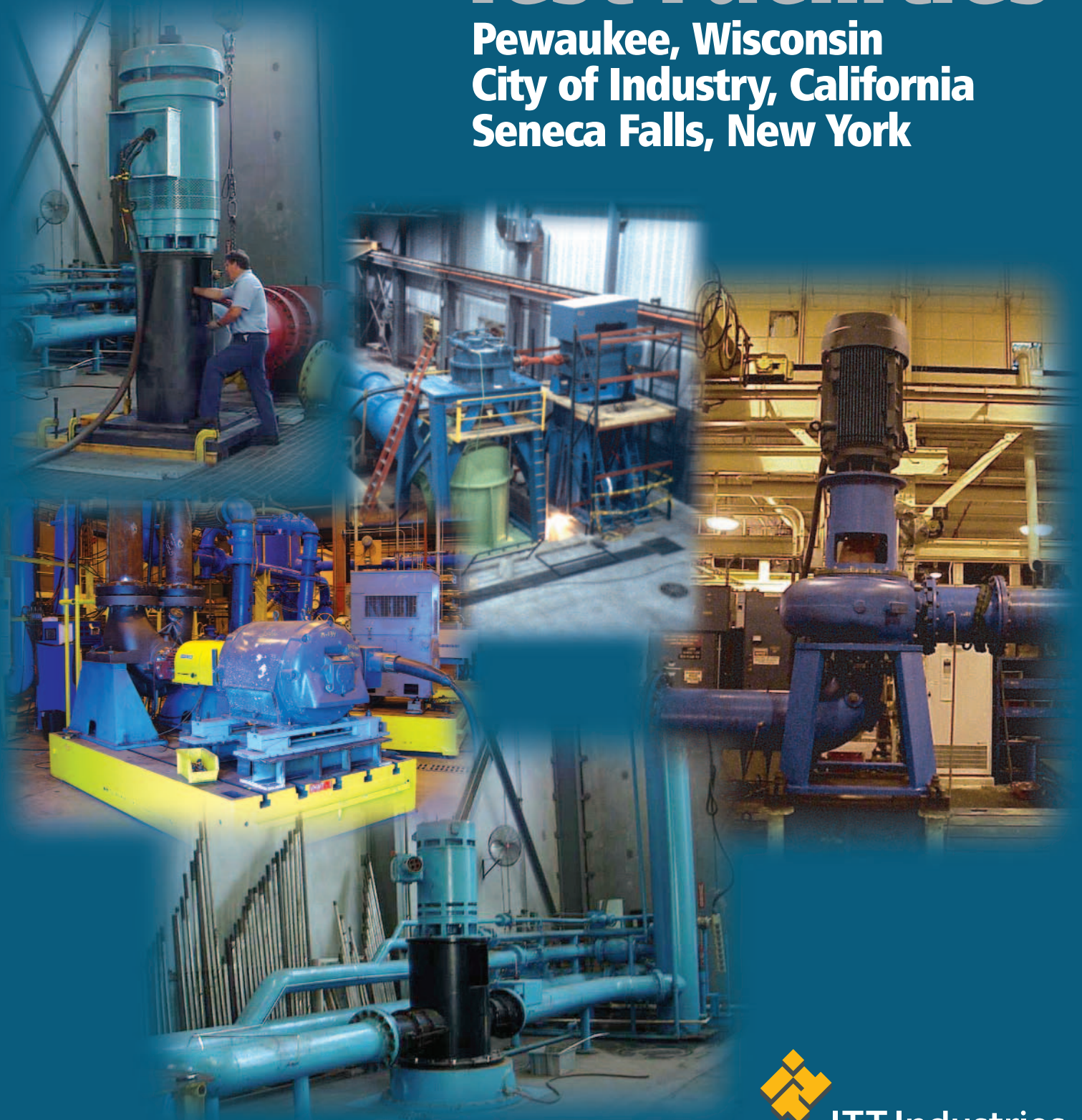


Engineered Pump Test Facilities

**Pewaukee, Wisconsin
City of Industry, California
Seneca Falls, New York**



ITT Industries
A-C Pump — Goulds Pumps

The ITT Industries Industrial Pump Group, Goulds Pumps and A-C Pump, has three state of the art pump testing facilities located in the continental United States. The facilities located in Seneca Falls, New York; Pewaukee, Wisconsin; and City of Industry, California

enable ITT IPG to test the full range of pump types and sizes manufactured by Goulds Pumps and A-C Pump. Strict adherence to ISO 9001 procedures and Industry Standards ensure accurate and consistent test results.

Pewaukee, Wisconsin Test Facility

Our Pewaukee, Wisconsin, USA manufacturing plant houses the largest indoor pump test facility in North America and is capable of handling test flows up to 300,000 gpm (68,100 m³/h) with heads up to 230 ft. (70m) and motors up to 3500 HP (2611 kW). Movement and set-up of equipment is accomplished with overhead cranes with lift capabilities up to 60 tons.

The Pewaukee test facility utilizes a wet pit sump arrangement. The sump is 100 ft. (30.5m) long, 24 ft. (7.3m) wide, 30 ft. (9.1m) deep on the deep end, and

20 ft. (6.1m) deep on the shallow end. (See Figure 1). The sump holds approximately 440,000 gallons (1665m³) of water. A dry pit runs along two sides of the sump with provisions for testing dry pit pumps and split case pumps under flooded suction conditions.

Discharge piping and support structures are movable to allow for a wide variety of testing arrangements. For large capacities the flow is split into two 42" lines for flow measurement. (See Figure 2).

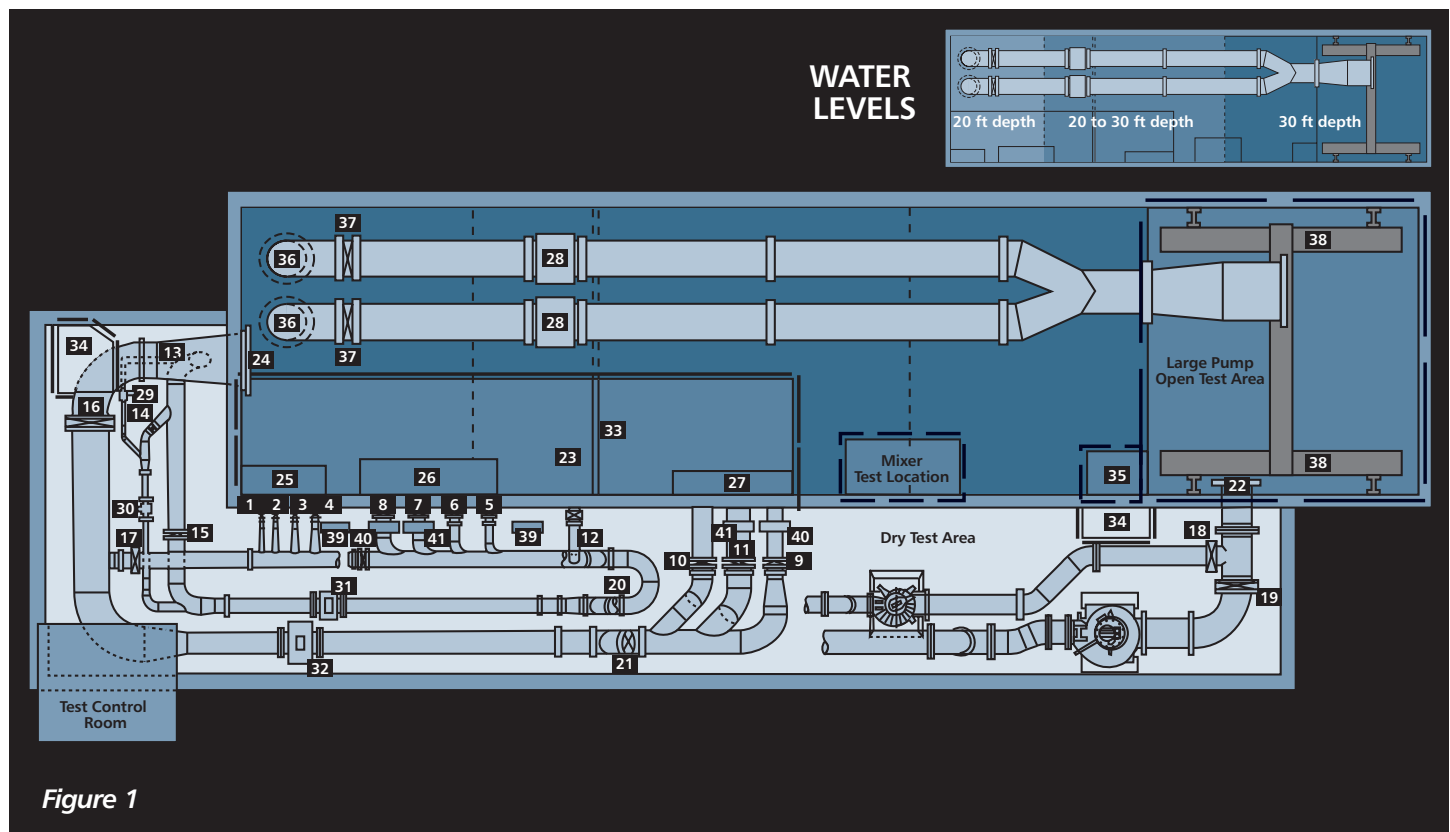


Figure 1

Key

- | | | | |
|------------------------------------|---|---------------------------------------|---|
| 1. Discharge connection valve, 2" | 10. Discharge connection valve, 20" | 21. CT-discharge valve, 24" | 33. Underwater turbulence baffle |
| 2. Discharge connection valve, 3" | 11. Discharge connection valve, 24" | 22. CT-test suction inlet, 30" | 34. Dry-pit entry |
| 3. Discharge connection valve, 4" | 12. B, CS pumps hose connector and valve, 10" | 23. BS, CS pumps test connection, 10" | 35. Wet-pit entry |
| 4. Discharge connection valve, 6" | 13. Metering valve, 3" | 24. System discharge | 36. System return discharge, 42" |
| 5. Discharge connection valve, 8" | 14. Metering valve, 8" | 25. CP test location, 2" thru 6" | 37. Motorized butterfly valve, 42" |
| 6. Discharge connection valve, 10" | 15. Metering valve, 16" | 26. CP test location, 8" thru 14" | 38. Movable pump support structure |
| 7. Discharge connection valve, 12" | 16. Metering valve, 30" | 27. CP test location, 16" thru 24" | 39. Satellite connection panel, 250 amp |
| 8. Discharge connection valve, 14" | 17. Flow-manifold crossover valve, 16" | 28. System magnetic flow meter, 42" | 40. Satellite connection panel, 400 amp |
| 9. Discharge connection valve, 16" | 18. CT suction-inlet valve, 20" | 29. Flow meter, 2" | 41. Satellite connection panel, 800 amp |
| | 19. CT suction-inlet valve, 30" | 30. Flow meter, 6" | |
| | 20. CT-discharge valve, 16" | 31. Flow meter, 14" | |
| | | 32. Flow meter, 24" | |



Figure 2

The flow is controlled via motorized butterfly valves controlled through the data acquisition system and discharged at the opposite end of the sump. Air release lines are utilized to ensure that all the air is evacuated from the system during testing. (See Figure 3).

Testing is conducted in accordance with the requirements of the Hydraulic Institute Standards and/or any contract specific requirements.

Test capacities of up to 300,000 gpm (68,100 m³/h) are possible through two 42" (107cm) calibrated magnetic flow meters. Additional magnetic flow meters of 2", 6", 14", and 24" diameter along with venturis of 10", 18", 24", and 30" diameter are also available for testing lower flow applications.

Pressure is measured by calibrated pressure transducers or mercury manometers. The system is designed to accommodate working pressures up to 100 psig (690kPa) through the magnetic flow meters. Higher test pressures are possible when using a venturi for flow measurement.

Power measurement is accomplished via calibrated torque meters (up to 63,000 ft-lbs.) or efficiency tested job motors.

Three separate shop variable frequency drive systems are utilized at the Pewaukee facility with ratings of 50 (37.3 kW), 500 (373 kW), and 3000 horsepower (2238 kW). Numerous calibrated shop motors and gear drives are also available. Shop voltages of 480, 2300, 4160, and 6600 volts are available for testing with job motors and variable frequency drives. Full train testing with the pump, job motor, and job VFD is available up to 3500 HP.

Vibration and noise measurement are also available during the factory performance tests.

A data acquisition system (DAS) is utilized to acquire, process and store all relevant test data. Pump operating

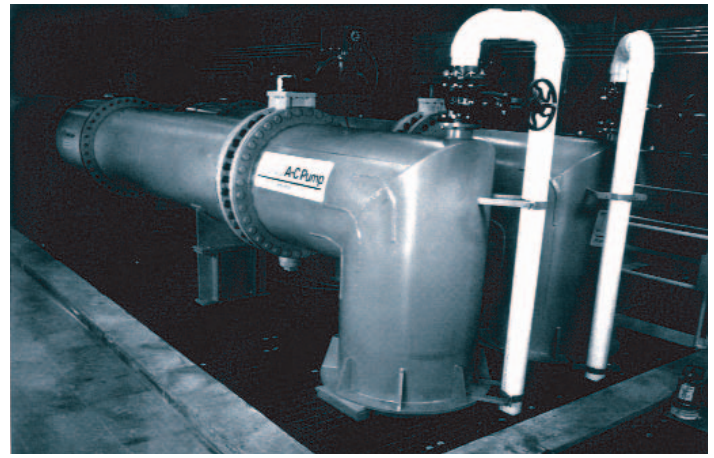
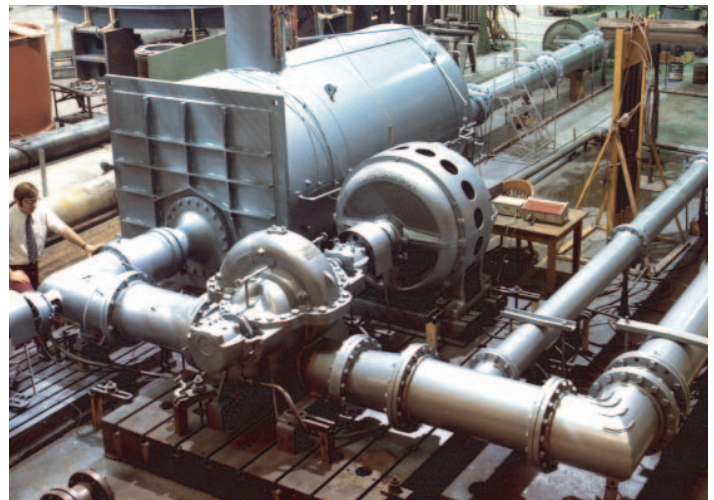


Figure 3



conditions can be controlled directly from the DAS. Display graphics are utilized to monitor current test outputs and can be utilized to review historical data during the test or after completion.

For pumps that are too large to be tested at our Pewaukee facility closed loop scale model testing is available. Closed loop scale model testing is also utilized to accurately determine NPSH requirements for pumps with low NPSH requirements. A vacuum is pulled on the pump suction to test for pump NPSH requirements that are below atmospheric conditions.



City of Industry, California Test Facility



Our City of Industry test facility is designed to test vertical turbine pumps from 10 gpm (2 m³/h) to 70,000 gpm (15900 m³/h) at heads up to 2800 ft. (850 m) and motors up to 2500 HP (1865 KW).

The City of Industry test facility utilizes a wet sump arrangement and is capable of testing pump lengths to 40 ft. (12.2 m). The sump is 30 ft. (9.14m) wide by 104 ft.(31.7m) long by 30 ft. (9.14m) deep, with a 10 ft. (3.0m) x 10 ft. (3.0m) x 15 ft.(4.6m) deep extension at the pump installation area.

The standard procedure includes performance testing of pump bowl assemblies with calibrated lab motors. Testing with fully assembled units and customer drivers is also available.

Testing is conducted in accordance with Hydraulic Institute Standards, API 610, our internal test procedures and/or any contract specified requirements.

Calibrated venturis of various sizes (2", 4", 8", 12", 18", 30") are utilized to measure flows to 70,000 gpm (15900 m³/h) Differential pressure across the venturi is measured with a differential manometer or differential pressure gauge.

Pressure is measured with calibrated pressure transducers, pressure gauges or manometers.

Pressure range for the bowls are as follows:

- Bowls 13" and smaller - up to 1200 psig
- Bowls 14" and larger - up to 275 psig.
- RPM is measured with a digital counter and a magnetic pickup.

Calibrated lab motors or efficiency tested job motors are used to drive the pumps and determine power requirements. Power is measured using a calibrated wattmeter. The following is a list of the facility's calibrated test motors:

| 3570 rpm | 1780 rpm | 1190 rpm | 890 rpm | 710 rpm | 590 rpm |
|----------|----------|----------|---------|---------|---------|
| 3 HP | 5 HP | 75 HP | 100 HP | 900 HP | 200 HP |
| 10 HP | 10 HP | 100 HP | 200 HP | | 2000 HP |
| 30 HP | 15 HP | 200 HP | 350 HP | | |
| 75 HP | 30 HP | 400 HP | 1000 HP | | |
| 150 HP | 60 HP | | | | |
| | 125 HP | | | | |
| | 300 HP | | | | |

The electrical service is 60 Hertz with the following voltage and power ranges

- 480 volts - up to 400 HP
- 2300 volts - up to 1500 HP
- 4160 volts - up to 2500 HP

Vibration measurements are also available during the performance test.



Data is collected and entered into the computer where the raw data is calculated and the performance test curves are generated.

NPSH (net positive suction head) testing is available using our NPSH closed loop setup. The NPSH loop is capable of testing flows to 10000 gpm (2271 m³/hr). Note: due to system head requirements any flows over 5000 gpm should be checked with factory to verify acceptable pressure output of the 1st stage impeller.

NPSH testing is performed using a closed loop. The 1st stage impeller is supplied from a closed tank in which the available NPSH is varied using a vacuum pump. The flow is held constant and the NPSH available is decreased in steps until cavitation is assured by a drop in differential head. NPSHA is then plotted against differential head to determine a 3% drop in head and the NPSH required at that flow.

The NPSH loop consists of a 48" dia. by 20 ft. long barrel to which is attached our 12" test head.

Water is pumped through our 12" head and into a manifold of venturis of various sizes (2", 4", 8", 12"). Each venturi has its own flow control valve, after which the water enters a 20" dia. by 20 ft. tall stand pipe before returning to the barrel. A vacuum pump is attached to the top of the stand pipe to allow the NPSH available to be adjusted.

Discharge pressure is measured using a calibrated pressure gauge.

Suction pressure is measured using a calibrated vacuum gauge.

Flow is measured across the venturi with a differential manometer or a differential pressure gauge.

Temperature is measured using a dial thermometer.

RPM is measured using a digital counter and a magnetic pickup.

Raw data is collected and entered into the test lab computer to be calculated and results printed.

For larger pumps a point test method can be used to determine a point of NPSH required. NPSH available can be adjusted by lowering the water level in the pit or by using columns of varying lengths. Performance tests can then be run at the different water levels and compared against each other to determine the NPSHR.



Seneca Falls, New York Test Facility

Seven separate test loops are utilized at our Seneca Falls, New York manufacturing plants. Six of which are closed loop systems, five tanks and a 42 in. loop. All NPSHr testing is done via vacuum suppression on closed loop facilities. A 220,000 gallon sump is also utilized for testing larger non-API pumps.

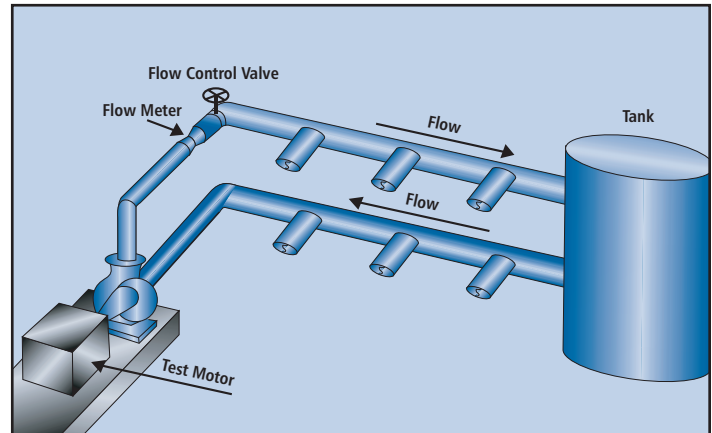
There is also a hot test loop that is capable of testing at temperatures up to 600 deg. F (315 deg. C).

Flow measurement is accomplished using calibrated magnetic flow meters and venturi tubes ranging from 2 inches to 24 inches. Flow measurement ranges from 5 gpm (1 m³/hr.) to 63,000 gpm (14,300 m³/hr).

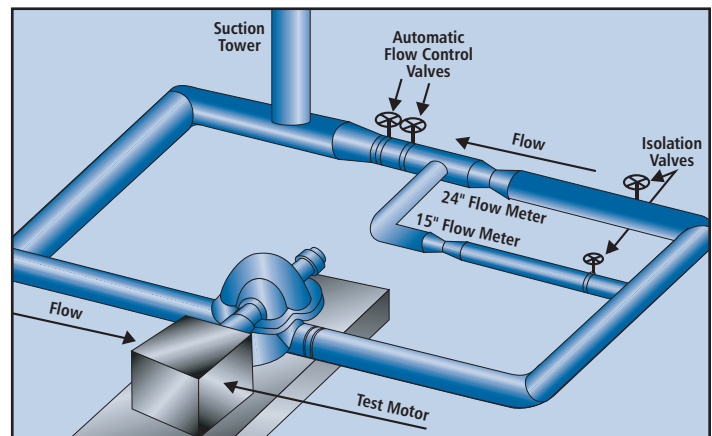
Pressure is measured with calibrated pressure transducers, pressure gauges, and/or manometers. Pressure measurement can be recorded up to 6930 ft. (64.3 m).

Power is measured with a variety of calibrated shop motors ranging from 5 HP to 850 HP; 120 HP to 225 HP dynamometers (ranging from 1180 to 3550 rpm); or by calibrated torque meters. When required, efficiency tested job motors can be utilized for the factory testing. Full train testing with a job VFD is also available for ratings up to 2000 HP (1500 kW). Available voltages are 220, 480, and 2300 volts.

When required vertical or horizontal booster pumps may be used. The vertical booster pumps are rated for 10,000 gpm, and 23,000 gpm. Three horizontal booster pumps are used with capacities up to 3,200 gpm.



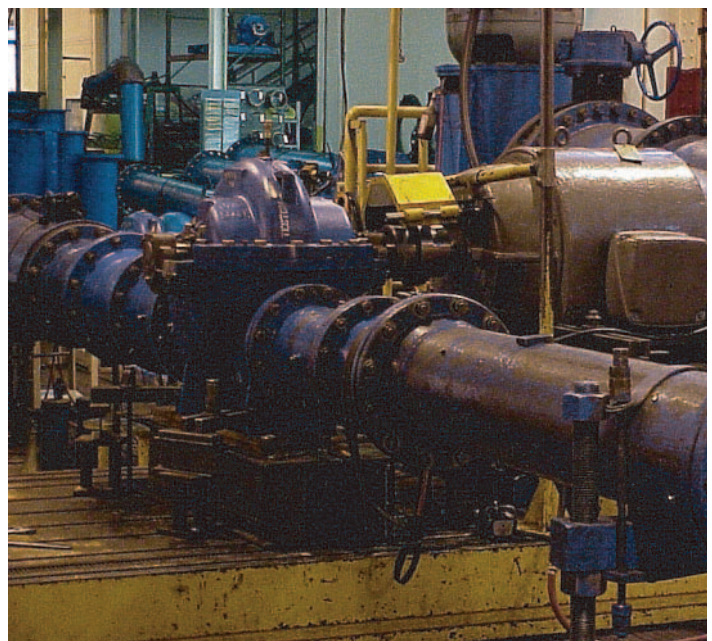
Typical Closed Loop Tank System



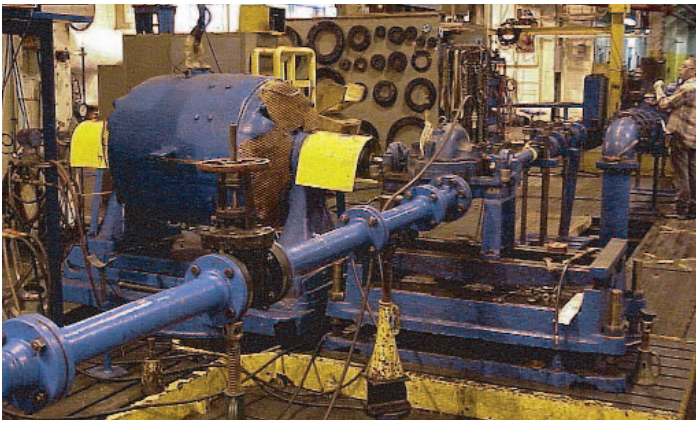
42 inch Loop System



API between bearings double suction pump, Model 3620, on test on a closed loop system.



Typical Split Case Test Setup



A 120 hp Dynamometer and 225 hp Dynamometer that range from 1180 to 3550 rpm, may also be used.

#2 Shop Test facility utilizes a 220,000 gallon sump for testing large pumps. NPSH testing is performed using the suction suppression method. Vacuum suppression is not available on most pumps. A 15 ton crane assists with moving large equipment across the test floor.

A 400 gallon closed loop system, for flow ranges up to 700 gpm and 100 hp, can be used to test small 3,316 and 3,410 models. A 4 inch Rosemount magnetic flow meter measures flow on this loop.

Vibration is guaranteed to Hydraulic Institute specifications and not to API specifications due to the configuration of the sump being below the test floor. An API limit requirement can be accommodated, but this must be discussed on a case to case basis, as a special test setup will have to be agreed upon. Full spectrum vibration analysis during testing can be taken, via the SKF Microlog.

All flow and pressure readings are taken using Rosemount transmitters, and Venturi tubes ranging from 2 inches to 24 inches.

All calibration records for equipment used on the test floor, are available for inspection, upon request.

Calibrated Horizontal Motors:

- 600 HP at 508 RPM
- 300 HP at 590 RPM
- 450 HP at 890 RPM
- 200 - 600 HP at 1,200 RPM
- 150 - 700 HP at 1,800 RPM
- 5 - 700 HP at 3,550 RPM

Calibrated Vertical Motors for NM3171:

- 5 - 30 HP at 1,800 RPM
- 5 - 25 HP at 3,500 RPM

Calibrated Vertical Motors:

- 150 HP at 720 RPM
- 10 HP at 860 RPM
- 100 HP at 900 RPM
- 5 - 125 HP at 1,200 RPM
- 10 - 30 HP at 1,750 RPM

For special test set ups, vertical or horizontal booster pumps may be used. The vertical booster pumps are rated for 10000 gpm and 23000 gpm. Any of three, portable booster pumps rated for up to 3200 gpm, may also be used.

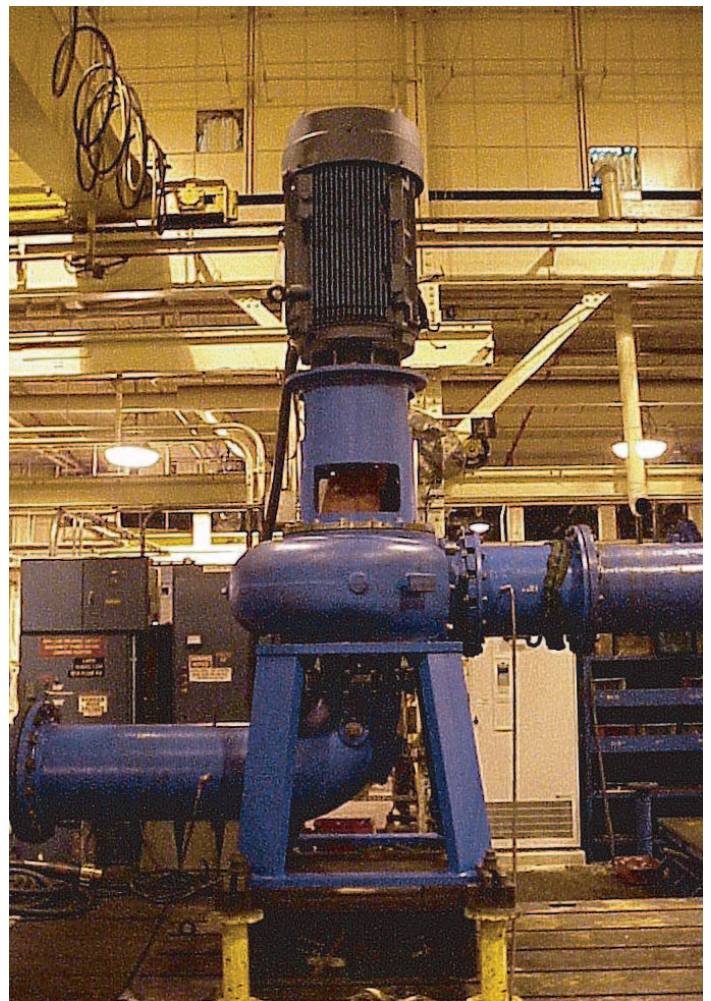
VFD Capabilities

When using the 200 hp 460 volt VFD for testing horizontal units, torque shafts will be to calculate motor hp and motor efficiency.

When using the VFD for testing vertical units, only motor amp draw can be reported since space constraints on these vertical units do not allow for the use of torque shafts. HP and Efficiency will not be reported.

Full Train Testing Capabilities

When Full Train Testing is required at multiple speeds, a VFD will be used with the customers motor. Torque shafts can be used if specifically required by the customer that HP and Efficiency must be recorded. Typically, only amp draw and not efficiency or HP will be reported to the customer. Should efficiency and HP be required, a second test will be completed only when requested, using one of the calibrated motors, but only when specifically required in the quote/order.



Non-Destructive Examination and Factory Testing Capabilities

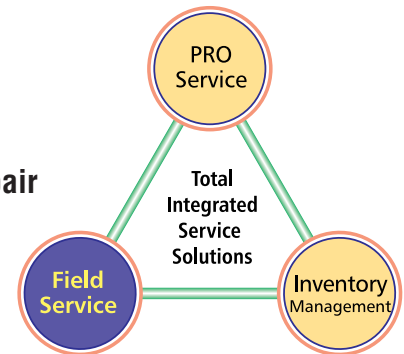
In addition to the performance testing capabilities, each of our facilities is fully capable of performing NDE and factory testing in accordance with contract specific requirements. A list of some of these capabilities are noted below.

- Hydro-static Testing
- Liquid Penetrant Examination
- Vibration Testing
- Magnetic Particle Examination
- Noise Testing
- Visual Examination
- NPSHR Testing
- Ultrasonic Testing
- Mechanical Run Testing
- Dimensional Checks
- Full Train Testing
- Runout & Tolerance Checks
- 50 hertz testing using generator sets
- Radiographic (X-ray) Examination



PRO Services™ Your Business Solution For...

Routine Maintenance ✱ Plant Shutdown ✱ Field Repair
Contract Services ✱ Turnkey Service



In The Shop...Or On The Road.

PRO Services engineers and technicians are experienced with servicing all types of pumps and rotating equipment. Customers utilize PRO Services for commissioning, troubleshooting, and field repairs of pumps, pumping systems and other pieces of rotating equipment.

PRO Services engineers and technicians utilize state-of-the-art techniques and equipment to provide the highest level of service in the industry.

- Technical Expertise
- Factory Trained Service Personnel
- Fast Turnaround
- Emergency Service – 24 hours/day, 7 days/week, 365 days/year
- Quality
- ISO and Safety Certified

PRO Service Centers: Worldwide...Wherever You Need Us.



ITT Industries

A-C Pump — Goulds Pumps