat generated by this closed loop system is removed by the heat exchanger. The engine coolant leaves the heat exchanger and is recirculated through the engine by the engine water pump. The sea water is circulated by the sea water pump through the fuel cooler (if supplied), through the heat exchanger and gear oil cooler (if supplied), and finally is injected into the exhaust or is discharged overboard.

! The engine cooling system must be treated with an ethylene glycol/water or propylene glycol/water solution and/or DCA-4 per Cummins Marine Operation and Maintenance Manual.

Cummins marine engines are designed to use a coolant that is 50% ethylene glycol or propylene glycol antifreeze and 50% water solution treated with a supplemental coolant additive (Ref: SAE J1034) (see figure 39). Cummins does not recommend running these engines with untreated water as the coolant.

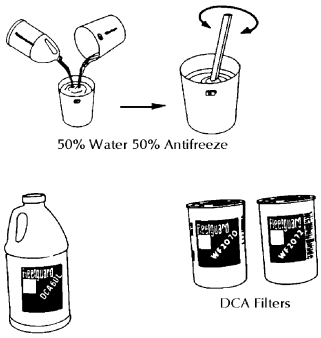


Figure 39: Use Proper Coolant Solution to Protect the Engine

The normal engine operating temperature range for B and C Series engines is 71 °C to 90 °C (160 °F to 195 °F) with the 103 kPa (15 psi) pressure cap in place. The Cummins alarm switches are preset for 96 °C (205 °F). Refer to the specific temperature range for your engine on the applicable Engine Data Sheet.

For engine fill and start-up procedures, consult the Owner's Operation and Maintenance Manual.

WARNING: Check the coolant level only when the engine is stopped. Wait until the temperature is below 50 °C (120 °F) before removing the pressure cap. Failure to do so can cause personal injury from heated coolant spray.

! The maximum sea water pressure at the outlet of the sea water pump must not exceed 103 kPa (15 psi). Refer to the installation diagram for your engine for the measurement location.

Pressure greater than 103 kPa (15 psi) may result in possible engine overheating and premature impeller failure (see figure 40). Any external cooling system components (such as a non-Cummins designed elbow or riser) must be sized so that the sea water pump outlet pressure is kept within specifications.

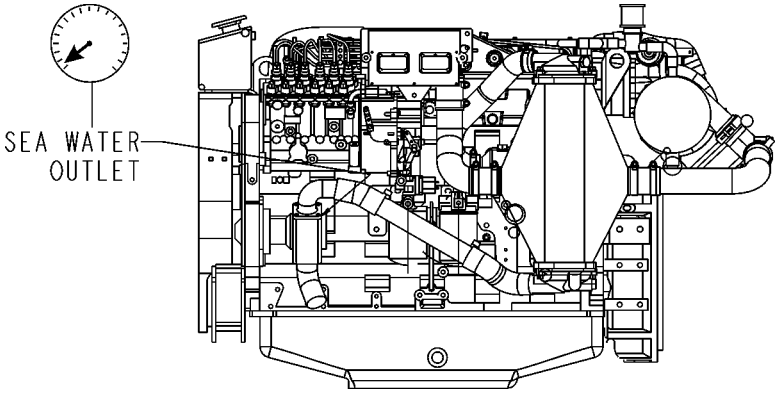


Figure 40: Sea Water Pump Outlet Pressure Drop Measurement

Expansion Tanks

Cummins Marine heat exchanger cooled engines are designed to incorporate an expansion tank. Attempts to redesign or modify this tank may result in engine failure due to overheating.

! Remote mounted expansion tanks must be mounted above the highest point in the cooling system circuit (water heater circuit, cabin heater circuit, etc.).

Cummins Marine recommends that the bottom of the expansion tank be above the highest point in the cooling system at any vessel trim and operating angle, and all vent lines must have a continuous upward run to prevent air traps from forming (see figure 41). The highest point in the cooling system includes any alternative circuit such as an external water heater, cabin heater etc.

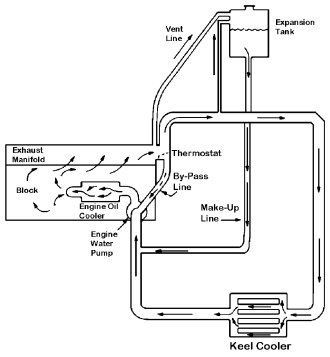


Figure 41: Expansion Tank Location

The positive fill line routed to the remote expansion tank must have a continuous upward slope from the engine to the expansion tank. This will allow the coolant to flow to the engine for proper fill.

All cooling systems on Cummins engines should have a 103 kPa (15 psi) pressure cap unless the expansion tank is more than 1.5 m (5') above the engine crankshaft centerline. Pressure cap ratings for distances greater than 1.5 m (5') above the engine crankshaft centerline are shown in table 6.

Expansion Tank Height Above Engine Water Pump Inlet	Minimum Pressure Cap
0 to 1.5 m (0 to 5')	103 kPa (15 psi)
1.5 to 4 m (5' to 13')	48 kPa (7 psi)
3 to 7 m (10' to 23')	28 kPa (4 psi)
6 to 9 m (20' to 30")	solid cap with vent

Table 6: Pressure Cap Requirements

Expansion tanks more than 9 m (30') above the engine fresh water pump inlet are not recommended.

Expansion tanks that require a solid cap must have a vent tube from the top of the tank to allow air gasses to escape from the cooling system (see figure 42). The vent must prevent dust and debris from contaminating the cooling system.

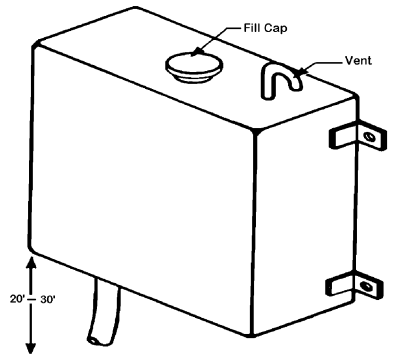


Figure 42: Expansion Tank With Solid Cap and Vent Tube

Coolant Recovery Bottle

! Four cylinder B series Marine engines require a coolant recovery bottle.

A coolant recovery bottle is provided with the heat exchanged cooling system on all 6-cylinder B and C Series engines.

A coolant recovery system or overflow bottle should be used to supplement the normal coolant expansion space in the expansion tank. A coolant recovery system is defined as an external volume of coolant, connected to the main system by a single connection, through which coolant, air, and vapor are free to expand as temperature rises and through which only coolant returns.

Note: The cooling system must be filled by pouring coolant through the fill/pressure cap on the engine mounted expansion tank. Do not assume that because there is coolant in the reservoir bottle that the engine cooling system is full. Coolant can be added to the reservoir when the system is cold to maintain a 50 mm (2") level.

Positioning of the Recovery Bottle

The ideal position for the reservoir is to be above the expansion tank. Mounting the reservoir below the tank but above the crankshaft centerline is acceptable, but not preferred. The reservoir should be mounted within 10 feet of the expansion tank. The hoses connecting the expansion tank and reservoir must be leak free. The hose must not have kinks or sharp bends as this will restrict the coolant flow to and from the recovery bottle.

Properly sized expansion tanks will not require a coolant recovery system, but these systems can be used to provide an easy visual check of the coolant level on boats with limited access around the engine.

Note: Visual checks do not insure proper engine coolant level due to leaks, cracks, faulty expansion tank caps, etc.).

Four cylinder B-series engines with factory expansion tanks **do** require the additional recovery bottle.

Vent Lines

! Cooling system vent lines must not be teed together.

Each vent line must be connected to the expansion tank without using Tee's or other fittings that would join the vent line together in a common vent (see figure 43). If two lines are tied together, one may have higher pressure than the other causing reduced flow and non-adequate venting.

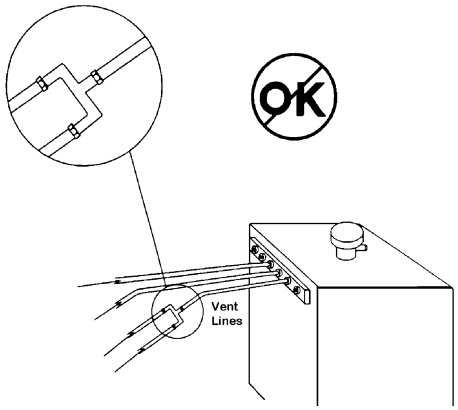


Figure 43: "T" Vent Lines Can Cause Cooling Problems

The Cummins Marine heat exchanger cooling systems are designed to remove entrained air at engine start-up and continuously during normal operation. Modifications to the vent hoses and routing may cause engine overheating (see figure 44).

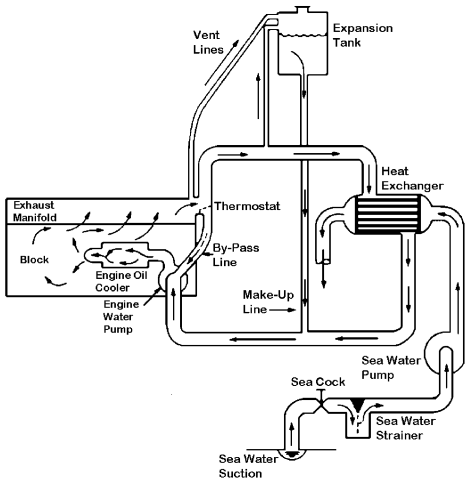


Figure 44: Typical Cooling System Hose Routing Schematic

! The sea water inlet restriction must not exceed 125 mm (5") Hg.

Each engine requires a dedicated water supply to the sea water pump inlet connection at the engine. This will ensure proper water flow to the engine. This piping from the sea water inlet on the bottom of the hull to the sea water pump should be short and as free from bends as possible. The sea water pumps have a lift capability of 3 m (10') with straight pipe. The sea water inlet must be in a location on the hull that provides a non-aerated water flow to the sea water pump at all times and in all operating conditions (see figure 45).

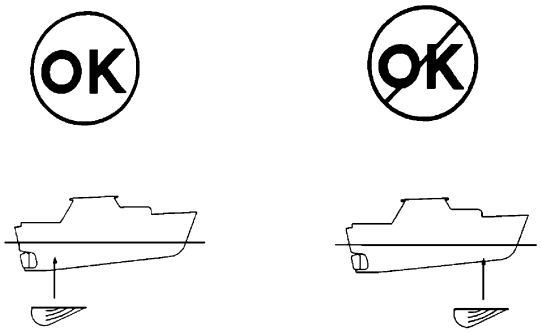


Figure 45: Sea Water Inlet Location Selection

The recommended minimum sea water piping sizes for each engine should be no smaller than the inlet connection on the sea water pump. The line size may have to be larger if the piping is especially long or has several bends that would increase the water intake restriction. Consult the applicable installation diagram for the sea water pump inlet connection size.

Restriction of the sea water flow can be caused by kinked or undersized sea water suction lines, undersized water cocks, through hull fittings, and sea water strainers (see figure 46). Use properly sized hoses and route them so they are not restricted or kinked.

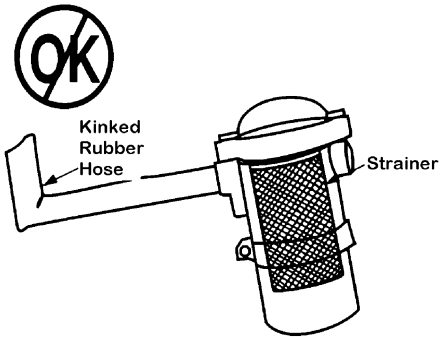


Figure 46: Improper Suction Line Design

! A sea water strainer or scoop with a maximum hole diameter of 1.4 mm (1/16") must be used.

A scoop on the inlet is recommended for achieving a solid water flow for use on planing hulls (see figure 47).

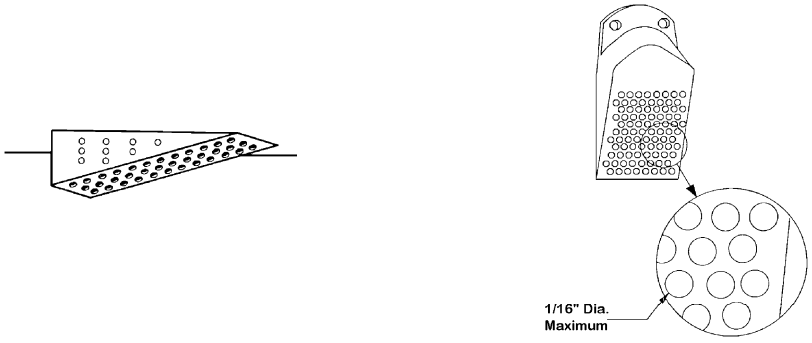


Figure 47: Typical Sea Water Inlet Design

The rubber impeller in the sea water pump can be damaged if the engine is run without water flowing into the pump or if excessive debris is run through the pump. A sea water strainer must be used ahead of the sea water pump to prevent damaging and plugging the pump.

Cummins recommends the use of a strainer in the sea water system prior to the sea water pump. These strainers are generally much more effective than scoop type strainers and can be checked for clogging and serviced more easily (see figure 48).

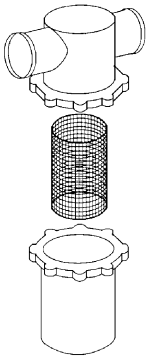


Figure 48: Typical Sea Water Strainer Designs

A seacock or inlet shut-off valve should be installed at the through hull fitting on the vessel.

Do not run the engine with the impeller dry or with the sea water inlet closed.

Auxiliary Heating Circuits

To prevent overcooling of the B and C Series engine, the amount of water circulated to an auxiliary circuit must be limited to no more than 5% of the engine water flow. To limit the water flow, any auxiliary heating circuit must have a flow restrictor installed in the circuit.

Coolant pressures on the B Series engines may reach 415 kPa (60 psi) and may exceed the pressure rating of some heater components. Pressure ratings on any auxiliary heater component should be rated at least to a minimum value of 415 kPa (60 psi). Use Cummins supplied flow restrictor (P/N 3916256) in the outlet from the engine to limit the flow and pressure in the heater circuit. Refer to the applicable engine installation drawing for the connection location.

The hot water supply to the heater component should be from a tapped hole in the cylinder head or exhaust manifold. The heater return should be into the water pump suction line. On C Series engines, the hot water supply is taken from the water rifle on the cylinder block (mid engine, lower tapped plug) or off the exhaust manifold. On 450C Series engines, the heater supply is returned back to the block behind the fuel pump. Refer to the applicable engine installation drawing for the water heater outlet and return locations.

CAUTION: **The top of the auxiliary heater must be located below the bottom of the engine expansion tank and must vent completely with the engine off.**

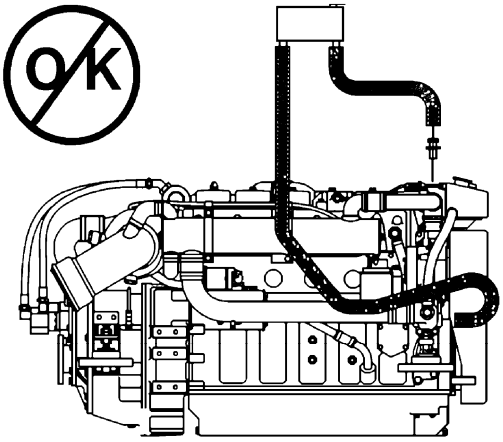


Figure 49: Use Care in Locating Auxiliary Water Heaters

Failure to comply with the above recommendations can result in auxiliary heater component failure or progressive engine damage caused by improper installation or operation. The installer is responsible for these components.

Fuel Coolers

In some installations and under some operating conditions, it is necessary to cool the return fuel recirculated by the injection pump. Cummins supplies fuel coolers on some of the high output engines. Alternate fuel coolers must meet the water inlet or outlet specifications and must also meet the fuel drain or inlet specifications.

Marine Gear Oil Coolers

Cummins Marine offers gear oil coolers. These gear oil coolers have been designed for the heat load removal from marine gears. Engines not supplied with a Cummins gear cooler or marine gear should be designed to meet the heat load dissipation requirements of the gear and should meet the engine cooling system flow pressure drop requirements. A 1/8" NPT drain plug is located in the sea water coolant side of the gear oil cooler for stuffing box lubrication. This fitting may also be used as a sea water supply. It is recommended that this fitting be used for only one driveshaft stuffing box.

KEEL COOLED COOLING SYSTEM

REQUIREMENTS:

! Keel cooled engines must be designed so that engine meets the operating temperature range as specified on the applicable engine data sheet. The maximum jacket water temperature must not exceed 96 °C (205 °F) under any operating conditions.

! The engine cooling system must be treated with an ethylene glycol/water or propylene glycol/water solution and/or DCA-4 per Cummins Marine Operation and Maintenance Manual.

! The keel cooling system must be designed to meet Cummins Marine Engine design requirements for initial fill rate and capacity, deaeration time, draw down capacity, and continuous deaeration.

! The pressure at the water pump inlet must be greater than atmospheric when the engine is run at rated speed with a coolant temperature in the operating range (specified on the applicable engine data sheet) and the system fill cap removed.

! The expansion tank volume must provide for a minimum excess coolant capacity that is equal to 20% of the engine coolant capacity listed on the Engine Data Sheet AND 5% of the total cooling system capacity.

! The bottom of any remote mounted expansion tank must be mounted above the highest point in the cooling system circuit.

! Cooling system vent lines must not be teed together.

! The system must have a pressure cap installed.

INSTALLATION RECOMMENDATIONS

Keel Cooling

A keel cooled system circulates engine coolant through a keel cooler and sea water flows around the outside of the keel cooler. The engine coolant leaves the keel cooler and is recirculated through the engine by the engine water pump. A keel cooler may be square channel or round pipe welded to the hull, or may be a manufactured unit with tubes or grid channels that is attached to the hull.

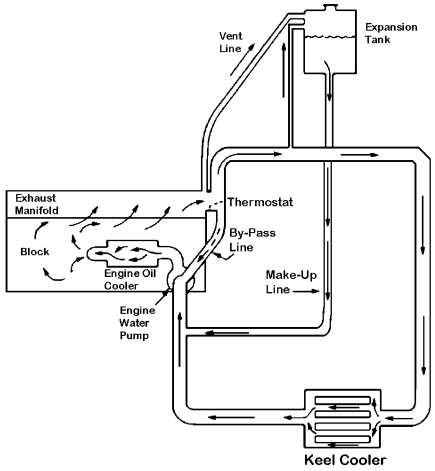


Figure 50: Typical Keel Cooling Circulation

! Keel cooled engines must be designed so that engine meets the operating temperature range as specified on the applicable engine data sheet. The maximum jacket water temperature must not exceed 96 °C (205 °F) under any operating conditions.

The normal engine operating temperature is 85 °C to 90 °C (160 °F to 195 °F). With the 103 kPa (15 psi) pressure cap in place, the engine can operate up to 96 °C (205 °F) intermittently. The Cummins alarm panels are preset for 96 °C (205 °F).

The installer is responsible for the correct installation of the keel cooler and plumbing to and from the engine, the design and installation of the expansion tank, and the vent line installation.

For assistance in sizing expansion tanks, and keel coolers fabricated by the boat yard, consult your local Cummins distributor or dealer.

Sizing of manufactured keel coolers should be done by the keel cooler supplier. Information required for correct sizing of the keel coolers can be found on the Marine Engine Data Sheet and Marine Performance Curve.

Commercially made keel coolers are designed for the marine environment and should not be painted as this will adversely affect their performance.

For assistance in sizing expansion tanks, and keel coolers fabricated by the boat yard, consult your local Cummins distributor or dealer.

! The engine cooling system must be treated with an ethylene glycol/water or propylene glycol/water solution and/or DCA-4 per Cummins Marine Operation and Maintenance Manual.

The Cummins B and C Series marine engines are designed to use a coolant that is 50% ethylene glycol or propylene glycol antifreeze and 50% water solution (Ref: SAE J1034). Cummins does not recommend running these engines with untreated water as the coolant.

For engine fill and start-up procedures, consult the Owners Operation and Maintenance Manual.

WARNING: Check the coolant level only when the engine is stopped. Wait until the temperature is below 50 °C (120 °F) before removing the pressure cap. Failure to do so can cause personal injury from heated coolant spray.

Cooling System Circuit

! The cooling system must be designed to meet Cummins Marine Engine design requirements for initial fill rate and capacity, deaeration time, draw down capacity, and continuous deaeration.

The cooling system must be designed to fill at a minimum of 3 gallons per minute to 80% of the total system capacity during an initial fill. This will remove entrapped air. Any air trapped in the system may cause the engine water pump to cavitate. This will cause engine overheating.

The system must be designed to deaerate all entrapped air within 20 minutes of engine running. Deaeration is completed when no more coolant can be added to the cooling system circuit.

The design of the cooling system must be able to tolerate 11% loss of coolant without overheating or pump cavitation.

The engine coolant vent system must provide continuous flow of coolant through the expansion tank as a method of removing entrapped air and gasses continuously during engine operation to prevent overheating. To accomplish this, all vent lines should be installed at the highest point on the engine. All vent locations are shown on the applicable engine installation drawing. Additional vent lines may be required for keel cooler designs to allow for initial fill and air entrapment. Vent lines must be 5 mm (3/16") ID lines or a #4 size flexible hose. Reference Bulletin #3382580 for additional information.

Engine Fill Procedure

Fill the engine slowly to allow the coolant to fill from the bottom up. Quickly filling the expansion tank can fill the vent lines with coolant and result in slow or incomplete fill of the engine. Open any petcocks and external vents to allow air to escape, then close them when the engine is full of coolant.

Note: Contain excessive coolant that may overflow from the engine. Do not allow this coolant to be pumped overboard.

Run the engine until it comes up to operating temperature. Shut down the engine and, after it has cooled, carefully check the coolant level. Refill if necessary.

The system should never be half filled with antifreeze and then topped off with water. Always pre-mix the water and antifreeze prior to filling the engine.

! The pressure at the water pump inlet must be greater than atmospheric when the engine is run at rated speed with a coolant temperature in the operating range (specified on the applicable engine data sheet) and the system fill cap removed.

If the pressure on the suction side of the water pump is negative, the pump will cavitate and, in some cases, lose its prime. This will result in a loss of coolant flow and overheating of the engine. Any external cooling system components must be sized such that there is always a positive pressure at the water pump. Pressure at the inlet should be checked at initial sea trial.

Expansion Tanks and Sizing

! The expansion tank volume must provide for a minimum excess coolant capacity that is equal to 20% of the engine coolant capacity listed on the Engine Data Sheet AND 5% of the total coolant system capacity.

WARNING: Check the coolant level only when the engine is stopped. Wait until the temperature is below 50 °C (120 °F) before removing the pressure cap. Failure to do so can cause personal injury from heated coolant spray.

The following formula is used to calculate the minimum required deaeration expansion tank size: $V = \frac{T}{18} + \frac{E}{4.5}$

where:

V = Minimum Expansion Tank Volume

T = Total System Coolant Volume (including engine)

E = Engine Coolant Volume

Note: The above equation for expansion tank sizing incorporates the drawdown and expansion volume. Engines with tanks sized to this volume do not need a coolant recovery bottle.

! The bottom of any remote mounted expansion tank must be mounted above the highest point in the cooling system circuit.

The bottom of the tank must be above all vent locations on the engine at any vessel trim and operating angle, and all vent lines must have a continuous upward run to prevent air traps from forming.

Vent Lines

! Cooling system vent lines must not be teed together.

Each vent line must be individually connected to the expansion tank without using tees or other fittings that would join the vent line together in a common vent.

If two lines are teed together, one may have higher pressure than the other causing reduced flow and non-adequate venting. Joining the vents into a common line will reduce the total vent water flow and may prevent aerated water from being properly vented.

Vent lines must be 5 mm (3/16") ID lines or a #4 size flexible hose.

! The cooling system must be designed to vent during initial fill to allow complete filling of the total cooling system volume. In addition, the system must continuously remove air during normal operation.

The engine vent system provides a continuous flow of water through the expansion tank as a method of removing air and gasses from the engine coolant. The highest points in the engine coolant circuit are the best locations for venting. All Cummins engines have venting provisions at the thermostat housing. Additional vent locations are show on the installation drawing.

Additional vents may be required to allow air to escape from the top of the keel cooler or heat exchanger during initial engine coolant fill. Vent lines must be 3/16" (5 mm) I.D. lines or a #4 size flexible hose.

All vent lines must be installed with a continuous upward run from the engine, keel cooler, or heat exchanger to the expansion tank at all vessel operating angles.

Auxiliary Cooling System

To prevent overcooling of the B and C Series marine engines, the amount of water circulated to an auxiliary heater circuit must be limited to no more than 5% of the engine water flow. Coolant pressures on the B Series engines may reach 415 kPa (60 psi) and may exceed the pressure rating of some auxiliary circuit heater components. Pressure ratings on all heater components should be rated at least to a minimum value of 415 kPa (60 psi). Use Cummins P/N 3916256 flow restrictor in the outlet from the engine to limit the flow and pressure in the heater circuit.

The hot water supply to the auxiliary heater should be from a tapped hole in the cylinder head or exhaust manifold, and the heater return should be into the water pump suction line. On C-series engines, the hot water supply is taken from the water rifle on the cylinder block (mid engine-lower tapped plug) or off the top exhaust manifold. On 450 C Series engines, the auxiliary return is to the block behind the fuel pump. Refer to the applicable engine installation drawing for water heater outlet and return locations.

The heater must be located below the bottom of the engine expansion tank and must vent completely with the engine off.

If this is not possible, coolant fill must be done at the heater or highest point in the system. A partially filled heater will eventually purge air back into the engine cooling system. This can caused localized overheating in the cylinder head, exhaust manifold, or turbocharger and will reduce engine water flow if air is trapped at the engine water pump. The entrapped air at the pump will cause cavitation resulting in little or no cooling water circulation through the engine.

Cummins is not responsible for water heaters, sea water strainers, and scoops and is not responsible for progressive engine damage caused by improper installation or operation of the items listed above.

Makeup Lines

The deaerated water return, or make-up line, connection is located in the bottom of the expansion tank. The purpose of the make-up lines is to provide a means for filling the engine and to feed the fresh water from the vent lines back to the engine after is has been deaerated during operation.

The make-up line is plumbed from the bottom of the expansion tank to the engine water inlet line. The make-up line should not be plumbed to the water pump housing or body.

When the make-up water enters the engine water inlet line, the turbulence created in the flow may cavitate the water pump. Therefore, the line should be plumbed at least 150 mm (6") from any bends or elbows in the piping. This will reduce the chances of pump cavitation.

The size of the make-up line is also important. The line must be large enough to allow proper coolant fill and to provide adequate return flow from the expansion tank without allowing air back into the system. The size of the make-up line will depend on the number and size of the vent lines. In general, the cross-sectional area of the make-up line should be 3 to 4 times the sum of the vent line cross sectional areas.

! The system must have a pressure cap installed.

All cooling systems on Cummins engines should have a 15 psi pressure cap unless the expansion tank is more than 1.5 m (5') above the engine. The recommended combinations of pressure caps and expansion tank height are as shown in table 7.

Expansion Tank Height Above Engine Water Pump Inlet	Minimum Pressure Cap
0 to 1.5 m (0 to 5')	103 kPa (15 psi)
1.5 to 4 m (5' to 13')	48 kPa (7 psi)
3 to 7 m (10' to 23')	28 kPa (4 psi)
6 to 9 m (20' to 30”)	solid cap with vent

Table 7: Pressure Cap Requirements

Expansion tanks more than 9 m (30') above the engine crankshaft are not recommended.

Expansion tanks that require a solid cap must have a vent tube from the top of the tank to allow air gasses to escape from the cooling system. The vent must prevent dust and debris from contaminating the cooling system.

Fuel Coolers

In some installations and under some operating conditions, it is necessary to cool the return fuel recirculated by the injection pump. Cummins supplies fuel coolers on some of the high performance B and C Series engines. Alternate fuel coolers must meet the water inlet or outlet specifications and must also meet the fuel drain or inlet specifications.

Marine Gear Oil Coolers

Cummins Marine offers gear oil coolers. These gear oil coolers have been designed for the heat load removal from marine gears. Engines not supplied with a Cummins gear cooler or marine gear should be designed to meet the heat load dissipation requirements of the gear and should meet the engine cooling system flow pressure drop requirements. A 1/8" NPT drain plug is located in the sea water coolant side of the gear oil cooler for stuffing box lubrication. This fitting may also be used as a sea water supply. It is recommended that this fitting be used for only one driveshaft stuffing box.

AIR INTAKE SYSTEM

REQUIREMENTS

! All engines must have an effective air cleaner to remove airborne dirt particles from the intake air and must be suitable for use in a marine environment.

! The air inlet system restriction must not exceed the value shown on the Engine General Data Sheet.

! The air inlet location, air piping, and engine room ventilation must be designed so that the air inlet temperature measured at the turbocharger or air cleaner is not more than 17 °C (30 °F) above the outside ambient temperature at rated load and speed. The maximum air intake temperature should never exceed 52 °C (130 °F) under any operating conditions.

! The vessel ventilation must be designed to prevent liquids (water) from entering the air intake system.

INSTALLATION RECOMMENDATIONS

General

To ensure long, reliable, and durable service, Cummins engines require properly designed air and ventilation systems:

- To provide sufficient combustion air to the engine.
- To ventilate the compartment of radiated heat and fumes from the engine or other machinery.
- To limit the engine compartment temperature to ensure proper engine performance.
- To minimize the entrance of material foreign to engine combustion (dirt, moisture, etc.).

Air Cleaners

! All engines must have an effective air cleaner to remove airborne dirt particles from the intake air and must be suitable for use in a marine environment.

B and C Series marine engines are available with a dry type air cleaner or blowby recirculation device mounted directly on the turbocharger (see figure 51).

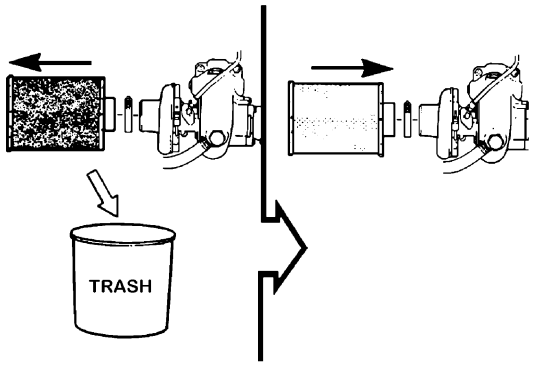


Figure 51: Replaceable-type Air Cleaner

Air cleaners are essential to keep debris and salt from entering the turbocharger. If debris larger than the air cleaner specifications enters the turbocharger or power cylinder, reduced engine life or premature engine failure can result.

The air cleaner should not be located where water can enter the element, either during operation or wash down.

Excessive air inlet restriction from a plugged or wet air cleaner will reduce engine power and increase black smoke levels.

Cummins Marine provides air cleaners based on the engine operating parameters. Engines that operate in a dirty environment or for more than 500 hours per year may need a medium or heavy-duty air cleaner. The air cleaner dirt holding capacity for marine filters should meet the minimum requirements shown in table 8.

Duty	Efficiency at 15% to 100% Air Flow	Dirt Holding Capacity g/l/s (g/cfm)	Type Construction
Normal	99.5%	6.4 (3)	Single Stage
Medium	99.7%	21 (10)	Single Stage
Heavy	99.9%	53 (25)	Two Stage

Table 8: Air Filter Specifications

Cummins Marine recommends the use of Cummins specified air filters. These filters are designed for use in the Marine environment.

Air Inlet Restriction

! The air inlet system restriction must not exceed the value show on the Engine General Data Sheet.

Cummins Marine engines are designed to operate within the specified restriction limits when engines are supplied with the recommended Cummins air filter.

The applicable General Engine Data sheet contains information on the maximum allowable intake restriction for new and in-service filters.

Restriction Indicators

Cummins Marine recommends restriction indicators or vacuum gauges be installed in the piping between the air cleaner and engine. On turbocharged engines, the indicator should be placed at the turbocharger inlet. On naturally aspirated engines, the indicator should be placed at the intake manifold. The restriction should be checked with the engine running at full load and speed.

Engine Room Ventilation

! The air inlet location, air piping, and engine room ventilation must be designed so that the air intake temperature measured at the turbocharger or air cleaner is not more than 17 °C (30 °F) above the outside ambient temperature at rated load and speed (see figure 52). The maximum air intake temperature should never exceed 52 °C (130 °F) under any operating conditions.

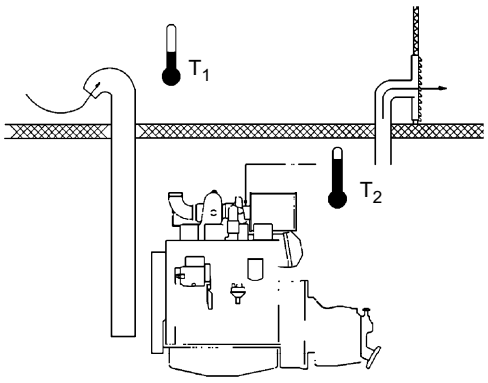


Figure 52: Air Inlet (T_1) and Air Intake (T_2) Temperature Measurements

Marine engines normally draw air from within the engine room. There must be adequate ventilation into and out of the engine room to provide combustion air for the engine and to carry away heat generated by the engine. The ventilation system must be large enough to maintain the engine inlet temperature at no more than 17 °C (30 °F) above the outside ambient temperature at rated engine speed and load. These temperatures may increase at lower speeds. The equation below shows the recommended MIMIMUM total ventilation area for EACH engine in the engine room (excluding auxiliary engines or generator sets). Auxiliary machinery located in the engine room will

require additional ventilation sizing for increased combustion air and to carry the additional heat out of the engine room (ventilation).

The configuration of the vent system, including turns and total length, will affect air flows. The recommended vent area may need to be increased to meet Cummins requirements for a particular vessel. The following equation should be used to determine the area required PER ENGINE. Refer to your Marine Performance Curve/Data Sheet for intake air flow for each engine.

Area (in^2) = 0.272 x Intake Air Flow (cfm) at rated speed

This equation does not take into account any flow restrictions through the hull.

In sizing the ventilation ports, two thirds of the area should be used for intake air and one third of the area should be for exhaust ventilation.

The placement of the air vents is critical to assure proper air flow to the engine compartment. The builder is responsible to design the vents to meet the specified requirements. Design of the vents will vary depending upon the boat design and air ducting passages.

Cummins Marine recommends that the air inlet vents be ducted near the bottom of the engine room to promote natural circulation of the fresh air (bottom to top) and to vacate fumes and moisture from the bilge. Hot air should escape through the outlet vents at the top of the engine room. Some engine rooms may require blowers and exhaust fans to circulate enough fresh air through the engine room to meet the temperature requirements.

In some applications, air inlet and exhaust blowers may be required to meet the engine requirements listed at the start of this section.

High engine room air temperature will reduce engine power output, increase the heat load on the cooling system, and reduce the life of belts, hoses, and wiring.

Remote Mounted Air Cleaners

On remote mounted cleaners, air inlet piping must be sized to provide inlet air to the engine without exceeding the air inlet restriction limit shown on the applicable General Engine Data Sheet.

Relative movement between the engine, air cleaner, and air inlet requires flexibility in the pipe components and flexible connections. Rubber hoses or elbows can be used to prevent overstressing of the piping sections.

The air cleaner should be mounted in an area that is free of dirt, dust, fish scales, or other debris that may plug the filter during regular operation, net handling, or deck operations.

Remote Air Filter Ducting—General Guidelines

Some of the factors to consider in selecting tubing for the air system are listed below:

- Piping must not collapse under maximum restriction conditions.
- A permanent seal against moisture and dirt is required at every joint in piping.
- Intake pipe size should never be smaller than the diameter of the turbocharger or engine inlet.
- If the tubing lacks strength or rigidity, tightening the hose clamps to provide an adequate seal may deform or crack the ducting.
- Rough end surfaces can cut or abrade the flexible connectors and prevent a proper seal.
- Inside and outside walls of tubing need to be smooth and leak-free to ensure a perfect seal and lessen air flow resistance.
- All inlet air piping must be supported adequately so no bending moments or undue stress are imposed on the turbocharger.

FUEL SYSTEM

REQUIREMENTS

! Do not remove the secondary fuel filter supplied with the engine.

! A primary fuel/water separator is required between the engine and the fuel tank.

! The maximum fuel pressure at the fuel pump outlet fitting must not exceed the values specified for clean filter conditions on the applicable Engine General Data Sheet.

! The maximum fuel restriction at the inlet fitting on the fuel pump must not exceed the value listed on the applicable Engine General Data Sheet

! All fuel hoses used on boats built or imported into the U.S. must have hoses that are U.S. Coast Guard Approved "Type A" or "Type A1."

! The fuel return line on the B and C Series engines must be routed to the bottom of the fuel tank.

! The fuel lines must be routed in such a way as to not cause pressure surges in the lines.

! The fuel piping used between the engine and shipboard piping must have a flexible section to allow for relative movement of the engine and hull.

! The fuel tank must be equipped with a vent and a fuel return connection that are adequate to permit air and other gasses to separate from the fuel. The vent must also prevent the entry of dirt and water.

! Fuel inlet temperature must not exceed 71 °C (160 °F).

INSTALLATION RECOMMENDATIONS

General

The function of an engine fuel system is to provide adequate supply of clean, deaerated fuel and control the fuel temperature within design values.

The B and C series engines use several different fuel pumps, but the basic principle of operation is the same on all of them: Fuel is drawn from the fuel tanks, through a fuel/water separator, and into the lift pump. The lift pump delivers fuel under low pressure through the engine mounted (or remote) fuel filter to the fuel injection pump. The fuel injection pump, whether inline or rotary, distributes high-pressure fuel to the individual injector nozzles.

Fuel Lift Pump

The fuel lift pump is used to manually prime the fuel system on initial start-up and whenever the fuel system or engine mounted fuel filter has been serviced. The boat design must allow for access to the fuel lift pump on the port side (fuel pump side) at the rear of the engine. Since 1996 Cummins Marine began using a Bosch fuel pump, which has the primer/lift pump mounted directly to the fuel pump. It is important to recognize that the lift pump can now be in two different locations when installing the engines.

Fuel Filters and Fuel/Water Separators

! Do not remove the secondary fuel filter supplied with the engine.

Fuel filters protect the close tolerance components in the fuel pump and injectors from damage or wear from dirt and water. The final fuel filter supplied by Cummins must always be used.

! A primary fuel/water separator is required between the engine and the fuel tank (see figure 53).

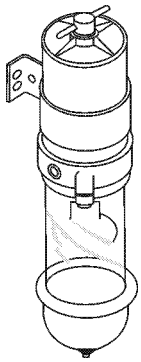


Figure 53: Typical Fuel/Water Separator

A fuel/water separator filter, available either as an option from Cummins or sourced separately, must be installed ahead of the engine mounted secondary filter to provide additional water and debris holding capacity and to protect the fuel system from damage. If the fuel/water separator available from Cummins is not used, the installer must supply and install a fuel/water separator that is properly sized for the engine's supply fuel flow as specified in the applicable Engine Performance Data Sheet. Primary (off engine mounted) filters are usually 30 microns. Secondary (engine mounted) filters are finer. Most are 10 micron, but vary according to engine specifications.

Fuel Plumbing

! The maximum fuel restriction measured at the inlet fitting on the fuel pump must not exceed the value listed on the applicable Engine General Data Sheet (see figure 54).

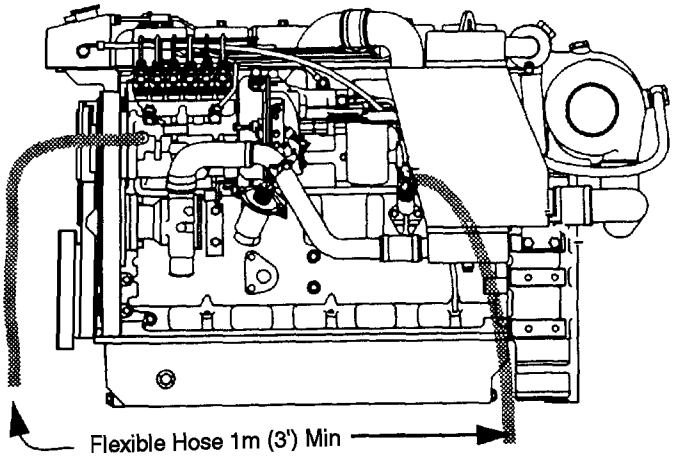


Figure 54: Fuel Inlet Restriction and Pressure Measuring Points

The fuel lift to the bottom of the tank cannot exceed 1.5 m (5') without exceeding the maximum fuel inlet restriction.

! The maximum fuel pressure at the fuel pump outlet fitting must not exceed the value listed on the particular Engine General Data Sheet (see figure 54).

The maximum allowable return line pressure on rotary pumps is 259 mm (10.2") Hg. For inline fuel pumps maximum allowable return line pressure is 517 mm (20.4") Hg. Fuel return restrictions are dependent on the line sizing used and the number and configuration of the fittings used to route the fuel back to the tank.

Table 9 shows minimum inlet and return plumbing sizing.

Engine Model	Supply Line (ID)	Drain Line (ID)
4B3.9M	#6 hose size 10 mm (3/8")	#4 hose size 6 mm (1/4")
4BT3.9M	#8 hose size 12 mm (1/2")	#6 hose size 10 mm (3/8")
6BT5.9M	#6 hose size 10 mm (3/8")	#4 hose size 6 mm (1/4")
6BTA5.9M	#8 hose size 12 mm (1/2")	#6 hose size 10 mm (3/8")
6CT/TA8.3M	#8 hose size 12 mm (1/2")	#8 hose size 12 mm (1/2")

Table 9: Minimum Inlet and Return Plumbing Sizes

Note that these are the minimum recommended sizes to maintain the engine drain line specification limits. These lines may need to be larger depending upon the return configuration and design and must be verified during a sea trial.

An auxiliary transfer pump is a possible solution if the fuel inlet restriction limit cannot be met. Auxiliary fuel pumps must limit their discharge pressure to 70 kPa (10 psi).

The actual fuel line sizes required on an engine will depend on the engine flow rate, the length of the line, the number of bends, and the number and type of fittings.

Larger fuel line sizes may be required when the fuel tanks are located farther than 3 m (10') from the engine or when there are numerous bends in the plumbing.

! All fuel hoses used on boats built or imported into the U.S. must have hoses that are U.S. Coast Guard Approved “Type A” or “Type A1.”

Fuel line or hose must meet the requirements of government agencies where the vessel will be operated. Vessels operating in the U.S. must meet U.S. Coast Guard regulations. For vessels built or imported into other countries, you must follow the regulations of the local governing agencies.

! The fuel return line on the B and C Series engines must be routed to the bottom of the fuel tank.

The point of supply and return should be located approximately 25 mm (1") above the bottom of the tank to provide space for collection of water and sediment.

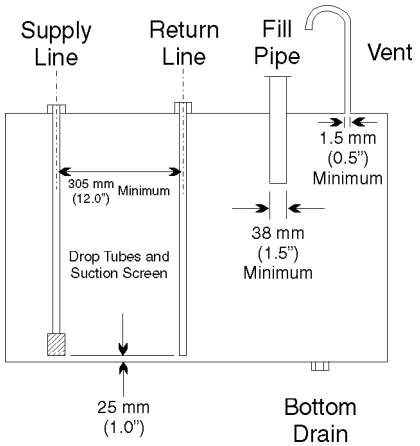


Figure 55: Fuel Tank Supply and Return Line Arrangement

Supply and return lines should be spaced as far apart as possible in the tank. This will prevent hot return fuel from easily entering the supply flow. External check valves in the return line or tank can create excessive restriction and should be avoided.

! The fuel lines must be routed in such a fashion as to not cause pressure surges in the line.

The fuel on B and C Series engines can be returned to either the bottom or top of the fuel tank. Cummins recommends that the fuel be returned to the top of the tank due to entrained air in the fuel under some operating conditions. It is acceptable to return the fuel to the bottom of the tank if the return drop tube is at least 305 mm (12") away from the supply drop tube.

Routing of fuel supply and return lines should be as direct as possible and avoid vertical loops and bends that could trap air.

Air leaks in the fuel lines may allow fuel to drain back into the fuel tanks and cause hard starting. An open drain line in the fuel tank will also allow the fuel to drain back. Therefore, the fuel drain lines must be installed with drop tubes in the fuel tanks to keep the drain line submerged at all times. To ensure a leak free connection at the fuel drain connections, threaded fittings should be used to connect the drain line to the engine fuel lines. Hose clamps and barbed fittings are poor substitutes.

If selector valves are used in the fuel supply line, the valve port should be at least as large as the fuel supply line I.D.

! The fuel piping used between the engine and shipboard piping must have a flexible section to allow for relative movement of the engine and hull.

Solid tubing cannot be directly connected to the engine fuel supply or drain connections. At least 1 m (3') of flexible hose is recommended between the engine and the vessel's fuel lines (see figure 56).

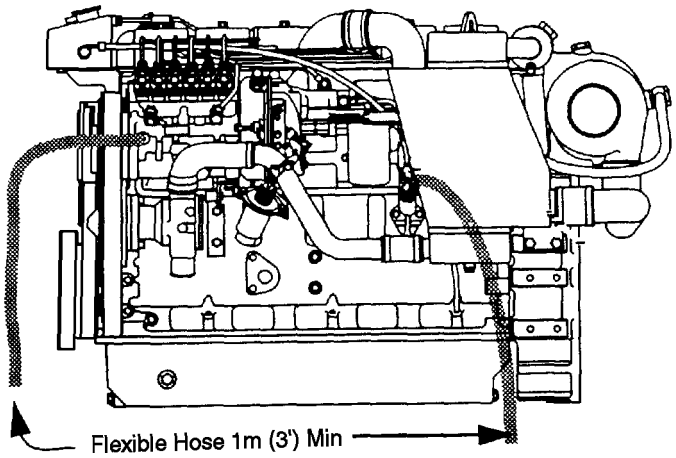


Figure 56: Fuel Supply and Return Points

Fuel Tanks

Marine fuel tanks are at the discretion of the builder. The tanks must meet the minimum requirements of shipbuilding code and must meet the applicable local ordinances, such as U.S. Coast Guard approval for use in the U.S. Cummins Marine assumes no liability for fuel tank construction or design or the materials used therein.

Marine fuel tanks can be made of stainless steel, terneplate (phosphate coated steel), aluminum, or fiberglass. Galvanized steel (zinc plated steel) tanks cannot be used for diesel fuel. Zinc reacts with diesel fuel to form an oxidized flake that clogs fuel filters and can damage fuel system components.

! The fuel tank must be equipped with a vent and a fuel return connection that are adequate to permit air and other gasses to separate from the fuel. The vent must also prevent the entry of dirt and water.

The fuel tank must be vented so that the tank will not be pressurized when the engine is running. Normally, a 13 mm (1/2") line will be adequate to prevent pressurization of the tank. Larger vents may be required to relieve the pressure when filling the fuel tanks with a high volume fuel delivery system.

The point of supply and return should be located a minimum of 25 mm (1") above the bottom of the tank to provide space for collection of water and sediment (see figure 57).

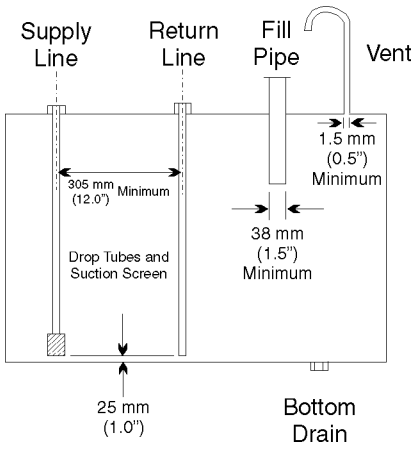


Figure 57: Typical Fuel Tank Design

Supply and return lines should be spaced as far apart as possible in the tank. This will prevent hot return fuel from easily entering the supply flow. External check valves in the return line or tank can create excessive restriction and should be avoided.

Fuel Coolers

! Fuel inlet temperature must not exceed 71 °C (160 °F).

In some installations and under some operating conditions, it is necessary to cool the return fuel recirculated by the injection pump. If not cooled, the fuel supplied to the engine will heat beyond the fuel operating specification limits and cause power loss.

Fuel return pressure should not exceed the values listed in the Engine General Data Sheet. Higher pressures can cause the fuel cooler passage to rupture, spilling fuel into the sea water or causing the fuel tanks to fill with sea water.

It is important to recognize that the return drain lines from the fuel cooler to the tank should be open at all times during operation.

CAUTION. Excessive pressure will damage the fuel cooler.

It is also important to note that service limitations require that the cooler not be plugged during fuel pump spill port or engine timing procedures. The cooler will be exposed to high pressures causing damage to the cooler. Consult your service manual.

STARTING/ELECTRICAL

REQUIREMENTS

! The installed battery capacity must not be less than that specified on the Marine Engine General Data Sheet.

! The maximum voltage drop during cranking for the starter system must not exceed the values listed in the Marine Engine General Data Sheet.

! If an alternator is not supplied with the engine, the installer must assume responsibility/liability for adequate mounting.

! Power interrupt during transition from key-on to crank mode must not exceed 80 milliseconds.

! The ECM must be wired directly to the corresponding engine battery.

! All switch contacts (except start, stop, and keyswitch contacts) must be gold flashed.

! The cylinder block must be properly grounded.

! Twisted triple wires (at the rate of 1 twist per inch) must be used on throttle input wiring.

! The throttle interface must meet Cummins Marine requirements.

! A functioning hourmeter must be installed.

! Engine must not be able to start in gear.

INSTALLATION RECOMMENDATIONS

Electrical Systems

An absolute requirement of a satisfactory installation is that the engine(s) start readily under the most severe ambient conditions. In order to achieve this objective, the installer must exercise good judgment in the selection, application and installation of the batteries, electrical and electronic system components. Following the recommendations offered in this guide will create a reliable system.

Battery and Starting System

! The installed battery capacity must not be less than that specified on the Marine Engine General Data Sheet.

To crank the engine fast enough to ensure reliable start, correctly sized batteries and cables must be installed. Table 10 gives the Cummins Marine Requirements for Battery Voltage selection. Check your Marine Engine General Data Sheet for up to date changes.

Engine Family	12 Volt Battery Capacity*	24 Volt Battery Capacity*
4B/4BT-M*	800 CCA / 1000 MCA	400 CCA / 500 MCA
4BTA-M*	1100 CCA / 1375 MCA	475CCA / 600 MCA
6B/6BT/6BTA-M*	950 CCA / 1200 MCA	475 CCA / 600 MCA
6BTA-M(SW)(JW)	1100 CCA / 1375 MCA	550 CCA / 700 MCA
6C/CTA-M*	1800 CCA / 2250 MCA	900 CCA / 1125 MCA
* The battery capacity ratings should meet SAE J537 test conditions and be in concurrence with ABYC Section E-10—STORAGE BATTERIES.		

Table 10: Cummins Marine Battery Selection

Cummins recommends that each engine have a dedicated battery or batteries. Accessories should run off of a separate battery that is not used for cranking the engine.

In addition to selecting the appropriate batteries, the battery cables to the engine must be properly sized to meet the voltage drop and circuit resistance requirements.

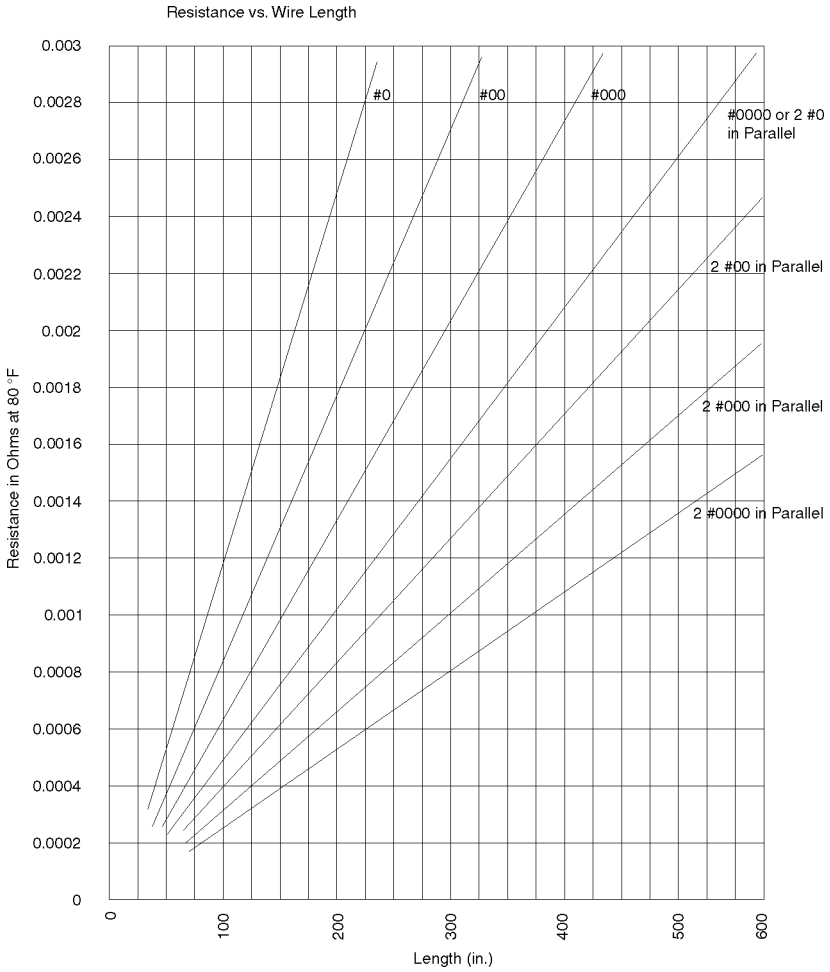
! The maximum voltage drop during cranking for the starting system must not exceed the values listed in the Marine Engine General Data sheet.

Table 11 summarizes the Marine Engine General Data sheet information. Always check your Marine Engine General Data sheet for up to date information.

Engine Model	System Voltage	Maximum Circuit Voltage Drop	Max. Circuit Resistance*
4B/6B	12	0.20 Volts	0.00012 ohms
6C	12	0.075 Volts	0.00075 ohms
4B/6B/6C	24	0.20 Volts	0.002 ohms
* Cable connection resistance is not significant enough to affect cable size determination.			

Table 11: Voltage Drop and Circuit Resistance Limits

Use Graph 1 to help select the correct battery cable size.



Graph 1: Resistance vs. Wire Length

After installation of the appropriate cables, check the starting system voltage drop during cranking versus at rest system voltage. Figure 58 shows a simple method for checking voltage drop with a common voltmeter.

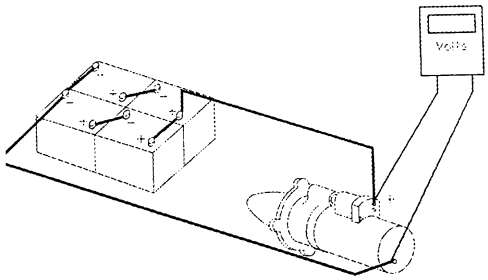


Figure 58: Circuit Voltage Drop Measurements

Battery Switch Installation Guidelines

CAUTION: Wiring the Electronic Control Module (ECM) through a battery switch will damage the ECM.

Battery disconnects are used in some applications to isolate the battery from the cabin or other auxiliary power system.

The battery disconnect should open the positive connection to the starter (see figure 59). Cummins Marine does not recommend using a battery disconnect on the negative side of the circuit.

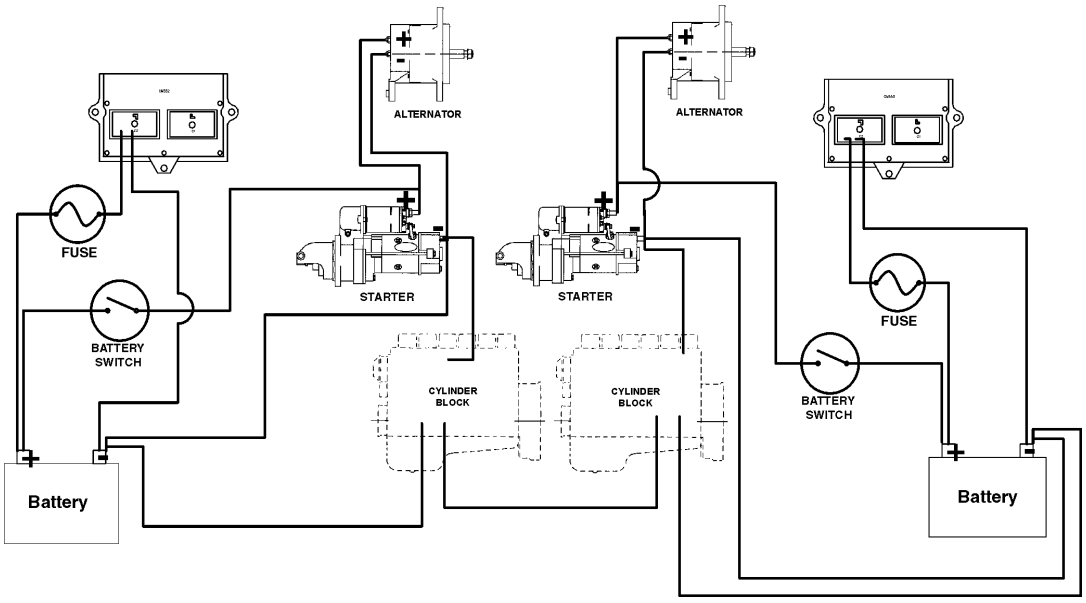


Figure 59: Typical Positive Side Battery Disconnect Setup (Dual Engine Setup Shown)

CAUTION: Battery switches should never be operated unless the engine has been turned off. Failure to follow this can cause current surge by operation of the battery switch while the engine is running and can cause fatal damage to the ECM (if applicable) or other electrical components.

The battery switch selected must be capable of handling the total system amperage.

Gel Cell Batteries

Gel Cell Batteries are another electrical storage option. Gel Cell batteries have special charging characteristics. Gel Cells can be easily overcharged if they do not have specific charging components that limit the incoming charging amperage and voltage to specified limits (refer to your Gel Cell owners manual). Typically, Gel Cell batteries are limited to a maximum charging voltage of 14.1 volts and, in comparison to typical lead acid batteries, which can be charged at higher currents. This requires the use of special voltage limiting hardware when the Gel Cells are used.

Cummins Marine does not currently offer any of the Gel Cell Battery voltage limiting devices. Please consult your local battery supplier or Gel Cell manufacturer for installation specifications and requirements.

Electrical Isolator Systems

Some vessels use isolator systems to charge the battery bank that has the greatest need at the time. Isolator systems can also be used to charge accessory batteries. Isolator systems require special hardware that, if not installed or applied correctly, can drain, overcharge, and/or damage the engine batteries and/or the house batteries. Please consult your isolator supplier or manufacturer for specific installation and wiring requirements.

! If the alternator is not supplied with the engine, the installer must assume responsibility/liability for adequate mounting.

CAUTION. Cummins Engine Co., is not responsible for any problems associated with an improperly mounted alternator that was not supplied with the engine or any modification to a Cummins supplied alternator. If the customer wishes to supply their own alternator, it must be properly installed. Items that should be considered are mounting, wiring, belt wrap, alignment, amperage, vibration, and safety guard. Failure to properly install the alternator can result in engine failure.

Any alterations to the alternators (or corresponding engine components) that effect the design envelope of the Cummins Marine supplied guard must have changes, alterations or additional guards added for protection.

Alternator selection should be based on the individual vessel requirements in conjunction with the engine requirements.

The following section shows the general amperage requirements and wiring recommendations. The vessel amperage requirements should be additive with the engine requirements to insure adequate delivery of electricity to the vessel and to maintain a charged battery condition.

The alternator output wiring should be sized to carry the rated current of the alternator. Use the following wire selection tables (tables 12 and 13) as a guide.

Length meters (ft)	Current (amps)												
	5	10	15	20	25	30	40	50	60	70	80	90	100
3 (10)	18	18	18	16	16	14	14	12	10	8	8	6	6
4.5 (15)	18	18	16	16	14	14	12	12	10	8	8	6	6
6 (20)	18	16	16	14	12	12	10	10	8	8	8	6	6
7.6 (25)	18	16	14	12	12	10	10	8	8	8	6	6	6
9 (30)	18	16	14	12	10	10	8	8	8	6	6	6	4
12 (40)	16	14	12	10	10	8	8	6	6	6	4	4	4
15 (50)	16	12	10	10	8	8	6	6	4	4	4	4	2
18 (60)	16	12	10	8	8	8	6	4	4	4	2	2	2
21 (70)	14	10	10	8	8	6	6	4	4	2	2	2	2
24 (80)	14	10	8	8	6	6	4	4	2	2	2	2	1
27 (90)	14	10	8	8	6	6	4	4	2	2	2	1	1
30 (100)	12	10	8	6	6	4	4	2	2	2	1	1	1/0
34 (110)	12	8	8	6	6	4	4	2	2	1	1	1/0	1/0
37 (120)	12	8	8	6	4	4	2	2	2	1	1/0	1/0	2/0
40 (130)	12	8	6	6	4	4	2	2	1	1	1/0	2/0	2/0
43 (140)	12	8	6	6	4	2	2	2	1	1/0	1/0	2/0	2/0
46 (150)	10	8	6	4	4	2	2	1	1	1/0	2/0	2/0	3/0
49 (160)	10	8	6	4	4	2	2	1	1/0	1/0	2/0	2/0	3/0
52 (170)	10	8	6	4	4	2	2	1	1/0	2/0	2/0	3/0	3/0

Table 12: AWG Conductor Sizes for a 3% Voltage Drop @ 12 Volts

Length meters (ft)	Current (amps)												
	5	10	15	20	25	30	40	50	60	70	80	90	100
10	18	14	12	12	10	10	8	8	6	6	6	4	4
15	16	12	10	10	8	8	6	6	6	4	4	2	2
20	14	12	10	8	8	6	6	4	4	4	2	2	2
25	14	10	8	8	6	6	4	4	2	2	2	1	1
30	12	10	8	6	6	4	4	2	2	2	1	1/0	1/0
40	12	8	6	6	4	4	2	2	1	1/0	1/0	2/0	2/0
50	10	8	6	4	4	2	2	1	1/0	1/0	2/0	3/0	3/0
60	10	6	6	4	2	2	1	1/0	2/0	2/0	3/0	3/0	3/0
70	10	6	4	2	2	2	1/0	2/0	2/0	3/0	3/0	4/0	4/0
80	8	6	4	2	2	1	1/0	2/0	3/0	3/0	4/0		
90	8	4	4	2	1	1/0	2/0	3/0	3/0	4/0			
100	8	4	2	2	1	1/0	2/0	3/0	4/0	4/0			
110	8	4	2	2	1	1/0	2/0	3/0	4/0				
120	6	4	2	1	1/0	2/0	3/0	4/0	4/0				
130	6	4	2	1	1/0	2/0	3/0	4/0					
140	6	2	2	1/0	2/0	2/0	3/0	4/0					
150	6	2	1	1/0	2/0	3/0	4/0						
160	6	2	1	1/0	2/0	3/0	4/0						
170	6	2	1	2/0	3/0	3/0	4/0						

Table 13: AWG Conductor Sizes for 10% Voltage drop @ 12 Volts

Wiring Recommendations

Most wiring problems arise due to loss of voltage as a result of the current demand on the system, corrosion which generates resistive connections, poor connections, or incorrect battery voltage, either high or low. Connecting the engine to a remote panel requires the correct wiring to minimize voltage drop and current resistance. This section will cover the engine/panel amperage requirements (current demand), wire routing and selection as well as wire harness assembly.

Current Demand:

Current demand in an electrical system is the current required to operate all the electrical devices connected to it. On an engine this includes, but is not limited to, the components listed in table 14

Device	Approximate Current Required
Warning Lamps	0.5 amps
Gauge Lamps	1.25 amps
Senders	0.2 amps
Intake heater module	0.5 amps
Heater contactors	1.5 amps
Fuel solenoid Hold coil	0.75 amps
Fuel solenoid Pull coil B&C	60 amps
Starter solenoid Pull in	97 amps
Air heater grid	100 amps
Starting motor C Series	1400 amps
Starting motor B Series	950 amps

Table 14: Current Requirements for Cummins Engines

To determine voltage drops due to these currents, the resistance of the wiring listed in table 15 will give a close approximation.

Wire Gauge	Resistance in Ohms per foot
18 AWG	0.006 ohm/foot
16 AWG	0.0041 ohm/foot
14 AWG	0.0026 ohm/foot
12 AWG	0.0017 ohm/foot
10 AWG	0.001 ohm/foot
8 AWG	0.0006 ohm/foot
6 AWG	0.0004 ohm/foot
4 AWG	0.00025 ohm/foot
2 AWG	0.00016 ohm/foot

Table 15: Resistance for AWG Wire Sizes

Remote Panels

Critical to the application is the distance the remote panel is from the engine. This requires close attention to the current requirements and the wire size of the extension harness. Cummins provides a harness for up to a 9 m (30') extension, do not join these together to make longer harnesses. ***THIS MUST NOT BE DONE!*** If an extension harness is needed which is longer than the standard 9 m (30'), a special harness should be made which will meet the guidelines shown in table 16:

Wire Color	Current in Wire	Max. allow. drop
Red	4.7 amps	0.3 volt
Purple	2.75 amps	0.2 volt
Black	1.75 amps	0.2 volt
Yellow/Red	1 amp	1 volt
All others	0.2 amp	0.2 volt

Table 16: Maximum Voltage Drops for AWG Wiring

If an extension harness is to be built, please use tables 12 and 13 to determine the correct wire size for the length of run.

The numbers given for current in the wires are based on today's components on the engine and in the panel. If the boat operator decides to connect his fish finder, radio, LORAN, etc., to the keyswitch, voltage drop will increase according to the current drawn by these devices. It will also adversely affect oil pressure and coolant temperature readings. ***Make sure that no accessory loads are wired to the engine control panel wiring!***

Connections and Corrosion

! All switch contacts (except start, stop, and keyswitch contacts) must be gold flashed.

Instrument panel gauges operate on relatively low current. Corrosion on contacts increases the resistance in the circuit. This can cause faulty gauge readings or no readings at all. Make sure all wiring and connections are supported and out of the bilge. Electrolysis will completely corrode away a connector pin if it is submerged in bilge water. In addition, the use of a wiring harness of the correct length will help to prevent corrosion problems. When wiring harnesses are daisy chained, each extra connection creates an inlet where corrosion can occur and interfere with the signal.

Any connections to the Cummins Marine supplied connectors or wiring harness, should be made corrosion resistant and weatherproof. The use of proper marine grade connectors is highly recommended.

The use of a light coating of Cummins DS-ES lubricant (PN 3822934) is recommended for all electrical connections

Grounding

! The cylinder block must be properly grounded.

Proper grounding is especially important on electronically controlled engines. The block, starter, and ECM should all be grounded directly to the battery. In addition, there should be a grounding cable from the starter to the engine block, and on twin engine applications there should also be a grounding cable from cylinder block to cylinder block (see figure 60). The grounding cables should be sized to carry the full cranking load of the starter. Make the terminals are clean and properly tightened

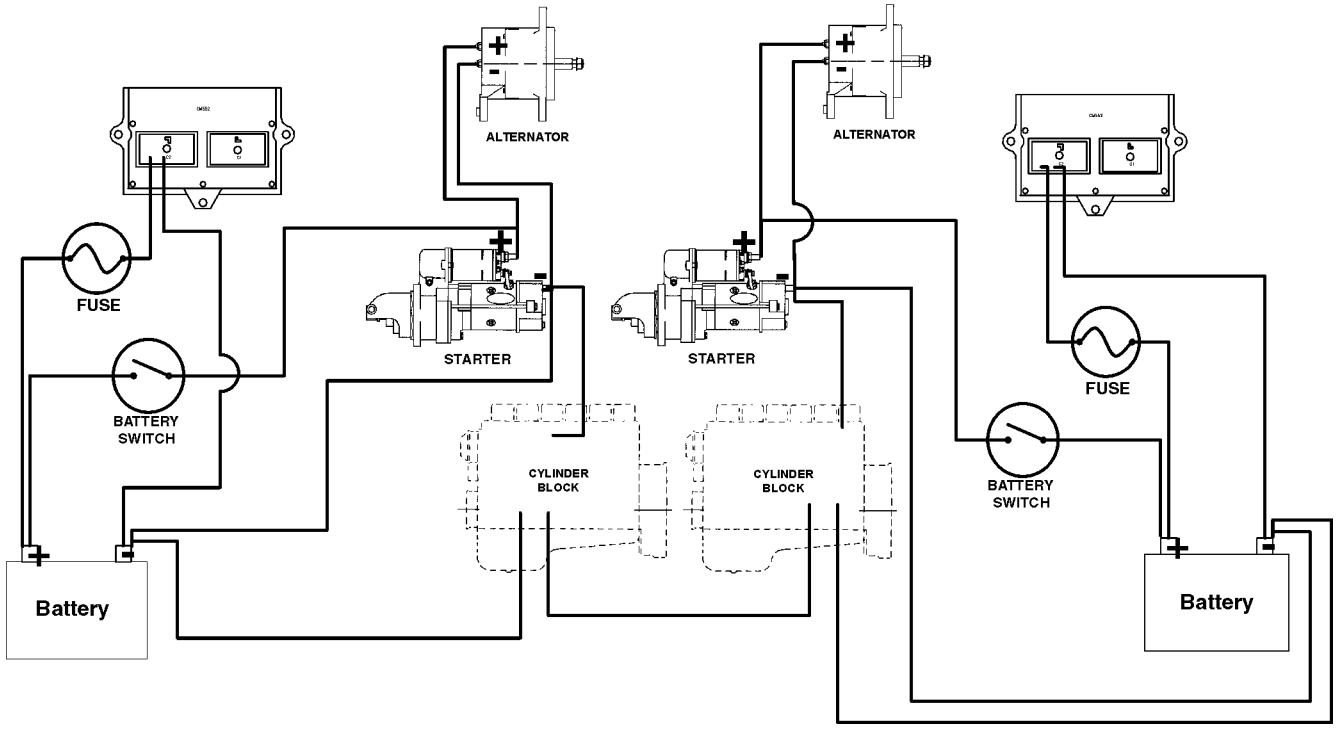


Figure 60: Engine Block Grounding

ECM Wiring Requirements

! Power interrupt during transition from key-on to crank mode must not exceed 80 milliseconds.

Cummins Marine uses a key switch to turn engine power on and a separate push button to crank the engine. If another manufacturer's key switch is used to crank the engine, the power interrupt from key-on to crank mode must be less than 80 milliseconds.

A power interrupt greater than 80 milliseconds will send reset commands and error codes to the ECM. These reset and error code commands will, in turn, result in hard starting.

! The ECM must be wired directly to the corresponding engine battery.

The ECM positive and negative power cables must be connected directly to the engine battery. This is done to maintain ECM voltage during cranking. If the ECM is wired to the starter or battery cables at the starter, low voltage during cranking will trigger ECM resets and/or fault codes which can affect starting. Do not wire the negative lead for the ECM to the engine block or starter post grounds.

Use the supplied dual cable wiring harness to connect the ECM to the engine starting battery (refer to"ECM Power Harness Connection" on page 61).

Connections and Corrosion

! All switch contacts (except start, stop, and keyswitch contacts) must be gold flashed.

The contacts of all customer supplied switches (except start, stop, and keyswitch contacts) must be gold flashed to carry the 10 mA current to the ECM. This will ensure system durability over the life of the equipment. Switches that contain contact material made of other metals will quickly oxidize and not be able to complete the circuit.

Instrument panel gauges operate on relatively low current. Corrosion and resistance can cause faulty gauge readings or no readings at all. Make sure all wiring and connections are supported and out of the bilge. Electrolysis will completely corrode away a connector pin if it is allowed to be submerged in bilge water.

Any connections to the Cummins Marine supplied connectors or wiring harness, should be made corrosion resistant and weatherproof. The use of proper marine grade connectors is highly recommended.

The use of a light coating of Cummins DS-ES lubricant (PN 3822934) is recommended for all electrical connections

Throttle Interface Requirements

! Twisted triple wires (at the rate of 1 twist per inch) must be used on throttle input wiring.

Any throttle hookups to the Cummins supplied power harness must be triple twisted. This will prevent RF noise from being transmitted into the ECM.

! The throttle interface must meet Cummins Marine requirements.

For the engine to operate properly, a specific throttle signal must be sent to the ECM. The throttle interface must comply with Cummins Engineering Standard (CES) 14118. It is critical with this engine or any electronically controlled engine to use a throttle capable of generating the correct signal. The following guidelines must be met to ensure the engine operates properly.

There are two types of throttles that can be used: electronic throttle controls or mechanical push pull cable controls. Mechanical throttles require the use of an electronic throttle potentiometer operated by the push pull cables to send the electronic signal to the ECM.

Electronic Throttle Controls

An electronic throttle control must be capable of generating a signal that the engine ECM can recognize and must comply with CES 14118. Cummins Marine is aware of two companies that currently meet this requirement. Twin Disc and Mathers offer systems that are compatible with the Cummins Marine ECM. Consult your local Twin Disc or Mathers Dealer for information on the application and installation of these systems.

△ CAUTION: Failure to comply with the recommendations may cause electronic fault codes, engine performance problems, or lack of engine control.

Failure to comply with the recommendations may cause electronic fault codes, engine performance problems, or lack of engine control. If there are any questions regarding the installation, please consult the control manufacturer, your local Distributor, or Marine Certified Application Engineer for assistance. Refer to the contact information in table 18.

Note: *Neither Twin Disc nor Mathers provide a wire harness to connect to the Cummins connector. Both systems require the installer to wire the controls to the ECM connector. Cummins Marine requires that the installer use the correct type connectors and proper wire size and twisted triple wires to make the connection. Follow the manufacturer's recommendation for wiring to the throttle. Additional information on specific connectors will be detailed in following sections.*

Mechanical Throttle Controls

Mechanical throttle controls can be used, but an electronic throttle potentiometer is required. The potentiometer must meet Cummins engineering standard CES 14118.

Mechanical throttle heads are used widely throughout the industry. There are many different manufacturers. It is important that the cable throw is compatible with the throw on the electronic throttle potentiometer. Since the engine ECM requires an electronic signal, it will be necessary to install an electronic throttle potentiometer between the throttle head and the engine connection. The location is up to the installer. The electronic throttle potentiometer must be capable of generating a signal that the engine ECM can recognize.

Cummins Marine offers a throttle potentiometer specifically designed as an interface between mechanical throttles and our electronically controlled engines. This allows for simple and economical installations using mechanical controls rather than more expensive electronic throttle controls. Wiring Harnesses will also be available in several lengths to be used with the Cummins Marine Throttle potentiometer.

For the installation instructions for the throttle potentiometer, please reference MAB No. 0.19.06 in the Cummins Marine Lotus Notes Database.

To make our calibration work with or without idle validation, we had to build in some dead band on the bottom end of the throttle sensor calibration. When using potentiometers to input the throttle signal you will need to adjust the minimum and maximum throttle potentiometer output to the **target** values listed in the Throttle Input Parameters listed in table 17. These values will minimize the required deadband, give some margin for voltage drift, and work without triggering throttle fault codes.

Electronic Marine Engine Throttle Input Parameters	
Minimum voltage error	<0.10 volts
Target minimum voltage	**0.95 volts**
Required minimum voltage	<1.00 volts
Throttle at 0%	1.27 volts
Throttle at 100%	3.93 volts
Target maximum voltage	**4.00 volts**
Maximum voltage error	>4.75 volts

Table 17: Electronic Throttle Input Parameters

The throttle potentiometer adjustment needs to be done with the throttle potentiometer connected to the engine wiring harness. To do this, you will need to make up a harness breakout connector or remove the pins from the connector for testing purposes.

Caution: If you remove the pins from the connector, use the appropriate Packard tool so the pins are not damaged. Damage to the pins could cause connection problems and possible loss of throttle control.

If there are any questions regarding installation, please consult the control manufacturer, your local Distributor, or Marine Certified Application Engineer for assistance. Refer to the contact information under the “Throttle Control Suppliers” section, below.

It is important to understand and comply with the manufacturer’s installation instructions regarding these components. Additional adjustment of the throttle potentiometer output may be required by the installer.

CAUTION: Unless specified by the supplier of the throttle interface, do not attach the throttle interface system to the engine. Vibration and/or environmental conditions may cause premature failure.

Throttle Control Suppliers

Table 18 provides contact information for the electronic and mechanical throttle controls described above.

Supplier	Telephone Contact	Internet Contact
Twin Disc	414/638-4000	http:\\www.twindisc.com
Mathers	360/757-6265	http:\\www.matherscontrols.com
Williams Controls	800/547-1889	http:\\www.wmcoind.com

Table 18: Throttle Control Supplier Contacts

Hour Meter

A functioning hourmeter must be installed.

Neutral Safety Lockout

Engine must not be able to start in gear.

Cummins Marine requires that the installer or vessel manufacturer provide a method for preventing the engine from starting in gear. Neutral safety lockout switches are available through gear and throttle suppliers. The engine will not crank unless a connection is supplied (see “Neutral Safety Switch Connector” on page 63)

Electrical and Electronic Installation Information

Engine Power Harness

The engine power harness provides easy connection to the ECM by using common connectors. The engine power harness provides terminals for connections to the engine, including ECM power, idle validation, J1939 data link, throttle input, neutral safety switch, engine synchronization, and an extension harness connection for gauges (see figures 61 and 62). The 40-pin connector for instrument and helm accessories will be detailed in “Instrument Panels, Switch Panels, and Wiring” later in this section.

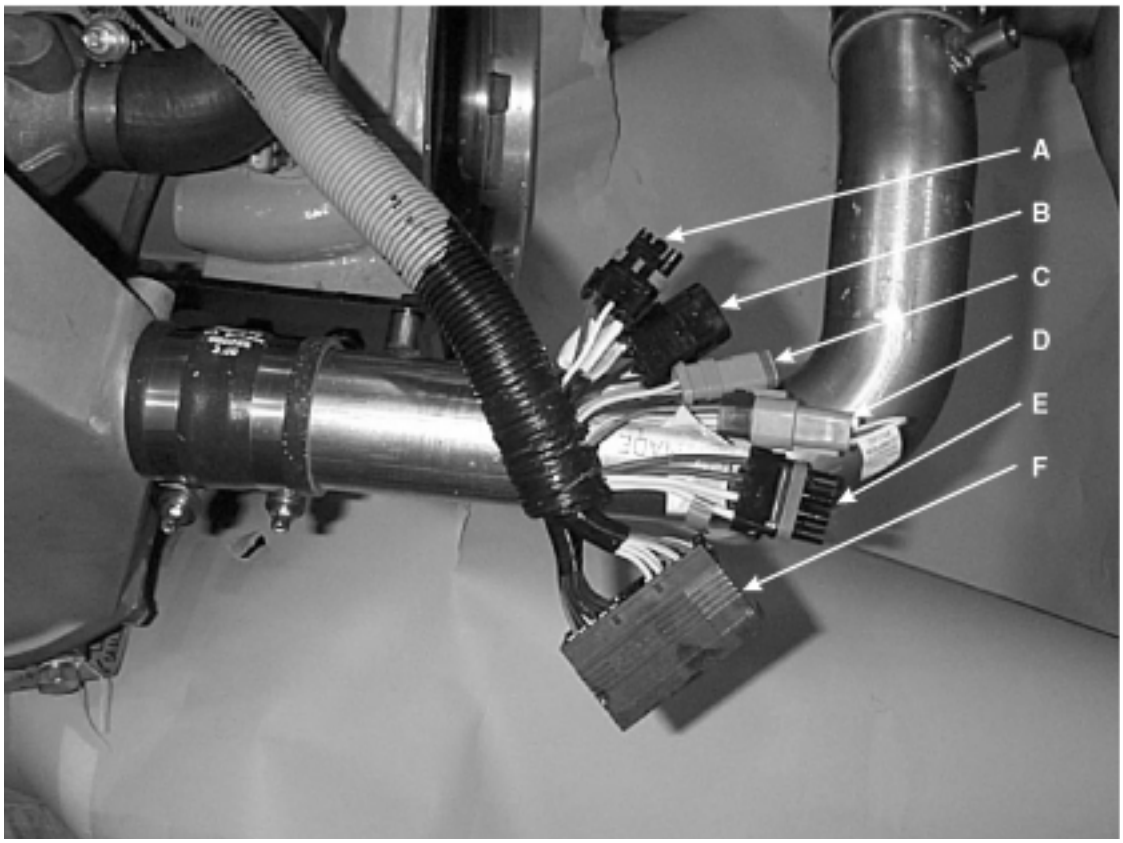


Figure 61: Electronic Engine Power Harness Connectors

Legend

A = Throttle Input	D = Neutral Safety Switch Input
B = Idle Validation	E = ECM Power
C = J1939 Data Link	F = 40-pin Engine Harness Connection

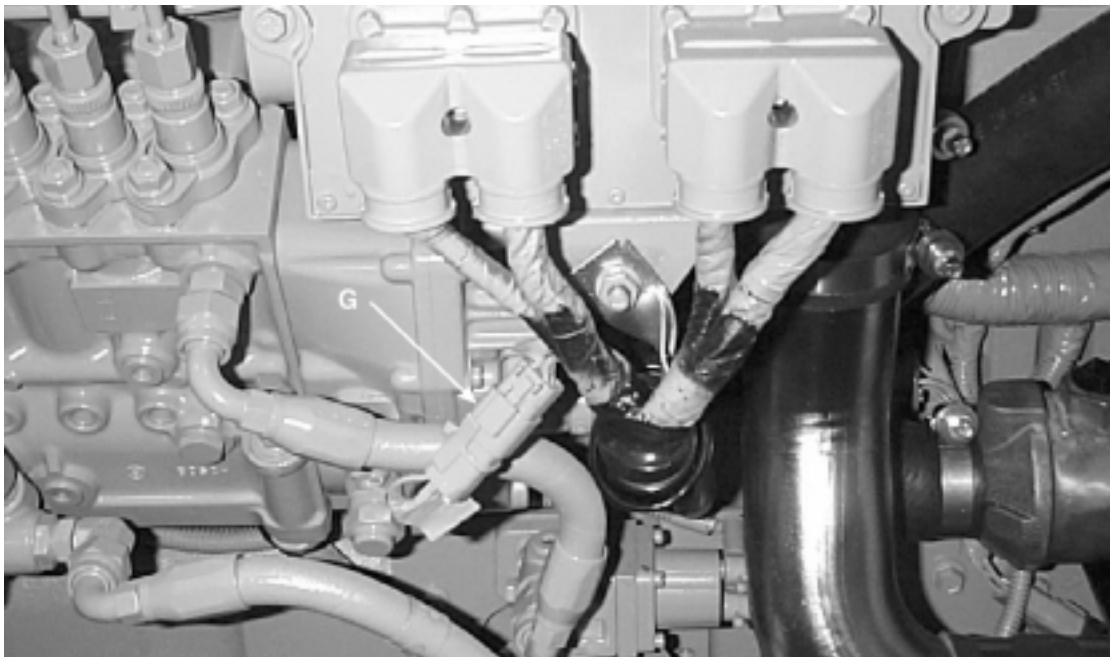


Figure 62: Engine Synchronization Connection

Legend

G = Master/Slave Connector

Cummins Marine recommends designing the appropriate harnesses with the mating connectors capable of attaching directly to the engine wiring harness connectors. These connectors are corrosion resistant and weatherproof. Do not cut the connectors from the wiring harness.

Reference the engine wiring diagram and the component manufacturer's wiring diagram before attaching components to the engine.

ECM Power Harness Connection

The ECM power harness connector is a 4-pin Weather-Pak plug (see figure 63). The corresponding 4-pin Weather-Pak receptacle (Cummins P/N 3823341) is attached to the battery wiring harness supplied with the engine.

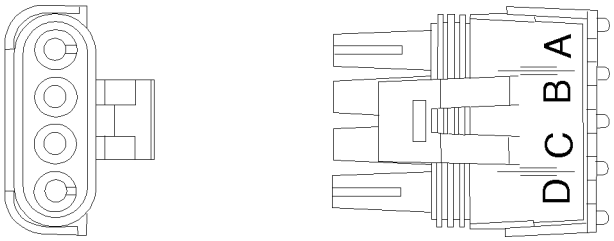


Figure 63: ECM Power Harness Connector

One end of each ECM cable is fitted with a Weather-Pak 4-pin receptacle (see figure 64) to plug into the corresponding power supply connector for the ECM, which is a Weather-Pak 4-pin plug (see figure 63). The other end of each cable is bare to allow the installer to add the correct connections to the battery posts. The battery post leads should be sealed and corrosion resistant. Note that each positive power lead contains a fuse within 180cm (72") of the bare ends to meet ABYC recommendations. (Consult local regulations if other than ABYC.) Cummins Marine recommends that the installer not revise the wiring length due to these requirements. If a shorter run is required, bundle the wire. If longer cable runs are required, it is imperative that the installer selects the correct size wire for the length used. Consult your local Cummins Certified Marine Application Engineer for assistance.

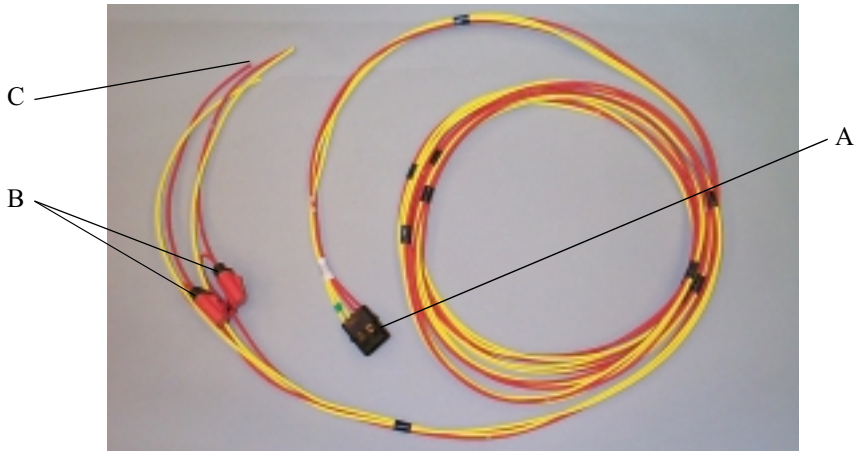


Figure 64: ECM Power Connection Harness

Legend

A = 4-Pin Receptacle
B = 10 Ampere Fuses
C = Bare Wire Ends for Connection to Battery

Idle Validation Connector (One Per Engine)

Cummins provides a 3-pin Weather-Pak receptacle in the event your throttle uses idle validation (see figure 65). Not all throttles use this feature. If your throttle does not specify idle validation, there is no need to connect anything to this plug. If your throttle does recommend or require the use of idle validation, you must connect to the engine harness with a 3-pin Weather-Pak plug (Cummins P/N 3823340). To install the idle validation, consult the throttle directions of the throttle supplier in conjunction with the Cummins wiring diagram.

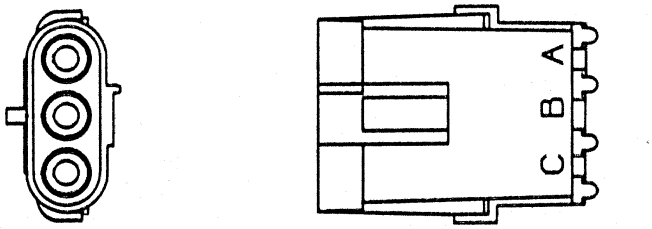


Figure 65: Idle Validation Switch Connector

J1939 Connector

This is a 3-pin triangular Deutsch plug (see figure 61 for location and figure 66 for profile). There is no connection made to this plug, but there is a termination resistor installed in the plug. **Do not remove the resistor.** Tuck the plug behind the harness and out of the way.

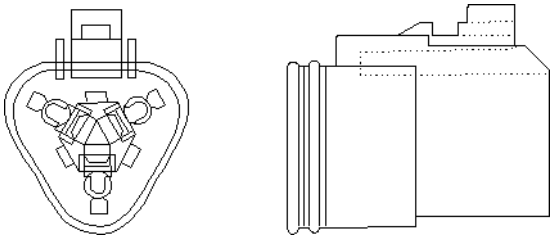


Figure 66: J1939 Connector

Throttle Input Connector (One Per Engine)

The engine harness provides a 3-pin Weather-Pak plug (see figure 67). You will need to wire a 3-pin Weather-Pak receptacle (Cummins P/N 3823339) to your throttle head (throttle potentiometer, etc.).

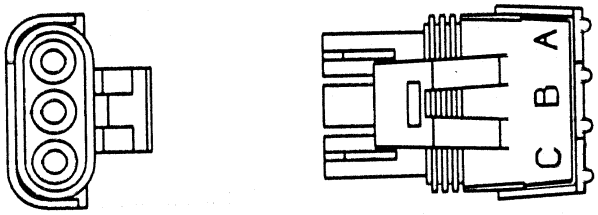


Figure 67: Throttle Connector

Neutral Safety Switch Connector (One Per Engine)

The connection is a 3-pin triangular Deutsch plug (see figure 68). The engine will not start without a connection to this plug. The corresponding 3-pin Deutsch receptacle (Cummins P/N 3824291) is supplied with the engine and wire-tied to the harness. The receptacle has a jumper wire installed for testing purposes (see figure 69). When wiring a neutral safety switch, remove the jumper wire from the receptacle and insert the corresponding wires from the neutral safety switch into the receptacle.

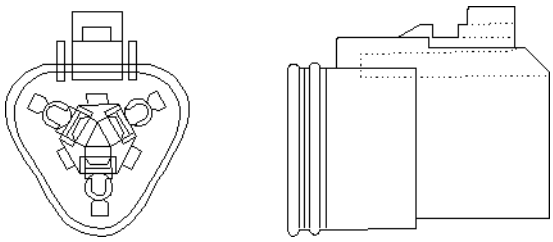


Figure 68: Neutral Safety Connector

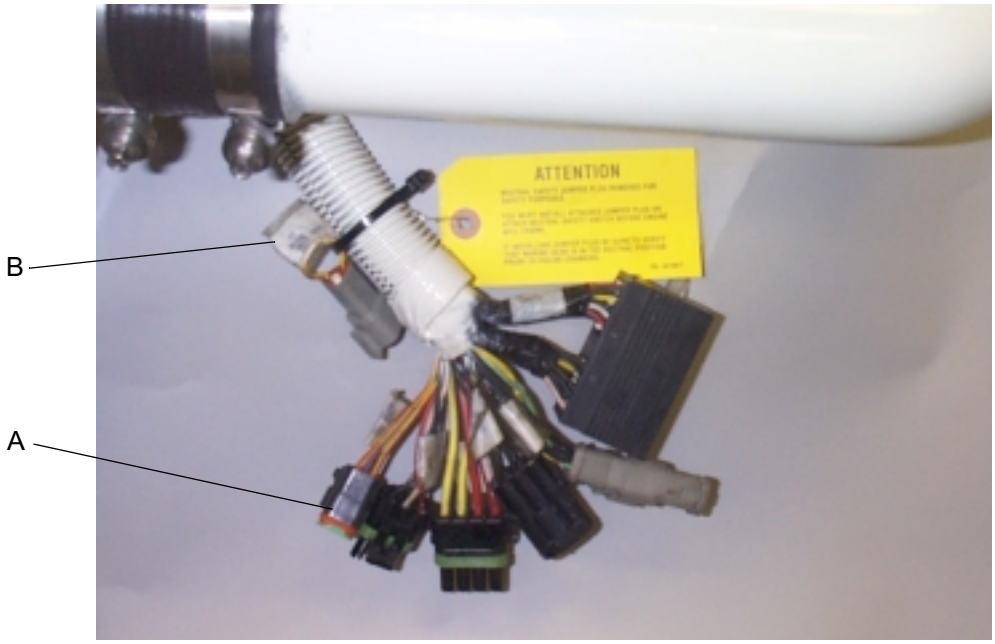


Figure 69: Neutral Safety Connection Location

Legend

A = Neutral Safety Switch Connection

B = Mating Connector with “Test” Jumper Installed

Multi-Engine Synchronization Connection (Not Used on Single Engine Applications)

Multi Engine Synchronization is used in dual engine applications, but only if the engines were ordered with the C-Cruise option package. Dual engine synchronization requires one engine to be identified as the master engine and the other must be identified as a slave engine. This will determine which throttle lever will be used when using the synchronization feature. The wiring harness is equipped with a Deutsch 4-pin plug (see figure 70). All engines come with the standard “master” receptacle installed over the plug (see figure 71). Decide which engine is to be the slave engine (usually port). Remove the “master” receptacle from this engine, and replace it with a “slave” receptacle. The “slave” receptacle is shipped with the C-Cruise option, packaged with the control panel. So, in a dual engine package with the C-Cruise option, one engine will need the “master” engine connector, and one will need the slave engine connector installed.

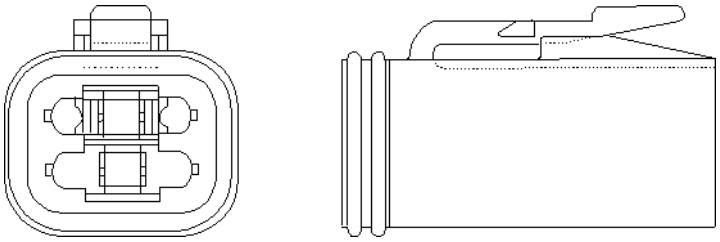


Figure 70: Master/Slave Connector

Figure 71: Dual Engine Synchronization Connectors (As Shipped on All Engines)

Legend

A = Master/Slave Connector

Do not remove the jumper wire from either the master or slave connector or an engine fault code will appear.

Instrument Panels, Switch Panels, and Wiring

All Instrument panels, switch panels and wiring, whether supplied by Cummins Marine or not, must be connected to the engine via the remote mounted 40-pin connector located at the end of the engine power harness (see figure 72). The connector is located on the fuel pump side, behind the aftercooler towards the rear of the engine as showin in Figure 72.

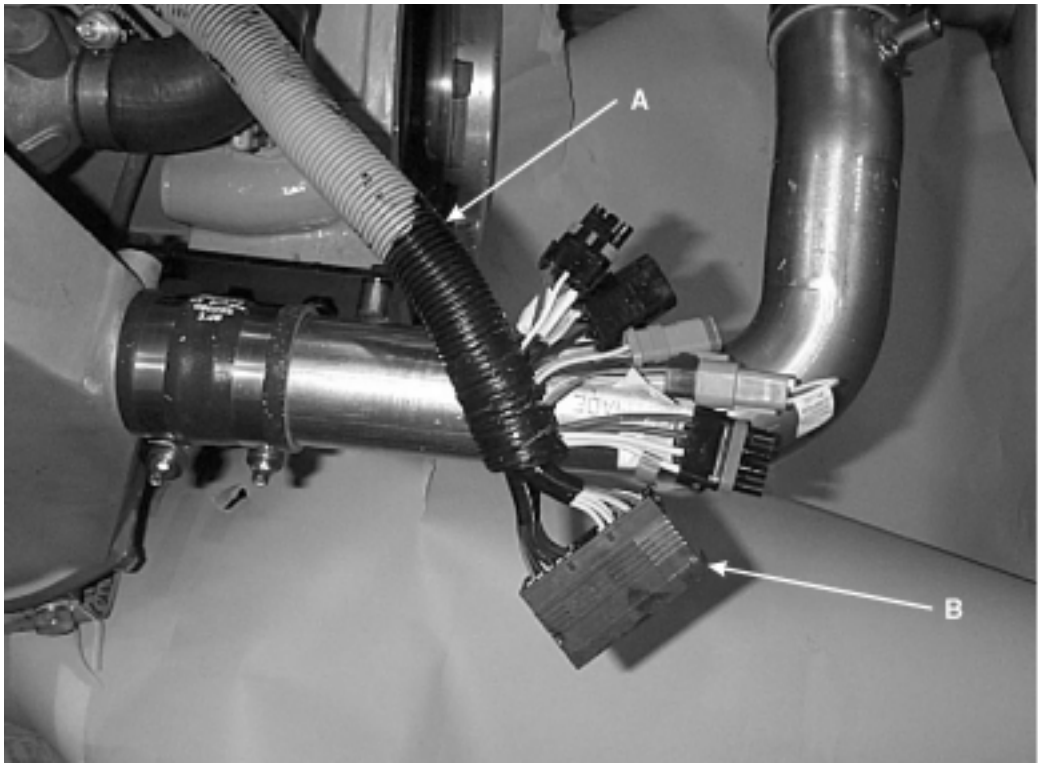


Figure 72: Engine Power Harness and Remote 40-Pin Connector

Legend

A = Engine Power Harness B = Remote 40-Pin Connector

The engine extension harness will connect all panels and display hardware to the remote mounted 40-pin connector.

Cummins Marine offers a full line of panels, switches, and harnesses with plug-in capability for single or dual engines and single or dual stations. There are several instrument and wiring options available. Twin engine applications use different switch panels than single engine applications and primary station panels differ from second station panels. It is important to first define which location will be the primary station in a dual station application. The backup throttles connect only to the primary station. The secondary station can support an instrument panel, engine control panel, and a data display.

Be sure you have the correct parts before installing them. When installing panels, Cummins Marine recommends the use of a marine sealant between the helm face and panel to minimize component moisture exposure.

Installation instructions are contained in the following engine and station combinations:

- Single Engine/Single Station
- Single Engine/Dual Station
- Dual Engine/Single Station
- Dual Engine/Dual Station

Single Engine, Single Station

The schematic in figure 73 shows the wiring and component layout for single engine, single station installation.

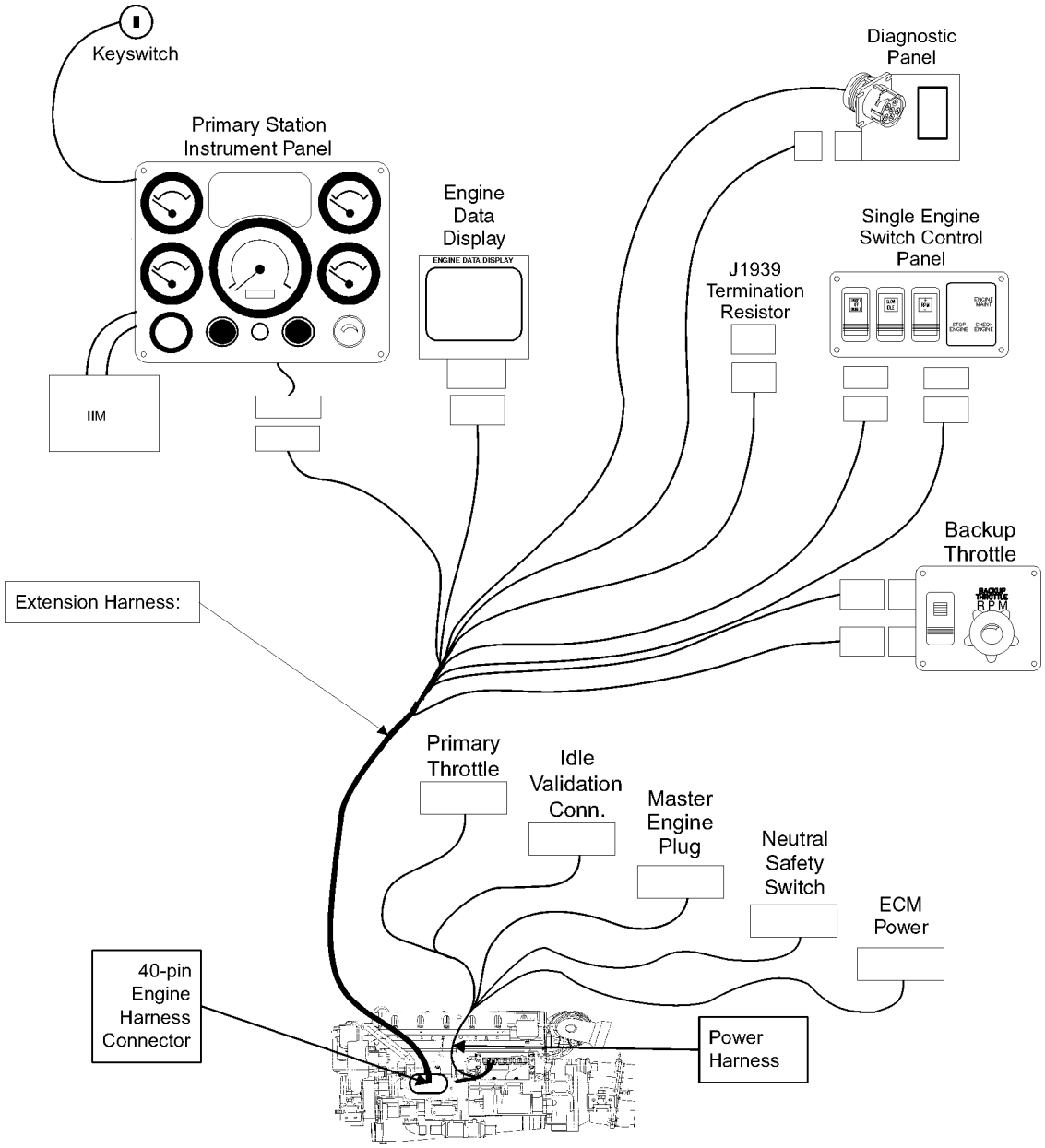


Figure 73: Single Engine, Single Station Wiring Harness

Engine Extension Harness

The extension harness 40-pin plug assembles to the remote Marine 40-pin receptacle located on the fuel pump side of the engine, below and forward of the engine ECM (see figure 72). The extension harness is available in lengths of 3m (10’), 6m (20’), 12m (40’), and 18m (60’). The other end of the harness provides connections for the Diagnostic Panel, Primary Instrument Panel, Engine Data Display, Engine Switch Control Panel, and Backup Throttle, which will be discussed in detail below.

Diagnostic Panel

The Diagnostic Panel consists of a rocker selector switch and a diagnostic port (see figure 74). The panel incorporates a 4-pin Deutsch receptacle (see figure 75) that mates with a corresponding 4-pin plug in the harness. The round Deutsch 9-pin diagnostic tool receptacle is hardwired into the extension harness. This connector must be attached to the diagnostic panel with the accompanying hardware. The panel installation location is at the discretion of the installer, but must be accessible to the technician and have a minimum of at least 150mm (6") of clearance in all directions for the corresponding diagnostic tool harness. The panel face dimensions measure 90mm (3.5") in width (horizontal) x 75mm (3.0") in length (vertical).

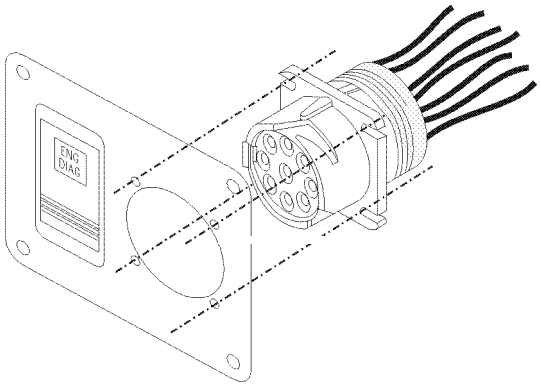


Figure 74: Engine Diagnostic Switch Panel (foreground) and Diagnostics Connector (background)

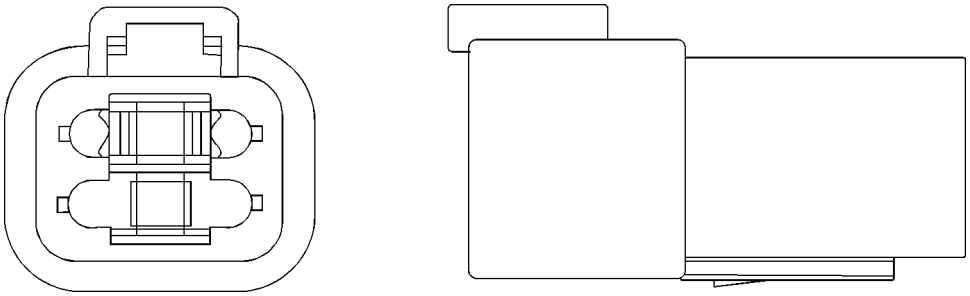


Figure 75: Diagnostic Switch Connector

Primary Instrument Panel

This panel consists of electrically driven analog gauges as well as an Instrument Interface Module (IIM) and is 190mm (7.5") tall x 240mm (9.5") wide. The panel requires the IIM to convert the digital signals from the ECM to drive the gauges and warning lights. The instrument panel has two connectors that plug into the IIM: a 23-pin AMP Instrument Panel plug (see figure 76) and a 4-pin Deutsch plug (see figure 77). The Primary Instrument Panel is wired with a Deutsch 12-pin plug, which connects to the corresponding 12-pin Deutsch receptacle in the engine extension harness (see figure 78).

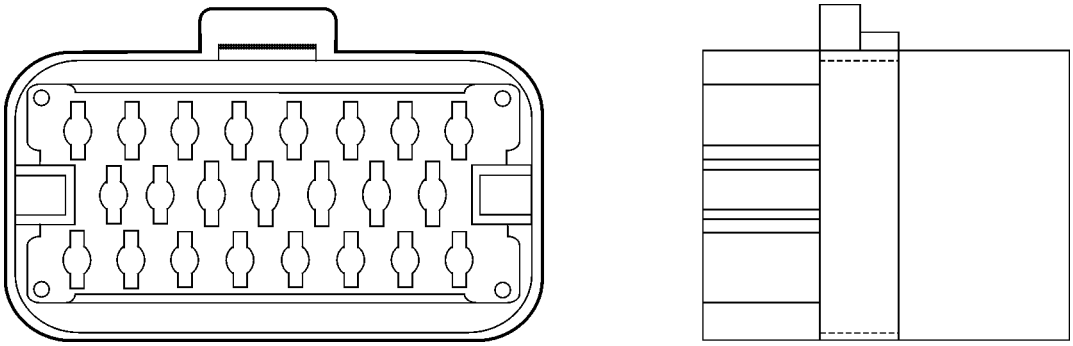


Figure 76: Instrument Panel to IIM Connector

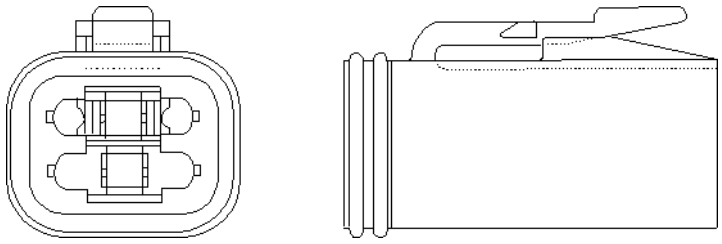


Figure 77: Instrument Panel to IIM Connector

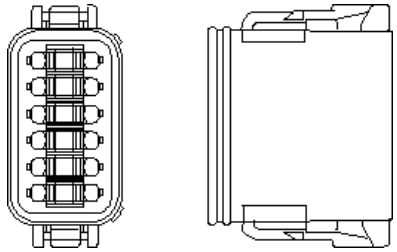


Figure 78: Instrument Panel to Extension Harness Connector

Keyswitch

The Instrument panel will also come with a keyswitch. The keyswitch is not installed into the panel and can be placed at the installer's discretion. The keyswitch wiring has a length of 600mm (24").

Engine Data Display

The Engine Data Display is a user programmable LCD used to display engine data. The display face dimensions measure 110mm (4.33") square. An installation template is shipped with the display (see figure 79).

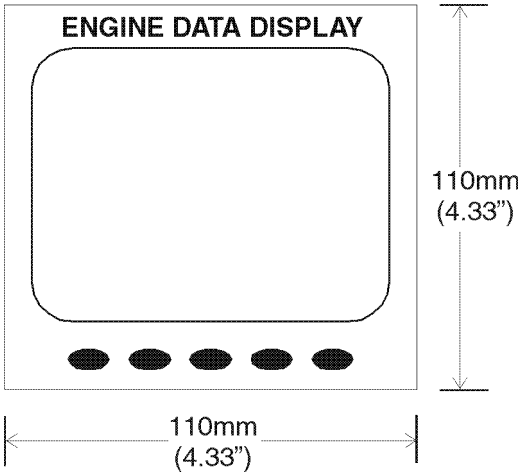


Figure 79: Engine Data Display

The engine data display is wired with a 6-pin Deutsch receptacle (see figure 80), which connects to a 6-pin Deutsch plug on the wiring harness.

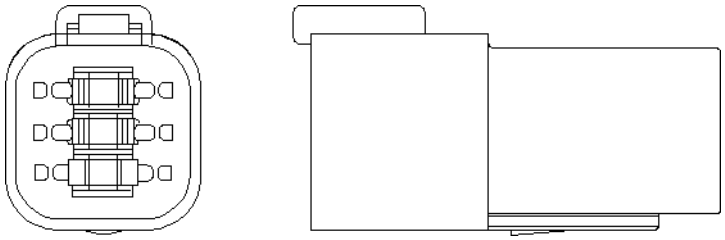


Figure 80: Engine Data Display Connector

Engine Switch Control Panel—Primary Station

The Engine Switch control panel consists of a set of 3 rocker switches and a single set of warning lights (see figure 81). This panel has two connections: one 12-pin Deutsch receptacle (figure 82) and one 6-pin Deutsch plug. These connectors mate with the corresponding connectors on the extension harness. This panel measures 75mm (3.0") in length (vertical) x 150mm (6.0") in width (horizontal).

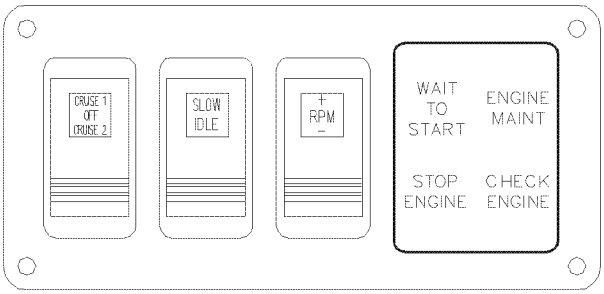


Figure 81: Engine Switch Control Panel

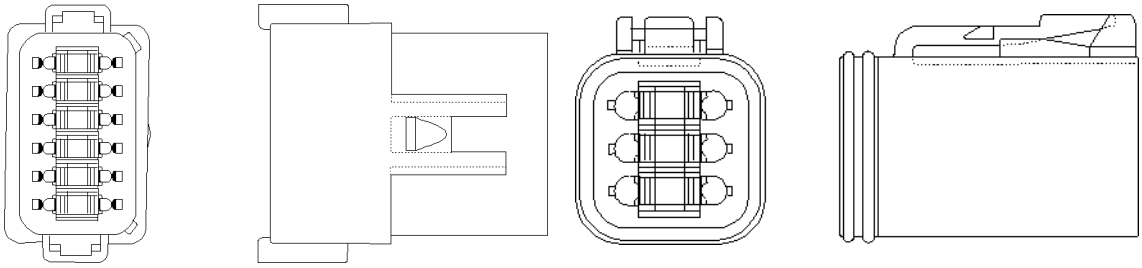


Figure 82: Switch Control Panel Connectors

Backup Throttle Switch Panel

The Backup Throttle Panel (shown in figure 83) consists of a rocker switch with lockout and remote throttle control head. The panel is supplied with a 3-pin Packard Weather-Pak receptacle (see figure 84) for the remote throttle and

a 2-pin Deutsch receptacle (see figure 85) for the switch. The panel dimensions measure 95mm (3.75") in length (vertical) x 115mm (4.5”) in width (horizontal).

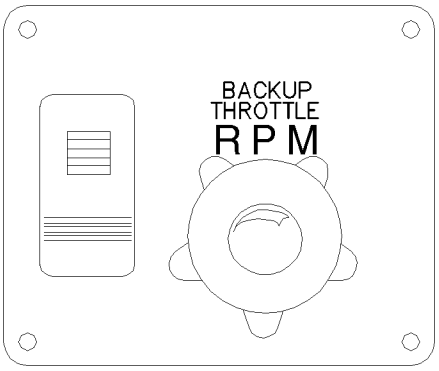


Figure 83: Single Engine Backup Throttle Panel

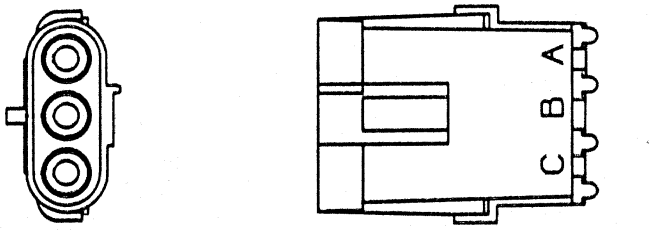


Figure 84: Backup Throttle Switch Connector

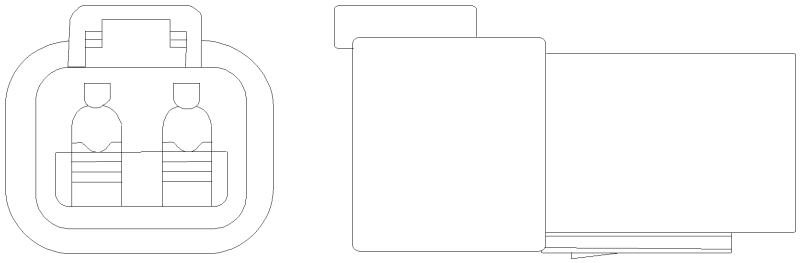


Figure 85: Backup Throttle Input Connector

NOTE: *The 3-pin plug on the extension harness comes with a backup throttle termination connector installed in the harness. When a backup throttle panel is installed, the termination connector must be removed from the extension harness. The extension harness should then be attached to the remote throttle receptacle. If the optional backup throttles are not used, the termination connector must remain plugged into the extension harness.*

Single Engine, Dual Station

The schematic in figure 86 shows the wiring harness and connections for a single engine, dual station installation. Note that, with a dual station vessel setup, the primary station is the same as described for the single station setup with the addition of a primary station select switch. An instrument/display Y-harness will be needed to connect to the second station. The second station setup will consist of the Engine Data Display, Instrument Panel, Switch Control Panel, and Station Select Switch.

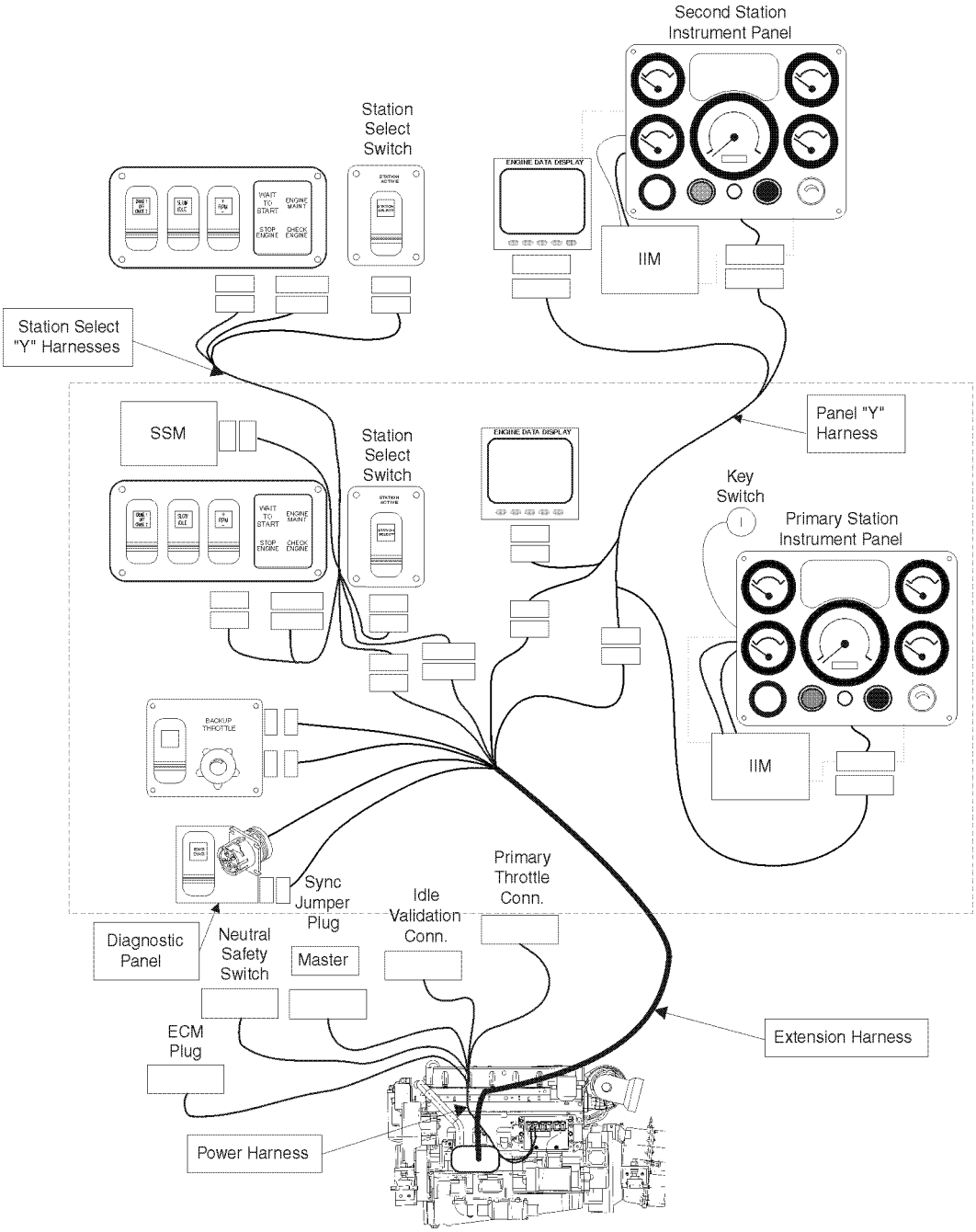


Figure 86: Single Engine, Dual Station Wiring Harness and Connectors

Instrument/Display Y-Harness Installation

A dual station installation requires an instrument/display Y-harness to connect the second station display and instrument panel. The instrument/display Y-harness can be obtained in 6m (20'), 12m (40'), and 18m (60') lengths.

The instrument/display Y-harness consists of four connectors at the primary station end and two connectors at the secondary station end. The four instrument/display Y-harness connectors at the primary station connect between the engine extension harness and the primary instrument panel and between the engine extension harness and the primary engine data display, if ordered (see connector descriptions in the instrument panel and engine display section below). Attach the 12-pin Deutsch connectors of the Y-harness between the 12-pin connector of the primary instrument panel and the 12-pin connector of the engine extension harness. Do the same for the 6-pin data display panel, if used.

NOTE: *If an instrument panel is not used at the second station, but is used at the primary station, do not use the Y--harness to connect the main engine extension harness to the instrument panel. Otherwise, the engine will not function due to an open loop in the ignition wiring.*

Second Station Instrument Panel

The second station instrument panel is the same as the primary instrument panel with the exception of the key-switch. The second station instrument panel requires its own IIM and has two plugs for connectors: a 23-pin AMP Instrument Panel plug (see figure 87) and a 4-pin Deutsch IMM plug (see figure 88). The Primary Instrument Panel is also wired with a Deutsch 12-pin plug, which connects to the corresponding 12-pin Deutsch receptacle in the Y-harness (see figure 89).

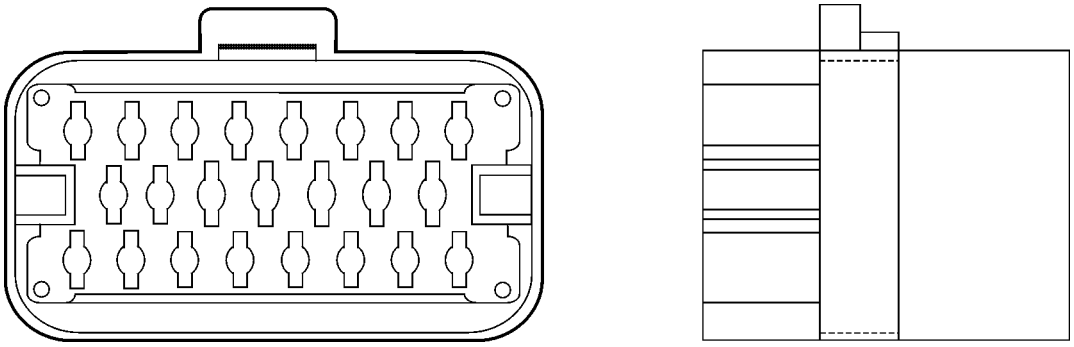


Figure 87: Instrument Panel to IIM Connector

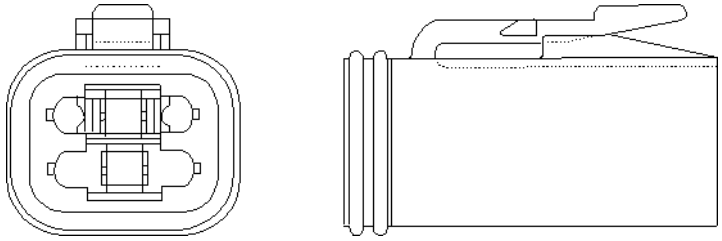


Figure 88: Instrument Panel to IIM Connector

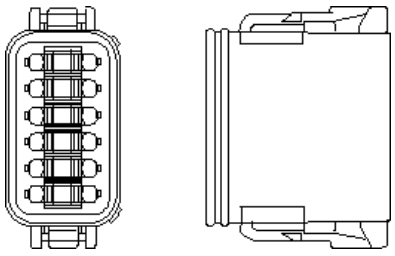


Figure 89: Instrument Panel to Extension Harness Connector

Second Station Engine Data Display

The second station engine data display and its connector is the same as the primary engine data display and connector (described under the single engine, single station section, above). The display face dimensions measure 110mm (4.33”) square (see figure 90). An installation template is shipped with the display

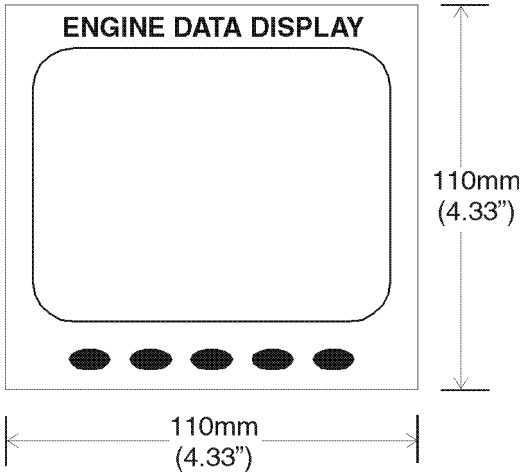


Figure 90: Engine Data Display

The engine data display is wired with a 6-pin Deutsch receptacle (see figure 91), which connects to a 6-pin Deutsch plug on the Y-harness.

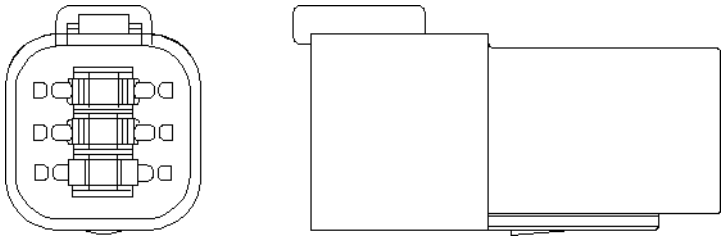


Figure 91: Engine Data Display Connector

Station Select Package

Adding a switch control panel to a second station requires a slight modification of the primary station installation. If two switch control panels are to be used (upper and lower stations) a station select switch must be installed at each station to activate the switch control panel at the station you are operating from. The station select package requires a station select Y-harness, a primary station switch control panel, a primary station select switch, a second station switch control panel, and second station select switch.

Station Select Y-Harness

A station select Y-harness consists of seven Deutsch connectors and a power wire at the primary station end (see figure 92) and four Deutsch connectors at the second station end (see figure 93).

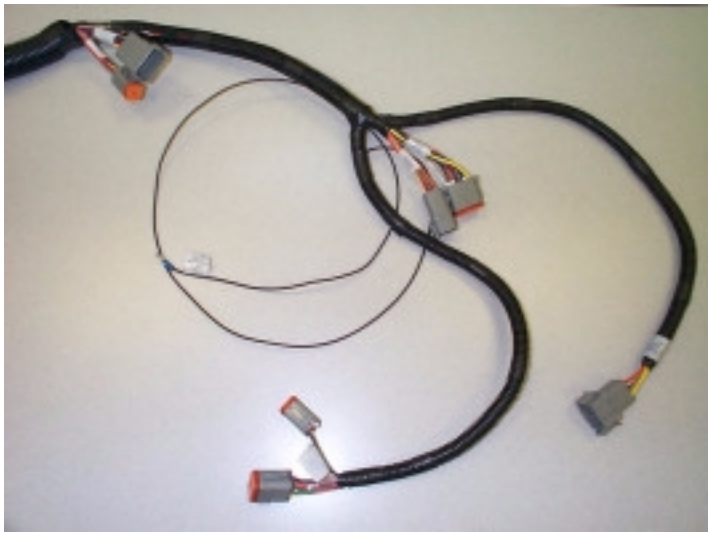


Figure 92: Station Select Y-Harness—Primary Station End

Figure 93: Station Select Y-Harness—Second Station End

NOTE: If necessary, disconnect the extension harness from the primary station switch control panel connector.

At the primary station, connect the 12-pin Deutsch plug and the 6-pin Deutsch receptacle from the engine extension harness (see figure 94) into the mating connections on primary station switch control panel. Connect the 12-pin Deutsch receptacle and 6-pin Deutsch plug on the station select Y-harness (see figure 95) to the mating connectors on the extension harness. Both connectors on the station select Y-harness are labeled **"To Extension Harness"**.

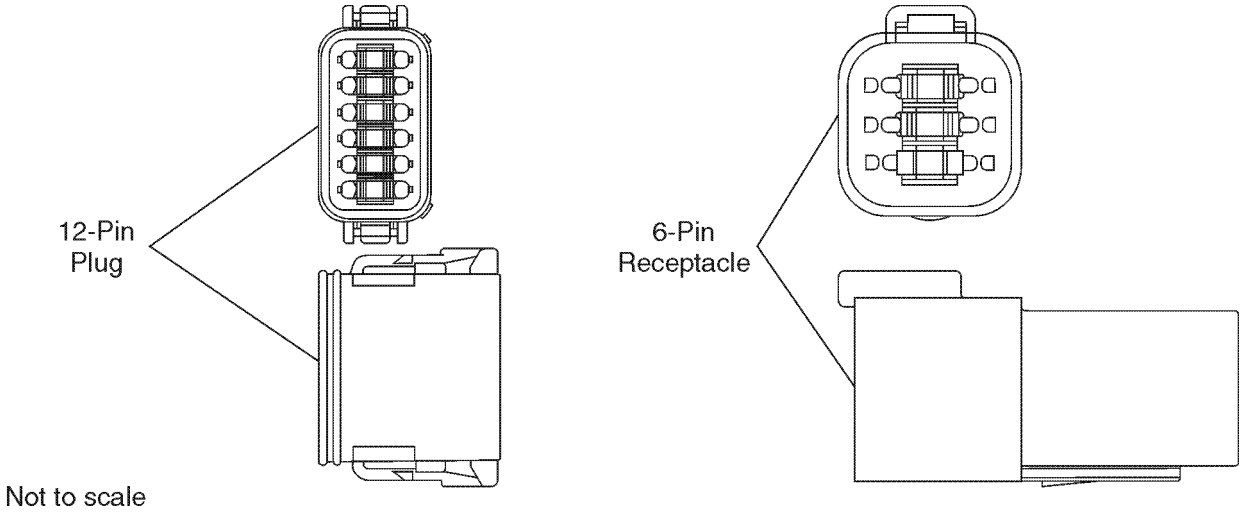


Figure 94: Connections at Extension Harness

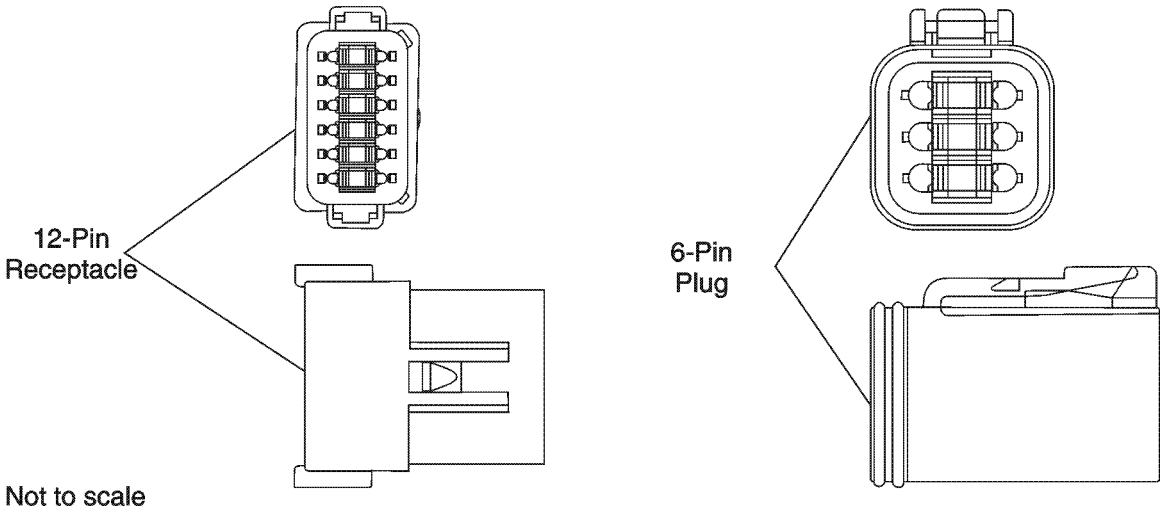


Figure 95: Connections at Station Select Y-Harness

Engine Switch Control Panel—Primary Station

The Engine Switch control panel consists of a set of 3 rocker switches and a single set of warning lights (see figure 96). This panel has two connections: one 12-pin Deutsch receptacle and one 6-pin Deutsch plug (see figure 97). These connectors mate with the corresponding connectors on the extension harness. This panel measures 75mm (3.0") in length (vertical) x 150mm (6.0") in width (horizontal).

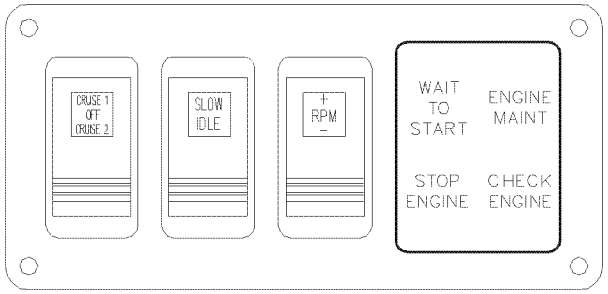


Figure 96: Engine Switch Control Panel

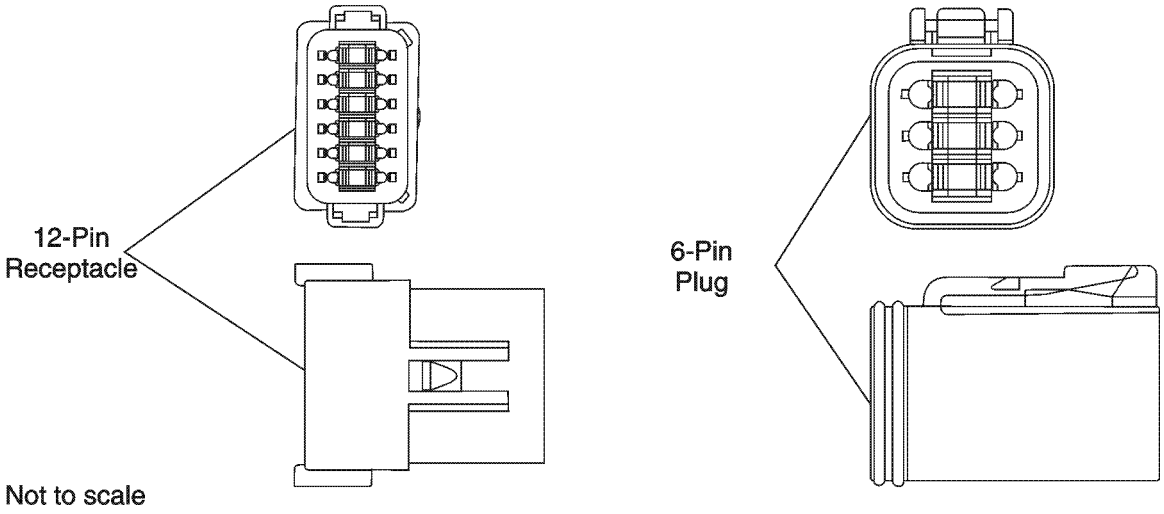


Figure 97: Connector—Station Select Switch

Station Select Switch—Primary Station

If two switch control panels are used (upper and lower stations) a station select switch (see figure 98) must be installed at each station to activate the switch control panel at the station you are operating from. The station select switch has a short harness with an 8-pin Deutsch plug (see figure 99). Connect the 8-pin Deutsch plug from the station select switch control panel to the 8-pin Deutsch receptacle (see figure 100) on the Station Select Y-harness labeled **"Main Station Select Panel"**.

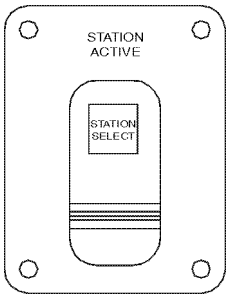


Figure 98: Station Select Switch

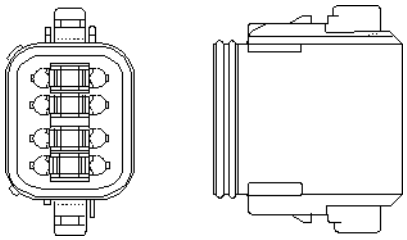


Figure 99: Station Select Switch Harness Connector

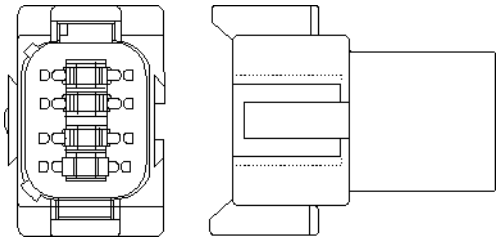


Figure 100: Station Select Y-Harness Connector

Station Select Module

The station select module is the brain of the station select system. The operator selects the station by depressing the station select switch. The station select module contains a processor that directs the inputs from the switch control panel to the ECM. The module is equipped with integral Deutsch connectors: one 8-pin receptacle and one 6-pin receptacle (see figure 101).

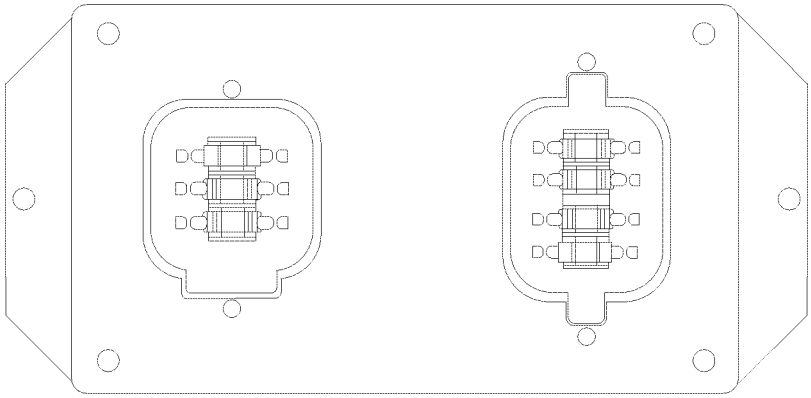


Figure 101: Station Select Module

Connect the 6-pin Deutsch plug from the station select Y-harness labeled **"Station Select Module Port Single Engine Only"** to the 6-pin receptacle on the station select module. Connect the 8-pin Deutsch plug from the station select Y-harness labeled **"Station Select Module Starboard"** to the 8-pin receptacle on the station select module (see figure 102).

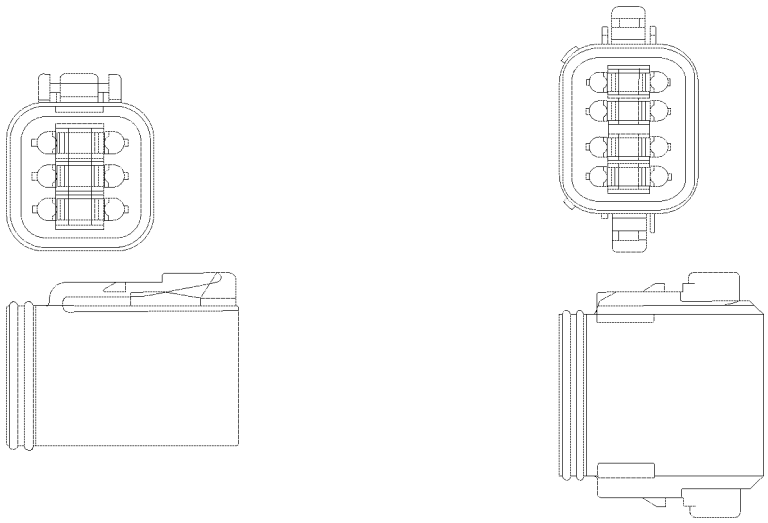


Figure 102: Station Select Module Connectors from Station Select Y-harness

Harness Power Wire

The station select Y-harness contains a separate wire with a No 8 size ring terminal (see figure 103). Connect this power lead to the battery side (unswitched) power supply to the key switch.

Figure 103: Station Select Y-Harness—Unswitched Power Connection

Engine Switch Control Panel—Second Station

The Engine Switch control panel consists of a set of 3 rocker switches and a single set of warning lights (see figure 104). This panel has two connections: one 12-pin Deutsch receptacle and one 6-pin Deutsch plug (see figure 105). These connectors mate with the corresponding connectors on the extension harness. This panel measures 75mm (3.0") in length (vertical) x 150mm (6.0") in width (horizontal).

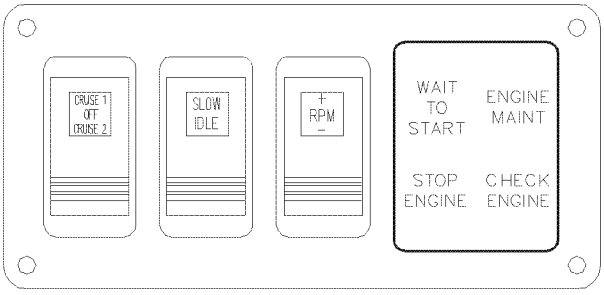


Figure 104: Engine Switch Control Panel

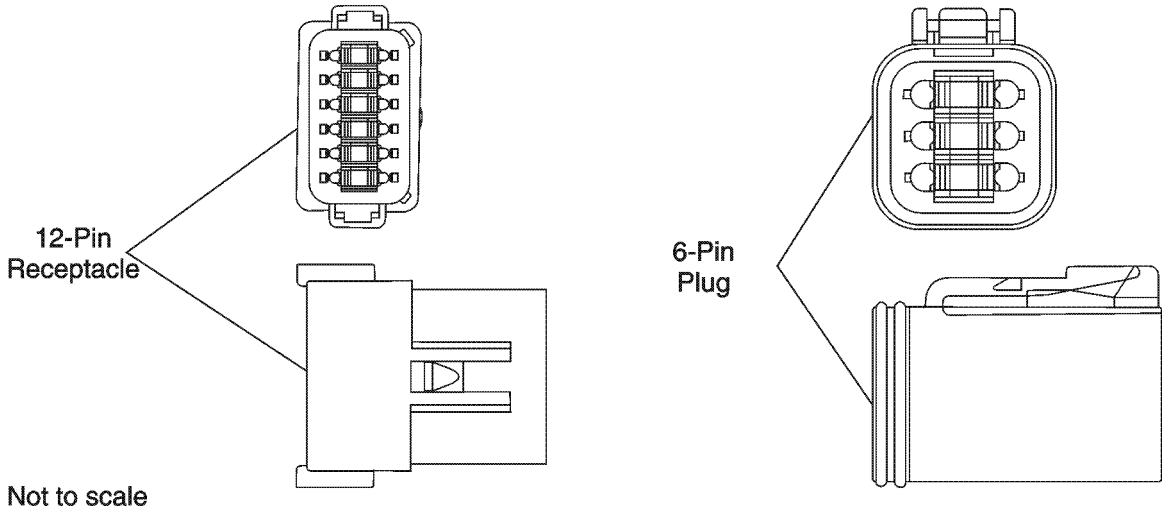


Figure 105: Connector—Station Select Switch

Station Select Switch—Second Station

If two switch control panels are used (upper and lower stations) a station select switch (see figure 106) must be installed at each station to activate the switch control panel at the station you are operating from. The station select switch has a short harness with an 8-pin Deutsch plug (see figure 107). Connect the 8-pin Deutsch plug from the station select switch control panel to the 8-pin Deutsch receptacle (see figure 108) on the Station Select Y-harness labeled **"Main Station Select Panel"**.

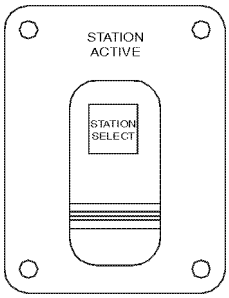


Figure 106: Station Select Switch

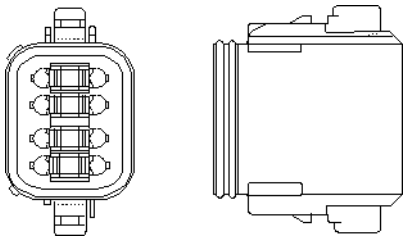


Figure 107: Station Select Switch Harness Connector

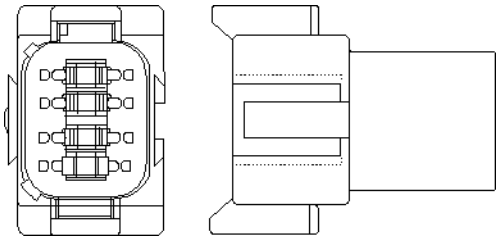


Figure 108: Station Select Y-Harness Connector

Dual Engine, Single Station

The schematic in figure 109 shows a Dual Engine, Single Station wiring and component layout installation.

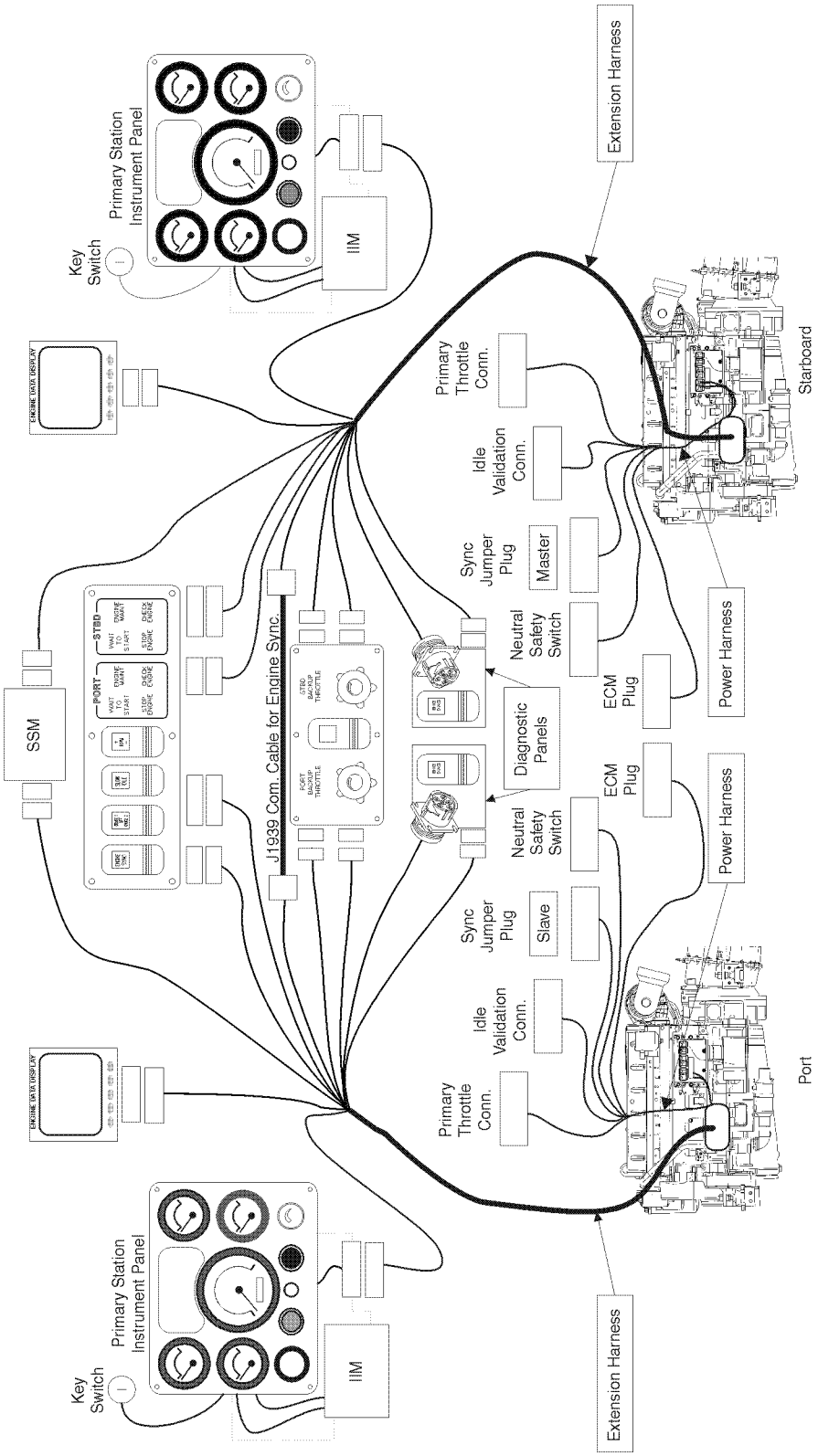


Figure 109: Dual Engine, Single Station Wiring Harness and Connections

Main Engine Extension Harness (One Per Engine)

The extension harness 40-pin plug assembles to the 40-pin receptacle located on the fuel pump side of the engine below and forward of the engine ECM. The extension harness is available in lengths of 3m (10'), 6m (20'), 12m (40'), and 18m (60'). The other end of the harness provides connections for the Diagnostic Panel, Primary Instrument Panel, Engine Data Display, Engine Switch Control Panel, and Backup Throttle, which will be discussed in detail below.

Diagnostic Panel (One Per Engine)

The Diagnostic Panel consists of a rocker selector switch and a diagnostic port (see figure 110). The panel incorporates a 4-pin Deutsch receptacle (see figure 111) that mates with a corresponding 4-pin receptacle in the harness. The round Deutsch 9-pin diagnostic tool receptacle is hardwired into the extension harness. This connector must be attached to the diagnostic panel with the accompanying hardware. The panel installation location is at the discretion of the installer, but must be accessible to the technician and have a minimum of at least 150mm (6") of clearance in all directions for the corresponding diagnostic tool harness. The panel face dimensions measure 90mm (3.5") in width (horizontal) x 75mm (3.0") in length (vertical).

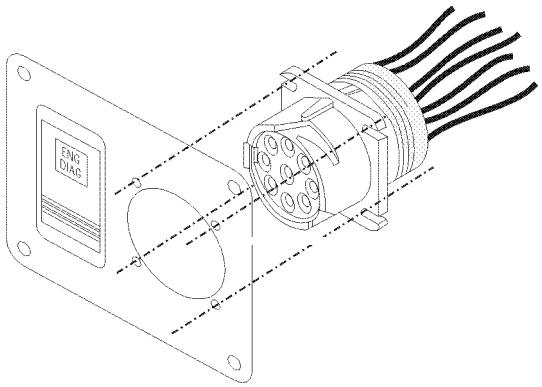


Figure 110: Engine Diagnostic Switch Panel (foreground) and Diagnostics Connector (background)

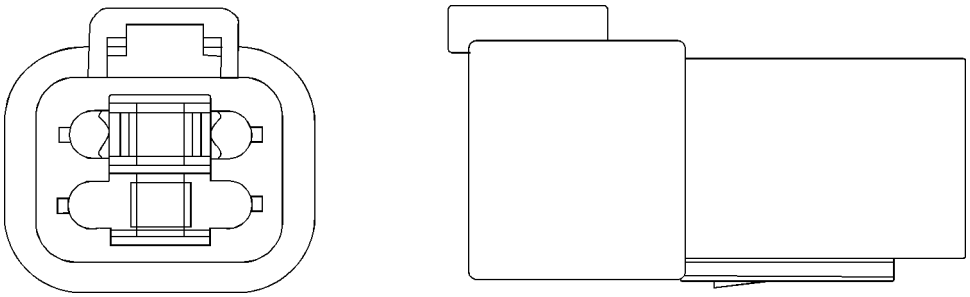


Figure 111: Diagnostic Switch Connector

Primary Instrument Panel (One Per Engine)

This panel consists of electrically driven analog gauges as well as an Instrument Interface Module (IIM) and is 190mm (7.5") tall x 240mm (9.5") wide. The panel requires the IIM to convert the digital signals from the ECM to drive the gauges and warning lights. The instrument panel has two connectors that plug into the IIM: a 23-pin AMP Instrument Panel plug (see figure 112) and a 4-pin Deutsch plug (see figure 113). The Primary Instrument Panel is wired with a Deutsch 12-pin plug, which connects to the corresponding 12-pin Deutsch receptacle in the engine extension harness (see figure 114).

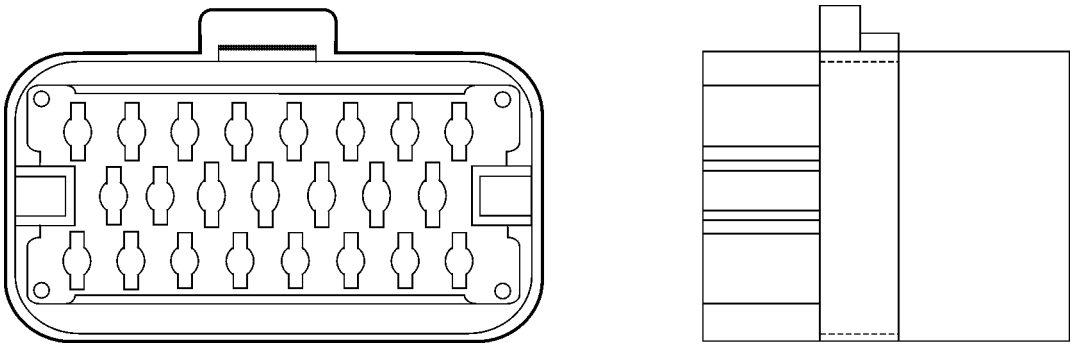


Figure 112: Instrument Panel to IIM Connector

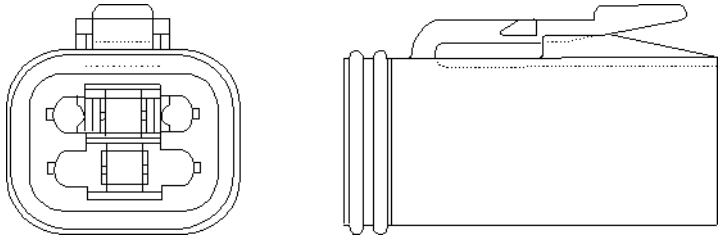


Figure 113: Instrument Panel to IIM Connector

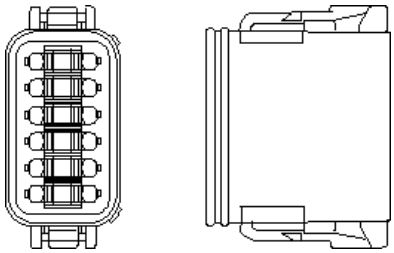


Figure 114: Instrument Panel to Extension Harness Connector

Keyswitch

The Instrument panel will come complete with a keyswitch. The keyswitch is not installed into the panel, so it can be placed at the installer’s discretion. The keyswitch contains a 600mm (24") extension wire.

Engine Data Display

The Engine Data Display is a user programmable LCD used to display engine data. The display face dimensions measure 110mm (4.33”) square (see figure 115). An installation template is shipped with the display.

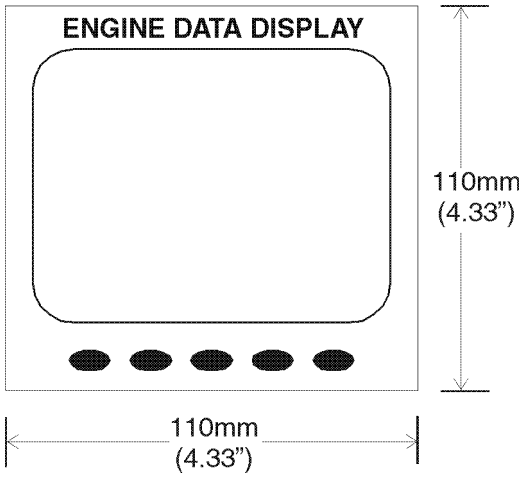


Figure 115: Engine Data Display

This engine data display is wired with a 6-pin Deutsch receptacle (see figure 116), which connects to a 6-pin Deutsch plug on the wiring harness.

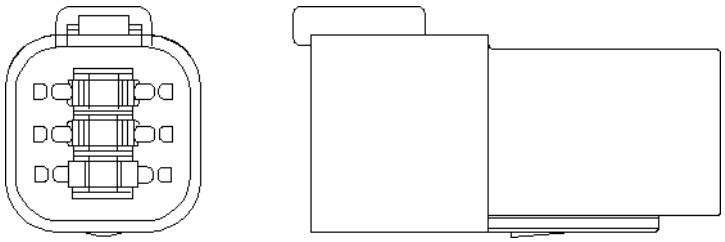


Figure 116: Engine Data Display Connector

Dual Engine Switch Control Panel (One Per 2 Engines)

The Dual Engine Switch Control Panel consists of a set of four rocker switches and two sets of warning lights (see figure 117). This panel has four connections: two 12-pin receptacles and two 6-pin plugs (see figure 118). These connectors attach to the corresponding connectors on the (port and starboard) engines' extension harnesses. This panel measures 75mm (3.0") in length (vertical) x 230mm (9.0") in width (horizontal).

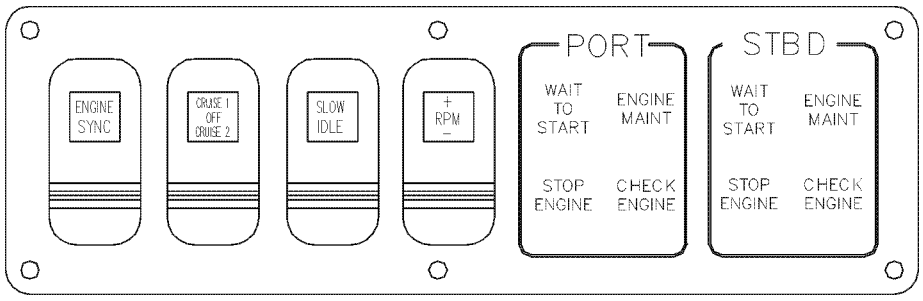


Figure 117: Twin Engine Switch Control Panel

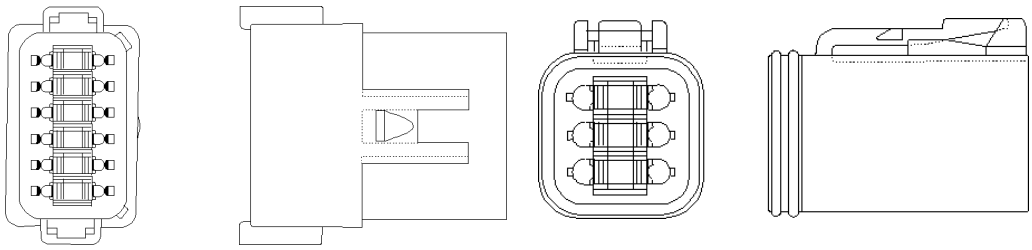


Figure 118: Switch Control Panel Connectors

Dual Engine Backup Throttle Switch Panel (One Per 2 Engines)

The Dual Engine Backup Throttle Switch Panel consists of a rocker switch with a lock out and two remote throttle control heads (see figure 119). The panel is wired with two 3-pin Packard Weather-Pak receptacles (see figure 120) for the remote throttle and two 2-pin Deutsch receptacles (see figure 121) for the switch—two for port and two for starboard, respectively. The panel measures 95mm (3.75") in length (vertical) x 185mm (7.25") in width (horizontal).

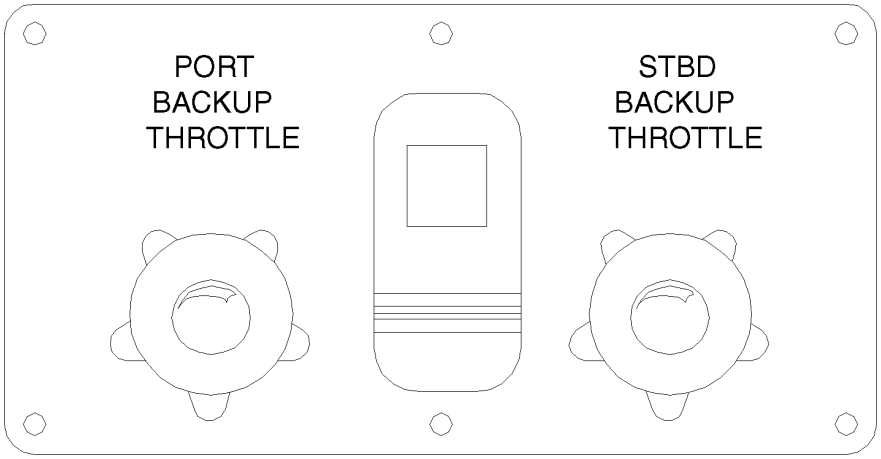


Figure 119: Twin Engine Backup Throttle Panel

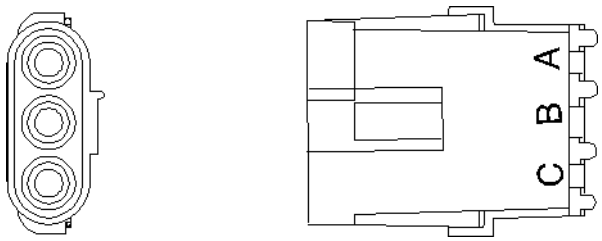


Figure 120: Backup Throttle Switch Connector

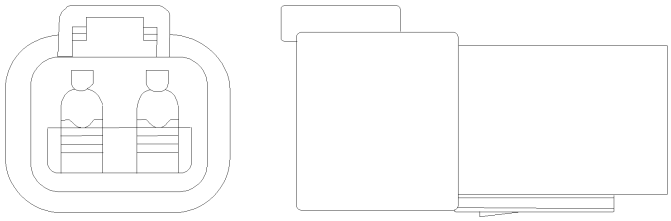


Figure 121: Backup Throttle Input Connector

NOTE: *The 3-pin connector on the extension harness comes with a backup throttle termination connector installed in the harness. When a backup throttle panel is installed, the termination connector must be removed from the extension harness so the backup throttle connector can be installed. If the optional backup throttles are not used then the termination connector must remain plugged into the extension harness.*

Multi-Engine Synchronization Connection

If the engine synchronization feature was ordered as an option, a 4-pin Deutsch “slave” receptacle (Cummins P/N 4003626—see figure 122) and J1939 jumper cable (Cummins P/N 4003624—see figure 123) will be provided.

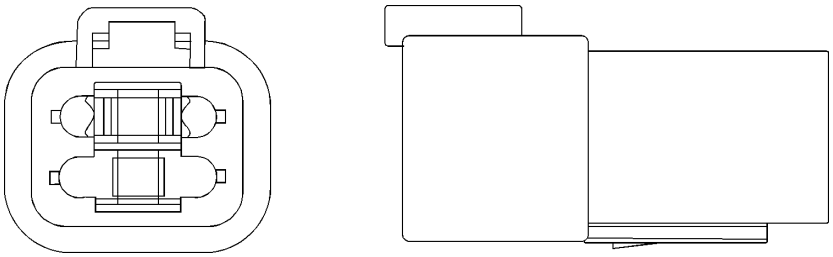


Figure 122: Master/Slave Connector

Figure 123: J1939 Jumper Cable

Perform these steps to install the feature and activate engine synchronization:

1. Multi-Engine Synchronization is used in dual engine applications, but only if the engines were ordered with the C-Cruise option package. Dual engine synchronization requires one engine to be identified as the “master” engine and the other to be identified as the “slave” engine. These designations determine which throttle lever will be active when using the synchronization feature. The wiring harness is equipped with a Deutsch 4-pin plug (figure 124). All engines come with the standard “master” receptacle installed over the plug (see figure 125). Decide which engine is to be the slave engine (usually port). Remove the “master” receptacle from the “slave” engine, and replace it with a “slave” receptacle. The “slave” receptacle is shipped with the C-Cruise option, packaged with the control panel. So, in a dual engine package with the C-Cruise option, one engine will need the “master” engine connector, and one will need the “slave” engine connector.

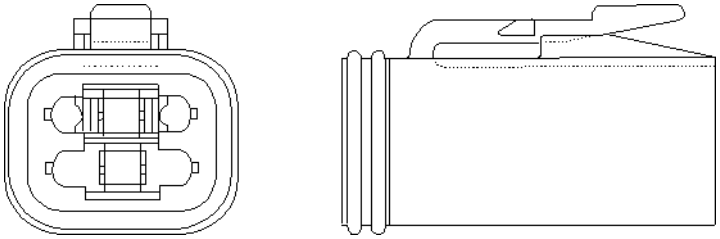


Figure 124: Wiring Harness Master Plug Connector

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Figure 125: Dual Engine Synchronization Connectors (As Shipped on All Engines)

2. Locate the triangular 3-pin Deutsch plug (see figures 109 and 126) in the port and starboard engine extension harnesses. Remove the termination resistor receptacles from both harnesses and connect the datalink synchronization harness (Cummins P/N 4003624).

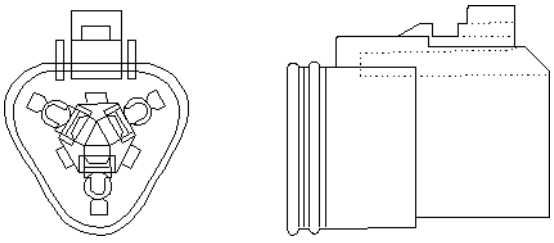

Figure 126: Master/Slave Connector

NOTE: *If the engine synchronization feature was not ordered with the engines, the ECM will require recalibration by your local Cummins Distributor to activate the synchronization feature after the connectors are installed.*

Dual Engine, Dual Station

The schematic in figure 127 shows a Dual Engine, Dual Station wiring harness and component installation. Note that, with a dual station vessel setup, the primary station will have all of the connections listed in the previous section for a dual engine, single station installation. In addition, a Switch Control Panel, a Station Select Switch, and a Y-harness must be added to each station. An instrument/display Y-harness also will be needed to connect each engine to the second station. The second station setup will consist of the Engine Data Display, Instrument Panel, Switch Control Panel, and Station Select Switch.

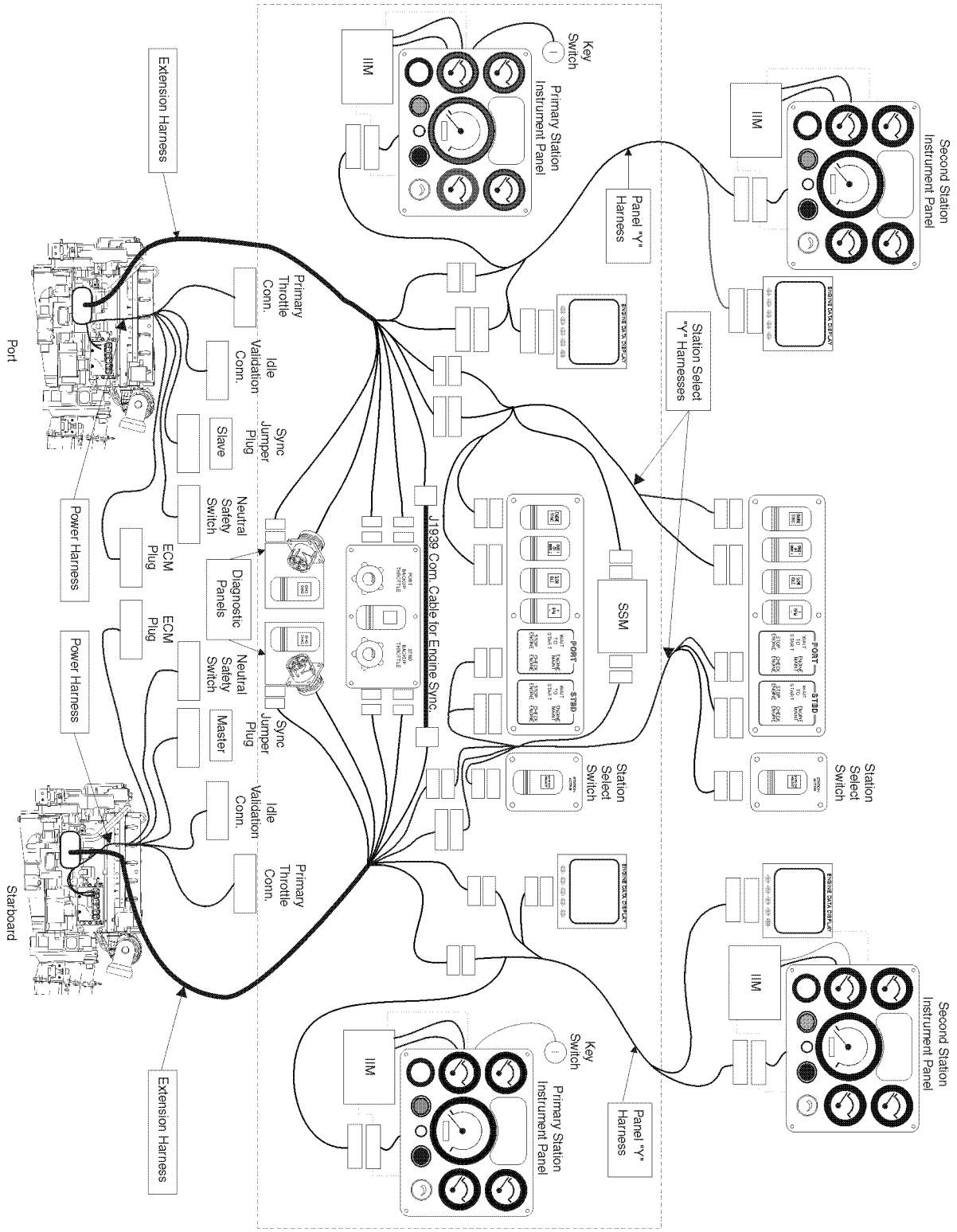

Figure 127: Dual Engine, Dual Station Wiring Harness and Connectors

Instrument/Display Y-Harness Installation

With a dual station installation, a Y-harness is required to attach the second station display and Instrument panel. The Y extension harness can be obtained in 6m (20'), 12m (40'), and 18m (60') lengths.

The Y-harness consists of four connectors at the primary station and two connectors at the secondary station. The four connectors at the primary station plug into the engine extension harness, the primary instrument panel and the primary engine data display, if ordered (see connectors description in the instrument panel and engine display section below). Attach the 12-pin Deutsch connectors of the Y-harness between the 12-pin connector of the primary instrument panel and the 12-pin connector on the engine extension harness. Do the same for the 6-pin data display panel (if used).

NOTE: *If an instrument panel is not used at the second station but is used at the primary station, do not use the Y-harness to connect the main engine extension harness to the instrument panel. Plug the main harness extension directly into the primary instrument panel; otherwise, the engine will not function due to an open loop in the key switch wiring.*

Second Station Instrument Panel (One Per Engine)

This panel is the same as the primary instrument panel with the exception of the keyswitch. The second station instrument panel requires its own IIM and has plugs for two connectors: a 23-pin AMP Instrument Panel plug (see figure 128) and a 4-pin Deutsch plug (see figure 129). The Primary Instrument Panel is wired with a Deutsch 12-pin plug, which connects to the corresponding 12-pin Deutsch receptacle in the Y-harness (see figure 130).

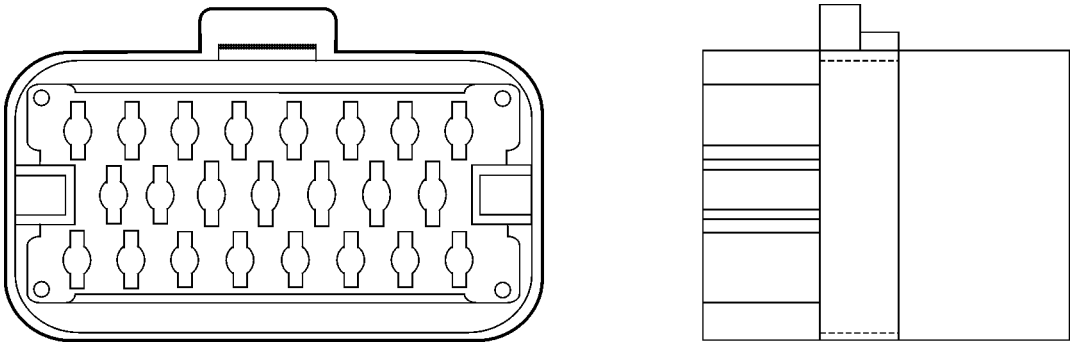

Figure 128: Instrument Panel to IIM Connector

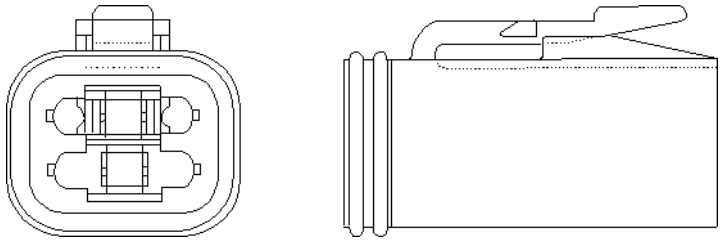

Figure 129: Instrument Panel to IIM Connector

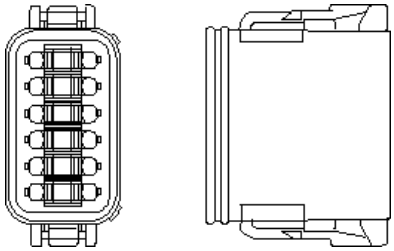

Figure 130: Instrument Panel to Extension Harness Connector

Second Station Engine Data Display

This display and its connector is the same as the primary engine data display and connector described under the single engine, single station. The display face dimensions measure 110mm (4.33”) square (see figure 131). An installation template is shipped with the display.

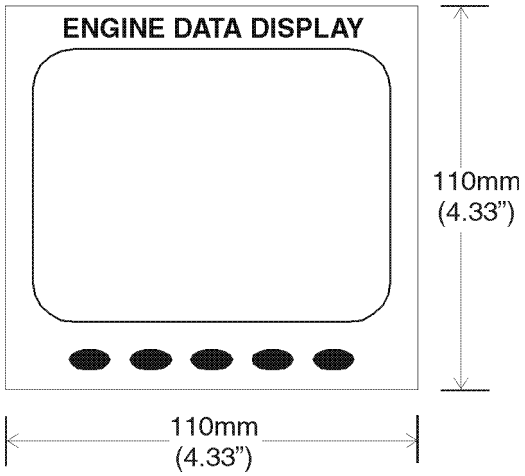

Figure 131: Engine Data Display

The engine data display is wired with a 6-pin Deutsch receptacle (see figure 132), which connects to a 6-pin Deutsch plug on the Y-harness.

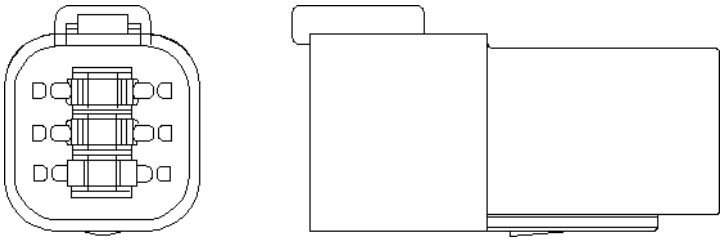

Figure 132: Engine Data Display Connector

Station Select Package

Adding a switch control panel to a second station requires a slight modification of the primary station installation. If two switch control panels are to be used (upper and lower stations) a station select switch must be installed at each station to activate the switch control panel at the station you are operating from. The station select package requires a station select Y-harness, a primary station switch control panel, a primary station select switch, a second station switch control panel, and second station select switch.

Station Select Y-Harness

A station select Y-harness consists of seven Deutsch connectors and a power wire at the primary station end (see figure 133) and four Deutsch connectors at the second station end (see figure 134).

NOTE: If necessary, disconnect the extension harness from the primary station switch control panel connector.

At the primary station, connect the 12-pin Deutsch plug and the 6-pin Deutsch receptacle from the engine extension harness (see figure 135) to the mating connections on primary station switch control panel. Connect the 12-pin Deutsch receptacle and 6-pin Deutsch plug on the station select Y-harness (see figure 136) to the mating connectors on the extension harness. Both connectors on the station select Y-harness are labeled **“To Extension Harness”**.

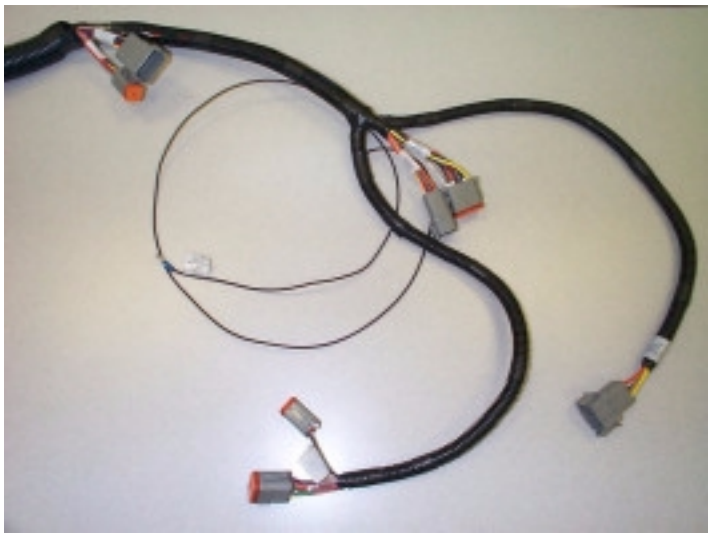

Figure 133: Station Select Y-Harness—Primary Station End

Figure 134: Station Select Y-Harness—Second Station End

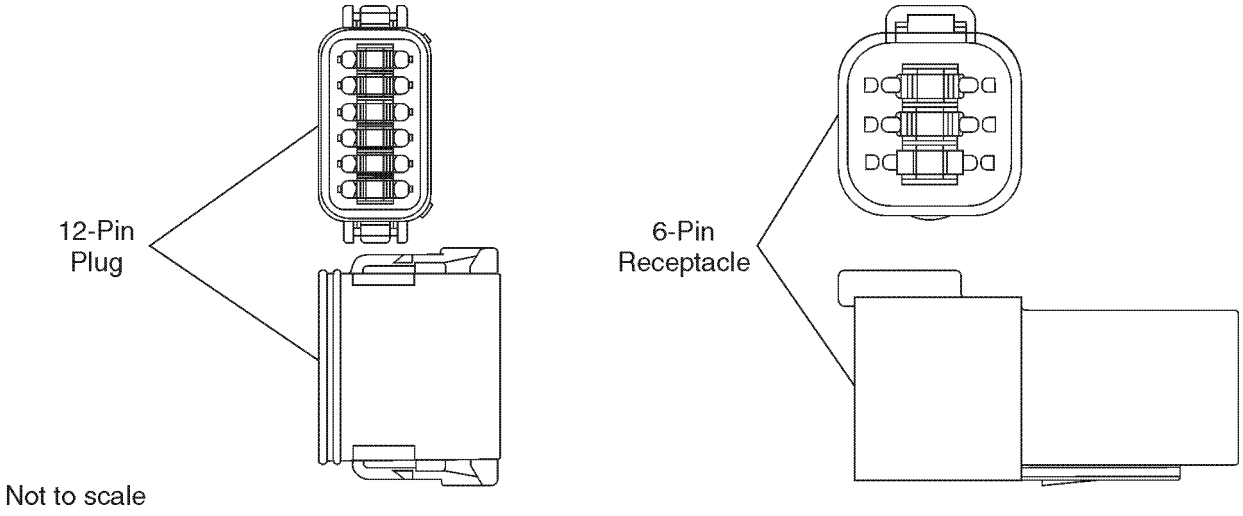

Figure 135: Connections at Extension Harness

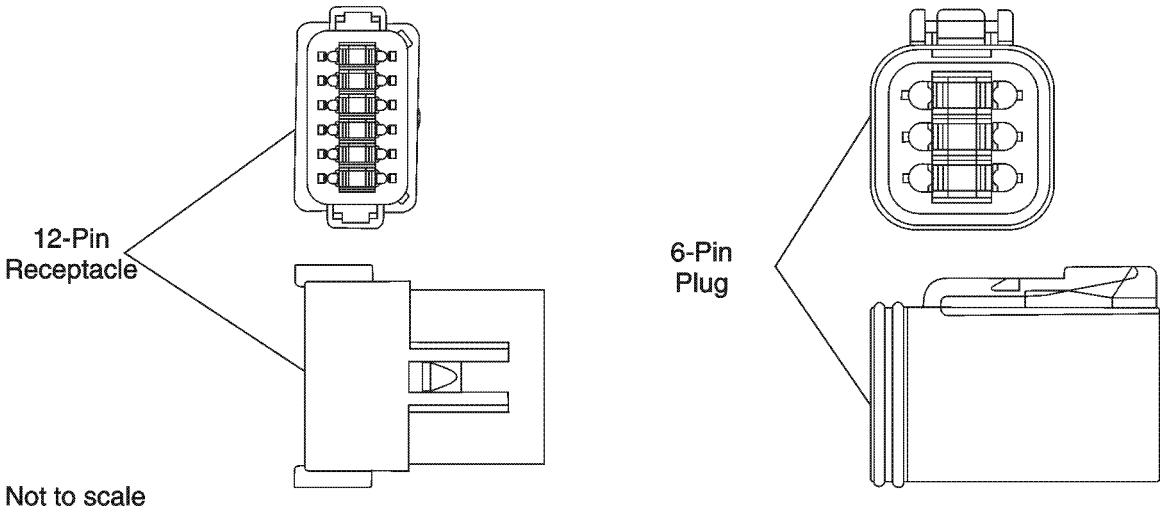

Figure 136: Connections at Station Select Y-Harness

Engine Switch Control Panel—Primary Station

The engine switch control panel consists of a set of 3 rocker switches and a single set of warning lights (see figure 137). The engine switch control panel measures 75mm (3.0") in length (vertical) x 230mm (9.0") in width (horizontal). This panel has two connections: one 12-pin Deutsch receptacle and one 6-pin Deutsch plug (see figure 138). These connectors mate with the corresponding connectors on the extension harness.

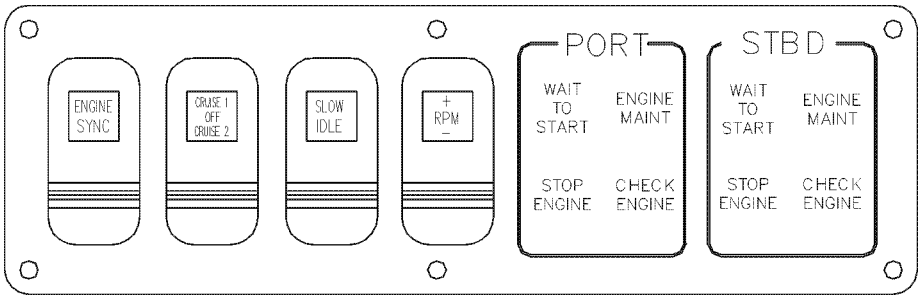

Figure 137: Engine Switch Control Panel

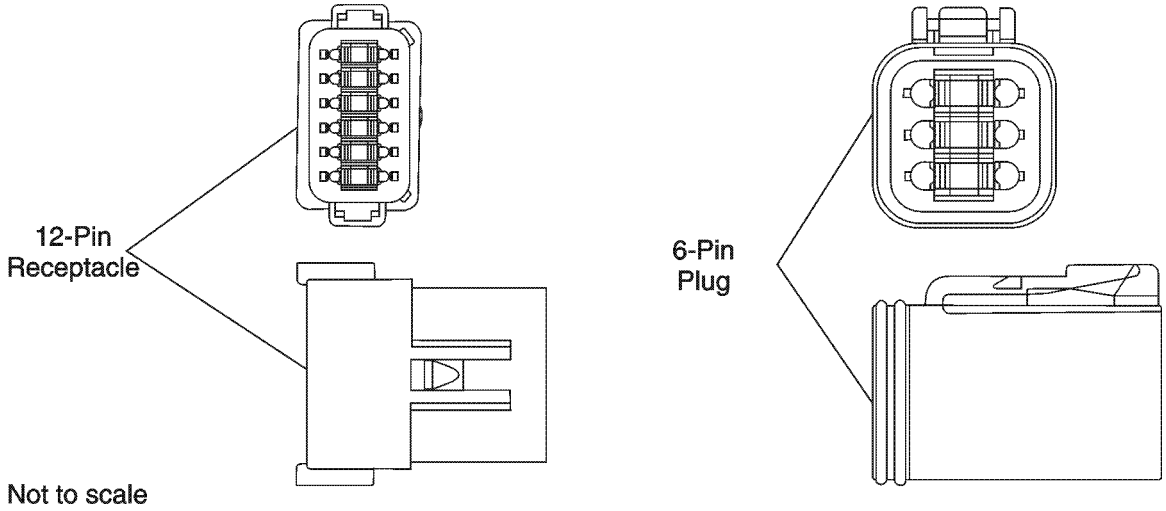

Figure 138: Connector—Station Select Switch

Station Select Switch—Primary Station

If two switch control panels are used (upper and lower stations) a station select switch (see figure 139) must be installed at each station to activate the switch control panel at the station you are operating from. The station select switch has a short harness with an 8-pin Deutsch plug (see figure 140). Connect the 8-pin Deutsch plug from the station select switch control panel to the 8-pin Deutsch receptacle labeled **"Main Station Select Panel"** (see figure 141) on the Station Select Y-harness.

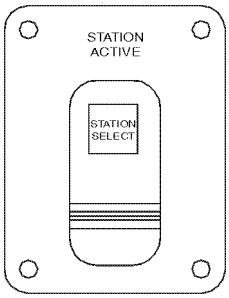

Figure 139: Station Select Switch

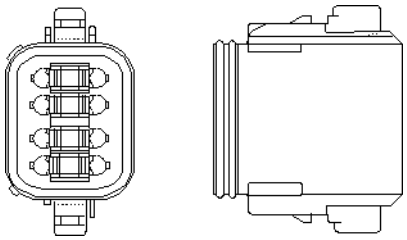

Figure 140: Station Select Switch Harness Connector

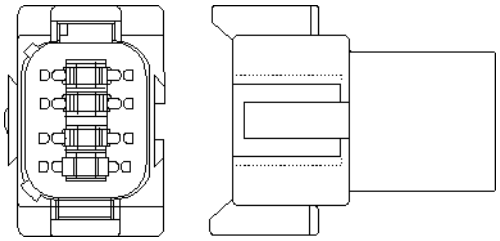

Figure 141: Station Select Y-Harness Connector

Station Select Module

The station select module is the brain of the station select system. The operator selects the station by depressing the station select switch. The station select module contains a processor that directs the inputs from the switch control panel to the ECM. The module is equipped with integral Deutsch connectors: one 8-pin receptacle and one 6-pin receptacle (see figure 101).

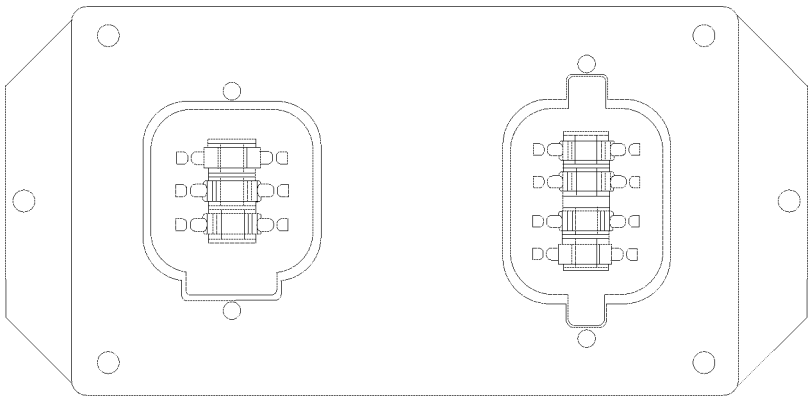

Figure 142: Station Select Module

Connect the 6-pin Deutsch plug from the station select Y-harness labeled **"Station Select Module Port Single Engine Only"** to the 6-pin receptacle on the station select module. Connect the 8-pin Deutsch plug from the station select Y-harness labeled **"Station Select Module Starboard"** to the 8-pin receptacle on the station select module (see figure 143).

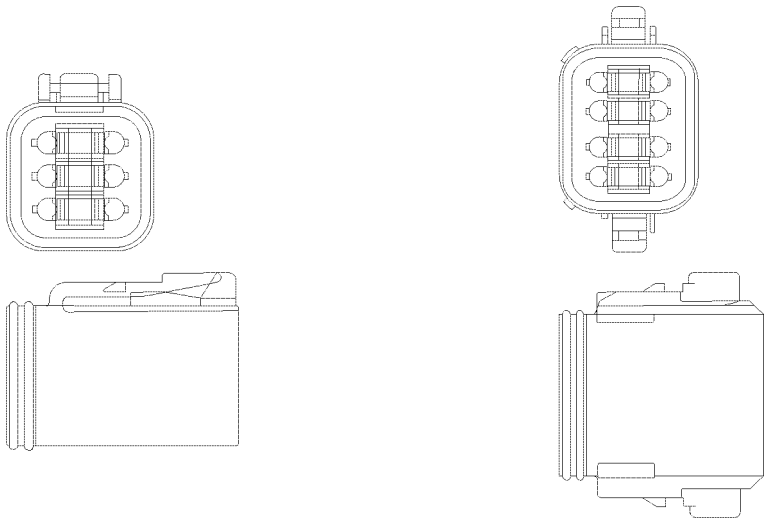

Figure 143: Station Select Module Connectors from Station Select Y-harness

Harness Power Wire

The station select Y-harness contains a separate wire with a No 8 size ring terminal (see figure 144). Connect this power lead to the battery side (unswitched) power supply to the key switch.

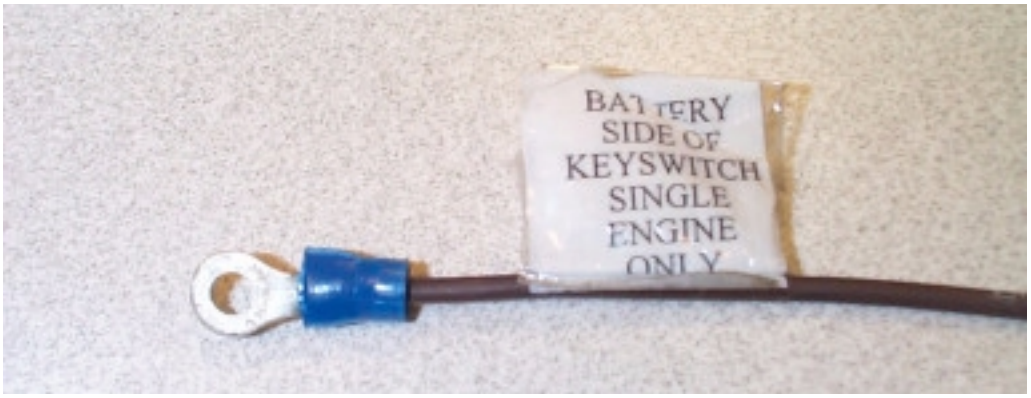

Figure 144: Station Select Y-Harness—Unswitched Power Connection

Engine Switch Control Panel—Second Station

The Engine Switch control panel consists of a set of 3 rocker switches and a single set of warning lights (see figure 145). The engine switch control panel measures 75mm (3.0") in length (vertical) x 230mm (9.0") in width (horizontal). This panel has two connections: one 12-pin Deutsch receptacle and one 6-pin Deutsch plug (see figure 146). These connectors mate with the corresponding connectors on the extension harness.

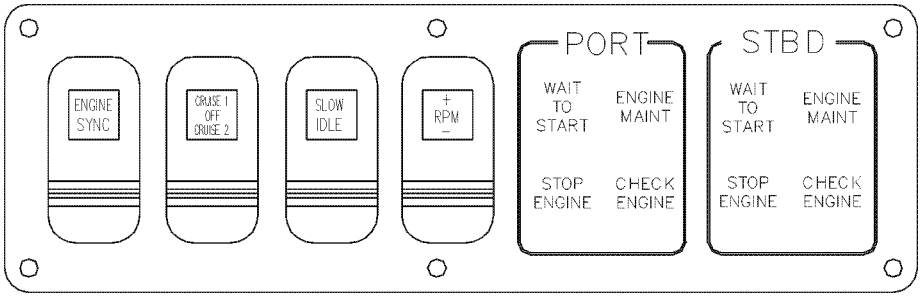

Figure 145: Engine Switch Control Panel

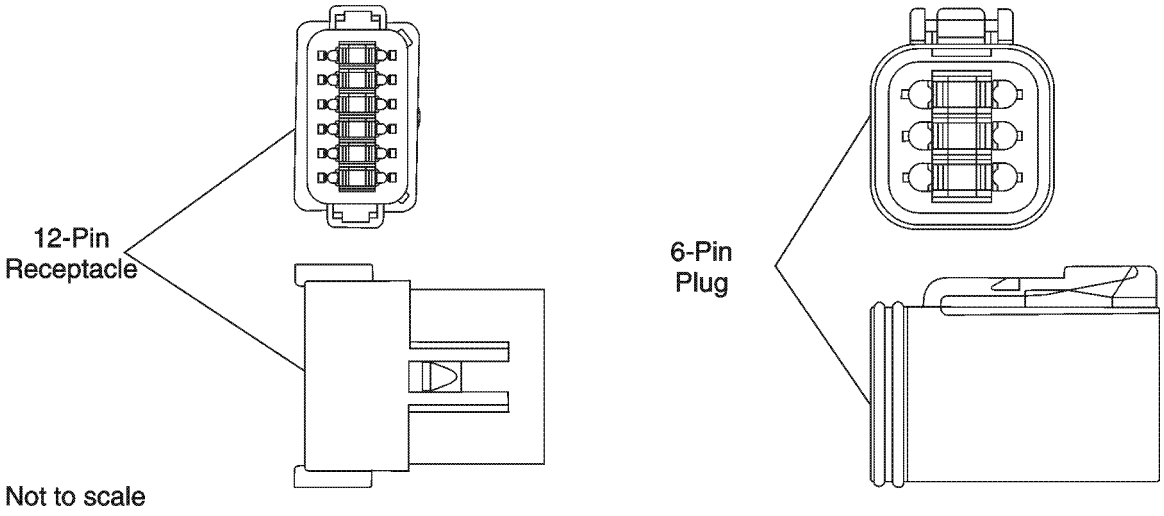

Figure 146: Connector—Station Select Switch

Station Select Switch—Second Station

If two switch control panels are used (upper and lower stations) a station select switch (see figure 147) must be installed at each station to activate the switch control panel at the station you are operating from. The station select switch has a short harness with an 8-pin Deutsch plug (see figure 148). Connect the 8-pin Deutsch plug from the station select switch control panel to the 8-pin Deutsch receptacle (see figure 149) on the Station Select Y-harness labeled **"Main Station Select Panel"**.

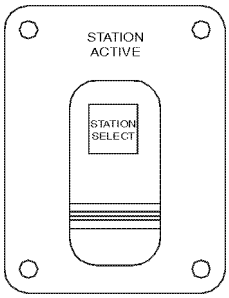

Figure 147: Station Select Switch

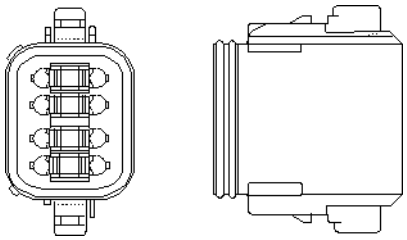

Figure 148: Station Select Switch Harness Connector

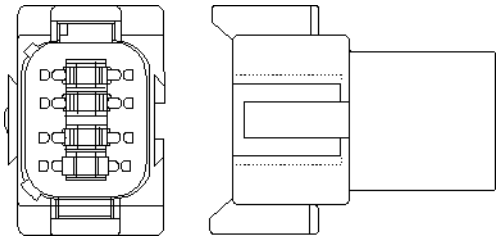

Figure 149: Station Select Y-Harness Connector

LUBRICATION SYSTEM

REQUIREMENTS

! The lubricating oil dipstick must be marked with the high and low oil level when the vessel is in the water and at its normal trim.

! The lubricating oil filter system that is furnished by Cummins Engine Company with every engine must be used.

! An oil pressure gauge and low oil pressure warning system are required on all installations.

! The lubricating oil used in the engine must meet the specifications listed in the Operation and Maintenance Manual.

! Hoses used in any part of the lubricating oil system must meet Cummins specifications.

! Remote mounted lube oil filters must meet Cummins specifications.

INSTALLATION RECOMMENDATIONS

The lubrication system must provide a continuous supply of clean lubricating oil to the engine at a controlled temperature. Proper installation and maintenance of the lubrication oil system is essential to ensure long engine life and performance.

Dipsticks

Cummins marine engines are shipped from the factory with the engine oil dipstick unmarked. Once the engine is installed and after the boat is in the water and floating at its normal trim angle, engine oil should be added and the dipstick calibrated (see figure 150).

! The lubricating oil dipstick must be marked with the high and low oil level when the vessel is in the water and at its normal trim.

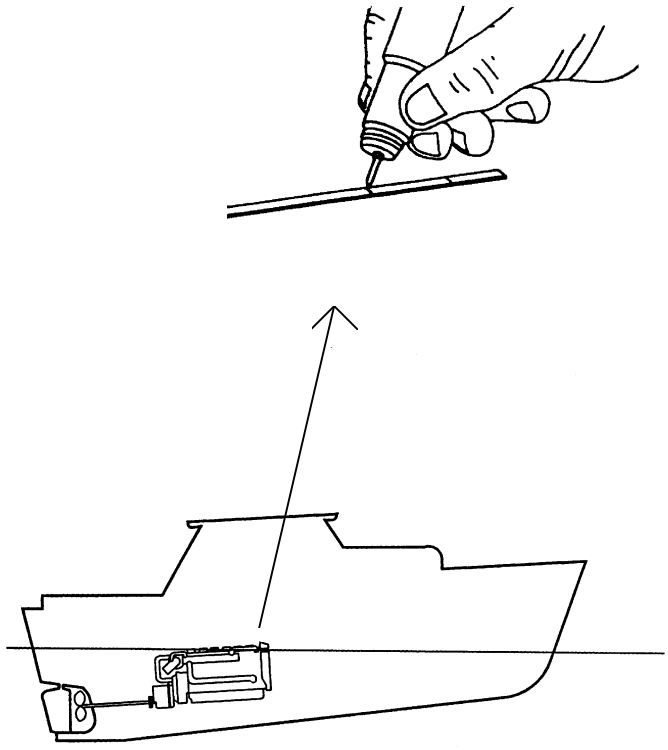

Figure 150: Lubricating Oil Dipstick Calibration

The procedure for calibrating marine engine dipsticks is located on the dipstick tag with the delivery.

1. Open the oil pan drain plug and make sure the pan is empty.
2. Add the volume of oil required for the “LOW” oil level.
3. Allow 5 minutes for the oil to drain into the oil pan.
4. Mark the oil level on the dipstick “LOW.”
5. Add the additional volume of oil required for the “HIGH” oil level.
6. Wait 5 minutes for the oil to drain into the oil pan.
7. Mark the oil level on the dipstick “HIGH.”
8. Start the engine and run at idle for 30 seconds to fill the filters and oil passages.
9. Stop the engine and add oil to bring the level up to the “HIGH” mark.

CAUTION: Dipsticks must be marked by engraving. Stamping or notching will weaken the dipstick and the tip of the dipstick may break off in the oil pan.

Refer to the Engine General Data Sheet for the high and low oil pan capacity.

Lubrication Oil Filtration System

The lubricating oil filter system that is furnished by Cummins Engine Company with every engine must be used.

All engines are supplied with a full flow oil filter as standard equipment. The engine has been designed for a mounted filter and should be used whenever possible; however, remote mounted full flow oil filters are available as optional equipment. If other remote locations are required, the filter system must meet Cummins specifications.

By-Pass Filters

C-Series engines are equipped with a combination full flow by-pass filter.

Oil Pressure Gauge

An oil pressure gauge and a low oil pressure warning system are required on all installations.

The tap for the oil pressure gauge is specified on the engine installation drawing. Optional locations are available on most engine models. Normal oil pressure ranges are given on the Engine Data Sheet. These pressures are to be expected when the engine is at operating temperature. The pressure with cold oil may be as much as 150% more than the maximum for a warm engine, and this should be considered when selecting a gauge.

Lubricating Oil

The performance and life of an engine in any installation can be significantly affected by the lubricant and fuel that are used. The following guidelines should be observed in the selection of these items.

The lubricating oil used in the engine must meet the specifications listed in the Operation and Maintenance Manual.

CAUTION: Failure to use the proper oil may result in engine damage or dramatically increase maintenance intervals.

Lubrication Plumbing

! Hoses used in any part of the lubricating oil system must meet Cummins specifications.

Hoses for bypass oil filters, oil pressure gauge lines, or replacement lines for the full flow filters must meet the specifications in table 19.

Parameter	Requirement
Temperature Range:	-40 °C to 135 °C (-40 °F to 300 °F)
Minimum Burst Pressure:	6900 kPa (1000 psi)
Minimum Working Pressure	1700 kPa (250 psi)
Inner Tube:	High temperature, high strength reinforced oil resistant elastomer.
Hoses	Fittings should be brass or corrosion resistant material. Must be properly supported and shielded. Must be installed without twists, kinks or sharp bends.

Table 19: Lubrication System Plumbing Specifications

Remote Mounted Lubrication Oil Filters

Cummins does not recommend the use of remote mounted lube oil filters unless supplied with the engine. In cases where a remote filter is needed the following conditions must be met.

B Series Engines

- Use hose lengths no longer than 1 m (40").
- Use #12 hoses.
- Measure the oil pressure at the filter before moving it and after moving it to determine if the pressure drop exceeds 21 kPa (3 psi). If the pressure drop exceeds this value, the remote system must be redesigned to eliminate restrictions.
- Filter inlet and outlet ports should not be more than 15cm (6") below or above the engine supply and return ports.
- Filter must be mounted vertically.
- Marine grade blue hoses must be used.
- Use only the approved Cummins oil filter.

C Series Engines

- Use hose lengths no longer than 1 m (40").
- Use #16 hoses.
- Measure the oil pressure at the filter before moving it and after moving it to determine if the pressure drop exceeds 21 kPa (3 psi). If the pressure drop exceeds this value, the remote system must be redesigned to eliminate restrictions.
- Filter inlet and outlet ports should not be more than 15 cm (6") below or above the engine supply and return ports.
- Filter must be mounted vertically.
- Marine grade blue hoses must be used.
- Use only the approved Cummins oil filter.

APPLICATIONS GUIDELINES

REQUIREMENTS

! Engine rating must be in accordance with published application guidelines.

INSTALLATION RECOMMENDATIONS

Application guidelines

! Engine rating must be in accordance with the published application guidelines.

It is a Cummins requirement that engine ratings must meet our published application guidelines. Applications not within our published limits can void engine warranty.

Application guidelines do not take into consideration operating environment. Service operating conditions may necessitate that heavier duty components (air cleaners, cooling system, exhaust system, etc.) be selected. The following is a list of our application guidelines:

High Output[1]
(Average load factor of 30% or less)

Engines with this rating are intended for powering marine pleasure craft used for personal use only and for powering some marine commercial boats such as gillnetters, bow pickers, skiffs, oil skimmers, and small fishing craft. Warranty coverage is different depending upon actual usage described above.

This power rating is intended for use in variable load applications where full power is limited to one hour out of every eight hours of operation. Also, reduced power operations must be at or below cruise RPM, which is 200 RPM below the maximum rated RPM. This rating is an ISO 3046 Fuel Stop Power Rating and is for applications that operate less than 750 hours per year.

Intermittent[1]
(Average load factor of 30-50%)

This power rating is intended for continuous use in variable load applications where full power is limited to two hours out of every eight hours of operation. Also, reduced power operations must be at or below 200 RPM of the maximum rated RPM. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate less than 1500 hours per year.

Medium Continuous Rating[1]
(Average load factor of 50-70%)

Engines with this rating are intended for powering commercial boats such as lobster boats, crew boats, party fishing boats, charter fishing boats, long range cruisers, harbor and coastal patrol boats, search and rescue boats, fire boats, bay shrimpers, clam boats, crab boats, and seine skiffs.

This power rating is intended for continuous use in variable load applications where full power is limited to six hours out of every twelve hours of operation. Also, reduced power operations must be at or below 200 RPM of the maximum rated RPM. This is an ISO 3046 Fuel Stop Power Rating and is for applications that operate less than 3000 hours per year.

1. These Application Guidelines and Engine Ratings do not apply to special or restricted ratings. Special or restricted ratings must have written approval by Cummins Marine.

Continuous Rating[1]
(Average load factor greater than 70%)

Engines with this rating are intended for powering commercial boats such as buoy tenders, research vessels, off-shore supply boats, fishing trawlers, purse seiners, tugs, tow boats and car/passenger ferries.

This power rating is intended for continuous use in applications requiring uninterrupted service at full power. This rating is the ISO 3046 Standard Power Rating and the SEA J1228 Continuous Crankshaft Power Rating.

1. These Application Guidelines and Engine Ratings do not apply to special or restricted ratings. Special or restricted ratings must have written approval by Cummins Marine.

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