300.0 Test Planning

301.0 *Conditions*

301.1 *Safety:* Any equipment testing must conform to the latest requirements of all applicable safety standards. These include but are not limited to plant, industry, local, state, and federal regulations. It is recommended that all testing be conducted under the supervision of personnel fully experienced in plant and equipment operating practices.

301.2 *Environmental:* The test procedures must conform to the latest requirements of all applicable environmental standards, which include plant, industry, local, state, and federal regulations. Environmental conditions that apply to the equipment in normal operation should also apply during testing.

302.0 *Resources*

302.1 *Time:* The test should be scheduled at a time when suitable operating conditions can be obtained and the presence of key personnel to carry out the test can be assured. Time should be allowed to determine objectives and provide proper instrumentation before an actual test is performed.

302.2 *Equipment:* After determining which measurements are necessary for achieving the test objectives, equipment or instrumentation must be selected and installed to obtain the necessary measurements. The required precision or accuracy of the measurements is an important factor in determining which instruments should be used. Also, proper consideration should be given to calibrating the instruments and installing them according to recognized procedures or practices.

303.0 *Process Considerations for Performing Tests*

If the test is to be performed under actual process conditions, as in an operating production unit, attention should be given to possible process upsets. A test may require the flow be "dead headed" (no flow) or that maximum flow rate is obtained.

303.1 For pumps that are being tested due to major flow discrepancies, the following steps may be considered for evaluating the system, when a means of measuring flow is not available.

303.2 If the pump and the system will permit a momentary deadheading (no flow while the pump is running) the head developed by the pump can be established providing a point on the test performance curve at zero flow.

303.3 If the resulting head compares to the manufacturers published curve, within +/- 10%, it is reasonable to assume the pump will provide the published values for the remaining flows and other system related issues are causing the discrepancy.

303.4 Also, suction and discharge pressures may be varied during a test. Determination must be made if the process can tolerate large changes in conditions, such as flow and pressure, without having the process gets out of control. Operating the pump at various flows can also change the temperature of the liquid being pumped. Having to operate the pump at conditions other than at design can cause mechanical problems that could result in a sudden shutdown of the pump, i.e., motor overload. Knowing the capability of the pump and the process system is essential in setting up the test to avoid unwanted upsets.

304.0 *Data Requirements*

The data required to evaluate the performance of a centrifugal pump depend on the purpose of the test. The following data may be required.

304.1 *Field Test Data*

304.1.1 Suction pressure at or near the suction flange of the pump, corrected for the gauge elevation above or below the selected system datum plane, which is usually the centerline of the pump.

304.1.2 Discharge pressure at or near the discharge flange.

304.1.3 Power Consumption: Electric motor Amps, electric motor kilowatt usage, steam rate of turbine, or fuel usage of engine.

304.1.4 Capacity (volume rate of flow) at the pump.

304.1.5 Speed of the pump shaft in revolutions per minute.

304.1.6 Liquid temperature at the suction and discharge.

304.1.7 Barometric pressure.

304.2 *Installation Data:* The following data concerning the installation should be known:

304.2.1 Piping details: items such as valves, orifices, reducers and suction strainers will affect performance.

304.2.2 Proper location of instrumentation.
Difference in elevation between the gauges and the centerline of the impeller must be considered.

304.3 *System Data or Equipment Information*

304.3.1 The required pump Brake Horsepower is an integral part of pump testing and must be evaluated. As electric motors are the major drivers for pumps see reference 805.2 for more details in estimating motor output horsepower to the pump. It is beyond the scope of this procedure to address all forms of drivers.

304.3.2 Pressure gauge calibration.

304.3.3 Suction and discharge pipe inside diameters.

304.3.4 Liquid Characteristics: specific gravity, viscosity and temperature effects. Specific gravity, vapor pressure and viscosity measurements are not within the scope of this procedure. These characteristics should be obtained from analyses of process samples or technical reference books.

304.3.5 Pump Information: rated capacity, rated head, rated speed, impeller drawing number, impeller diameter, materials of construction, mechanical seal or packing details, $NPSH_R$, efficiency, and performance curve.

305.0 *Pump Considerations*

Certain conditions should be observed and recorded prior to the initiation of a pump performance test.

305.1 The pump should be identified, preferably by serial number. All available information concerning the pump's performance should be obtained. This information will be used later in the test.

305.2 The pump history should be known. A newly installed pump would be tested in a different manner than an older pump. If the pump has had problems, it should be noted prior to the test so that considerations can be given to the effect of the problems on the test results.

305.3 *Pump Installation*

305.3.1 Alignment between pump and driver should be checked.

305.3.2 The installation should be inspected for proper support of the pump. If the support is not adequate, it can cause misalignment between the pump and driver. Misalignment can cause vibration, bearing and seal failure, and coupling wear.

305.3.3 The foundation conditions should be noted at this time. Does the pump appear to be on a substantial concrete foundation? Is it mounted on a substantial frame? Are there externally excited vibrations in the foundation area from the nearby equipment? These factors should be noted at this time for later evaluation.

305.3.4 The pump piping system should be observed. Conditions such as long lengths of unsupported pipe, thermal expansion, etc. may impose excessive strain on suction and/or discharge nozzles of the pump. Excessive strain could cause misalignment, internal rubbing and affect the performance of the pump.

305.3.5 If a suction strainer is used, the cleanliness and the location will affect pump performance.

305.4 *Hydraulic Conditions*

305.4.1 Operational conditions of the pump should be considered. It is to be noted that there may be flow limitations. Centrifugal pumps may have minimum flow limitations due to heat rise, internal recirculation or mechanical limitations. There may also be maximum flow operational limits. Some pumps are designed to run with an open discharge valve while others may require discharge valve throttling to keep them at an acceptable point on their performance curve. These possibilities should be checked with the manufacturer.

305.4.2 The suction conditions of the pump should be observed. The suction piping system should be considered to insure proper inlet flow conditions. Observations of suction vessel level should be conducted

during the pump test to assure smooth inlet flow. Observation of entrained gas or vortexing should be noted.

305.4.3 In taking performance data, there may be fluctuations in the readings due to pump instability, system instability, or mechanically generated vibrations. These should be identified and corrected before proceeding with the test.

305.4.4 It may be necessary to take data readings simultaneously, such as inlet and outlet temperatures. This may require special provision if instrumentation is separated from the pump.

305.5 *Conditions That May Affect Performance*

305.5.1 Gas in the fluid will affect the performance of a centrifugal pump. The presence of 4% entrained vapor in a fluid can cause a reduction in pump total head at a given capacity in excess of 40%. Even small amounts of gas may substantially increase the $NPSH_R$ of the pump reducing or even eliminating the anticipated margin between the $NPSH_A$ and $NPSH_R$.

305.5.2 Submergence of the suction pipe on a horizontal or vertical pump is critical to proper performance. Insufficient submergence can induce vortexing or other problems that can affect pump performance.

305.5.3 The pump and the system involved in the performance test should be checked for leakage. Excessive leakage can cause erroneous performance indications. The piping should also be checked to determine if there are any bypass lines that may divert flow from the flow measuring device. It should be noted that a line with an apparently closed valve could still be diverting fluid from the flow-measuring device if there is internal damage to the valve.

305.5.4 The pump stuffing box should be checked. Stuffing box packing that has been tightened excessively can cause erroneous power reading on smaller pumps. The same condition can exist with improperly adjusted mechanical seals. Turning the pump over by hand prior to operation can give an indication of such a problem.

305.5.5 Manufacturer's published test curves typically do not include the power losses of mechanical seals or shaft packing as equipment is normally tested at a low suction pressure with only a minimal shaft seal resistance. High suction pressures and double mechanical seals can add a measurable load to pump driver of small pumps (with drivers of 25 hp or less).

305.6 *Internal Mechanical Condition:* The wear surface clearances, impeller adjustments, and general internal wear can affect performance. The troubleshooting section (see section 703.0) should be used to diagnose problems.

306.0 *Test Plan*

A test plan should be prepared taking into account the foregoing considerations and the conditions of the specific system and equipment.