

## Contents / Notes

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Sea Trial Application Review (EXCEL Document)

Sea Trial Port Guides (PDF Files)

## Purpose

John Deere Engine Distributors and Dealers are responsible for ensuring Marine Engine Application Reviews are performed on every engine installation.

The purpose of performing an Application Review is to ensure customer satisfaction. Customer satisfaction is directly related to the proper engine application in the end product. Proper engine installation is the best way to ensure repeat sales, optimum product reputation and reduced warranty claims. **Improper application or installation without a proper Application Review can result in denial of warranty should issues arise.**

The best assurance to achieve a trouble-free installation is to follow application guidelines found on the John Deere Power Systems Portal, perform engine application tests, and complete the Marine Engine Application Review Form (Application Review Document on page 1 of this guide).

Deere cannot guarantee engines have been properly matched to give desired vessel performance. Vessel performance is impacted by characteristics of the hull and engine propulsion system, including the engine power, marine gear ratio, propeller diameter and pitch, hull shape, and even geographic location in which the vessel operates. To ensure correct engine selection, customers should work with distributors and dealers to identify the operating conditions of the engine.

### Note

Marine Application Reviews should follow instructions contained in the Application Review section of this guideline. The review procedure does not include provisions for testing radiator cooled installations. Review of marine applications that use a radiator-type cooling system should use the industrial application review guidelines.

## Application Review Procedure

The Application Review process begins during the first engine selection discussion with a customer and it concludes with a Sea Trial; the performance check of the completed installation. This Application Review procedure is designed as a step-by-step process to be followed for each marine engine installed.

### Application Review Depot

It is required that all application review forms are completed and submitted to the “JDPS-Application Review Depot” on the Power Systems Portal. This information is used to validate installations and is helpful for ensuring warranty coverage if needed. In the event a DTAC case is created on a given engine, the application review information is extremely helpful for DTAC to review and provide advice for a more timely solution. The Application Review Depot is used for both Industrial and Marine application reviews, so not all editable fields are required for a Marine review.

The following fields should be filled out for a proper Marine review:

### **Information under “Application information”**

- Application Owner
- Application Email
- Initial Application Name & Model (Vessel Make/Model)
- Application Name & Model (Vessel Name)

### **In the “Main” tab**

- Information under “Market Segments”
- Information under “Engine Information”

### **In “Application Data”**

- **In the “Test Data” tab**
  - Serial Number
- **In the “Pictures & Files” tab**
  - Upload completed Sea Trial Review Form
  - Upload pictures of vessel and installation
  - Upload any applicable supplementary information (e.g. added equipment data sheets)

## Prior to Visiting the Vessel

Before visiting the vessel, it is encouraged to record as much information on the application review form as possible. Any vessel or engine information that is already known should be recorded. Also, any data or forms that may be helpful while at the vessel should be downloaded to your laptop and/or printed. These include, but are not limited to:

- Performance curve for the engine/rating
- Latest software version
- Engine installation and/or option drawings
- Application guidelines

## Gathering Information

The first step in an engine installation is gathering information about the vessel and current equipment (if this is a repower). If this data was not collected at the time the engine was sold to the customer, collect it at the time of the Application Review by means of the Sea Trial Review Form linked on page 1 of this guideline.

- **Vessel**  
Record the information on the vessel's manufacturer, model and hull number. The length, beam, draft, and weight should also be recorded along with the hull type and material. Other required information is the application type (pleasure vs. commercial) and propulsion system.
- **Previous Engine and Gear—Repowers only**  
Customers often request assistance in sizing propulsion system components. When applicable, record the previous engine and accompanying data. This information is often requested by propulsion system suppliers
- **Engine**  
Record the engine model, serial number, and power rating selected. The rating can be found by looking up the Performance Option Part Number or the Factory Option number on the Marine Performance Option Codes spreadsheet on the Portal. The part numbers can be found using Service Advisor. Record any

options that may have been modified between factory build and installation in the vessel.

- **Marine Gear**  
Record marine gear manufacturer, model and reduction ratio. Also note if it is an electrical or mechanical shift and the type of trolling valve, if any is present. At the time of the Sea Trial, record the serial number of the gear. If installed, document the type of gear cooler and verify proper installation (installed downstream of aftercooler).
- **Propeller**  
Record propeller manufacturer, style, diameter, pitch and number of blades.
- **Other Propulsion System Information**  
Note if the vessel has any special or unique propulsion equipment such as a Kort Nozzle, steerable nozzle, Z-Drive, Arneson surface drive, Aquadrive, jet drive, tunnel drive, surface piercing propeller, etc.
- **Powered Components**  
Record all components (not installed at the factory) that will be driven by the engine. For any components installed on a gen-set engine, attach those component's mass-elastic data.

## Visual Inspection

Before conducting any performance tests, take a few moments to inspect the vessel and engine installation. Use this time to record any information concerning the vessel, engine, or transmission that was previously left blank

- **Engine Installation (reference AG-01.5)**
  - Ensure engine is properly installed in the vessel to meet requirements of AG-01.5.
- **Engine Mounting (reference AG-27 guideline)**
  - Measure the engine installation angle. Remark the dipstick if necessary using the instructions provided in the Oil System Guideline (AG-23.5)
  - Ensure all connections to the engine (excluding driveline) are flexible
- **Lubrication System (reference AG-23.5 guideline)**
  - Record any additional components that have been added to the lubrication system (remote oil filters, duplex oil filter, oil fill system, etc.)
- **Air Intake System (reference AG-03 guideline)**
  - Note the airflow path to the engine, measure vent area to ensure it is large enough to meet the engine requirements found on the performance curve  
*Note: Minimum ventilation area on performance curve is for combustion air only, considerations should be made for ventilation of radiated engine heat and any other equipment requiring airflow*
  - If installed, engine room ventilation fans should add air flow into the engine room. Record ventilation fan flow capacity.
- **Fuel System (reference AG-19 guideline)**
  - Review the fuel connections to the engine to verify proper line sizes
  - Verify the cap for the return fuel line has been removed and replaced with a proper return line (for High Pressure Common Rail engines)
    - Record any additional components added to the fuel system (double wall fuel lines, water separators, vessel fuel filters, etc.)
- **Exhaust system (reference AG-17.5 guideline)**
  - Verify excessive forces and moments will not be applied to the engine, turbocharger, or exhaust manifold
  - Review the outlet location to ensure exhaust will not recirculate to the intake
  - Make sure that rain and sea water cannot reach the engine through the exhaust
  - In wet exhaust systems, make sure sea water is injected into the exhaust above the waterline (or utilize a waterlift muffler appropriately) and that water cannot flow back into the turbo
- **Electrical System (reference AG-11 guideline)**
  - Record components engaged during cranking, such as hydraulic and bilge pumps
  - Verify that the engine is grounded to the vessel bonding strip (for wood or fiberglass vessels only. A bonding strip is not required on steel, aluminum, or any other metal hull).
  - Ensure a Transient Voltage Protection (TVP) device is installed if the alternator has been removed
- **Cooling System (reference AG-09.5 guideline)**
  - Record requested information for any coolant recovery (overflow) or remote expansion tank(s) in use. Make sure cap style matches the type of system in use. Need dual-action for a recovery system and single-action for overflow only
  - Note: A recovery tank is not the same as an overflow tank
  - Keel cooled engines require a cooling system test to verify the performance of the keel cooler (described at the end of this document)
  - On heat exchanged engines, check sea water pump inlet pressure during the Sea Trial
  - Record coolant port usage for auxiliary components such as cab heaters

## Sea Trial

The final step in an application review process is to record the engine and vessel performance data during a Sea Trial, in the Sea Trial Review Form. The best time to record this information is when the boat is launched. During the Sea Trial, vessel information is gathered and verified, the engine installation is reviewed, and performance data is recorded. It is important to note the Sea Trial procedure outlined in this guideline is not a measure of the seaworthiness of the vessel; it is only a check of the engine installation and application. **A Sea Trial is a vital step to ensure the engine is reliable, performs as expected, and meets emissions regulations. There may be serious legal repercussions if engines are operating outside of the emissions regulations (reference AG-01.5 for Emissions-related Installation Instructions).**

### Take Photographs

A series of photographs of the installation should be taken to help document the proper application of the engine. These photographs are helpful if future questions arise and for review when compiling the final information. They should be uploaded to the Application Review Depot with the Sea Trial Review Form. Key areas to include in the photographs are:

- Overall vessel
- Serial plate on engine
- Each side of the engine
- Exhaust piping
- Fresh air path
- Auxiliary equipment (serial plates and overall view)
- Marine gear

### Instrument the Engine-Electronic Engines

Before the Sea Trial, review the installation to confirm proper engine oil and coolant levels. Install instrumentation required for the test as listed below and shown in attached guides. If possible, connect Service Advisor to the ECU of the engine being tested to obtain sensor-measured values as well as checking for diagnostic codes; both active

and stored. If codes are found, ensure they remedied before the Sea Trial begins.

Service Advisor or the instrument panel may be used to record the values for the following test parameters

- Engine Speed
- Percent Load
- Fuel Rate
- Coolant Temperature
- Oil Pressure
- Air intake manifold temperature
- Boost pressure

In addition to the information that can be extracted from the ECU using Service Advisor, the following measurements are required. This information is required regardless of cooling system used.

- Air intake restriction
  - Referenced to ambient conditions, ensure no vacuum or positive pressure exists in engine room
- Exhaust temperature
- Exhaust back pressure
  - Referenced to ambient conditions, ensure no vacuum or positive pressure exists in engine room
- Ambient air temperature
- Coolant pump inlet pressure—minimum of 4.4 psi for all engines. If coolant system was not modified in any way, this data point is not necessary to measure
- Coolant pump inlet temperature
- Sea water temperature
- Fuel inlet pressure
- Fuel return pressure
- Fuel return temperature
- Engine room temperature

For heat exchanger cooled engines, the following information is required in addition to the information above:

- Sea water pump inlet restriction
- Sea water pump inlet temperature
- Sea water return temperature—temperature of sea water before exiting the engine (i.e. before entering wet exhaust)

## Instrument the Engine-Mechanical Engines

Before the Sea Trial, review the installation to confirm proper engine oil and coolant levels. Install instrumentation required for the test as listed below and shown in attached guides.

The instrument panel may be used to record the values for the following test parameters

- Engine Speed
- Coolant Temperature
- Oil Pressure
- Air intake manifold temperature (if equipped)
- Boost pressure

In addition to the information that can be viewed on the instrument panel, the following measurements are required. This information is required regardless of cooling system used.

- Air intake restriction
  - Referenced to ambient conditions, ensure no vacuum or positive pressure exists in engine room
- Exhaust temperature
- Exhaust back pressure
  - Referenced to ambient conditions, ensure no vacuum or positive pressure exists in engine room
- Ambient air temperature
- Coolant pump inlet pressure—minimum of 4.4 psi for all engines. If coolant system was not modified in any way, this data point is not necessary to measure
- Coolant pump inlet temperature
- Sea water temperature
- Fuel inlet pressure
- Fuel return pressure
- Fuel return temperature
- Engine room temperature

For heat exchanger cooled engines, the following information is required in addition to the information above:

- Sea water pump inlet restriction
- Sea water pump inlet temperature

- Sea water return temperature—temperature of sea water before exiting the engine (i.e. before entering wet exhaust)

## Propulsion Engines

The engine operating speed is verified during the Sea Trial. The propeller must be sized to allow the engine to run at the appropriate operating speed and load during normal operating conditions. The vessel should be loaded with a full supply of fuel, water, supplies, and passengers (or equivalent weight) to ensure an accurate measure of boat performance.

It is important to make sure that the temperatures and pressures stabilize at each data point (typically 1-5 minutes) before recording the data. The test procedure used will vary based on the type of application.

Propulsion engine tests should be conducted under maximum load conditions for the engine. The appropriate tests for the type of boat operation should be performed. Do not conduct any tests which may damage the boat. Speed measures should be taken in two directions, 180° from each other, in order to have an average run accounting for currents.

### **For all engine ratings not intended for extended Bollard (Dead Shove) operation:**

The maximum full-load operating speed is 40 rpm above published rated speed

### **For Water Jets:**

Jets should be sized to allow the engine to obtain no-less-than rated speed. When calculating impeller size, it is important to account for parasitic losses. A parasitic loss is caused by a component that consumes a portion of the engine's energy, such as an alternator, sea water pump, auxiliary pumps, marine gear and driveline, etc. If the exact quantity of parasitic energy loss is unknown, a good "rule-of-thumb" is to assume the loss will be 5% of bare engine power.

For example, for a typical engine installation with rated power of 400 HP @ 2800 RPM, this “rule-of-thumb” can assume that the parasitic loss is 5%, or 20 HP (400 HP x 0.05=20 HP). In this example, the impeller should be sized to absorb approximately 380 HP (400-20=380 HP) while allowing the engine speed to reach 2800-2825 RPM at full throttle.

*Note: During sea trials, the engine may not reach rated speed if the 100 hour break-in service has not yet been performed. Engine speed at full throttle should be confirmed with the customer after: 1) 100 hours of engine operation and 2) break-in service has been performed.*

### Fixed Pitch, Submerged Propellers:

The engine must obtain at least 25 RPM above rated speed with the vessel in customer’s fully loaded condition with the customer’s operating supplies, a clean hull bottom, and clean and damage-free propellers.

However:

- For Sea Trials conducted before the vessel is 100% completed, the engine must achieve 40 RPM above rated speed with less than 100% engine load. The result from this test is a provisional acceptance of the propeller dependent on follow-up Sea Trial results with correct (or correctly simulated) maximum load, in-service conditions.
- For Sea Trials of 100% completed vessels in “customer delivery condition” the RPM may be less than 40 RPM above rated speed but not less than 25 RPM above rated speed at 100% load.
- For vessels intended for occasional, short duration Bollard operation, the engine must obtain between rated speed and 40 RPM above rated speed under Bollard conditions.
- The owner may operate the vessel until the engine RPM drops below 50 RPM less than rated speed, at which time maintenance is required (hull bottom cleaned, propeller repair, etc.)

### Test Procedure—Free running

1. Instrument engine
2. Warm up engine prior to conducting the test. This will ensure accurate readings during the test
3. Begin recording data at 1000 RPM. Allow the temperatures and pressures to stabilize before recording the measurements

4. Increase engine speed in increments shown on the application review form, recording information on the form. Measurements outside the acceptable range should be flagged
5. Continue to increase speed until the throttle is wide open. Record maximum engine speed. This should be within the limits described above
6. Turn boat 180° and follow the same procedure
7. Review data to ensure that all measurements are within acceptable levels. Make necessary corrections to the system to bring all values within the acceptable levels.
8. If necessary, repeat test to verify corrections have fixed the issue(s)
9. Congratulations! You have now completed the Sea Trial portion of the Application Review

### For engines intended for Bollard (Dead Shove) operation:

The engine must be within 100 RPM of rated speed under Bollard conditions

### Test Procedure—Bollard Pull or Push (Dead Shove)

*Note: If possible, conduct test in a location with at least 10 feet (3 meters) of water depth below the keel of the vessel. In shallow water the water recirculation increases water flow into the propeller which decreases propeller load. Vessels that normally “push” a load should do a Push Test against a dock or other fixed structure. Vessels that normally tow a load or nets behind the vessel should do a Pull Test with a line or cable running from the vessel to a bollard on the dock.*

1. Instrument the engine
2. Warm up engine prior to conducting the test. This ensures accurate readings during the test
3. Begin recording data at 1000 RPM while pushing or pulling against the bank or dock. Once temperatures and pressures stabilize, record the necessary information
4. Increase engine speed in increments shown on the application review form, recording information on the form. Measurements outside the acceptable limits should be flagged
5. Continue to increase speed until the throttle is wide open. Record maximum speed. It should be within the limits described above

6. Make necessary corrections to the system to bring any measurements that are outside the acceptable limits into range
7. If necessary, repeat the test to verify that corrections have fixed the issue(s)
8. Congratulations! You have completed the Sea Trial portion of the Application Review

## Generator Engines

Once generators are installed in the vessel, the operating performance should be checked to verify performance and operating conditions. Generator sets should be run under maximum steady-state electrical load anticipated with the vessel stationary at the dock.

Details on generator engine basics and selection criteria can be found AG-21. Marine gen-sets typically operate as prime power units.

If possible, use a reactive load bank to verify load pick-up and performance at various conditions.

### Test Procedure—on board—no load bank

1. Instrument the engine as described earlier
2. Warm up engine prior to conducting the test. This ensures accurate readings during the test
3. Fully load the engine with the highest load possible. Record measurements
4. Make necessary corrections to the system to bring any measurements that are outside the acceptable limits into range
5. If necessary, repeat the test to verify corrections have fixed the issue(s)
6. Congratulations! You have completed the Sea Trial portion of the Application Review

### Test Procedure—load bank

1. Instrument the engine as described earlier
2. Warm up engine prior to conducting the test. This ensures accurate readings during the test
3. Load engine to 10% load. Record measurements
4. Increase load to 25% load. Record measurements
5. Increase load to 50%. Record measurements
6. Increase load to 75%. Record measurements
7. Increase load to 100%. Record measurements
8. Increase load to 110% (only for Prime Power ratings). Record measurements
9. Values should be within the limits on the performance curve for all test points
10. Make necessary corrections to the system to bring any measurements that are outside the acceptable limits in to range
11. If necessary, repeat the test to verify corrections have fixed the issues(s)
12. Congratulations! You have completed the Sea Trial portion of the Application Review

## Keel Cooler System Analysis

This test should be done to verify that the keel cooler is adequately sized for the engine power

### Analysis Procedure (Reference AG-09.5)

1. Use rated speed operating point temperature for keel cooler outlet (coolant pump inlet) from performance curve
2. Determine maximum anticipated sea water temperature. Calculate the temperature difference between the maximum temperature and the current sea water temperature
3. Add the sea water temperature difference to the keel cooler outlet temperature. If the new value is less than 212°F (100°C) then the keel cooler is adequately sized for the engine. If the value is more than 212°F (100°C) then the keel cooler is not large enough for the engine
4. Measure the keel cooler inlet and outlet pressure. The pressure difference should be less than 6 psi (40 kPa) for propulsion engines, 4 psi (28 kPa) for 1800 RPM gen-set ratings and 3 psi (21 kPa) for 1500 RPM gen-set ratings



## **Serviceability Checklist and Sea Trial Recommendations**

The last page of the Sea Trial Review Form contains a serviceability checklist that is intended for review between the vessel representative and the engine representative. A thorough evaluation of all items listed on the sheet is suggested in order to ensure that serviceability at a later date, if needed, is easily accomplished. This will also give the vessel representative a chance to get familiar with the service points of the engine.

Complete the serviceability checklist and discuss any items considered “poor”. In the recommendations section, record any items discussed and any changes that will be made to remedy these issues.

Use the Operator’s Manual to review coolant and oil requirements and service intervals.


Also in the recommendations section, record any issues found during the Sea Trial and any actions needed to remedy these issues.

After agreement on data collected and recommendations provided, all parties involved in the Application Review shall sign the last page of the Application Review Form. At this point all portions of the Application Review have been completed.

## Test Instrumentation

Sea trial kit JDG11800 should be used when possible.


If performing a sea trial without the Sea Trial Kit, the following image shows typical instrumentation needed to perform a sea trial. Exact equipment will vary based on specific engine being tested.



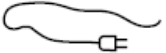
**Pressure/Vacuum Gages**

- 1- ±10 psi gage
- 1- 20-50" H<sub>2</sub>O vacuum gage
- 1- 60-80" H<sub>2</sub>O gage
- 1- 15 psi gage
- 1- 30 psi gage
- 1- 60 psi gage


Equip gages with desired fittings for 1/8" OD pressure sensing lines



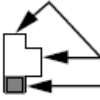
5- pieces 4" K-type thermocouple probes to 1/8" NPT-M thread




4- pieces K-wire temperature sensors



6- pressure sensing lines, 1/8" OD & 6-10' long




3- pieces T-fittings, 1/8" NPT-F and 1/8" NPT-M



**Adapter Fittings:**

- 6- 1/8" NPT-M to 1/8" OD Hose
- 4- 1/4" NPT-M to 1/8" NPT-F
- 2- 3/8" NPT-M to 1/8" NPT-F
- 1- 1/2" NPT-M to 1/8" NPT-F



1- copper line 12-18" long, 1/8" NPT-M to 1/8" OD hose fitting

**HAND TOOLS**

QTY	DESCRIPTION
1	3" straight screwdriver
1	8" adjustable open-end wrench
1	Small wire cutter
1	Clipboard
1	Flashlight
1	Tape Measure (10 ft or 12 ft)
1	Set of open/box-end wrenches (3/8" to 1")
1	Set of hex-head wrenches
1	3/16" square drive

**SPECIAL EQUIPMENT**

QTY	DESCRIPTION
1	Carrying case
1	Digital thermometer, hand-held, battery-operated
1	Minimum 10-channel selector switch, K-wire compatible
1	Hand-held tachometer
1	Angle gage or 8" carpenter's level and 8" rafter square
1	Camera with film

**MISCELLANEOUS PARTS** -- Nylon ties (24); Duct tape; Teflon tape

# Marine Engine Application Review; Sea Trial

Date	Section Owner	EIB	Page(s)	Description of change(s)
2009 May	Nathan Stabile	- - -	AG 25-5 -4; All pages	<ul style="list-style-type: none"> <li>• Additional detail added under “For Water Jets” to compensate for parasitic losses.</li> <li>• On all pages, heading changed to “Marine Electronic Engine Application Review.”</li> </ul>
2012 Dec	Nathan Stabile	- - -	AG 25-5	Under “For engines intended for Bollard (Dead Shove) operation:” the stated speed range was changed to 100 rpm.
2016 Jun	Nick Pfeiffer	- - -	AG 25-5; all pages	<ul style="list-style-type: none"> <li>• Combined AG-25 and AG-25.5 into one document</li> <li>• Provided updated instrumentation information</li> <li>• Added a new Application Review document.</li> <li>• Added Sea Trial Port Guides.</li> </ul>
2016 Aug	Nick Pfeiffer	- - -	Attachment	Revised “Sea Trial Application Review” document.
2016 Oct	Nick Pfeiffer	- - -	Attachment	Replaced “Sea_Trial_App_Review_2016Aug12.xlsx” with revised file, “Sea_Trial_App_Review_2016Oct14.xlsx”
2017 May	Nick Pfeiffer	- - -	Attachment	Replaced “Sea_Trial_App_Review_2016Oct14.xlsx” with revised file, “Sea_Trial_App_Review_2017May18.xlsx.” This update adds missing channels to sea trial data form.
2017 Aug	Nick Pfeiffer	- - -	Various pages; Excel file; Port Guides	<ul style="list-style-type: none"> <li>• Minor updates in multiple locations</li> <li>• Added gen-set sheet; Channels added to performance table.</li> <li>• Port Guides: Updated for sea trial kit usage.</li> </ul>