SuperFlow
DYNAMOMETERS & FLOWBENCHES
A Division of Power Test, Inc.

Operator Manual

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Original Instructions

www.SuperFlow.com

SF- 902S
Engine Dynamometer

Trademark Notices

Please keep this manual for future reference.

This manual is intended to assist operating personnel in becoming familiar with the product and as guidance in ordering necessary parts inclusive of SuperFlow's warranty requirements. Maximum operating efficiency and life of any SuperFlow product will be attained through complete understanding of the instructions and recommendations contained within this manual.

⚠ WARNING

Services performed beyond preventive maintenance by personnel other than SuperFlow Service Technicians on any SuperFlow products during the warranty period may void the warranty.

IMPORTANT

When available, please include the model number and serial number of the product in any correspondence.

Table of Contents

Table of Contents

1.0 Introduction

1.1 About This Manual

This manual is provided as a reference to explain the operation of the SuperFlow dynamometer system as used on an engine test system and also covers the operation and maintenance of the SF-902S engine test stand.

An electronic PDF copy of this manual is provided on the system configuration thumb-drive sent with the SuperFlow system.

IMPORTANT
 **Please read the complete manual in detail, prior to operating the dynamometer. Contact SuperFlow immediately if you experience problems to avoid any warranty issues.**

1.2 Target Audience

This manual is intended to be used by skilled operators trained in the operation of the equipment by a SuperFlow representative.

1.3 Product Features

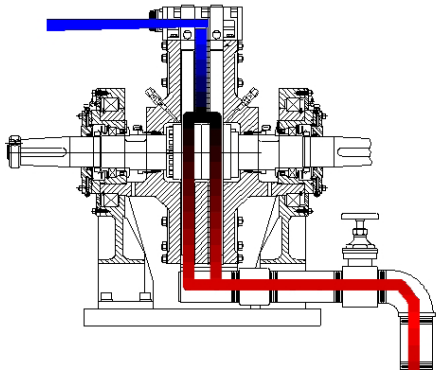
- A system consists of two major components:
  - Dynamometer stand with a Power Absorption Unit (PAU).
  - Data Acquisition and Control (DAC) system – Computer system with WinDyn software.

1.0 Introduction

1.4 Principles of Water Brake Dynamometer Operation

An engine dynamometer (dyno) is a service tool that allows the operator to safely place a controlled load on an engine. A loaded engine test is the only method of verifying engine capability. With the use of a dyno, an engine can be properly operated throughout its power range without being placed into service. Assembly deficiencies may be detected before the engine is installed into a chassis and an actual evaluation of an engine's operating condition may be performed. The dynamometer is the final quality test before an engine is installed.

A dynamometer has two major components: the absorption unit and the torque indication system. A water brake dynamometer uses an absorption unit (absorber) to absorb power through momentum exchange; using water as the working fluid. A water brake absorber consists of one or more shaft mounted rotors and at least two stators (or end bells). The rotors spin freely inside the absorber housing in the absence of water. When water is introduced into the absorber, the spinning rotor accelerates the water and "throws" it into the stators. If the stators weren't restrained, they would also begin to rotate, similar to a torque converter. But the stators are restrained using a torque arm that is connected to a load cell.



The load cell measures the force with which the stators are trying to rotate. By knowing the distance from the axis of the absorber to the torque arm, torque can be measured by: T = F x d

If we measure speed, horsepower can then be found by the relationship: HP = (T x rpm)/5252
The amount of load absorbed is proportional to the volume of water inside the absorber housing. The water is ultimately absorbing all of the horsepower in the form of heat, therefore the warm water must be exhausted and replenished with cool water to avoid boiling. By restricting the exhaust and controlling the flow of water through the absorber, the volume of water inside, and therefore the load, can be precisely controlled.

2.0 Safety Guidelines

Safety is the most important consideration when operating any dynamometer system. Operators and service personnel should read this manual and become familiar with its content before attempting to operate this machine or to perform service or maintenance to it. Familiarization with this manual will minimize the possibility of accidents or injuries. Although the procedures covered in this manual have proven safe in use, Power Test assumes no responsibility for personal injury or damage to equipment resulting from its applications. All operators must be aware that there are several hazards present to anyone in the test cell. Some of these hazards are:

- Objects rotating at high speeds
- Electrical shock
- Noise
- Pressurized hoses
- Flammable liquids
- Hot solids or liquids
- Exhaust emissions

Certain precautions must be exercised. They are:

- DO NOT operate without ALL shields, guards, and emergency cutoffs in place and operating.
- DO NOT enter the test cell during an engine test unless necessary.
- DO NOT wear loose fitting clothing in the test cell.
- Warning decals are located near areas of potential danger. Replace damaged or lost decals.
- DO NOT make any connections while power is applied to the system.
- DO NOT open any panels while power is applied to the system.
- DO NOT make any plumbing connections without shutting down all water supplies and pumps.
- DO bleed air pressure from all lines before connecting or disconnecting any air hoses.
- ALWAYS wear eye protection.
- ALWAYS wear eye and hearing protection whenever the engine is operating.
- ALWAYS keep work area clean. If a spill occurs, eliminate the hazard immediately.
- NO smoking or open flame in the test area.

These are general guidelines for working with a dynamometer system. It is often helpful to prepare a safety checklist that is distributed to all personnel who enter the test cell. Proper safety is achieved through reinforcement and discipline.

This manual places safety concerns into four categories, they are:

⚠ DANGER

This is the highest level statement. Failure to follow the listed instructions will most likely result in severe injury or death.

⚠ CAUTION

The statements used with this level of warning deal with a safe operating procedure. If they are ignored the possibility of equipment damage or personal injury may exist.

⚠ WARNING

This is a statement of serious hazard. Failure to follow the listed instructions could place the individual at risk of serious injury or death.

IMPORTANT

IMPORTANT indicates precautions relating to operation or usage of the machine or highlights important information on a page.

2.0 Safety Guidelines

The following universal warning decals can be found in the appropriate locations on your equipment. A description of each warning decal is provided below. In addition, these symbols will appear throughout the manual in sections where these hazards may be encountered.

Refer to Manual
- Read and understand manual before operation.
- Failure to understand manual may result in personal injury and/or death.

Wear Eye and Hearing Protection
- Rotating components could cause flying debris.
- Noise levels can reach up to 85 decibels (dB) during machine operation.

Warning
- General warning label.
- Indicates an imminent hazard.

Entanglement Hazard
- Keep hands and arms free of rotating shaft.
- Ensure system has stopped and starting has been disabled prior to servicing.
- Do not operate without all guards and covers in place.

Automatic Starting Hazard
- Equipment can be started remotely.
- Ensure dynamometer system starting has been disabled prior to servicing.

Burn Hazard
- Hot components, water and/or oil.
- Do not touch during operation or while cooling.
- Allow to cool before disconnecting.

Electric Shock
- Exercise caution when working on or nearby. Make certain that power has been disconnected and all residual voltage has been taken under consideration. Unqualified personnel should never attempt electrical work.

Electrostatic Discharge
- Printed Circuit Boards (PCBs) and other electronic devices contain static-sensitive parts. Observe the following precautions to prevent damage to these parts.
- Discharge body static before handling electronic devices.
- Use wrist or ankle straps to contact a grounded surface and maintain contact while handling electronic devices.
- Turn power to the device OFF before disconnecting or connecting cables or wires.
- Do not touch the components or conductors on a PCB with your hands or with conductive devices

Carbon Monoxide (CO) Hazard
- Engine exhaust contains carbon monoxide fumes, be sure test cell is properly ventilated
- If anyone shows signs of carbon monoxide poisoning, get them to fresh air. Fumes can cause headache, dizziness, lack of consciousness and/or death.

Contact Power Test if you have any questions about the safe operation of our equipment and for service and advice.

2.0 Safety Guidelines

2.1 At Installation

⚠ WARNING

- **Do NOT lift the dynamometer by the input shaft. This may damage the dynamometer and void its warranty.**

⚠ CAUTION

- **Take care that the dynamometer is not dropped or set down sharply. This could cause damage to the bearing races and brinelling of the bearings.**
- **The load cell should be handled with equal care. Distortion of this cell will hinder its proper operation.**

2.2 During Operation

⚠ DANGER

- **Extreme care should be taken in the area of the drive shaft that connects the engine to the dynamometer.**
- **All rotating parts must have their guards secured in place.**
- **A drive shaft is considered the fuse in the test setup. In the event of a failure in the engine or dynamometer, the shaft may break. This will save on costly repairs to an engine or dynamometer. However, because of this possible failure, the machine should NEVER be operated without a shaft guard.**

⚠ DANGER

- **Engine exhaust contains carbon monoxide fumes, be sure test cell is properly ventilated**
- **If anyone shows signs of carbon monoxide poisoning, get them to fresh air. Fumes can cause headache, dizziness, lack of consciousness and/or death.**

⚠ WARNING

WEAR EYE and HEARING PROTECTION. Proper eye and hearing protection should be worn at all times when the equipment is operating.

⚠ WARNING

AUTOMATIC STARTING HAZARD. The dynamometer could be started remotely. Ensure starting has been disabled prior to servicing.

⚠ WARNING

BURN HAZARD. During operation water temperature inside the dynamometer can reach over 125° F. Do NOT touch discharge water, piping or the dynamometer surface during operation. Allow to cool before servicing.

2.0 Safety Guidelines

⚠ WARNING

- **Inspect the equipment monthly to ensure that there are no broken or worn parts which could cause injury to personnel or damage to the equipment.**
- **Only qualified operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ CAUTION

- **Personnel should NOT be in the test cell during operation and observation areas MUST be constructed to protect personnel.**
- **Personnel and other equipment should be kept clear of the drive shaft guard area and NEVER cause an obstruction or block doorways.**

IMPORTANT

The dynamometer is a tool. All personnel should be kept clear of the area and only be in the test area on a "need to be" basis.

2.3 Lockout/Tagout Procedures

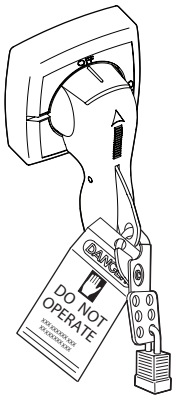


Figure 2.1: Lockout/Tagout

⚠ WARNING

When working with electrical or electronic controls, make sure that the power source has been locked out and tagged out according to OSHA regulations and approved local electrical codes.

The Occupational Safety and Health Administration (OSHA) requires, in addition to posting safety warnings and barricading the work area (including, but not limited to, control room and testing bay), that the power supply has been locked in the OFF position or disconnected. It is mandatory that an approved lockout device is utilized. An example of a lockout device is illustrated in figure 2.1. The proper lockout procedure requires that the person responsible for the repairs is the only person who has the ability to remove the lockout device.

In addition to the lockout device, it is also a requirement to tag the power control in a manner that will clearly note that repairs are under way and state who is responsible for the lockout condition. Tagout devices have to be constructed and printed so that exposure to weather conditions, or wet and damp locations, will not cause the tag to deteriorate or become unreadable.

Power Test does not recommend any particular lockout device, but recommends the utilization of an OSHA approved device (refer to OSHA regulation 1910.147). Power Test also recommends the review and implementation of an entire safety program for the Control of Hazardous Energy (Lockout/Tagout). These regulations are available through OSHA publication 3120.

3.0 System Overview

3.1 Overview

The WinDyn dynamometer software system is an instrumentation package designed for complete test control and data acquisition of an engine or chassis dynamometer. Typical applications include:

- Research and development (R&D)
- Performance testing
- Durability and quality control testing
- Fuel consumption and emissions testing
- Education
- Certification testing

You can configure WinDyn for your specific testing needs and can expand it with additional data acquisition capabilities and interfaces as needed. For highest productivity, you can share test data over a facility computer network.

A dynamometer system consists primarily of two major components: the Power Absorption Unit (PAU) on a stand with its associated equipment, and the Data Acquisition and Control (DAC) system with its associated accessories.

- The absorber stand also holds auxiliary equipment such as a flow measurement system, and an engine cooling system.
- The DAC system is made of the Central Processing Unit (CPU), an operator control interface, a device to control the load applied to the absorber, and a network of sensors to collect data from the absorber and the engine. The WinDyn software on a stand-alone Personal Computer (PC) allows users to display and analyze the data during and after a test.

The purpose of using a dynamometer is to test the performance of an engine prior to putting it back in service. It allows for the break-in of a new or newly rebuilt engine in a controllable environment. Typically the SF-902S system is distributed to racing engine manufactures or rebuilders. They have proven this type of break-in procedure through many years of experience. Properly run-in engines last longer, run better and cost less to maintain.

3.0 System Overview

3.2 Dynamometer

The dynamometer stand provides all of the connections from the sensors to the data acquisition system and the mount for the power absorber.

SF-902S

The SF-902S system utilizes a floor-mounted absorber stand and a roll-around engine docking cart to maximize test efficiency in high-volume environments. The versatile docking engine carts are used to pre-stage and dress the engines before they are installed in the test cell. The dynamometer stays in the test cell connected to all its supply lines and support systems. Roll the engine into the cell, dock the cart to the dyno, and attach the fuel supply, airflow turbine, oil and coolant lines, and sensors. The cart is clamped to the absorber stand for testing.

The boom provides clean routing of cables, fuel lines, and cooling pipes. It keeps all the accessories and engine support lines close and available when needed.

The docking cart and boom system keep the test cell safe, organized, and attractive while allowing rapid engine changes. Additional mounts for ignition boxes and work tools can be added if desired. Optional features include cooling flow measurement, and temperature control on oil and engine coolant.

High-speed bearings are available for both the SF-833 and SF-871 to increase the capability when testing at extended intervals at speeds greater than 12,000 rpm. The standard bearings can handle speed up to 12,000 rpm as long as it is for short durations. High-speed testing (>10,000 rpm) shortens the life span of the bearings. The rate of degradation is strongly linked with lubrication. Fresh oil is better than older, contaminated oil.

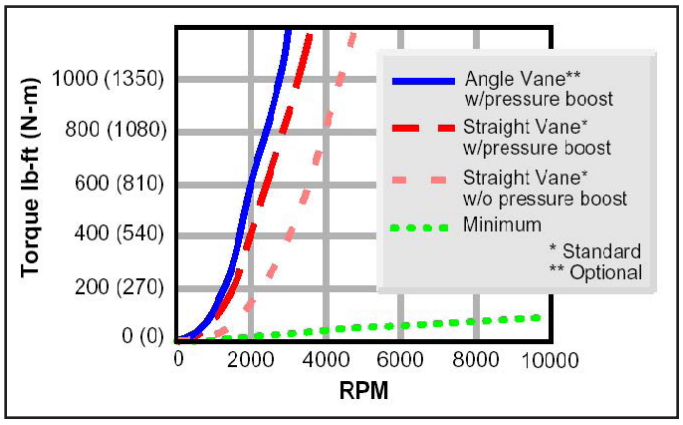


Figure 3.3: SF Water Brake Absorber Torque Capacity

Specifications

- Maximum absorber speed
  - Standard bearings: **10,000 rpm**
  - High-speed bearings: **14,000 rpm**
- Tachometer (magnetic pickup on 60-tooth gear)
  - Range: **0–22,000 rpm**
- Torque (Temperature-compensated strain gauge)
  - Standard strain gauge: **0–1,000 lb-ft (0–1350 N-m) x 0.3 ± 0.2% fs**
  - High-torque strain gauge: **0–2,000 lb-ft (0–2,700 N-m) x 0.3 ± 0.2% fs**
  - Compensated temperature range: **0–150°F (–15° to 65°C)**

3.0 System Overview

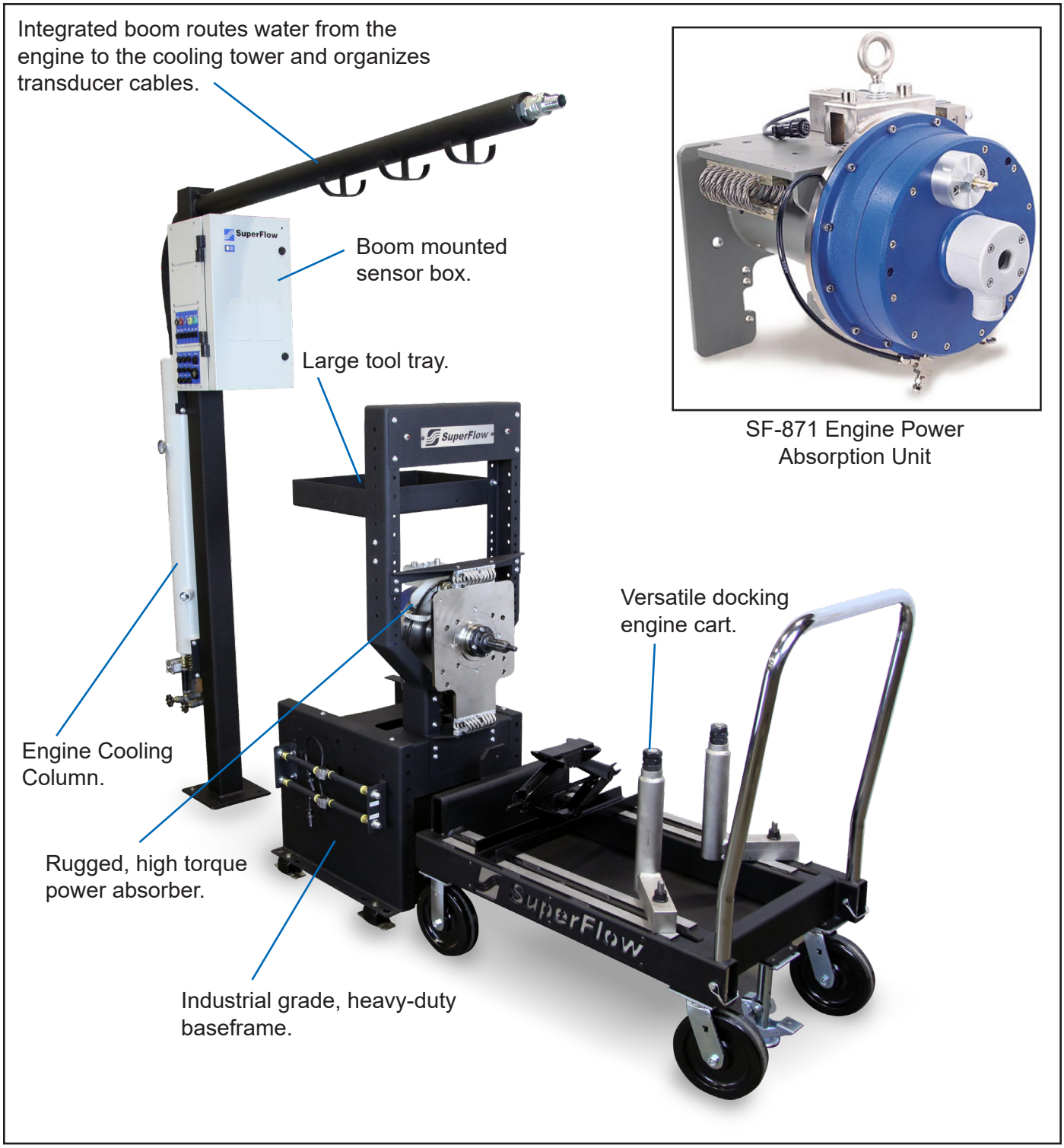


Figure 3.1: SF-902S Engine / Absorber Stand

3.0 System Overview

Water Quality

The quality of the water used in a dynamometer affects absorber and water pump operation. Contamination, salt water, or water with a high mineral count can reduce their life and increase maintenance costs. The load control valve and water seals in the absorber can quickly deteriorate with bad water. Provisions should be made to prevent the growth of algae and bacteria, as well as corrosion or scale formation within the equipment. Water system maintenance is essential to efficient operation, consult a water system specialist to create the proper program to monitor your system.

Filters:

For both open water and recirculating systems, install a filter to clean the water before it enters the dynamometer and engine cooling tower. Install a differential pressure gauge across the filter to determine when the filter needs cleaning. The water should be filtered to remove 0.004- inch diameter particles [100 microns]. In recirculating systems, a filter installed on the return water line back to the supply tank helps keep particles from the engine and dynamometer from getting into the supply water system.

3.0 System Overview

3.3 Data Acquisition

Components

A WinDyn data acquisition system consists of at least two components. They are the sensor system and the computer system.

NOTE: Additional options and accessories that can be added to the system are described later in this chapter.

The Sensor Box

The sensor box consists of a set of data acquisition and control electronics mounted inside a sheet metal sensor box and is the central core of data acquisition. The box is normally mounted on the absorber stand but can be installed on a boom, the wall, a rolling stand, or on other support apparatus.

The sensor box contains the CPU circuit card, sensor panels, and system interconnect panels.

The CPU measures and records all data and generates control signals, then broadcasts this data over an Ethernet network to display on the WinDyn computer software.

The sensor box has slots for expansion panels such as thermocouple panels, pressure panels, analog inputs panels, and so on.

The system inputs signals from various sensors and converts those signals into a digital format. Airflow, fuel flow, and engine speed are measured as frequencies. A load cell measures torque as an analog voltage. Pressures and temperatures are also measured as analog voltage. A barometric pressure transducer is mounted on the CPU to measure atmospheric conditions during the test. Other sensors can be added as needed.

Figure 3.2: The Sensor Box

IMPORTANT
Do NOT adjust any of the potentiometers on the 2640 board. Contact your representative if you have any questions about the safe operations of our equipment and for service and advice.

3.0 System Overview

The Computer System

The computer system consists of a standard computer with up to three monitors installed, a color printer, and WinDyn dynamometer software. Other than the network connection and minimum performance specifications, no special requirements must be met.

SuperFlow's WinDyn dynamometer software was designed for Microsoft® Windows®-based computers.

The computer communicates with the sensor system through an Ethernet Local Area Network (LAN) cable. Commands to the test system can only be issued from this computer.

All printers supported by Windows can be used. A color printer is recommended for highest impact and clarity of test graphs. The printer is connected to the computer.

Figure 3.3: Operator Console

IMPORTANT

SuperFlow recommends dedicating the computer connected to the dynamometer for dynamometer use only and not utilizing it for other purposes. Multiple programs and Internet access could possibly slow down the computer and affect the dynamometer operation.

Electrical Requirements

The WinDyn instrumentation system requires a dedicated, stable electrical power source for proper operation. SuperFlow recommends using an Uninterruptible Power Supply (UPS) that has a minimum rating of 750 VA or a high-quality surge suppressor for the sensor box and computer. This may protect the electronics from damage in the event of a power surge and keep the engine running if the power goes out. It is best to connect all instrumentation devices to the same circuit to minimize ground loop noise. Adding devices such as battery chargers and fan motors to the same circuit can cause noise problems.

The total power requirement for a basic instrumentation system is 120V/15A or 240V/8A.

TIP: Your electrician can wire the electrical circuits in your test cell with outlets for the sensor box and computer wired to a special protected circuit.

3.0 System Overview

Sensor Panel Modules

System Interconnect Panel (LEMO)

The system interconnect panel provides the primary connection between the sensor box and the peripheral devices (computer, relay box, etc.). The panel also provides connections for some sensor inputs.

- Color-coded and keyed LEMO connectors
- Brown - Remote handheld controller serial port
- Red - Air sensor frequency inputs
- Blue - Air temperature and humidity sensor inputs
- Yellow - Auxiliary frequency input (Tach./Freq.)
- Green - Engine speed sensor input (May also be used for frequency type devices)
- RJ-45 Category 5 (Cat-5) serial connectors

Figure 3.4: System Interconnect Panel

Sensor Interconnect Panel (AMP)

The sensor interconnect panel provides the primary connections between the sensor box and the dynamometer sensors.

- Absorber speed and torque sensor connections (engine dynos)
- Dynamometer interface (chassis dynos)
- Servo valve connection (engine dynos)
- Electronic throttle connection
- Auxiliary voltage sensor inputs
- Fuel turbine frequency inputs
- Auxiliary control outputs
- Digital input and output connections

Figure 3.5: Sensor Interconnect Panel

NOTE: SuperFlow recommends capping or covering any unused AMP connector.

3.0 System Overview

Thermocouple Input Panel

The thermocouple panel provides 16 channels for temperature measurements on the test device.

- 16 channels per panel
- Type K, (grounded or ungrounded)
- Type K thermocouple range, -454° to 2,300°F (–270° to 1260°C), linearized
- Universal panel jacks accept both standard and miniature connectors

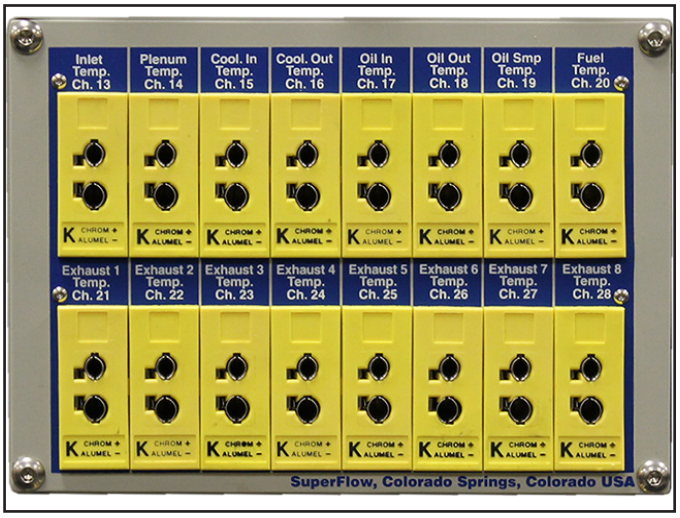


Figure 3.6: Thermocouple Input Panel

Pressure Input Panel

The pressure panel provides up to 10 channels of pressure measurements on the test device. The standard system ships with three channels installed. These are:

- Channels 63, 67 & 68: 0–150 psi [0–1034 kPa]

  63 = Man_P

  67 = Oil_P

  68 = DynWTP

Figure 3.7: Pressure Input Panel

3.0 System Overview

Engine Control Panel

The engine control panel has five outputs electrically controlled by console switches or by programmed test profiles. Four outputs provide 12V switched DC power for ignition, starter, fuel pump, and auxiliary control.

- Internal, automatic reset, 50A thermal breaker on input source, automatic reset, 10-amp polyfuse on ignition output; 14 amps on the starter and fuel pump outputs and 5 amps on the auxiliary output
- Emergency stop functions when used with WinDyn limits or emergency stop switches
- Provides one unswitched, 10-amp, fused 12V connection for external devices
- Connection for remote starter switch (not used on SF-902S systems)

Figure 3.8: Engine Control Panel

⚠ CAUTION

DO NOT use the Magneto Kill Ground connection.

3.0 System Overview

3.4 Accessories and Options

A wide selection of additional sensors, adapters, and engine accessories are available. Contact SuperFlow Sales or Customer Service for additional details.

Analog Voltage Input Panel

The analog voltage panel is an optional accessory that provides up to eight channels of voltage measurements on the test device.

- Eight channels per panel
- Adjustable gain and offset. Available gain headers are: 0-1, 0-5, 0-8, 0-10, 0-20 & 0-30
- Color-coded and keyed 11-pin LEMO connectors

Recommended levels of excitation and reference voltages available on each of the front panel connections for sensors or other devices:

- +5F: +5VDC @ 100 mA, poly-fused at 0.1A
- +12F: +12VDC @ 500 mA, poly-fused at 0.5A

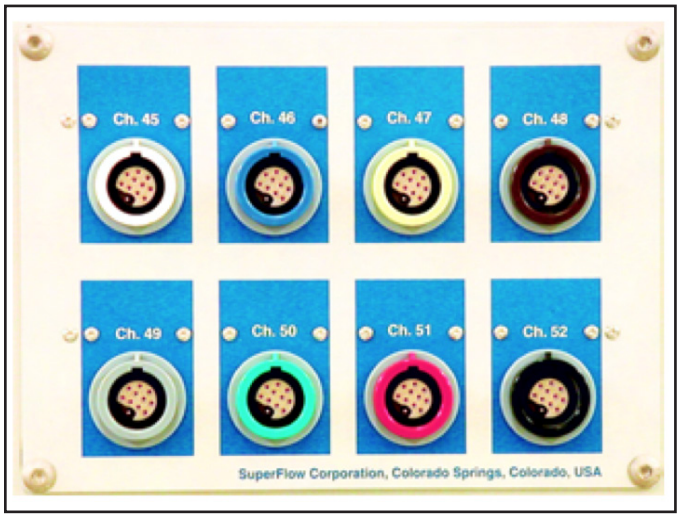


Figure 3.11: Analog Voltage Input Panel

Air Fuel Kit

AEM's 4-Channel Wideband UEGO Controller allows users to simultaneously monitor individual cylinder Air/Fuel Ratios (AFR) on up to four cylinders. Pair multiple units together for use on 6, 8, 10 or 12 cylinders.

- Allows for monitoring of individual cylinder AFRs for maximum engine power and safety
- Two status lights per sensor for error detection and operating status
- Compact (4.8" x 4.55" x 1.44"), weather & shock proof enclosure
- Accurate to 0.1 AFR
- Refer to the AEM Performance Electronics Wideband UEGO Controller instruction manual for detailed information.

Figure 3.12: Air/Fuel Monitor

3.0 System Overview

Fuel System

The fuel system consists of a high performance fuel pump and fuel regulators to provide two measured and regulated engine fuel channels. The system is rated up to 800 lbs/hr total delivery with both channels used.

- Range per channel @ 7psi: 0–400 lb/hr (100 g/s) x 0.1 ± 0.5% fs
- Specific gravity range: 0.40–1.40

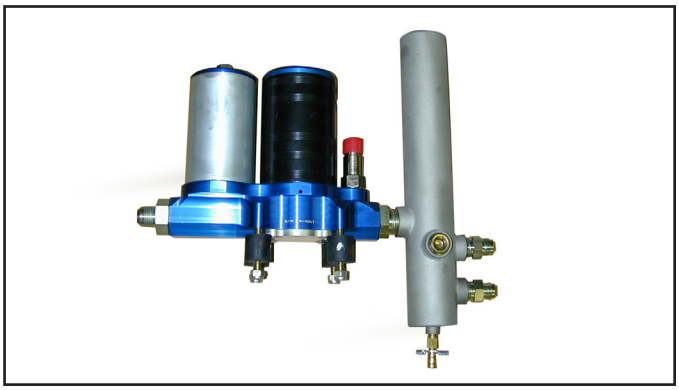


Figure 3.13: Fuel System

Fuel Canister

Designed to measure fuel consumption of fuel injected engines.

- Mid flow unit available in 20 – 720 lb./hr.
- High flow unit available in 30 -1070 lb./hr.
- Available for gas or alcohol.

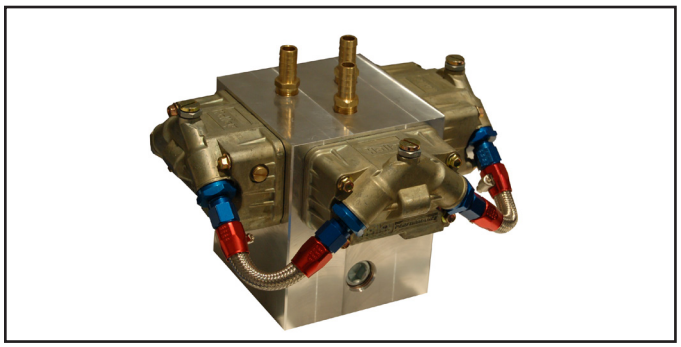


Figure 3.14: Fuel Canister

Electric Throttle Control

Electric throttle actuators provide engine throttle automatic control by the Data Acquisition Control System (DACS). They can also allow automated testing while providing manual operator control.

Figure 3.15: Throttle Control

3.0 System Overview

Oil Coolers

A constant engine temperature is vital in dynamometer testing, especially during endurance tests. Figure 3.15 shows a multi-pass heat exchanger with the water inlet controlled by a mechanical thermostat valve. It can be mounted on the absorber stand, the engine cart, or in an alternative convenient location.

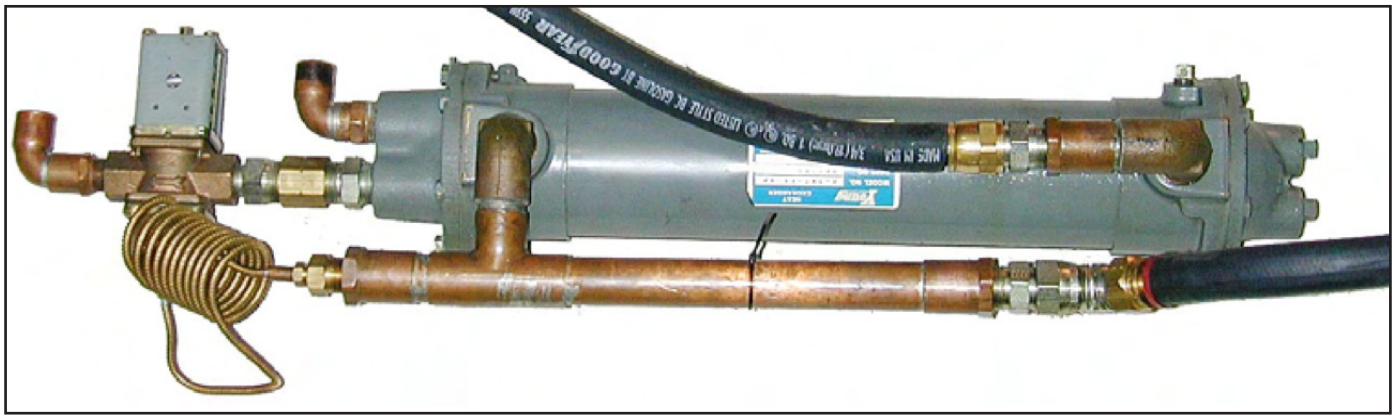
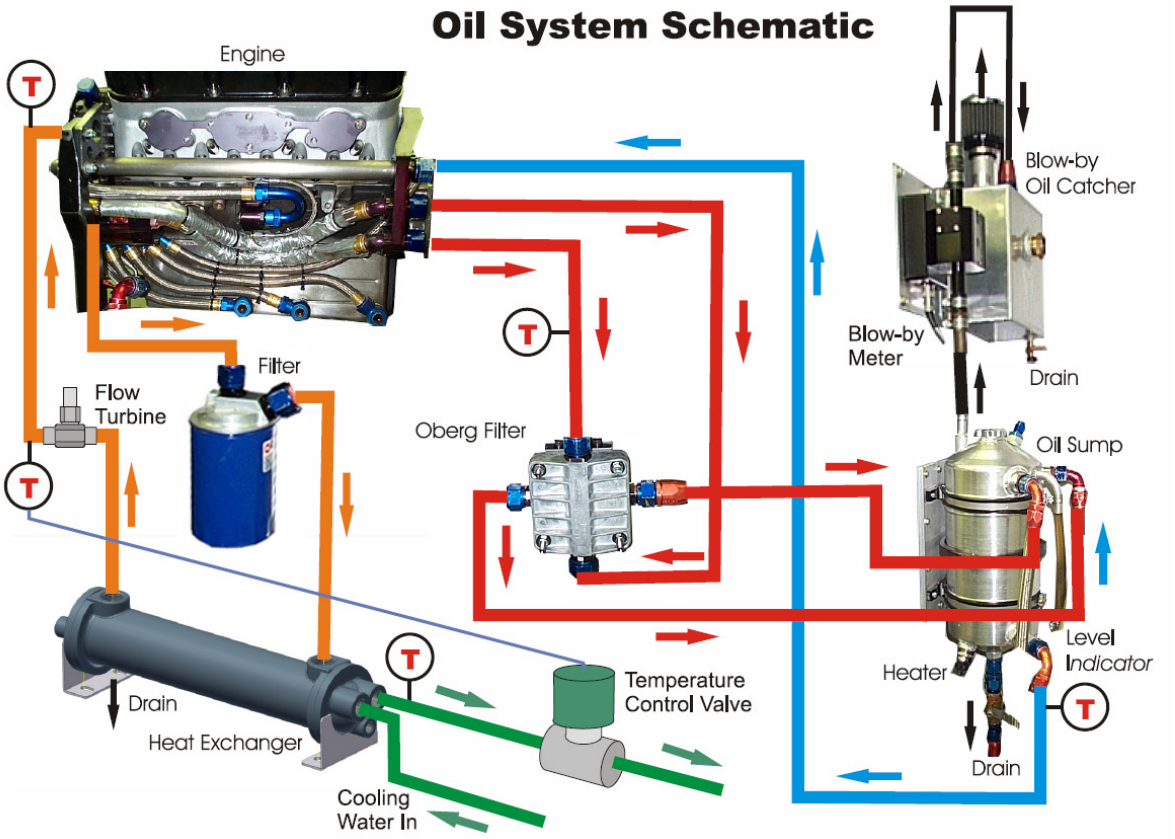


Figure 3.15: Oil Cooler



3.0 System Overview

Engine Cooling Towers

The cooling tower replaces the radiator for water-cooled engines (see Figure 3.16). The thermostat on the cooling tower can be set to control the engine water temperature to a specific setting. The SF-902S CT600 cooling tower is mounted on the boom support assembly.

The standard CT-600 cooling tower controls the engine coolant temperature to between 115° and 185°F (46° and 85°C) and is non-pressurized. It is easy to operate and maintain because it uses the same water for both the engine and the absorber.

Use the optional pressurized CT300P, CT700, or CT1001 cooling towers for higher temperatures (160/ 230°F, 71/110°C) or with antifreeze mixtures. Pressurized cooling towers have separate chambers for engine cooling water and heat exchanger cooling water so you can use Glycol solutions in the engine without having to add Glycol to the dyno water supply. A pressurized cooling tower makes it easier to detect head gasket leaks and provides better temperature stability.

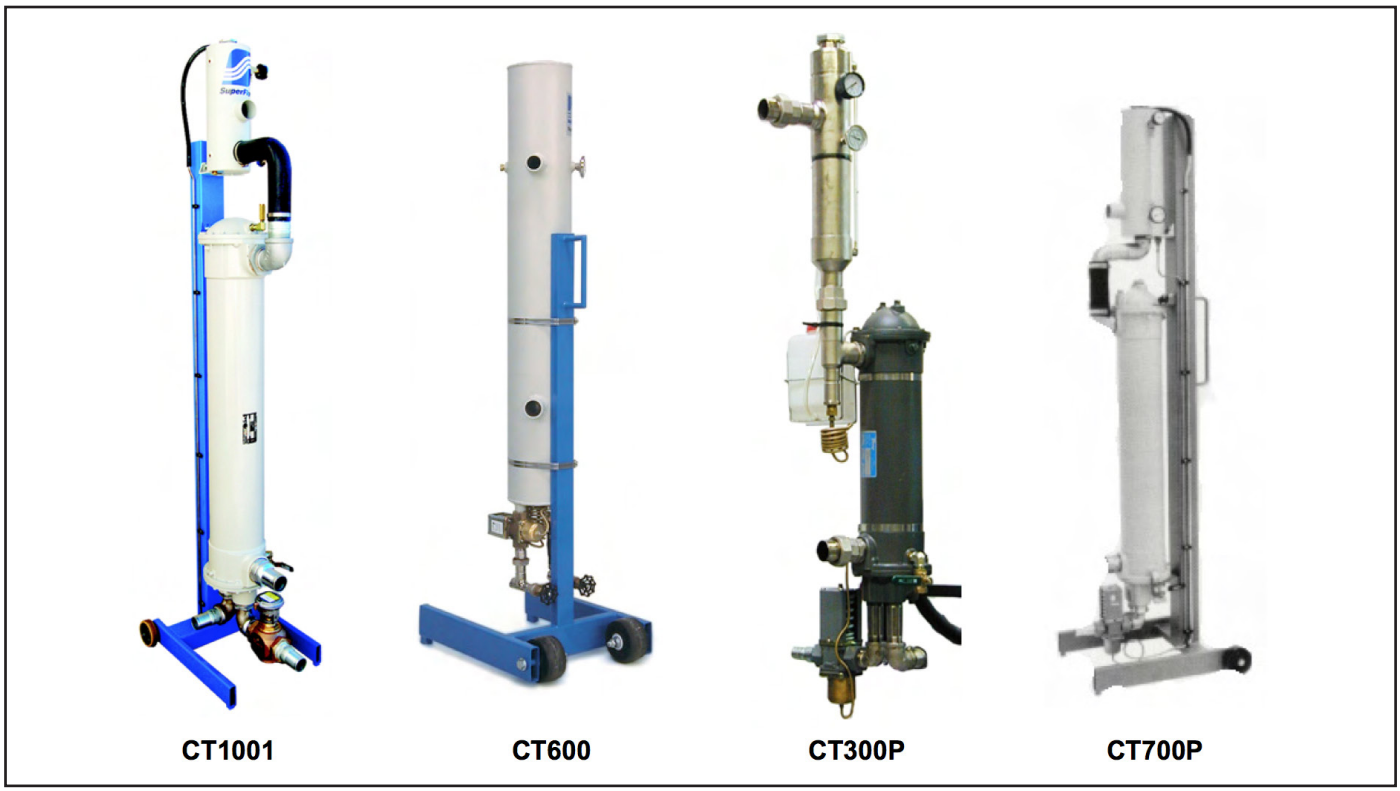
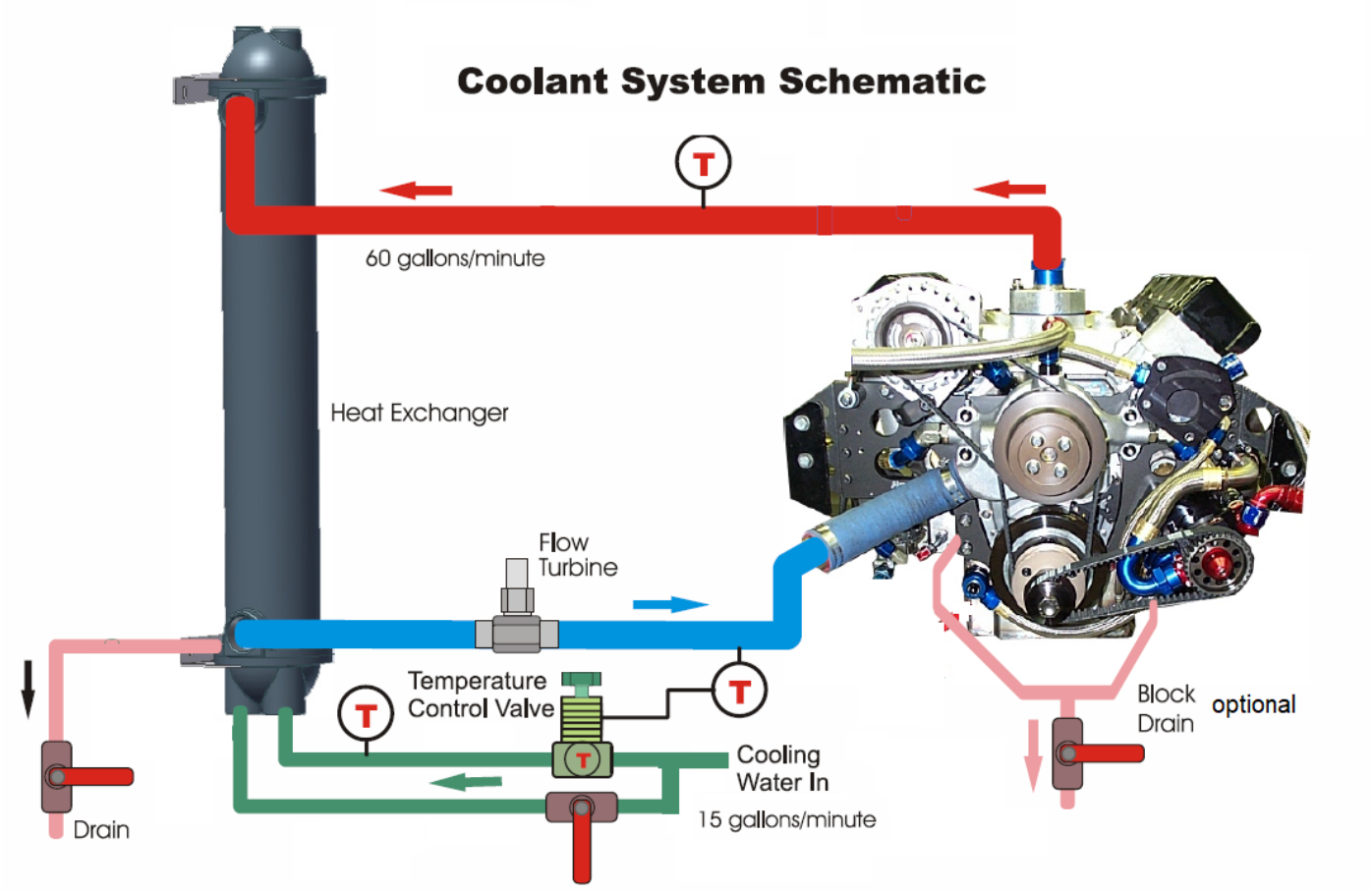


Figure 3.16: Engine Cooling Towers

A temperature gauge on the cooling tower monitors the cooling tower conditions. The CT300, CT700, and CT1001 also have a pressure gauge. The temperature and pressure measurements for all four cooling towers can be integrated into the data acquisition system.

3.0 System Overview



Volumetric Blow-by

The JTEC VF563 series flow meter provides exceptional accuracy. The sensor measures blow by in Actual cubic feet per minute (ACFM) units.

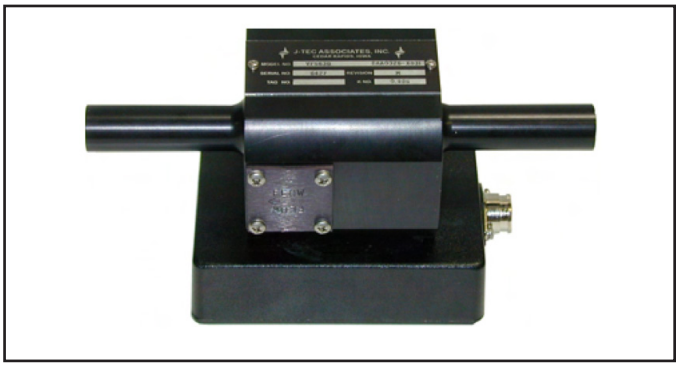


Figure 3.17: Blow-by Sensor

3.0 System Overview

SuperStart

SuperFlow's SuperStart option positions the starter on the dynamometer, saving setup time by eliminating the need for a starter on the motor. The SuperStart lets you start engines without starter bosses such as sprint car engines.

The SuperStarter can be configured for several applications:

- Dual starters, clockwise or counterclockwise rotation
- Single starter, clockwise or counterclockwise rotation
- Dual starters, bidirectional

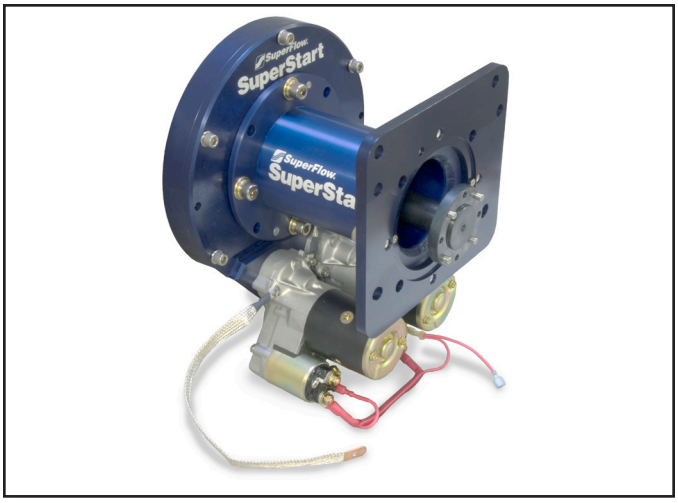


Figure 3.18: SuperStart

Additional Docking Cart

An extra docking cart to save time between engine tests. Pre-stage one engine while another is being tested.

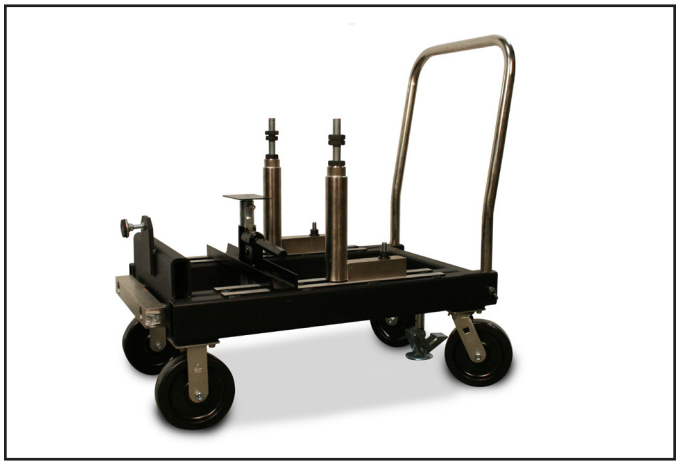


Figure 3.19: Docking Cart

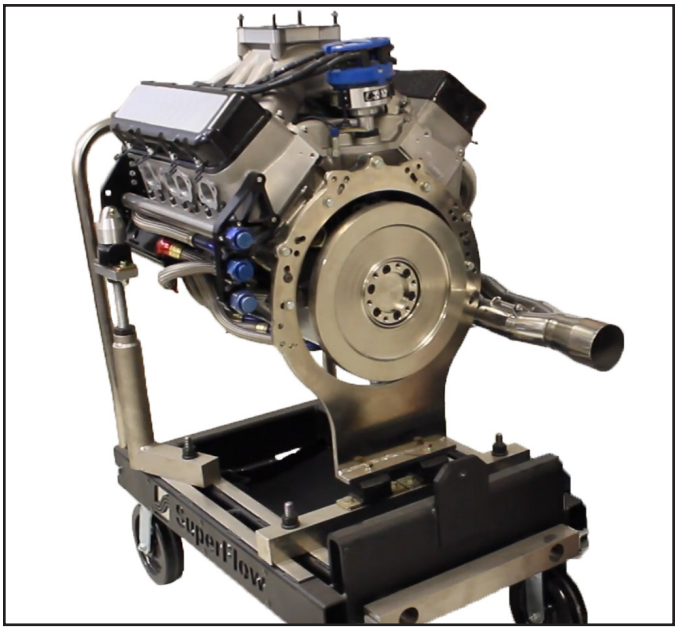


Figure 3.20: Engine On Docking Cart

4.0 Installation

4.1 Location

Location and positioning of the dynamometer is an important factor in creating a functional, easy-to-use test cell. The following guidelines have been provided to assist in positioning your dynamometer:

- The engine dynamometer test cell should be located in an area that is easily accessible from the rebuild area.
- The dynamometer should be located in an area where the noise generated by its operation will not interfere with other processes.
- The electrical and mechanical requirements must be mechanically feasible to install.
- Adequate space must be provided for testing operations.

The following is only a suggested room layout. If conflicts arise, local building codes must be followed. Consult your specific room layout drawings for additional details. Contact your Power Test representative should any questions arise concerning the location or installation of your equipment. Dimensions shown are subject to change.

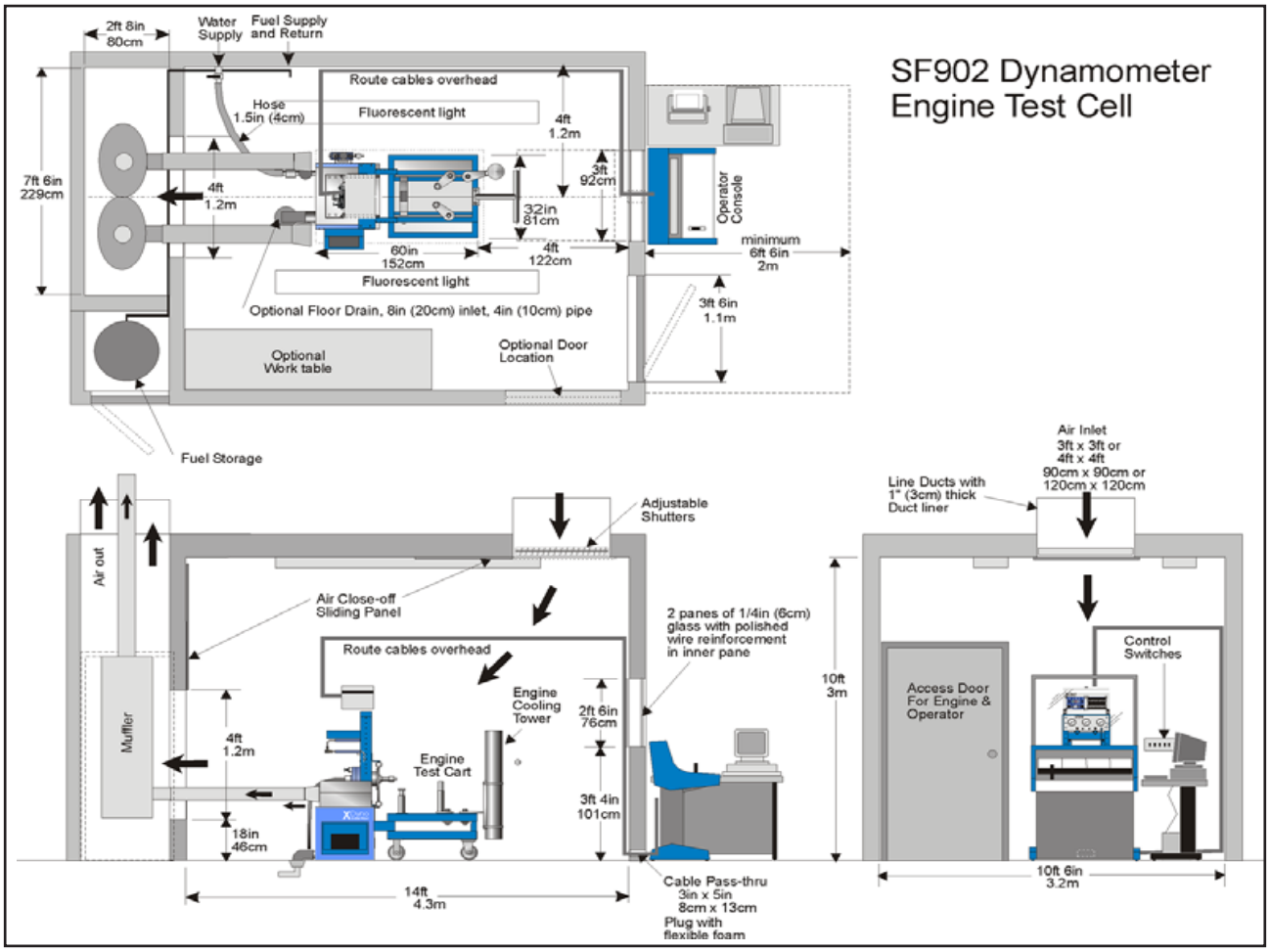
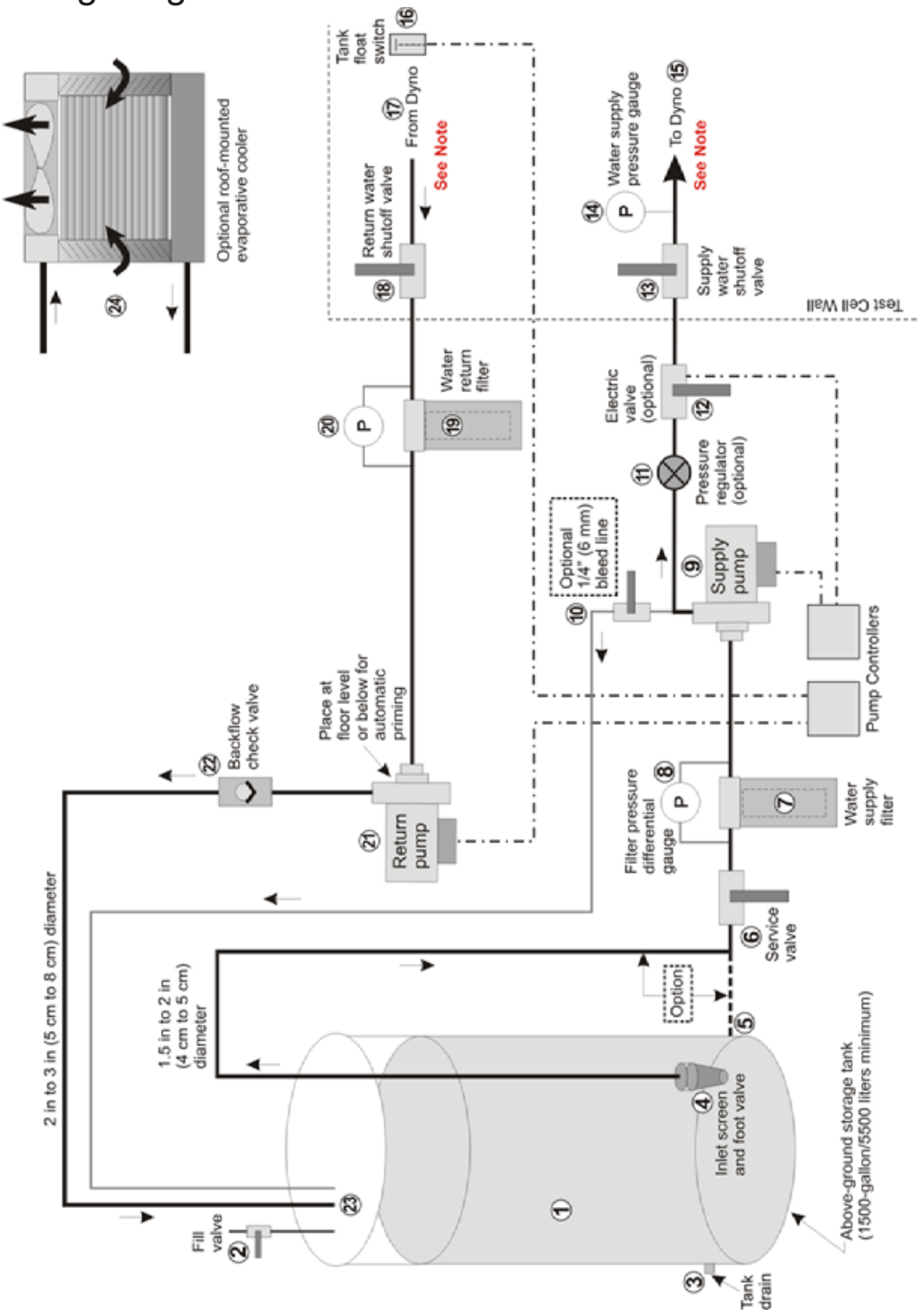


Figure 4.1: Recommended Test Cell Layout

4.0 Installation

4.2 Plumbing Diagram



NOTE: The water line to the dyno inlet is routed ***to*** the left side of the dynamometer as looking at it from the back of the test cell. The water line ***from*** the dynamometer is routed to the right side.

Figure 4.2 Engine Test Cell Water Recirculating Supplky System

4.0 Installation

4.3 Unpacking

The SF-902S system is shipped partially assembled. Some parts are left off for protection during shipping. Interconnect and sensor cables require installation prior to use.

1. Inspect the crates and boxes for external damage. Be sure to check underneath the crate for possible forklift damage. Report any damage to the shipping company and SuperFlow Customer Service.
2. Remove all components and accessories from the crates or boxes.
3. Inspect all components for loose parts or any damage.
4. Open the rear panel of the operator's console and inspect for loose parts or damage. Ensure that all circuit cards are secure and cables are properly seated in their connectors.
5. Position the sensor box on a stable surface. Locate the sensor box door key. Carefully open the sensor box door, and inspect the inside of the sensor box for any loose parts or visible damage. Ensure all circuit cards are secure and cables are properly seated in their connectors.

⚠ WARNING

HEAVY OBJECTS.
Use lifting aids and proper lifting techniques.

4.4 Engine Docking Cart

The engine cart comes fully assembled except for the support posts and engine mounts.

1. Set the jack post cross-member in place toward the rear (absorber end) of the cart.
2. Install the two engine mount posts, one on each side, toward the front of the cart. Install extension tubes into the posts.

Figure 4.3 Engine Docking Cart

4.0 Installation

4.5 Absorber Stand

The SF-902S absorber stand can be installed stand-alone, fixed in place, or used as a combined unit with the engine cart.

1. Position the SF-902S absorber stand in a suitable location in the test cell leaving enough space at the front of the stand for the engine cart, the rear of the stand for the exhaust system, and the sides for access to the engine.
2. Secure the stand to the floor using the 3/8x3 floor anchors that are supplied or other suitable fasteners. Not applicable for roll-around stands.
3. Slide the sump tank into place under the absorber (Figure 4.2). Position it so the servo valve and absorber intake are above the respective compartments. Ensure the cross drain valve inside the tank between the chambers is closed.

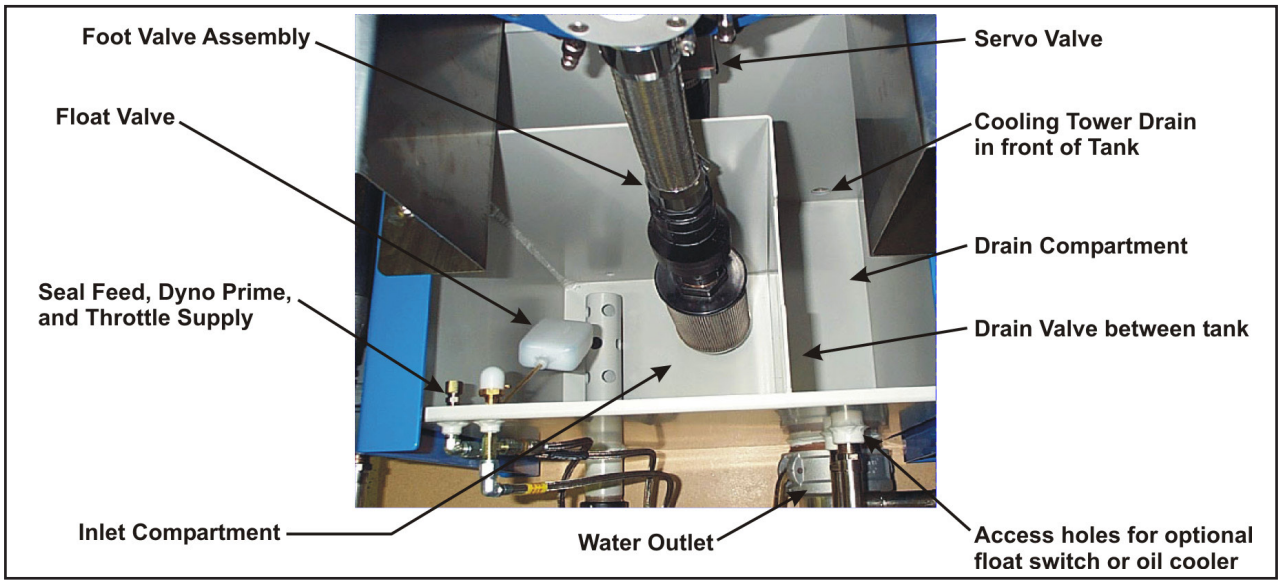


Figure 4.2 Dynamometer Stand Sump Tank

4. Place the absorber vent tube and throttle drain tube outlets in the outlet (or drain) side of the tank. These are the two small, black nylon hoses with open ends. The throttle drain is near the right side upright support, and the absorber vent is on the back side of the absorber. Make sure the tubes cannot be submersed in water. Trim if necessary.
5. Install the servo valve (if not already done) and extension hose. The large opening on the valve faces downward and the side with the two openings is against the absorber. Make sure the valve outlet is positioned above the drain compartment so water cannot spill out of the tank. The extension hose must not contact the sides of the tank.
6. Install the foot valve and filter assembly on the absorber inlet. Make sure the assembly is in the inside (inlet) compartment and does not contact the sides of the tank.

4.0 Installation

7. Locate a small (1/4”) black nylon line on the absorber stand right-side channel with a hose fitting on the end. This is the supply line for the dyno prime, absorber seal feed, and hydraulic throttle. Attach the hose to the supply fitting on the rear left corner of the tank (Figure 4.2). The other nylon line without a fitting is the throttle drain line. It is placed so water will drain into the drain compartment.

8. Install the pressure boost hose from the water inlet to the open fitting on the back of the absorber (Figure 4.3). Leave the ball valve in the closed position.

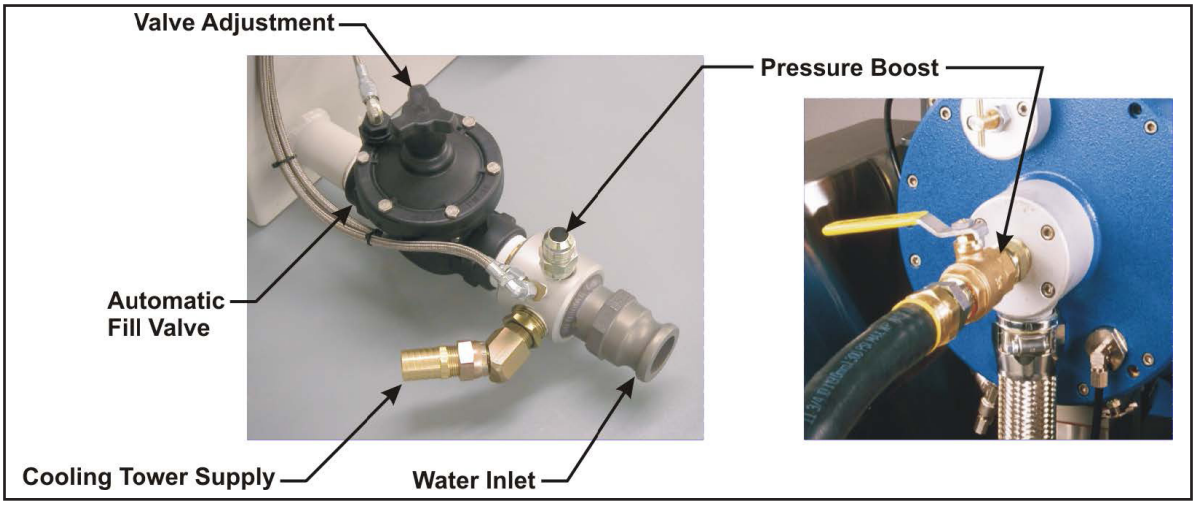


Figure 4.3 Water Supply Connections

9. Connect the water inlet and outlet ports on the rear of the tank to the appropriate sources. You may need to slide the tank out a little to allow access to the fittings.

NOTE: Consult Power Test if information on hose sizes and pump specifications is required.

- Other fittings are available on the back of the tank for auxiliary accessories such as temperature probes, level control switches, and external coolers.
- The automatic fill valve sets the rate at which the valve shuts on and off. It should not require adjustment. The tank level is set with the float valve inside the tank. The tank can possibly overflow the first time it is filled but should not happen again after the automatic valve is primed.

4.0 Installation

10. Install the exhaust heat shields on each side and on the rear of the stand (Figure 4.4).

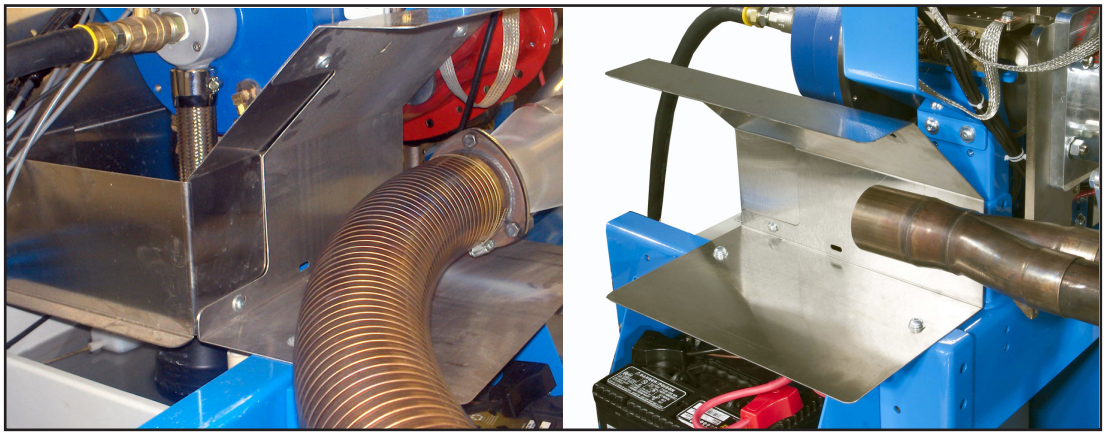


Figure 4.4 Exhaust Heat Shield

11. Place the water tank cover in position on top of the tank (this cover requires periodic removal to access inside the tank for maintenance).

12. Install pressure hoses to the appropriate connectors on the rear panel of the absorber stand (Figure 5-9) using the supplied hardware. Tee adapters are provided to connect both the console mechanical gauges and the pressure panel on the sensor box.

TIP: If desired, the tee adapters can be placed on the sensor box pressure inputs.

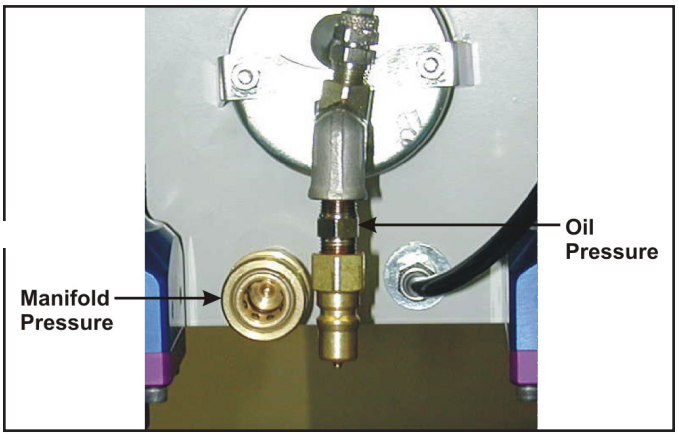


Figure 4.5 Absorber Stand Gauge Connections

4.0 Installation

4.6 Sensor Box

Mount the sensor box on the absorber stand boom. The absorber stand mount makes the sensor connections to the engine easy.

A power cord attaches to the bottom of the box. Electrical power for the sensor box should come from a dedicated, protected line. If desired, a long power cord can be routed into the control room and plugged into the same outlet (UPS or surge suppressor) as the console and computer. Refer to "Electrical Requirements" on page 12.

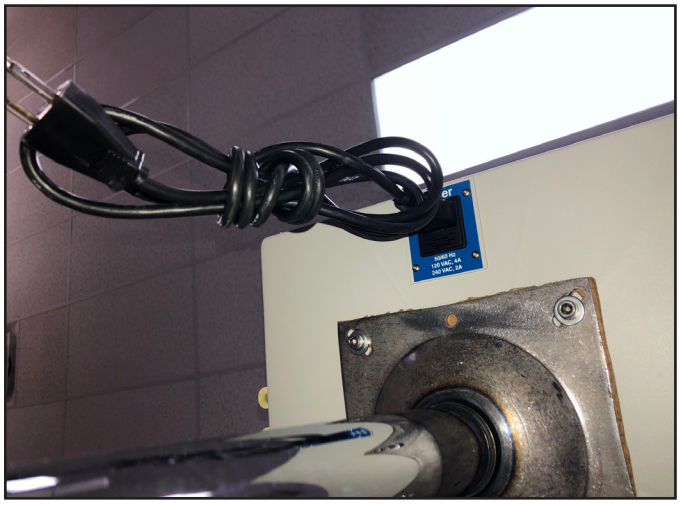


Figure 4.5 Sensor Box Power Cord Connection

4.0 Installation

4.7 Cooling Towers

The engine cooling tower is mounted on the boom support. The two water hoses (supply and drain) must be connected as shown in Figure 4.6.

A thermocouple should be installed on the cooling tower and connected to the Data Acquisition System to monitor and record the cooling temperature with WinDyn. Use the Cool IN channel. A second thermocouple should be installed in the engine water jacket, typically on the intake manifold. Use the Cool OUT channel.

⚠ WARNING

Improper connection of the water inlet and outlet hoses to the CT700-NOP cooling tower can pressurize the system and blow the hoses off the engine which can result in serious equipment damage or bodily injury.

Both the CT300P and CT700P have the cooling water outlet on the thermostat valve which is different than the CT600. The arrow imprinted on the valve housing indicates the water flow direction.

NOTE: Basic operation instructions for cooling towers is provided in Chapter 5.6.

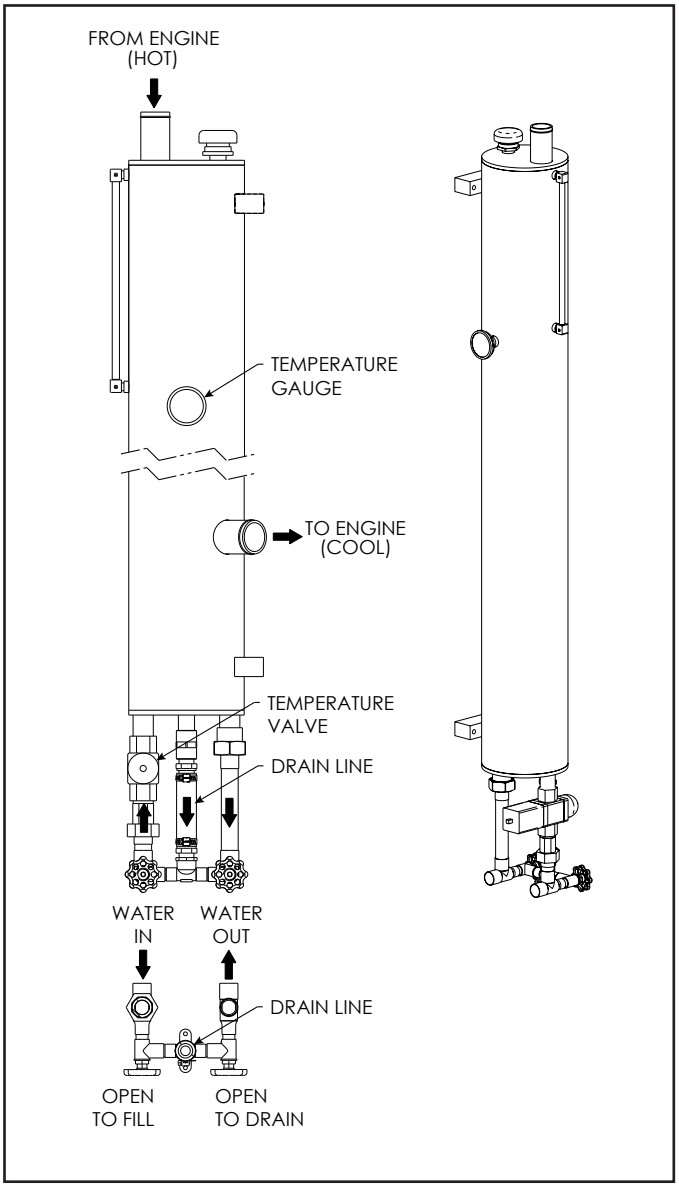


Figure 4.6 CT700-NOP Unpressurized Cooling Tower

4.0 Installation

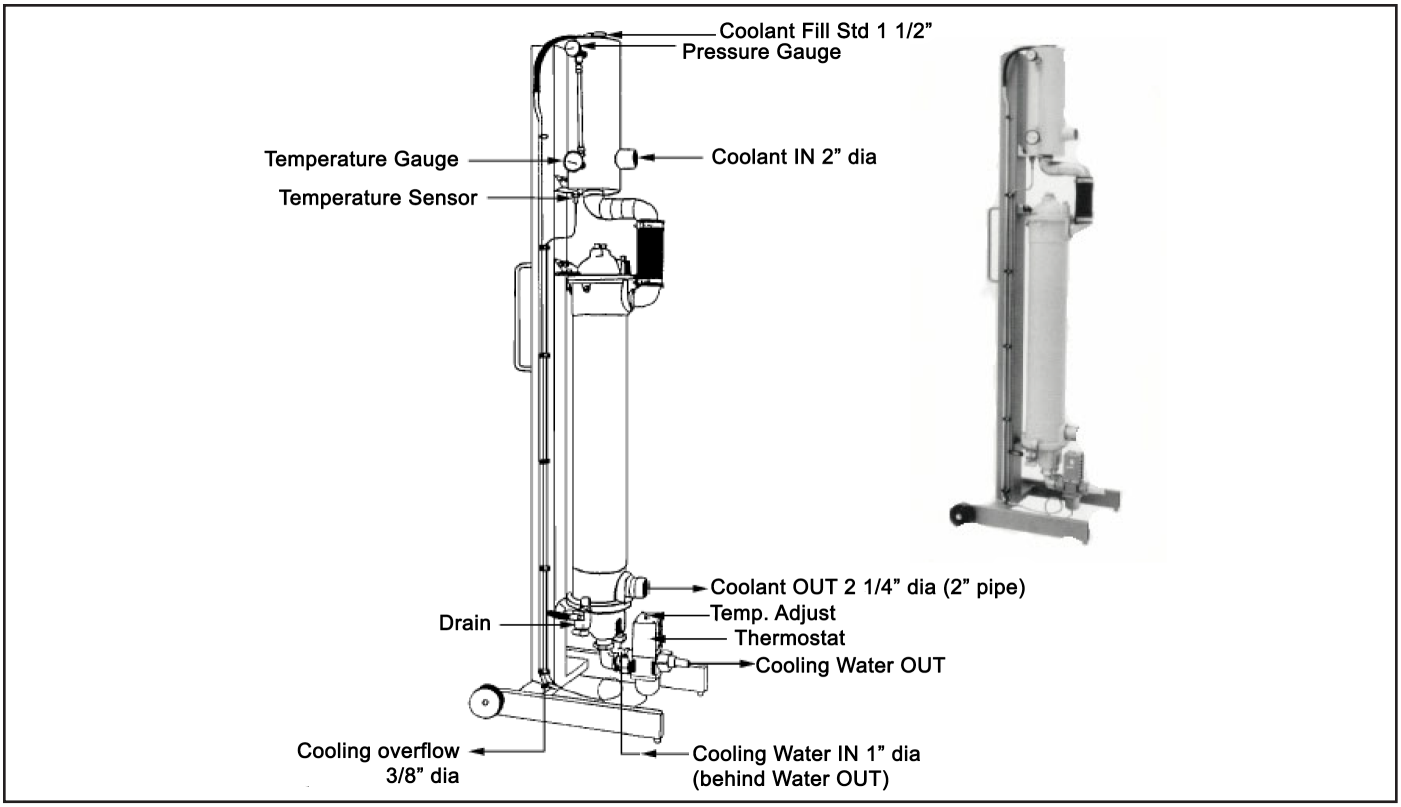
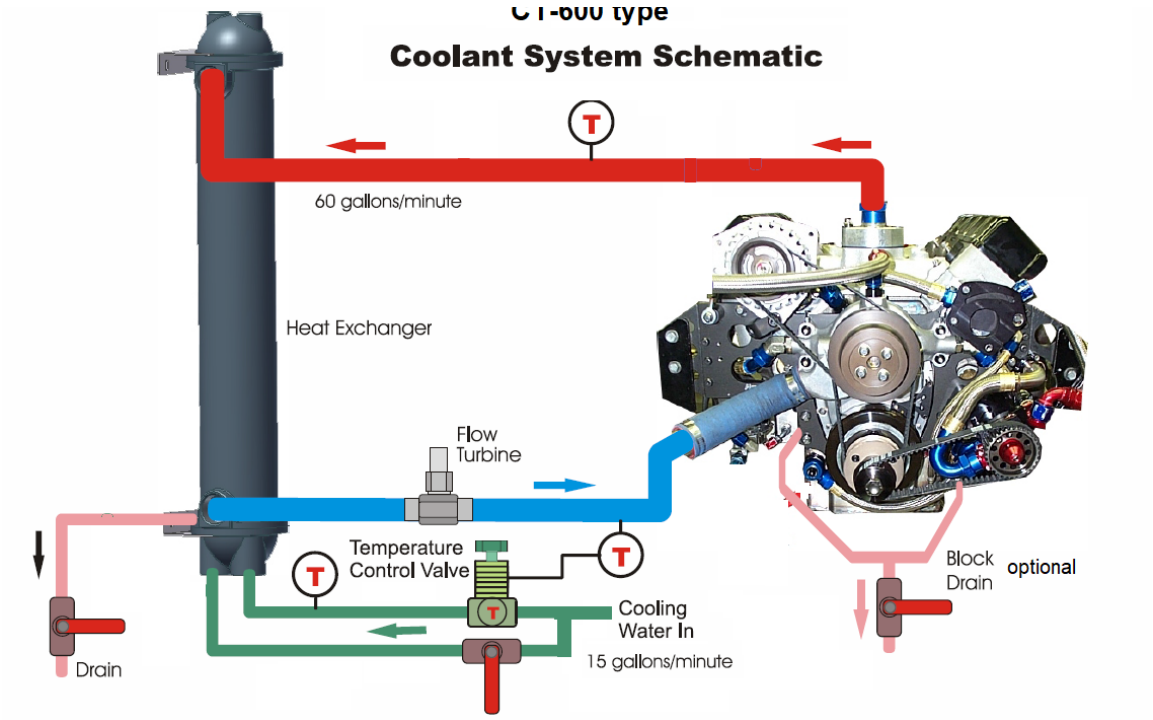


Figure 4.6 CT700P Pressurized Cooling Tower



4.0 Installation

4.8 Computer System

Communication

The computer communicates with the sensor system through an Ethernet Local Area Network (LAN) cable. Connect the Category 5 (Cat-5) network cable from the computer network switch to the RJ-45 connector located on the side of the sensor box labeled Computer Network.

SuperFlow WinDyn 4.0 systems use TCP/IP network protocol. WinDyn 3.2.R2 uses NetBEUI protocol.

Figure 4.7 Network Router

Software

SuperFlow provides a USB thumb-drive containing the WinDyn software. The WinDyn software was installed and configured on your computer system by factory personnel. The thumb-drive is only necessary if you must recover or reinstall the Windyn software. Windyn software is also installed in a SuperFlow System Recovery folder on the computers hard drive, along with manuals and other pertinent documentation.

4.9 System Cable Connections

Open the sensor box. Verify all cables are firmly seated and connected. Close the box, lock it, and put the keys in a safe place.

NOTE: The power supply used in the sensor box and the console is 12 volt switching power supply. Voltage checkpoints for both power supplies are provided on labels affixed to their case. Both use universal input power supplies 100 - 240 VAC.

NOTE: All system cables and their connection ports on the sensor box are labled. The cables are labeled on each end to match the connection port they are to be connected to.

Power

Plug the computer and sensor box power cables into a convenient outlet. The power connection for the sensor box is on the bottom. SuperFlow recommends plugging both units into a suitable surge suppression circuit and using an Uninterruptible Power Supply (UPS) or other power backup for power outages. Refer to "Electrical Requirements" on page 12. There is a 2 amp fuse for current overload protection in the power plug receptacle on the sensor box.

⚠ WARNING

Always turn the power off to the system when plugging or unplugging devices into the sensor box and console.

4.0 Installation

System Interconnect Panel

The system interconnect panel has connections for several different types of sensors and features plus provides the connections to the console and the computer (Figure 4.8).

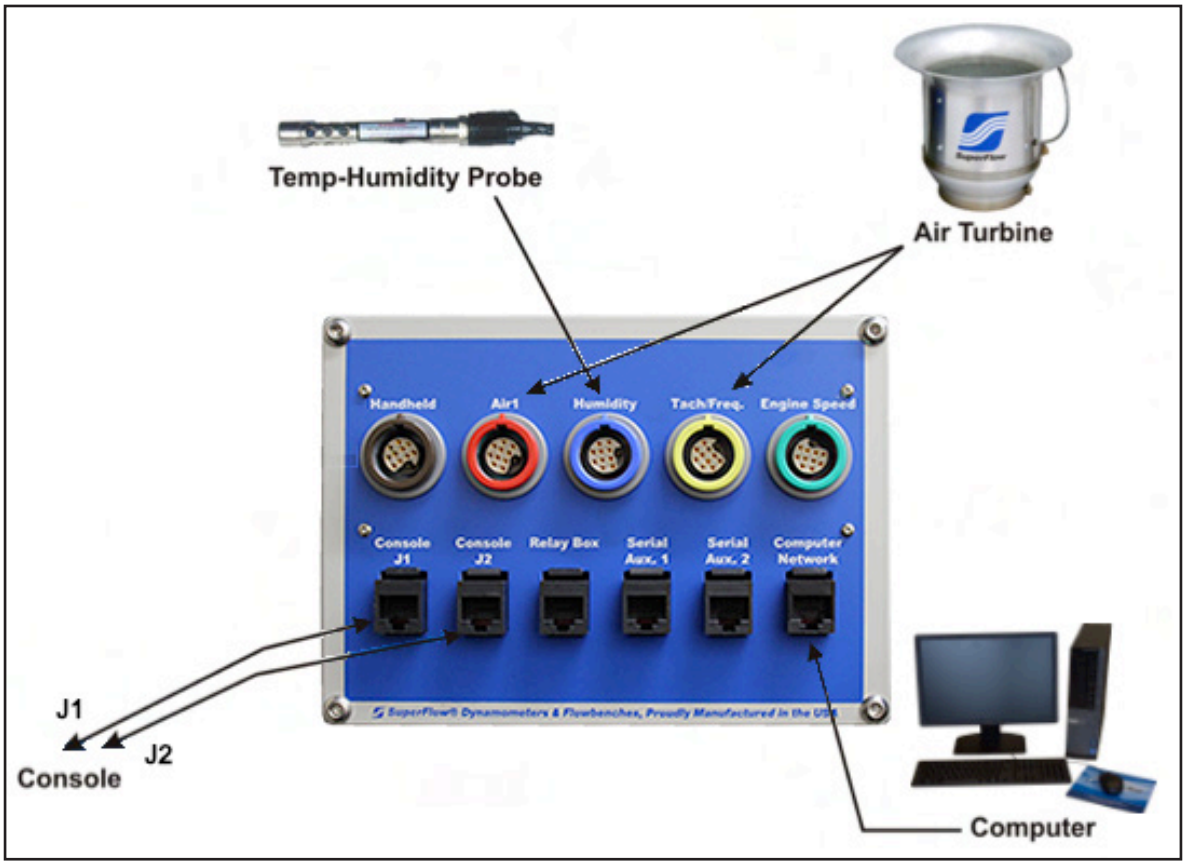


Figure 4.8 System Interconnect Panel

Air 1

SuperFlow airflow measurement turbines are connected to the sensor box system interconnect panel. Use cable 1200A-2044 to connect to the red receptacle labeled Air 1. Calibration tables for each flow turbine are entered in the configuration file. Other TTL or MAG frequency devices can be connected here as well but require modification to the definition of channel 7.

Humidity

The humidity and air temperature probe plugs into the blue receptacle on the sensor box system interconnect panel labeled Humidity. The humidity sensor is sensitive to contamination, so place it in a fresh air stream for the engine intake system and away from potential engine oil, gasoline, and exhaust spray. It is also sensitive to sunlight, so keep it out of direct sunlight.

4.0 Installation

Tach/Freq

A second SuperFlow air turbine can be connected to the yellow receptacle labeled Tach/Freq if desired. Calibration tables for each flow turbine are entered in the configuration file. Other TTL or MAG frequency devices can be connected here as well but require modification to the definition of channel 12.

Engine Speed

Other TTL or MAG frequency devices can be connected here as well but require modification to the definition of channel 11.

Console J1/J2

These connections are used with an operator's console. Cables connected between the console and this panel carry several signals:

⚠ CAUTION

All serial cables should be routed away from any other cables or devices that may produce Radio Frequency (RF) interference such as ignition wires or power cables.

- Serial data: Transmit and receive signals allowing the console to display real-time data from the CPU and control the system from the console.
- Power-on: When the power switch on the console is turned on, the sensor box is also turned on. The push-button power switch on the sensor box should never be used when a console is connected.
- Emergency Stop: When the ES button on the console is pressed, a system ES action initiates.

1. Connect a Cat-5 serial cable (supplied) from the RJ-45 connector J2 on the back of the console to the Console J2 connector on the sensor box system interconnect panel. Make sure the cable is properly secured and protected.
2. Connect a second Cat-5 cable (supplied) from the RJ-45 connector J1 on the back of the console to the Console J1 connector on the sensor box interconnect panel.

Relay Box

A Cat-5 cable connects to the optional SF-1843 relay control enclosure.

Serial Aux 1 & 2

These are for optional serial interface connections.

Computer Network

Connect a Cat-5 shielded Ethernet LAN cable (supplied) from the RJ-45 connector sensor box interconnect labeled Computer Network (Figure 4.8) to the Ethernet router. Connect a cable from the router to the computer network connection port. Do not use the WAN connection on the router.

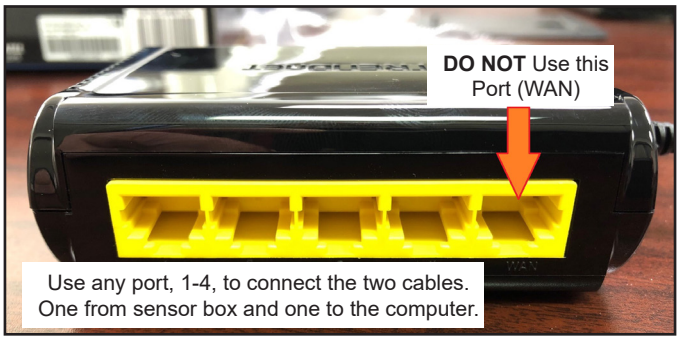
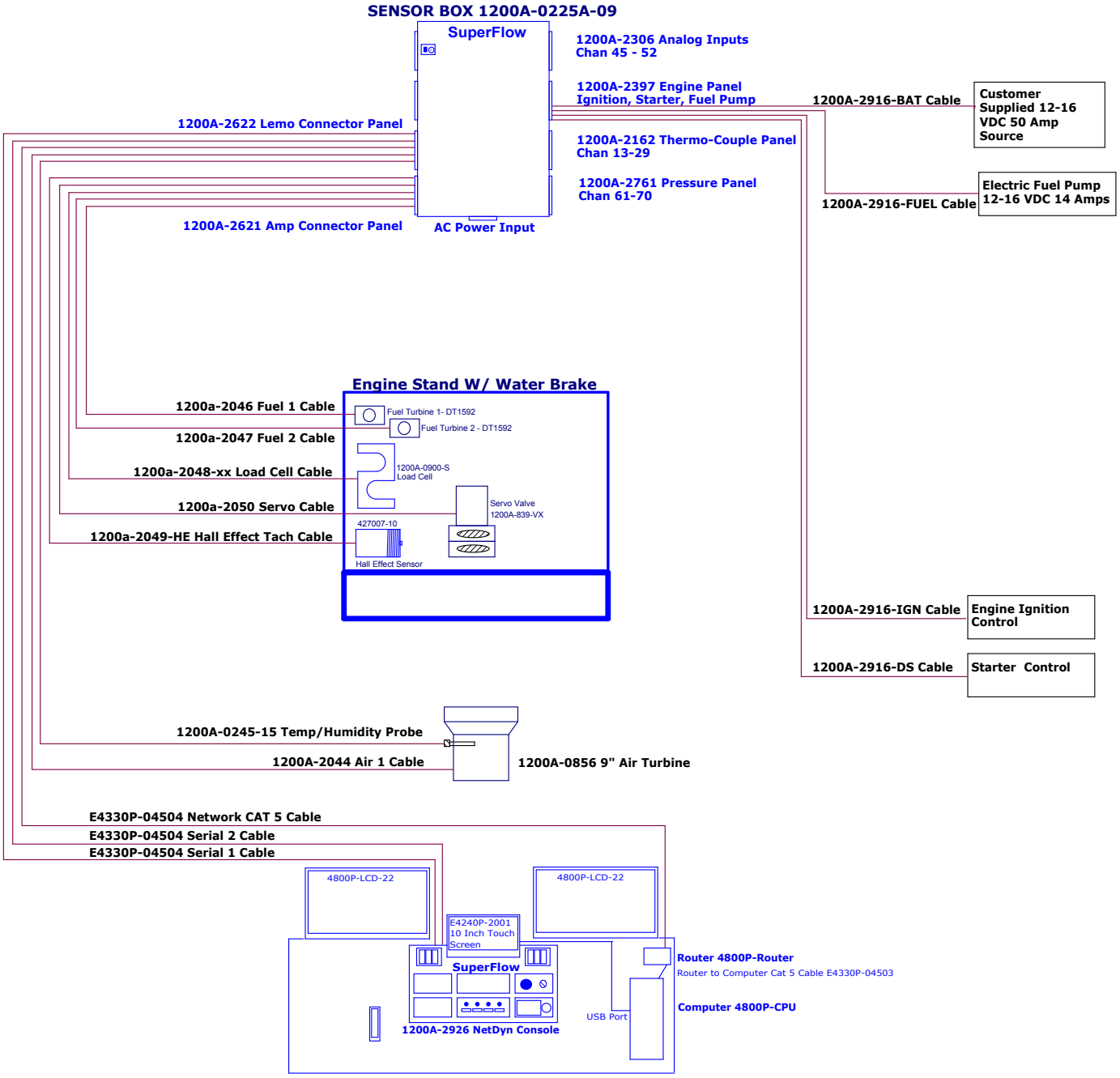


Figure 4.9 Router Connections

4.0 Installation

Electrical Diagram



4.0 Installation

Sensor Interconnect Panel

The sensor interconnect panel (Figure 4.10) provides connections to the primary sensors and controllers on the dynamometer.

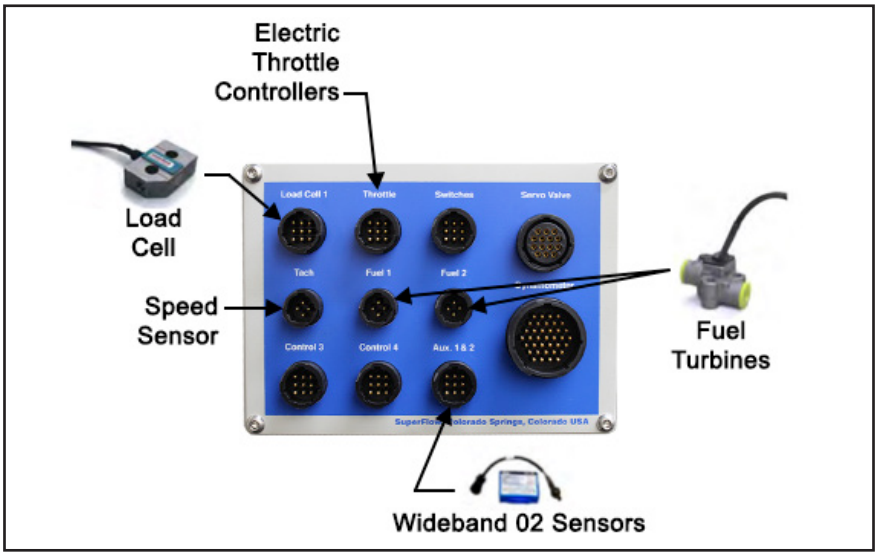


Figure 4.10 Sensor Interconnect Panel

Load Cell 1

Plug the load cell (strain gauge) cable into panel connector marked Load Cell 1.

Tach

Plug the tach sensor cable into the connector labeled Tach. The other end plugs into the absorber speed sensor.

Fuel 1 & Fuel 2

Fuel flow measurement turbines or meters are connected to the sensor box sensor interconnect panel. Connect the cable to Fuel 1 and the cable to Fuel 2. Be certain to plug it into the correct turbine to ensure the calibration matches the turbine. Calibration values for each flow turbine are entered in the configuration file.

Aux 1 & Aux 2

The Auxiliary #1 and Auxiliary #2 inputs are direct (not multiplexed) analog voltage inputs. These inputs are designed for a 0–10 VDC signal and configured for the sensor type in the software. A common application for these inputs is Air/Fuel or lambda sensors. Insert the auxiliary input cable into the connection labeled Aux 1 & 2 on the sensor interconnect panel. This cable splits into multiple connections. Connect other extension cables required for the sensor type used to the other ends of the auxiliary input cable.

NOTE: If your system is utilizing the AEM wideband option, you will not need to use this cable.

This connector is also used to input digital signals for WinDyn off/on indicators from external switches. A cable is available that has the connections for Auxiliary #1 and Auxiliary #2 plus two digital input connections (DI-1 and DI-2).

4.0 Installation

Throttle
If you have the optional electronic actuator, the throttle connector on the sensor interconnect panel connects to an SF-1805 electric throttle controller or other device using a 0–10VDC control signal.

4.10 Expansion Panels

Pressure Connections

Connect the hose to the appropriate pressure source. SuperFlow recommends using reinforced rubber. Stainless steel hoses can be used but have the potential to conduct Radio Frequency Interference (RFI) noise. If used isolate them from the sensor box with short rubber hoses. The standard system comes with #4 AN fittings for channel 63 - Man_P, Channel 67 - Oil_P, and Channel 68 - Dyno WtP.

Figure 4.11 Pressures

4.0 Installation

Thermocouple Connections

The sensor box temperature panel has inputs for up to 16 type K thermocouples. Open-tip thermocouples have a faster response time because of the smaller mass. These are typically used for exhaust gas temperature measurement. Closed-tip thermocouples are typically used for fluid measurement. Plug the thermocouple into an extension cable (if needed) or directly into the thermocouple panel. The panel will accept standard or miniature plugs. The system is typically supplied with 12 closed tip 1/8" thermocouples.

⚠ CAUTION

The standard probe type thermocouples are designed so they can be bent. However, once they are bent in one direction they cannot be straightened without damaging the internal wiring rendering them inoperative. Use a tubing bender to create a smooth radius curve.

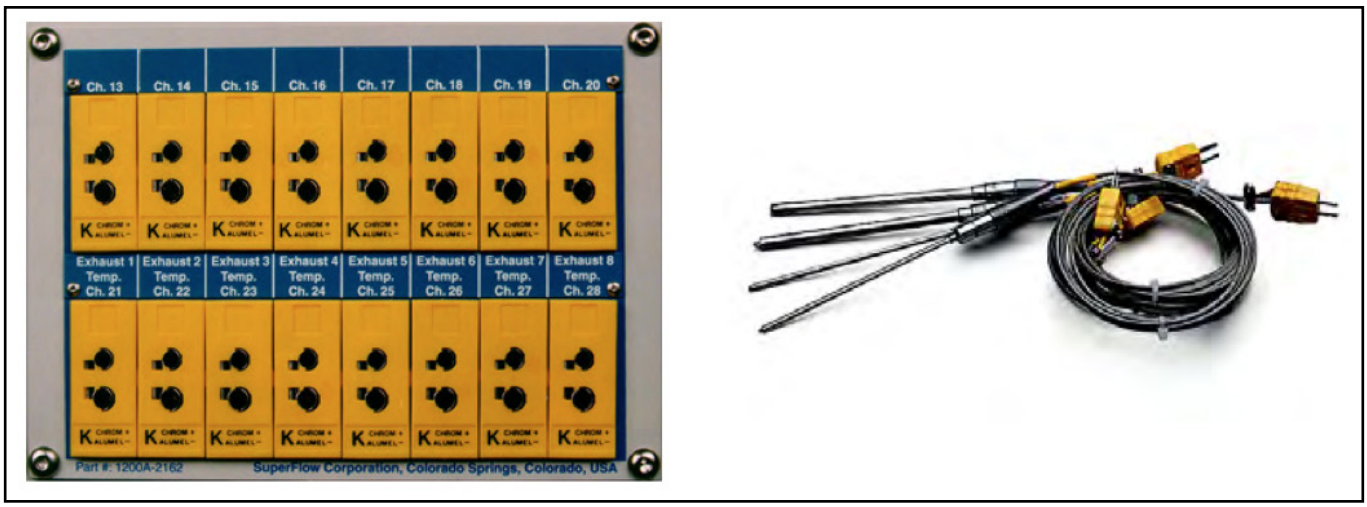


Figure 4.12 Thermocouples

4.0 Installation

Analog Voltage Expansion

⚠ CAUTION

The input circuitry can be damaged if more voltage is applied by the sensor than what the channel is designed for.

This is an eight-channel analog DC voltage input panel used to integrate exhaust gas analyzers, multi-channel Lambda sensors, O2 sensors, pressure transducers, and other voltage output devices. The standard configuration is seven 0–10 VDC channels (45 to 51) and one 0–20 VDC channel (52). Other configurations are available upon request including 0–1 V, 0–5 V, and 0–30 V in any combination.

Excitation and reference voltages are available if needed. The +12F excitation voltage is limited to 500 mA output. All others are limited to 100 mA.

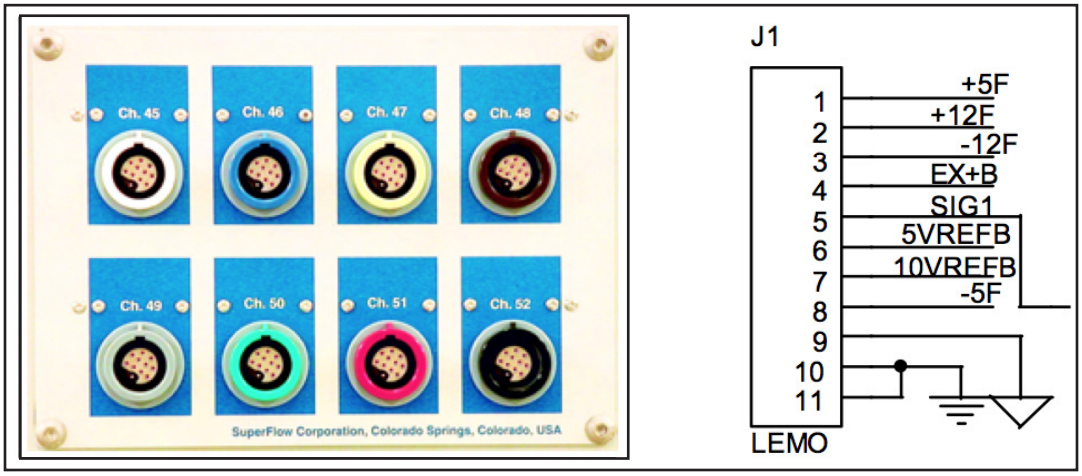


Figure 4.13 Analog Expansion

Receptacles are color coded. All are keyed the same and use the same pin out. The channels are configured in the software as to the type of sensor used. Prefabricated cables are available to connect to this panel:

- 1200A-2462-x: Un-terminated cable for input only, x=color
- 1200A-2462-01-x: BNC terminated cable for input only, x=color
- 1200A-2860 w/1200A-2188: Battery voltage input cable for 20 V channel only
- 1200A-2469-x: For pressure transducers or other devices requiring a +5.00VDC excitation voltage, x=color

IMPORTANT

Use of custom sensors requires special modification to the system configuration file.

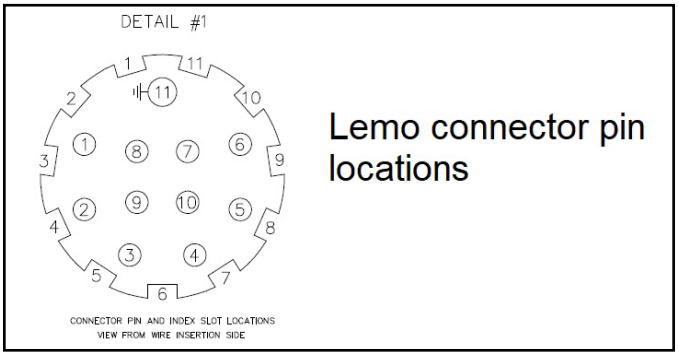
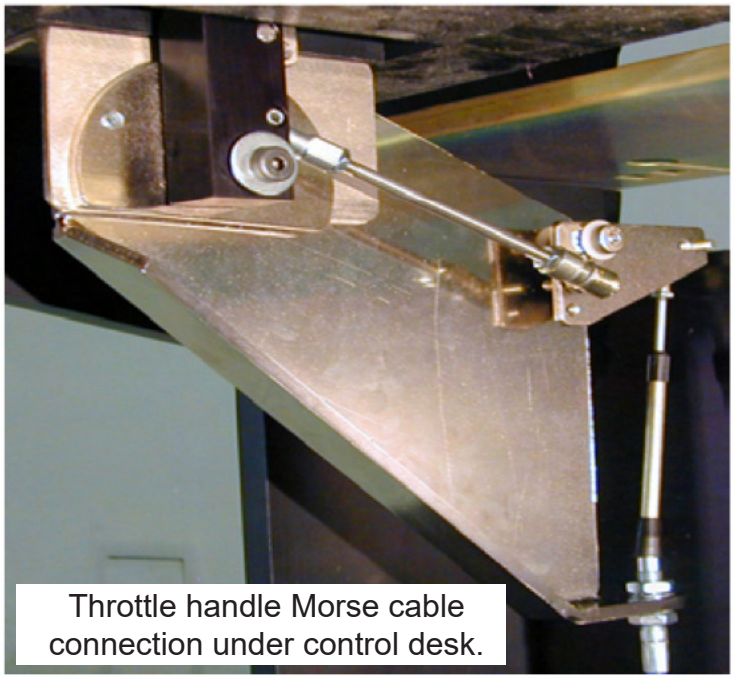


Figure 4.14 Lemo Connector

4.0 Installation

4.11 Throttle System

Several styles of throttle control systems are available. The standard system uses a Morse cable. Electric throttle actuators are also available. Due to the variety of fuel supply systems used on today's engines, you may be required to fabricate special adapters to work with throttle systems. Consult the documentation that accompanied the throttle system on your order.



Throttle handle Morse cable connection under control desk.

Example of Morse cable connection on engine.

Figure 4.15 Morse Cable Throttle System

4.0 Installation

4.12 Initial Check-out

After the sensor box is secured and all the cables are connected, the system can be tested for operation.

1. Ensure the power cables for the sensor box are plugged into a suitable power source.
2. Turn console key switch ON to power ON to the sensor box.
   - Notice that a small green light in the upper right corner on the front of the sensor box illuminates.

   NOTE: The white power button on the sensor box is disabled; do not use it.
3. Turn the computer ON and start the WinDyn and NetDyn programs from desktop.

IMPORTANT
Prior to first using the dynamometer, SuperFlow recommends calibrating the systems torque measurement sensor. Refer to "Calibrating the Sensors" on page 63 in Chapter 6.

IMPORTANT
Sensor calibration is a critical function of accurate measurements. Do not attempt to calibrate any of the sensors in a SuperFlow Data Acquisition System without the proper calibration equipment.

The system is now ready for use. Proceed to Chapter 5 for operation instructions. Consult the WinDyn Operators Manual for detailed information on how to use the software.

NOTE: Refer to Chapter 6 for instructions on calibrating the various sensors in the system. If you experience any problems in getting the system operational, or if the system fails to communicate with the console or with WinDyn, contact SuperFlow Customer Service for assistance.

5.0 Operation

5.1 Introduction

This section describes setting up and running a test on the SuperFlow dynamometer system.

5.2 Safety

⚠ DANGER

- **Extreme care should be taken in the area of the drive shaft that connects the engine to the dynamometer.**
- **All rotating parts must have their guards secured in place.**
- **A drive shaft is considered the fuse in the test setup. In the event of a failure in the engine or dynamometer, the shaft may break. This will save on costly repairs to an engine or dynamometer. However, because of this possible failure, the machine should NEVER be operated without a shaft guard.**

⚠ DANGER

- **Engine exhaust contains carbon monoxide fumes, be sure test cell is properly ventilated**
- **If anyone shows signs of carbon monoxide poisoning, get them to fresh air. Fumes can cause headache, dizziness, lack of consciousness and/or death.**

⚠ WARNING

WEAR EYE and HEARING PROTECTION. Proper eye and hearing protection should be worn at all times when the equipment is operating.

⚠ WARNING

Do not attempt to use the dynamometer without proper training from SuperFlow. Severe injury or property damage may result from improper use.

⚠ WARNING

- **Inspect the equipment monthly to ensure that there are no broken or worn parts which could cause injury to personnel or damage to the equipment.**
- **Only qualified operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ WARNING

BURN HAZARD.
During operation water temperature inside the dynamometer can reach over 125° F. Do NOT touch discharge water, piping or the dynamometer surface during operation. Allow to cool before servicing.

⚠ CAUTION

- **Personnel should NOT be in the test cell during operation and observation areas MUST be constructed to protect personnel.**
- **Personnel and other equipment should be kept clear of the drive shaft guard area and NEVER cause an obstruction or block doorways.**

IMPORTANT

The dynamometer is a tool. All personnel should be kept clear of the area and only be in the test area on a "need to be" basis.

5.0 Operation

An engine test cell can be a dangerous environment. The dynamometer operator will be exposed to a number of hazards. These risks are generally associated with the engine under test rather than with the dynamometer itself and it is thus not possible for SuperFlow to protect the operator against all these hazards by the design of the dynamometer instrumentation system.

A proper test cell environment eliminates or reduces the risks associated with dynamometer testing as much as possible. Examples of risks are:

- Excessive noise
- Risk of fire due to the fuel used
- Risk of burns due to hot engine and exhaust system parts
- Exposure to rotating parts
- Exposure to parts being projected from the engine during operation
- Excessive exhaust gas concentrations

NOTE: WinDyn is capable of automating test cell controls and integrating certain safety features in these controls. Contact a SuperFlow Customer Service or Sales representative for more information or advice.

Emergency Stop

An Emergency Stop switch is mounted near the computer system. Additional emergency stop switches can be installed in the test cell and control room. In the event of an emergency, press the nearest emergency stop switch. The emergency stop command will trigger a shutdown of the dynamometer system and return it to a safe mode.

When the emergency condition has been resolved, turn the switch clockwise to release it, or pull the switch back out depending on switch type. Then clear E-stop in the NetDyn pop-up window to reset the system. If the emergency stop condition was not cleared (the push-button released), the condition will remain active.

Electrical Safety

The sensor box and electric throttle control (if equipped) require 110/230 VAC power. They each have internal power supplies. Opening, adjusting, and repairing the power supplies should not be attempted. Defective power supplies should be replaced.

IMPORTANT
Repairs to the sensor box, console, or throttle controller should only be performed by a qualified Customer Service technician.

Fuses

All SuperFlow equipment is electrically protected by appropriate fuses. If a fuse blows, the cause must be found and removed. Do not replace fuses with a different type. This may result in a severe hazard for the user and/or damage to the equipment.

5.0 Operation

Safety Procedures

The WinDyn instrumentation system controls the engine and the dynamometer. As a result, there is a possibility that a certain function or equipment is activated at a time when this creates a hazard to a person in the area. Avoid such hazards by strictly enforcing the following policies:

- Only authorized personnel, trained in the operation of the complete test system, should have access to the dynamometer area.
- Never allow anyone in the test cell during a test. Access during warm-up periods and when the engine is idling is permissible.
- Power OFF the system during periods when the dynamometer is not in use.
- Ensure good visibility of the complete test cell area from the operator position.
- Ensure circuit breakers are easily accessible and have the proper rating.
- Ensure fuel and water shut-off valves are easily accessible.
- Ensure fire extinguishers are available and certified.
- Allow only authorized personnel to perform maintenance and repairs on electrical and mechanical equipment.
- Always turn power OFF to the system before plugging in cables and sensors to the Data Acquisition sensor box.
- Always turn power OFF to the system when changing engines.

5.0 Operation

5.3 Test Preparation

Prior to the start of dynamometer testing, the entire system should be checked to ensure everything is ready. Some of the items to check are:

- Ensure:
  - – The water supply and cooling systems are operational. Top off the water supply tank if necessary .
  - – The water pressure to the system is set between 60-90psi when deadheaded.
  - – You have an adequate supply of fuel.
  - – You have an adequate supply of engine oil.
- Verify the computer is communicating with the system.

Mounting the Front of the Engine

Mount the engine to the cart. If the carts front mounts do not mate with your engine, you must fabricate your own mounting attachments. SuperFlow does not supply such devices. The engine should be level (parallel to the floor) once mounted.

Mounting the Engine

It is usually easier to mount the engine on the stand before the headers are installed. Refer to figure 5.1 when following this procedure.

1. Support the engine from a lift at the angle it will be mounted on the Docking Cart. Rotate the front engine mounting pedestals out to each side of the stand.
2. Position the rear of the engine about 4” (10cm) from the rear of the Docking Cart.
3. Raise the rear support post to contact the bottom of the oil pan and position the rear engine center line at the same height of the dyno drive shaft.
4. Attach the front engine mounts and carefully position the engine center line with the Docking Cart center line as the engine is lowered from the hoist.
5. Tighten the front engine mount bolts at the frame.

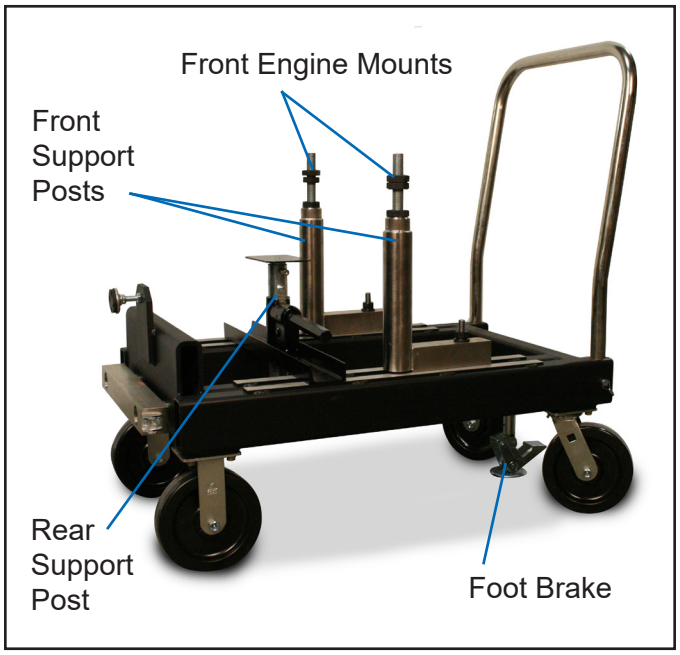


Figure 5.1: Docking Cart

6. Install the appropriate rear engine mount to support the engine.
7. Roll the Docking Cart into the test cell and dock it with the dynamometer absorber stand. Use the docking clamps and foot brake to secure the cart.

8. Once docked and secured, you may lower the rear support post and remove it if you wish.

Dyno Shaft Connection

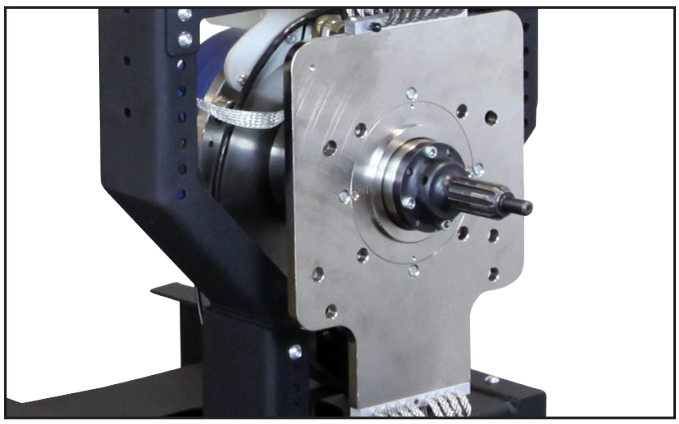


Figure 5.2 Driveshaft

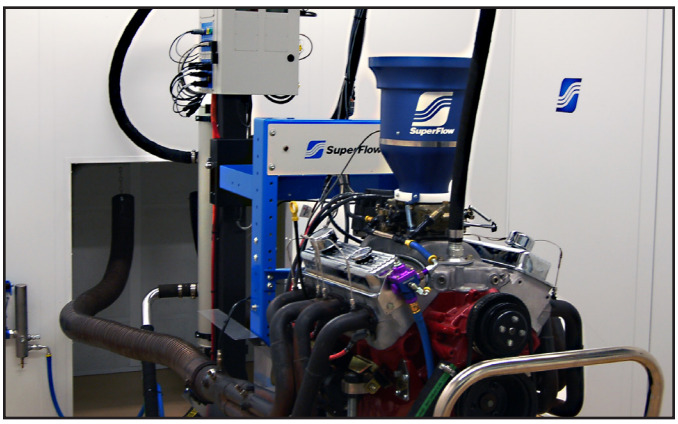


Figure 5.3 Engine Connected

The dynamometer shaft (figure 5.2) is driven by the engine in the same manner that a standard shift transmission connects to the engine.

First install an adapter plate to the flywheel or flex plate. Engine Adapter Plates for many engines are available from SuperFlow.

It is very important that the adapter plate be perfectly centered on the flywheel to minimize vibration and damage to the engine and absorber.

5.0 Operation

5.4 Engine Water Cooling System

1. The thermostat or any flow restrictions should be removed from the engine. The thermostat on the cooling tower will perform the temperature control function.
2. Connect the tower supply hoses to the engine (Figure 5.3). Coolant is supplied to the engine from the lower connection on the CT700-NOP cooling tower. Coolant from the engine enters the CT700-NOP cooling tower at the top connection (other cooling towers may vary).
3. Close the drain valve and open the inlet valve to fill the system. Air is purged automatically. Observe the sight tube to determine the cooling tower fill level. Close the inlet valve when the tower is full. After the engine is started it may be required to open the inlet valve and let in more water to compensate for air purging out of the engine. Both valves must be closed for normal operation.
   - **SuperFlow CT300P, CT700P, and CT1001 pressurized cooling towers.**

     The coolant chamber is filled through the radiator type cap at the top of the tower. Once the engine is started and the air purged, replace the cap to pressurize the system.
4. Once the engine and cooling tower are full, the engine can be started and warmed up. Adjustment for temperature control can be made on the control valve located at the bottom of the tower.
5. When the test is completed and before disconnecting the hoses, open the outlet valve to drain the water from the tower and the engine.

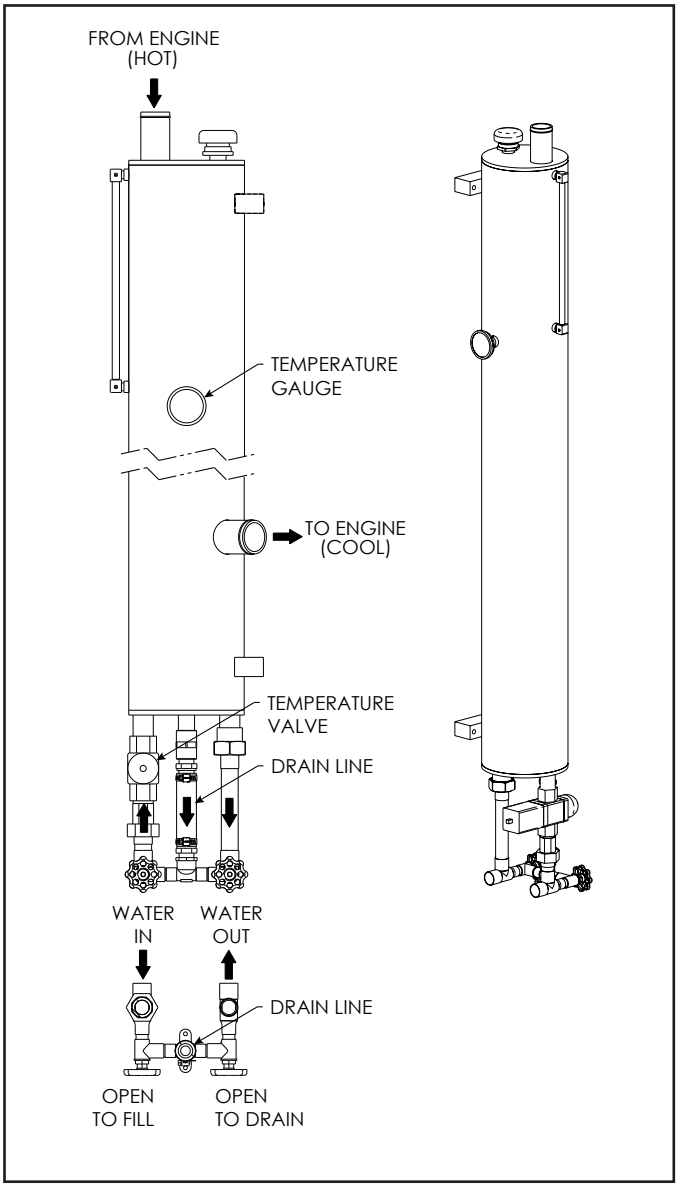
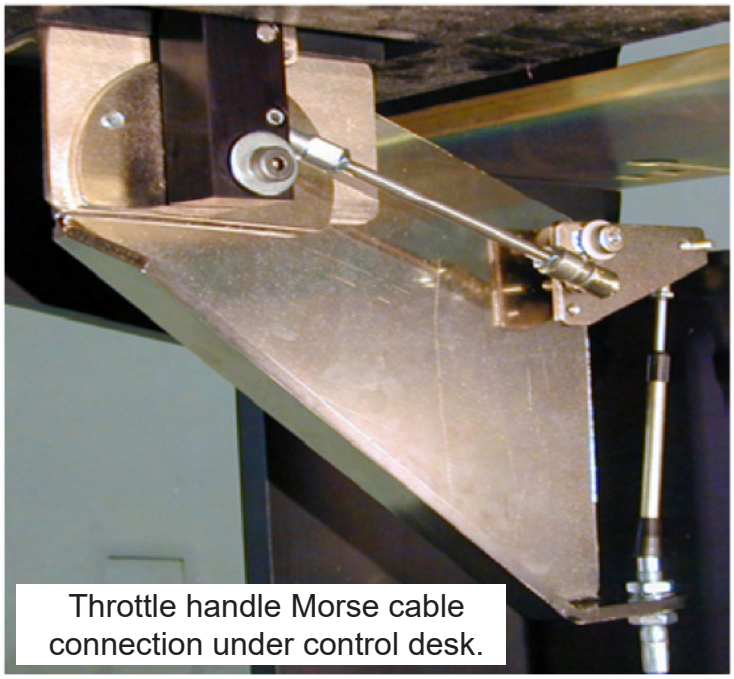


Figure 5.4 CT700-NOP Unpressurized Cooling Tower

5.0 Operation

5.5 Throttle System

Several styles of throttle control systems are available. The standard system uses a Morse cable. Electric throttle actuators are also available. Due to the variety of fuel supply systems used on today's engines, you may be required to fabricate special adapters to work with throttle systems. Consult the documentation that accompanied the throttle system on your order.



Throttle handle Morse cable connection under control desk.

Example of Morse cable connection on engine.

Figure 5.5 Morse Cable Throttle System

5.0 Operation

5.6 Sensor Connections

Stand Connections

1. Place the Air Temperature and Humidity sensor in a location close to or in the airflow to the engine air intake. Do not put too close to the engine as heat from the engine could affect the readings or a backfire from the engine air inlet could damage it. As a rule, put the sensor in the same general location for every test. The data from this sensor is used to apply power correction factors, so its repeatability is critical to your dyno testing results.

⚠ WARNING

Always turn the power OFF to the sensor box when plugging or unplugging devices.

2. Connect the DC Power In cable to the connector labeled DC Input on the engine control panel. The other end of the cable is connected to the 12VDC battery or power supply source.

Engine Connections

1. Attach thermocouples to the engine and connect them to the proper plugs on the sensor box temperature panel.
2. Attach pressure lines to the engine and connect them to the proper transducers on the sensor box pressure panel.
3. Install an air turbine(s) on the engine air intake and connect it to the proper plug on the sensor box interconnect panel.

   NOTE: To prevent damage to the air turbine propeller due to engine backfire, SuperFlow suggests performing initial start and ignition timing without the air turbine mounted to the intake.

4. Connect the ignition, starter, and fuel power cables to the proper plugs on the sensor box engine control panel.

⚠ CAUTION

DO NOT use the Magneto Kill Ground connection.

Figure 5.6: Engine Control Panel

5.0 Operation

5.7 Running an Automated Test

Follow this procedure for running each test. Repeatable and accurate test results are obtained by consistent test methods. Quick reference instructions are provided with this manual as a stand alone document that can be placed near the console for easy viewing.

Infrastructure and Engine Setup

1. Verify the engine installation and all connections to the engine.
2. Ensure:
   - That the connection between engine and dynamometer is aligned and secure and that all guards are properly installed.
   - No tools are left on the engine or dynamometer.
3. Verify:
   - Oil and water levels in the engine and heat exchanger(s).
   - Fuel connections.
   - Electrical connections to the engine.
   - Battery hook-ups and battery charge condition.
   - Throttle connections and adjust throttle end stops, insure you have idle and WOT.
   - Sensors are connected as required for the test.

⚠ CAUTION

DO NOT use the Magneto Kill Ground connection on the Sensor Boxes Engine Control Panel.

4. Ensure no sensor cables, electrical wires, or pressure lines interfere with the engine exhaust system or other hot or rotating parts.
5. Verify that dyno water supply valves are in the correct position.
6. Secure all objects that might move due to air flow in the test cell.
7. Verify:
   - The fuel supply is adequate for the test.
   - The power is on at the console, sensor box, computer, printer, and any additional control equipment.
8. Open ventilation air shutters in the test cell.
9. Open fuel supply valves.
10. Turn ON water pumps and ventilation fans.

⚠ CAUTION

ALWAYS turn ON water pumps and ventilation fans BEFORE starting engine. Damage to the absorber seals may occur if the engine is run without water supplied to the absorber.

5.0 Operation

Quick Start Checklist for SF-902S Engine Dynos With NetDyn

Step	Action	Location	Purpose
Preliminary Steps	Water System Exhaust System Airflow System Mount Engine	Dyno cell	Insure all infrastructure systems are functional Insure all necessary engine mounting functions are completed
1	Power on computer system	Power switch on Dyno Computer	Turns on computer to prepare to load WinDyn software
2	Power on Dyno Console	Key switch on Console	Turns on sensor box and console
3	Launch NetDyn application	NetDyn Icon on left computer desktop	Starts the NetDyn application for the center monitor; NetDyn should automatically connect to the sensor box
4	Launch WinDyn Software	WinDyn Icon on left computer desktop	Establishes comm to sensor box, runs WinDyn application on dyno computer
5	Open desired Test Group	**'F2'** function key on computer keyboard	Installs the selected files from the computer to the sensor box
6	Check Torque and Weather	**'2'** key on dyno computer keyboard	Verify the torque system is at or near zero (+/-2), verify weather conditions are current
7	System setup	**'S'** key on dyno computer keyboard	Set the data file name and beginning sequence number Set the file storage location (folder) for test data files Select test profile to perform (Normal test is **Accel**) Set correct engine specifications Set test parameters Enter test notes to be appended to the data files Memorize settings for future use
8	Activate Test Setup	**'F2'** function key on computer keyboard	Installs and activates test setup into sensor box.
9	Return to main viewing screen	**'1'** key on dyno computer keyboard	Normal viewing screen when running tests
10	Prepare the engine for testing	Engine and test cell control switches	Connect all desired sensors, warm engine up
11	Start test	**'START'** button on NetDyn application	Begins execution of the selected test type, stops at ramp command; Bring throttle to WOT, servo should hold engine at LOWER RPM setting; allow engine time to stabilize
12	Run Test	**'D'** key on NetDyn application interface	Executes ramp (accelerates engine); when ramp completes, return throttle to IDLE
13	Analyze data	**VIEW SAVED** icon on WinDyn "Analysis - Saved" Toolbar	 Select desired data file to analyze, print, or plot

5.0 Operation

Operator Console and Computer

Figure 5.7: Operator Console Controls

Figure 5.8: Dyno Computer Desktop

Use the power switch on the Dyno Computer and the power key switch on the Operator Console to turn both systems ON. The Dyno Computer desktop will show on all screens once the computer operating system has properly loaded.

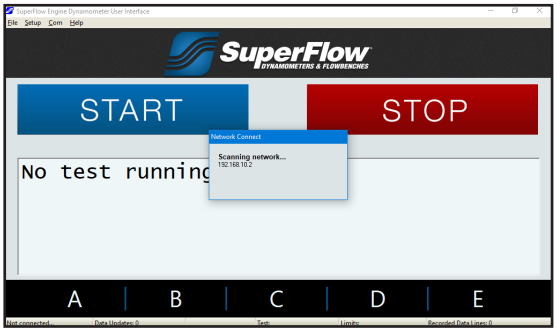


Figure 5.9: NetDyn Loading

Figure 5.10: WinDyn Loading

Load Software

1. Locate the SuperFlow NetDyn program icon on the desktop and **double-click** the icon to load the program.
2. Once NetDyn has been loaded, locate the SuperFlow WinDyn program icon on the desktop and **double-click** the icon to load the program.
   a. The WinDyn initialization screen will show and automatically close once the program has been initialized. WinDyn will require additional load time once the initialization screen closes, wait approximately 15 to 30 seconds for WinDyn to load completely.

IMPORTANT
DO NOT attempt to reload the WinDyn software once the initialization screen closes, wait an additional 30 to 45 seconds before attempting to reload the software.

5.0 Operation

Test Group Dialog

When WinDyn is loaded, operators will be presented with a blank WinDyn desktop. To begin preparing the system for testing, select and load the appropriate Test Group file. Press the **F2** function key to open the **Install Test Group** window. Select the **Test Group** file and press **Open** button to load the associated files.

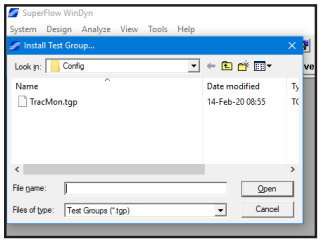


Figure 5.11: Install Test Group Window

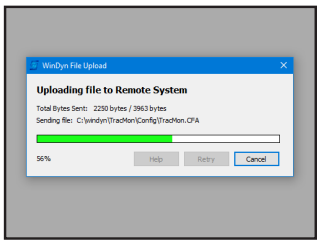


Figure 5.12: Test Group Loading Dialog

WinDyn Prep

Prior to testing, press the '**2**' key on the dyno computer keyboard to load **screen two**. Once the screen is loaded, verify the torque system is at or near zero (± 2) and the weather conditions are current. It is also good practice to verify other sensors appear to be reading correctly. See section "6.3 Calibration" on page 63 if you feel calibration should be performed before testing.

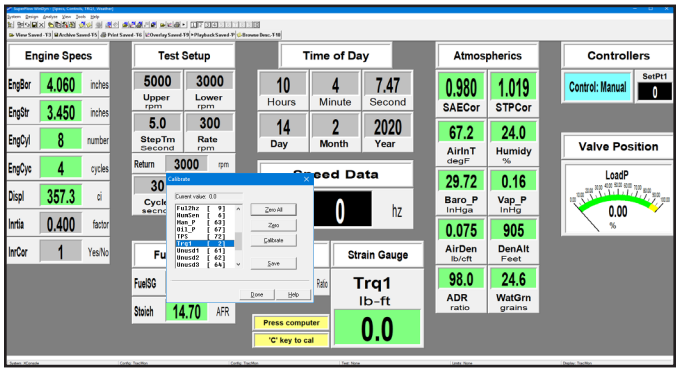
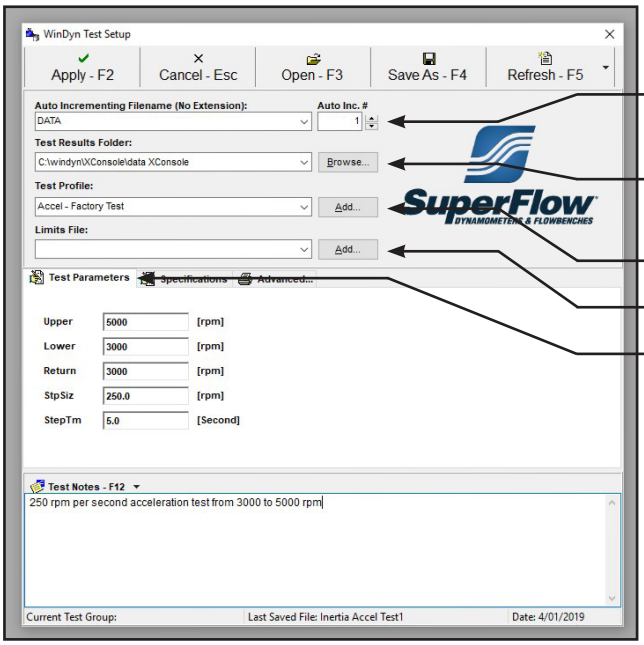


Figure 5.13 Test Setup - Test Parameters

WinDyn Setup Dialog

WinDyn preferences can be set up to quickly prepare the system for testing. To bring up the **Test Setup** window **LEFT-CLICK** anywhere on the main WinDyn display and then type the letter **s** from the computer keyboard and enter the following information:



1. Enter a name you wish to use for the data file and set the increment.
2. Specify the location where the data file will be saved.
3. Select the Test Profile you want to run.
4. Specify a safety limits file if desired.
5. Set the test parameters.

Figure 5.14 Test Setup - Test Parameters

5.0 Operation

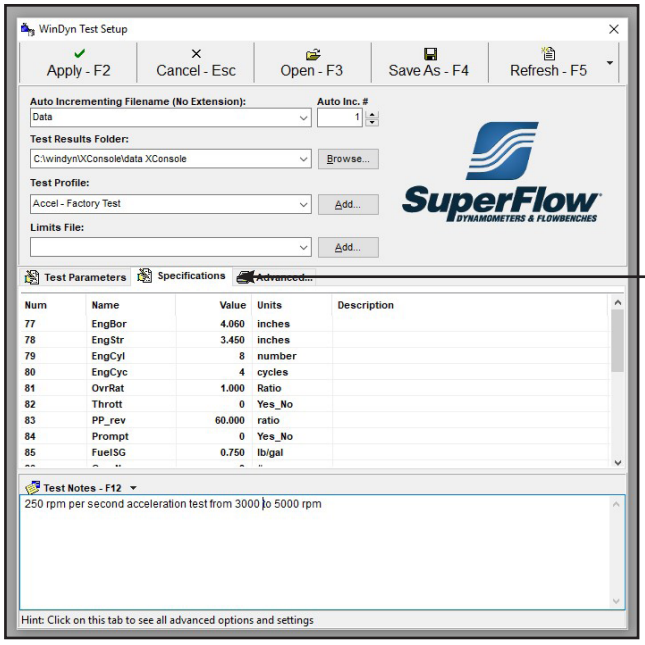


Figure 5.15 Test Setup - Specifications

6. Click the **Specifications** tab and enter the engine specs.
7. Adjust the **Valpos** setting as necessary.
8. Adjust the **fuel specific gravity** as necessary.
9. Verify all other specification settings.

ValPos Adjustment

ValPos Adjustment – WinDyn channel 88

The **ValPos** adjustment allows the user to tune the dyno to the engine being tested. Each integer represents an inlet valve movement of 20%. Values between integers may be used, i.e., 2.5 or 3.3, etc. The key is to observe outlet water temps from the absorber. SuperFlow prefers to see temps no higher than 190 deg F. Optimally, use a **ValPos** and **water pressure** setting that gives best control and low outlet water temps.

The **ValPos** channel will range in value from 1 – 5 (default is 3).

Recommended settings are as follows:

- 1 = Power levels from 0-300 Hp
- 2 = Power levels from 300-700 Hp
- 3 = Power levels from 700-1200 Hp
- 4 = Power levels from 1200-1700 Hp
- 5 = Power levels > 1700Hp

IMPORTANT
The power level values listed require a water inlet pressure between 60-90 psi. Outside this range the values are not valid.

5.0 Operation

Running a Test

Automated tests are executed from the operator console touch screen or computer keyboard and mouse. The steps below show how to run an Accel Test using the operator console. The following steps assume the Accel Test has been select, WinDyn Software is properly setup, Engine is properly connected to dyno, warmed up and running.

1. Press the **START** button to begin.

Figure 5.16: NetDyn Loading

2. Follow the on screen prompt and increase throttle setting and stabilize speed at 3,000 RPM.

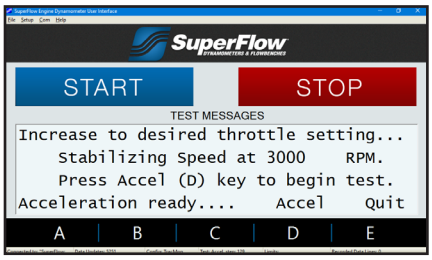


Figure 5.17: Start Accel

3. Once stabilized, begin test by pressing the (**D**) button on the operator console and accelerate speed to upper limit.

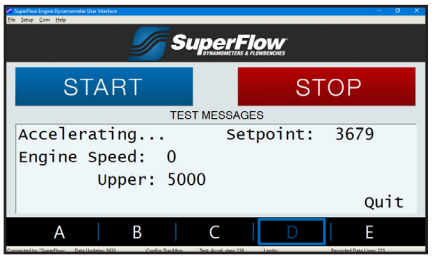


Figure 5.18: Ramping

4. Once test has been completed, return throttle to idle.

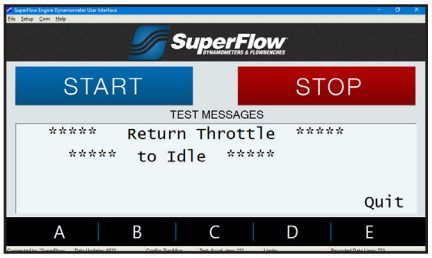


Figure 5.19: Return to Idle

5. At the conclusion of the test, data will be saved.

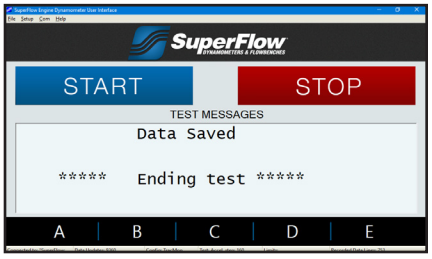


Figure 5.20: Data Saved

5.0 Operation

Post Test

Each test can be viewed after it is saved. Current data is stored in memory in the Data Acquisition sensor box. Saved data is on the computer in the location and with the filename specified in the Test Setup screen. Press “Shift + F3” to select and view the saved test data.

Shutdown

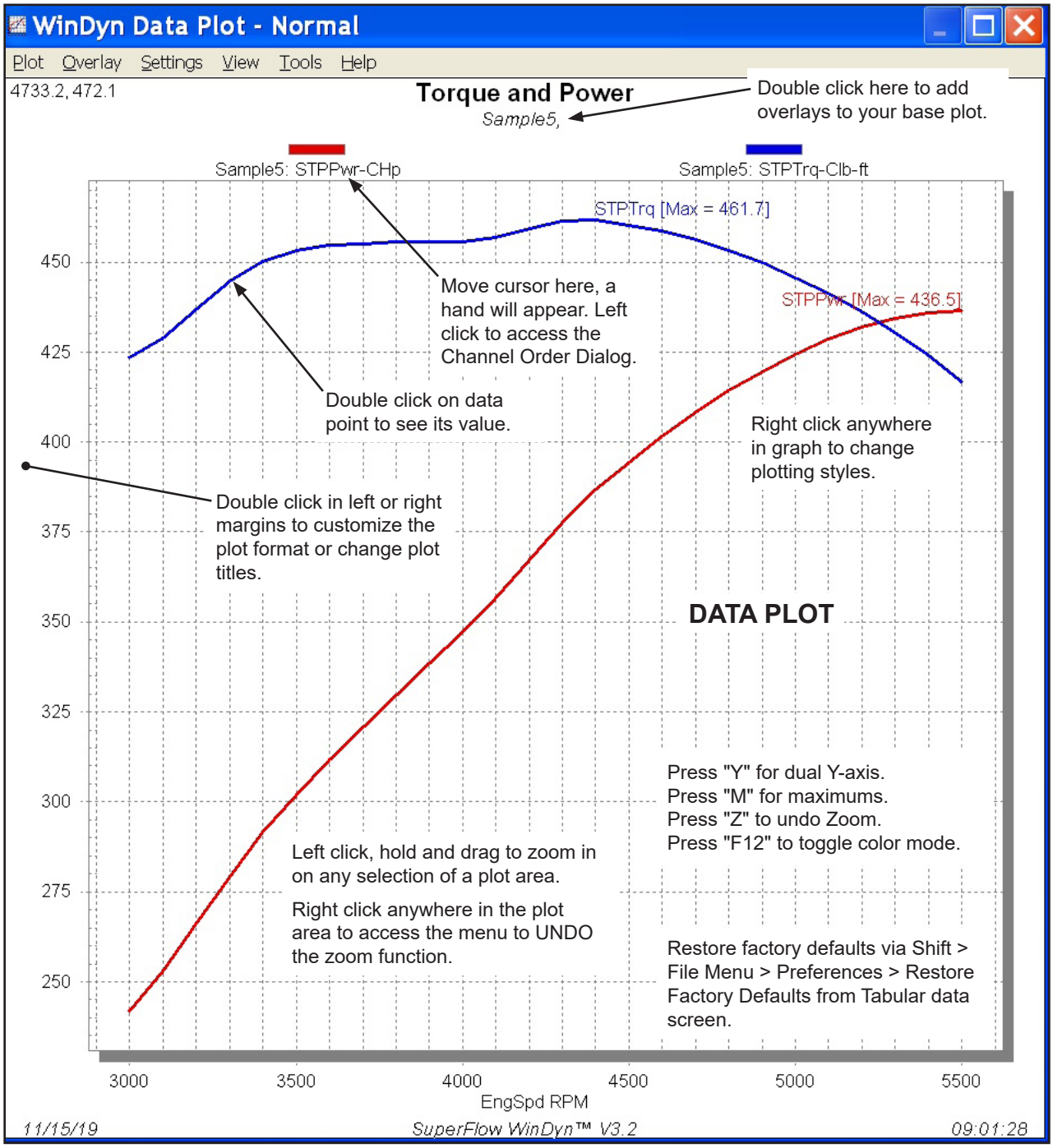
Let the engine cool down as necessary in idle mode, then turn off fuel and ignition. When the test cell ambient temperature and the engine coolant temperature are normal, shut down the test cell pumps and fans.

5.0 Operation

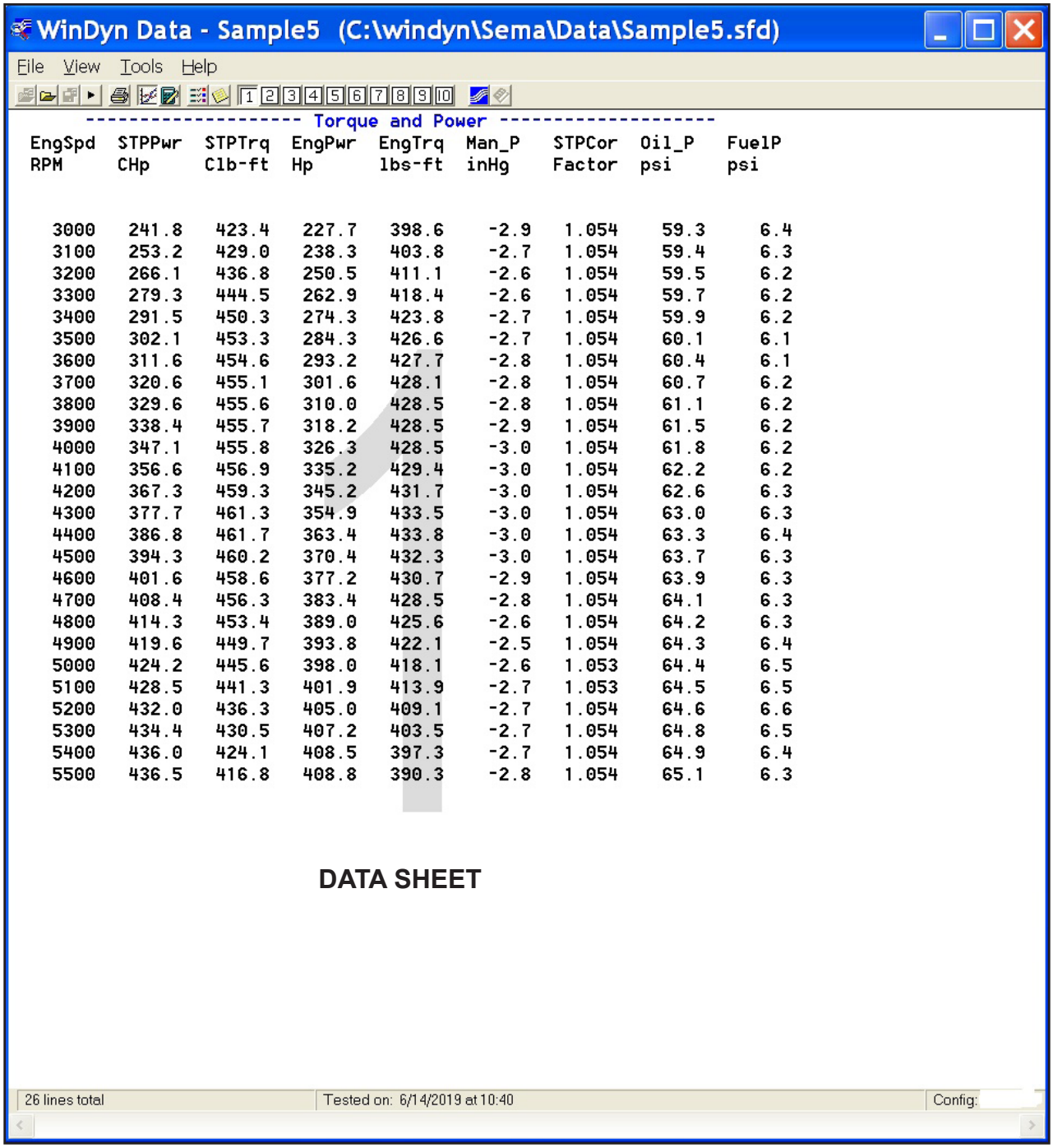
5.8 Analyzing the Test Results

All automated tests will save the test data automatically on the computer. The recorded data can be viewed, plotted, and printed using the WinDyn Stored Data Viewer.

NOTE: Refer to the WinDyn operators manual for more information on how to use the Stored Data Viewer.



5.0 Operation



DATA SHEET

6.0 Maintenance

This product is designed to provide years of trouble free service with a minimum amount of regular maintenance. The system should be periodically serviced according to the maintenance schedule below.

6.1 Maintenance Schedule

If necessary, the dynamometer can be cleaned using an all-purpose cleaning detergent and water. Pay special attention that the load cell is not “soaked” during the cleaning process. The load cell can become wet but should be dried without delay.

⚠ CAUTION

Do not use more than the defined amount of grease as over filled bearings are liable to over heat.

Table 6-1. Maintenance Chart

Maintenance Schedule		
Component	**Interval**	**Action**
System cables	Each Use	Inspect for wear or damage
Pressure hoses & fittings		Inspect for wear or damage
Other sensors		Inspect for wear or damage
Water Filter/Strainers	Every 3 months	Inspect and clean
Water System		Add 1 gallon of chlorine bleach per 1,000 gallons of water.
Load cell calibration		Calibrate per software manual
Servo valves		Inspect for water leaks
Absorber		Inspect for water leaks
Speed pickup		Inspect for debris or grease
Engine cart		Lubricate castors
Connected sensor calibration		Calibrate
Emergency stop		Verify proper operation
Computer, absorber, stand, and sensor box		Clean
Battery on the Sensor Boxes 2640 Circuit Board	Every Year	Check and replace battery if less then 2.9 VDC

6.0 Maintenance

⚠ WARNING

- **Post safety warnings and barricade work area to prevent unauthorized use of the dynamometer before maintenance has been completed.**
- **Only qualified machine operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ WARNING

AUTOMATIC STARTING HAZARD. An engine connected to dynamometer could be started remotely. Ensure starting has been disabled prior to servicing.

6.2 SF-902S Maintenance

The absorber requires very little maintenance. Follow the suggestions below to increase the life and reliability of your absorber.

Water Filters

Contaminated water can reduce the life of an absorber and increase maintenance cost. Clean the filter on the input to the absorber after every 50 hours of operation and change when needed. Signs of a clogged filter is if the absorber cannot hold a load at the upper end of an acceleration test. A replacement filter can be ordered through SuperFlow Customer Service, part number 4500P-5060.

Change and clean filters on the water supply line to the dyno according to the manufacturer's recommendations. An indication of a defective supply filter is when the water supply cannot maintain a full sump tank.

Automatic Water Fill Valve

The black plastic valve on the main inlet to the water tank controls the water flow to the dynamometer tank. The tank level is set with the float valve inside the tank. The tank can possibly overflow the first time it is filled but should not happen again after the automatic valve is primed. The control valve rarely fails to work properly, but if it does, it is because debris is trapped under the diaphragm in this valve or the float valve does not shut off properly.

The handle controls how fast water bleeds from one side of the diaphragm to the other and therefore controls how fast the valve turns on and off. This is usually left wide open for the fastest response and should not require adjustment, but it can be adjusted if necessary.

If the water does not shut off completely or almost completely (just a couple drops per second at worst), check the float and the diaphragm before ordering a replacement valve because it is unlikely the entire valve is faulty. Usually the float valve is not shutting off completely because of debris in the orifice or the float is not set properly.

1. Check the float valve in the tank to make sure it is being pushed up far enough to close. If necessary, bend the rod on the float until the valve shuts off.
2. If the valve still does not shut off, remove the eight bolts that secure the top of the black valve, and remove the cover and the diaphragm from inside.

3. Make sure the rubber seals inside are not torn or damaged and that no debris is in the sealing area. If everything checks out, reassemble it.

Replacing the valve requires removing many of the fittings from the aluminum coupler and then removing the tank from the stand because the black valve cannot be spun off with the tank on the floor. It is acceptable to let the water overflow the inside divider (as long as the excessive water usage is not a problem) to allow the dyno to keep running until the replacement arrives.

Fuel Filters

SuperFlow's high-capacity fuel pump system also has high-sufficiency filtration capabilities. The end result is that regularly cleaning the fuel filter is necessary to ensure consistent fuel delivery. Signs of a clogged fuel filter are slow priming times for the pump and decreased fuel-handling capacity during operation. The fuel system's filtration factor is determined by its 40-micron (0.0015-inch) capacity filter. This high-capacity filter traps grit, rust, flakes, lint, animal hair, and insect parts. If you are not testing with highly filtered fuel, your fuel system will catch a large quantity of contaminants you may not realize are even present.

To clean the system, remove the filter screen assembly from its canister and wash it using a parts- washing solvent. Never clean it with carburetor cleaner.

After cleaning the filter, blow the cleaning solution and any remaining particles off the screen using an air hose. Hold the nozzle of the hose at a 45-degree angle and blow air from the outside toward the inside of the filter element.

Depending on the source of your fuel, regular cleaning schedules will vary. At the outset, SuperFlow recommends cleaning the filter weekly. After that it should be cleaned after every 50 hours of dynamometer operation or every 3 months, whichever comes first.

Speed Pickup

A magnetic pickup is used to measure the speed of the absorber. A damaged pickup can cause erratic engine rpm readings and can cause the engine to "run away" during automatic testing. In most cases no maintenance is required on the pickup. However, check it when experiencing problems with rpm readings.

On an SF-871 absorber the air gap between the pickup and the tach gear is set at 0.03 in (0.75 mm).

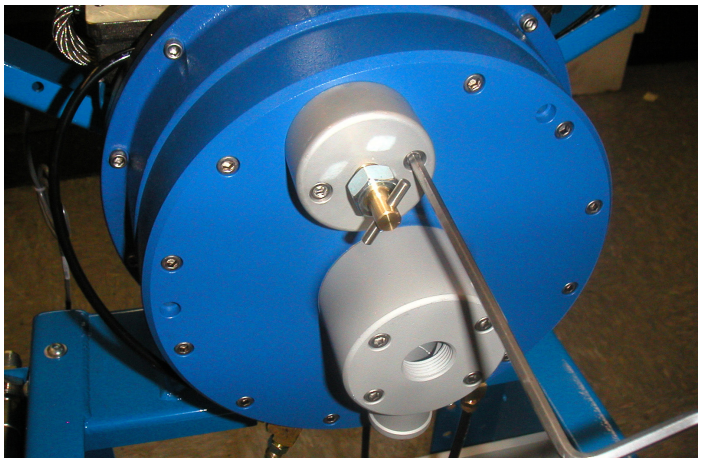
6.0 Maintenance

Absorber Water Pump Seal

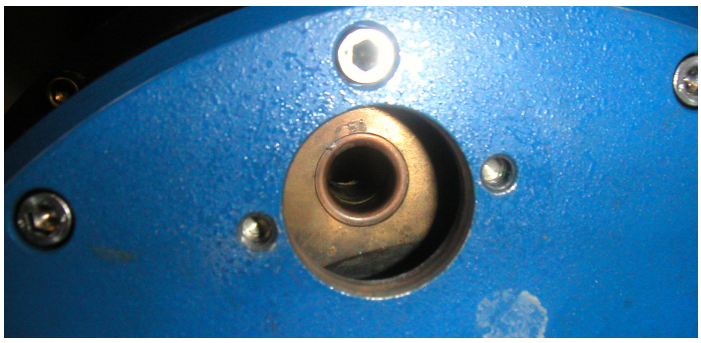
A damaged water pump seal will usually cause significant instability problems. If speed instability becomes evident (+ 20 rpm in manual valve control mode), SuperFlow recommends this quick water seal test.

Pump Seal Leak Test

1. Place the dynamometer's load controller to minimum load. This ensures that the servo valve is wide open.
2. Fully loosen the lock nut on capacity valve.
3. Turn the capacity valve fully counterclockwise (open).
4. Remove the capacity valve from the back of the absorber pump housing.

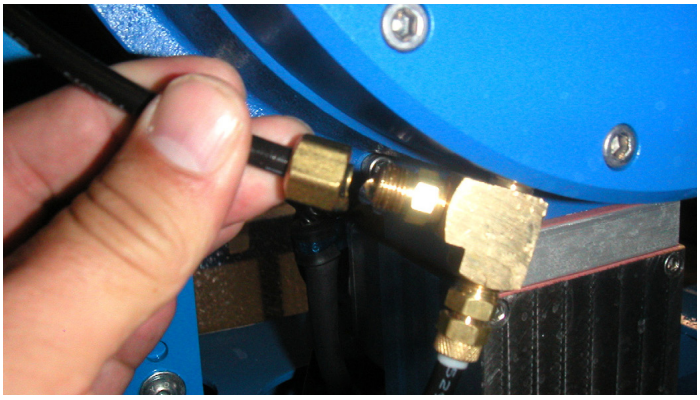


5. Fashion a cork or rubber stopper to fit tightly into the seat of the stator housing. The cork or stopper must be trimmed so that it does not protrude out of the seat more than 1/8".



6. Remove the seal bleed hose and compression fitting from the T fitting on the absorber.
7. Plug the open T fitting where the seal bleed line was removed.

6.0 Maintenance



8. Re-install the capacity valve with the valve still in the fully open position.
9. Close the capacity valve (clockwise) to just where the tip of the whole valve touches the plug.
10. Energize your water supply and return pumps.
11. Open any valves necessary to supply water to the dynamometer.
12. Open the pressure boost ball valve fully.
13. Observe water exiting the servo valve outlet.

- Any water observed leaving the servo valve outlet must be water that is leaking past the pump seal 3200P-0750.
- If this amount is more than just a few drops, SuperFlow recommends replacing the pump seal.

14. Remove the plug and restore the absorber to normal operation.

Pump Seal Replacement

All water brake absorbers manufactured by SuperFlow Technologies Group use the 3200P-0750 pump seal. The purpose of this seal is to prevent water from moving between the rotor and stator area and the pump housing. Failure of this seal can lead to absorber controllability issues such as reduced loading capacity, surging, and erratic changes in load.

This part is relatively inexpensive and easy to replace and should be considered a maintenance item. SuperFlow recommends changing this seal at least once every year or after every 200 hours of operation, whichever occurs first.

If you experience any of the above symptoms, first check for cleanliness, the overall integrity of the foot valve, and the water filter attached to it. Also ensure that the load control valve (servo valve) is properly indexed and that it operates smoothly. Realize that your water supply system must be adequate to keep the water level in the sump tank above the filter at all times.

After confirming the above criteria are met, if you still experience absorber control issues, pump seal replacement usually solves the problem. Contact your representative for more information on pump seal replacement.

6.0 Maintenance

6.3 Calibration

The sensors used with the SF-902S should be periodically calibrated for highest measurement accuracy.

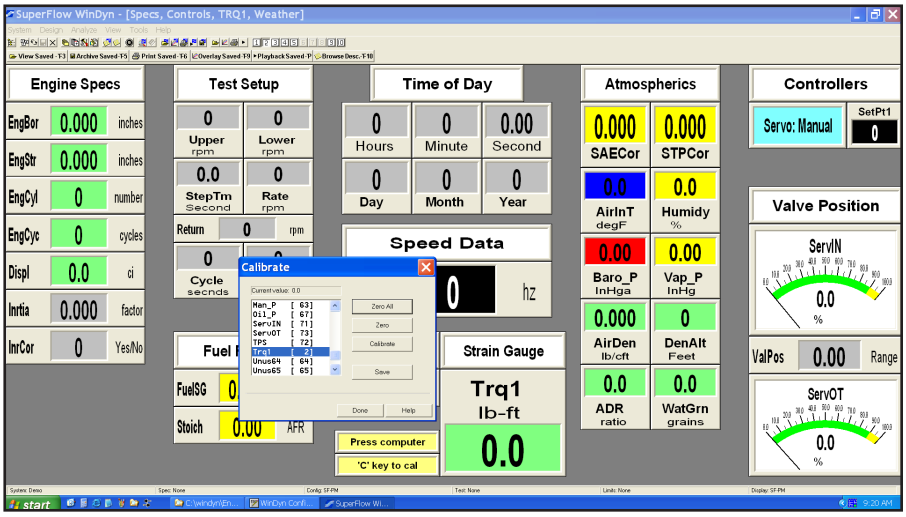
Not all sensor channels require calibration. Some, such as thermocouples, are calibrated at the factory and normally do not need re-calibration. Pressure transducers and analog voltages, have the calibration set in the configuration file based on the manufacturer's specifications.

As a rule, the source used to calibrate a sensor should be 10% more accurate than the sensor being calibrated. For example, if a sensor has an accuracy of +/–1%, the standard used to calibrate it should have an accuracy of +/–0.1%.

Calibrating the Sensors

NOTE: The following procedures are performed using the WinDyn Data Acquisition and Control Software, please refer to the software manual for additional calibration details.

Torque:



15. Power on computer system.
16. Power on dyno system.
17. Launch WinDyn application.
18. Use **System | Install | Test Group** menu option (or **F2** key) to load your specific test group (.tgp) file.
19. Select **SCREEN 2** to observe **Trq1** channel (2).
20. Press '**C**' key on computer keyboard.
21. Calibration dialog box should appear on computer screen.
22. Scroll down in channel dialog and highlight '**Trq1**' channel.
23. Mount cal arm and weight pallet to absorber.
24. Click '**ZERO**' button.
25. Hang cal weights on weight pallet.
26. Observe '**Current value = ????**' in Calibrate dialog box.
27. Click '**Calibrate**' button.
28. Enter computed torque value of hanging weights (**Weight x effective length of arm**) in calibrate dialog box. Click **OK**. The SF-PM system uses a 2 foot arm. The SF-902s and SF-BW use a 3 foot arm.
29. Remove weights and calibration arm

30. Click '**ZERO**' button again.

31. Click '**SAVE**' and overwrite existing calibration file by continuing to click '**OK**' as dialogs appear.

32. Click '**DONE**' to exit calibration dialog box.

Torque calibration is now complete. If the readings do not correspond with the procedure or are not within acceptable limits, contact SuperFlow Customer Service.

Pressure Transducers:

If you have pressure sources and calibrated pressure measurement equipment with a higher accuracy than the transducer, it is possible to calibrate the pressure sensors using the procedures similar to those used to calibrate the torque sensor. However, scroll and locate the desired pressure channel and apply a known pressure to the sensor within range to verify calibration.

⚠ WARNING

An abrupt change in pressure may result in damage to the sensor being calibrated. Make certain that the regulated air supply is set to zero before introducing pressure at a slow pace. When finished calibrating, slowly bleed off the air supply before removing from the sensor being tested.

Atmospheric Transducers:

Check the calibration of the weather channels, **AirInt**, **Humidy**, and **BaroP** using a weather station of your choice.

- **AirInt** is calibrated via the AirSen channel 1.
- **Humidy** is calibrated via the HumSen channel 6.

Raise or lower the voltage values in either channel to perform calibration. SuperFlow uses a Kestrel 3500 pocket weather station to calibrate these channels. Any similar device will suffice.

Temperature:

There is no adjustment for the calibration of the temperature sensors. If a temperature is reading incorrectly, try using a different probe. If available, the temperature may be verified with a thermocouple simulator. If that does not work, contact your SuperFlow representative.

Speed:

There is no adjustment for the calibration of the speed sensor. If the speed is reading incorrectly, check the cables, connectors, and, if possible, the gap between the pickup and the gear. If it is still reading incorrectly, repair parts or service may be required. If available, the speed may be verified with a hand tachometer.

Speed pickup gap .015"-.020"

6.0 Maintenance

Calibration Coefficients:

A calibration printout with the coefficient values can be obtained and kept in a log which is useful for documentation and tracking any drift trends in the sensors or changes in the channel definitions.

Performing a current value calibration creates a new coefficient number for that channel or channels. All other channel coefficients should remain the same. The offset value changes every time the system is zeroed.

1. From the main ***WinDyn*** menu, select **Tools>>View Sensor Calibration**.
2. Using the Tutorial at the bottom of the window, follow the steps to open the file and print the calibration values.

6.4 2640 Circuit Board LEDs

1. Both LEDs should be ON when powered up.
2. Active LED should be blinking when powered up.
3. Both LEDs should be ON when connected to the computer network. The top LED will be flashing when WinDyn or NetDyn are active.

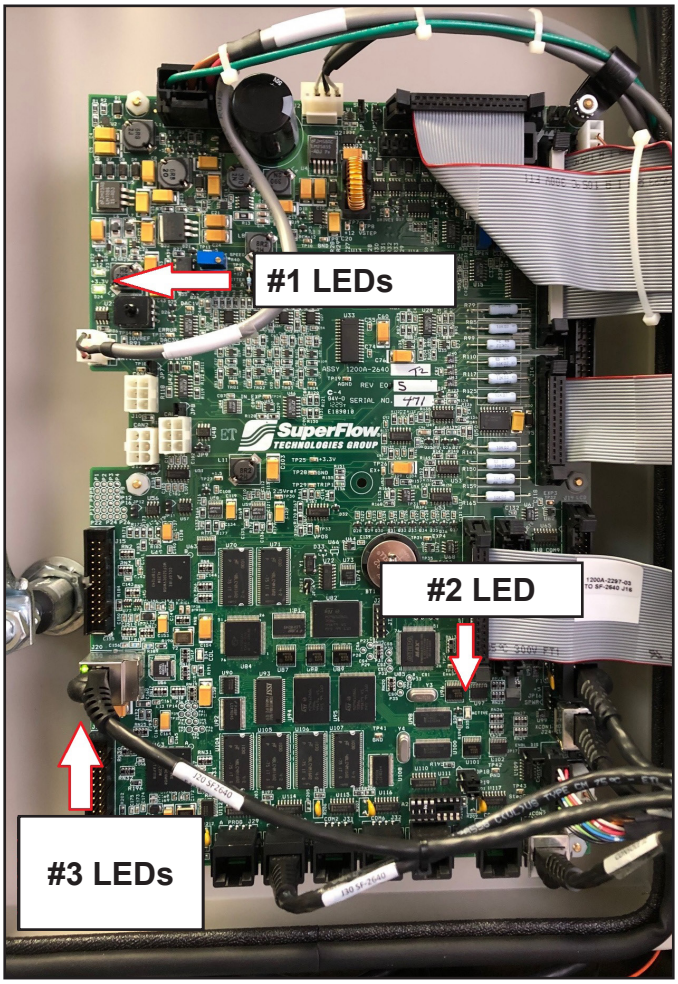


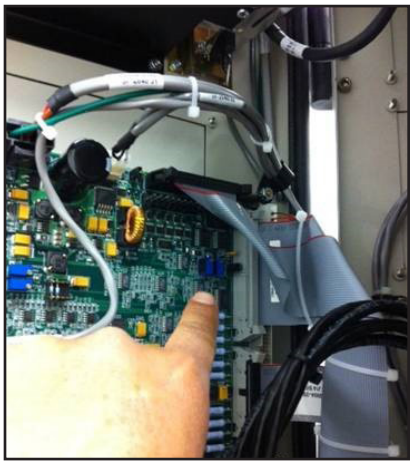
Figure 6.1 2640 Circuit Board LEDs

6.0 Maintenance

6.5 SF-902S Servo Valve End Stop Adjustment On 2640 CPU Boards

1. Open the sensor box and locate the CPU board mounted on the door. Below the CPU board is P/N SF1200A-2640.

2. In the upper right hand corner located under the gray ribbon cable you will find two blue potentiometers.



3. One is for “OPEN” position of the servo; the other is “CLOSED” position.

6.0 Maintenance

4. Using the Servo Control panel with the knob. In “MANUAL” mode adjust the knob so the display reads “0.0%”. This should be the open position on the servo valve.

5. If not adjust the Blue “OPEN” potentiometer on the CPU board (SF1200A-2640) that we located in step one so the servo valve matches the photo right.

6. Next adjust the Servo Control panel so it reads “100%” this should be the “CLOSED” position.

7. If not adjust the Blue “CLOSED” potentiometer on the CPU board (SF1200A-2640) that we located in step one so the servo valve matches the photo right.
8. The servo valve open / closed position adjustment is complete.

7.0 Troubleshooting

This section outlines basic procedures to follow if the component or instruments do not function properly. Contact SuperFlow Technical Support if you have any questions about the safe operation of the equipment or for service and advice.

⚠ WARNING

- **Post safety warnings and barricade work area to prevent unauthorized use of the dynamometer before maintenance has been completed.**
- **Only qualified machine operators and maintenance personnel should perform the procedures covered in this manual.**

⚠ WARNING

AUTOMATIC STARTING HAZARD. The dynamometer could be started remotely. Ensure starting has been disabled prior to servicing.

7.1 Absorber/Servo Troubleshooting

When troubleshooting a load control problem on a water brake equipped SuperFlow engine dyno system, always begin by checking whether the system can load the engine manually or in servo control mode. If one way works but the other does not, this information can be very helpful when diagnosing the problem.

Use the following procedure to diagnose whether the control system can command the servo valve.

SF-902 Systems:

1. Load the DIAG_902.tgp test group.
2. Load the DiagTest.tpf test profile.
3. Start the test and follow the prompts to run the RAMP test.
4. This will allow you to check the function of your servo valve.

If the above test shows that the servo valve is not acting correctly, the problem is most likely with the servo or associated electronics in the console or sensor box.

7.0 Troubleshooting

Use the troubleshooting tips in the following table to help diagnose a servo valve or absorber problem. Along with servo valve problems, additional problems may be associated with the water supply system:

Symptom	Possible Cause
Absorber does not load (no pressure boost)	• Absorber not primed (check dyno prime assembly and foot valve for proper operation) • Capacity valve closed • Absorber drain petcock open • Water filter dirty • Insufficient water supply • Servo valve spool loose or incorrectly indexed • Pump seal bad • Pump impeller bad • Absorber rotor or stator bad
Absorber loads only with Pressure Boost on	• Check dyno prime assembly and foot valve for proper operation • Water filter dirty • Pump seal bad • Pump impeller bad
Control unstable (Manual mode)	• Engine not running smoothly • Severe ignition noise • Air vent on absorber restricted • Water filter dirty • Foot valve defective or clogged • Insufficient water supply • Pump seal leaking • Incorrect capacity valve setting • Capacity of absorber exceeded • Servo valve spool loose or incorrectly indexed
Control unstable (servo or EngSpd mode); rpm rate inconsistent with selected rate	• Check in Manual mode for control problems • PID control parameters incorrect; try putting control system in analog mode and repeat test • Electronics failure in sensor box • Bad rpm signal • Servo valve spool loose or incorrectly indexed
Absorber loses load while testing	• Insufficient water supply • Inlet temperature too high (above 110 degrees F) • Outlet water flowing into inlet side of water tank (creates too high water temperature and aeration of the water) • If occurs above 4000 rpm, then pump seal has failed.
Oil leaking from weep hole on bottom of absorber	• Inner oil seal leak

7.0 Troubleshooting

Symptom	Possible Cause
No load cell reading (no torque measurement)	• Load cell installed backwards (binding on absorber) • Broken wires on load cell • Load cell bad
Servo valve does not move (manual mode)	• Cable disconnected • Motor failure • Debris in valve jamming spool • Electronics failure in sensor box
Servo valve spins constantly (manual mode)	• Cable disconnected (console to stand) • Damaged potentiometer • Broken wire on potentiometer assembly on outside of servo valve
Load occurs when servo valve is open	• Servo valve spool loose or incorrectly indexed • Check for plugged vent tube on absorber

7.0 Troubleshooting

Servo Valve Diagnosis:

During the manual sweep test, not only should the valve sweep evenly, but it is sometimes helpful to put your hand on the servo and feel the little ticks as it rotates.

The ticks should be even without any stutter. If the stutter happens at even increments, like every 4th one, then it is likely that it is a motor problem, or every 16th one, then it is likely an electronics problem. If the stutter is random, it's probably a pot signal issue.

The table below shows resistance values that should be received on a good servo motor assembly. It is a quick way to see if a physical problem with the servo actually exists. The most common problems are high resistance where open circuits should be in the motor; this can indicate water in the motor. Also, if the resistance of Y+Z is substantially less than 1320, such as 1100, this is usually a sign of water in the potentiometer. Lastly, any open circuits in pins 1–6 that have a value in the table (other than 4) are a sign of a burned-out coil or damaged cable.

Servo Valve Connector Resistance Check in ohms (Ω)											
Description	**Pin #**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Coil A	1		11.4	∞	∞	∞	5.7	∞	∞	∞	∞
Coil B	2			∞	∞	∞	5.7	∞	∞	∞	∞
Coil C	3				11.4	5.7	∞	∞	∞	∞	∞
Coil D	4					5.7	∞	∞	∞	∞	∞
Center Coil C-D	5						∞	∞	∞	∞	∞
Center Coil A-B	6							∞	∞	∞	∞
Shield	7								∞	∞	∞
Potentiometer – (Servo CW)	8									5.8	Y
Potentiometer + (servo CCW)	9										Z
Potentiometer Signal (wiper)	10										

Notes:

1. All measured values should be within 10% of values indicated in table.
2. ∞ indicates infinite resistance, e.g. open circuit.
3. Y + Z should total approximately 5.8k Ω
4. Y should equal 100 when servo valve marks are aligned.
5. Pin 9 to red wire connection on outside of servo should be 320 Ω.

8.0 Appendix

The following pages contain information specific to the SuperFlow SF-902S dynamometer. As specifications and part numbers change, these documents will be updated to reflect the equipment and requirements for your machine at the time of shipment. Contact your sales representative for further information.