O&M NOTES FOR GAUGES ON SEWAGE PUMPS

PRESSURE GAUGE OPERATION INSTRUCTIONS

Pressure gauges should be left in place, and should not be removed. Optimum mechanical reliability entails immediate trouble-shooting and attention to problems, so gauges on pumps need to remain in place and ready. If gauges were in storage, they would not truly be ready, reducing effective reliability.

Gauges in sewage service are normally glycerin or silicone filled between the gauge face and the diaphragm seal. They should be fitted with isolation valves, and should have drip legs for purging sewage solids from the seal down. Normally the isolation cock should be kept closed, and the drip leg open. This allows the gauges to remain isolated and left open to atmospheric pressure. Otherwise they will "bounce" and wear out.

If a drip leg is not fitted below the gauge, a tap water flushing connection must be used. To read a flushed gauge, simply close the flushing connection and open the isolation cock. However, the gauge should then be flushed immediately to prevent solids from plugging the assembly. Flush the gauge root from its diaphragm past the isolation valve, then close the isolation valve while flushing. Finally, disconnect the flushing hose and leave the flushing connection open. Failure to flush, isolate, and relieve the pressure on the gauge can cause false readings and will eventually ruin the gauge.

PUMP CAPACITY CHECKS

Operators should keep track of pump capacity as the impellers keep wearing down over the years. Eventually pumping rates will decline to a point where the impellers should be replaced.

Where there is no installed flowmeter, one can estimate flow rate from the manufacturer's pump curve. Pressure gauge readings are used to measure TDH (total dynamic head), which then marks the true flow rate on the pump curve. Flow measurement is perhaps the main purpose of gauging a centrifugal sewage pump.

However, the use of pressure gauges as a surrogate flowmeter is not accurate unless the procedure takes pump wear into account. As pump impellers wear down over time, the shutoff head normally declines at the same rate as the operating head. When this happens, the shutoff head and the whole pump curve shift downward together.

The shift is exactly parallel to the original curve. A new curve needs only to be sketched under the original by using the current shut-off head as a starting point. The accuracy of this new curve will be as good as the original unless there is some unusual imbalance in the wear pattern.

HOW TO MEASURE SHUT-OFF HEAD

The first step is to measure shut-off head ("dead-head" pressure) at the pump shut-off point. This is accomplished by closing the discharge isolation valve with the pump fully primed and running. Note the pressure adjusted to the elevation of the eye of the impeller. Due to wear, the shut-off head of used pumps will invariably be lower than the original factory curve shut-off head.

HOW TO MEASURE TDH

When measuring TDH (total dynamic head), all measurements and gauge readings must be translated to the elevation of the pump impeller. This requires measuring the gauge height or offset from the eye of the pump impeller. Next the gauge readings and offset measurements need to be converted to consistent units to calculate TDH (total dynamic head). For example, convert inches and psi to feet. Finally, TDH can be used to estimate the flow rate with reference to the pump curve as described above.

Note that gauge offsets from the elevation of the impeller eye are often small. While this adjustment might be neglected in some high-head pumping applications, not so with centrifugal sewage pumps. Sewage pump curves often indicate variations of 75 - 100 gpm for every foot of headloss, so gauge offsets must be taken into account.

A pump will discharge at its maximum rate on pump START, when the level in the wetwell is deepest; pumping rate will decline as the wetwell empties. This points to the importance of exact timing when reading gauges. Both suction and discharge pressures will change significantly from pump start to stop, and both readings must be made simultaneously.

The mid-point or average depth of the pump's operating pool is normally taken as the design point. Pumps should be evaluated exactly at mid-depth. This is most easily accomplished by taking readings at the start and stop elevations and averaging, as indicated on the attached Flow rate Check form.

Gauge are normally mounted higher than the elevation of the pump impeller. This offset causes the gauge to indicate a lower pressure than exists at the pump. The amount of gauge offset must be taken into account by adding it to the reading on the gauge.

Discharge pressure alone is not sufficient for estimating TDH of centrifugal sewage pumps. The suction side must also be measured. If the pump impeller is above the level of the liquid, the suction reading will represent a vacuum which must be added to the discharge pressure to calculate TDH.

If the pump is below the liquid level, pressure on the suction side will diminish TDH developed at the pump. A positive suction-side pressure reading must be subtracted from discharge pressure to calculate TDH.

Submersible and self-priming pumps present special situations:

· The suction side of a self-priming pump is under vacuum. The pump must develop the amount of negative pressure shown on the suction gauge. Hence Total Dynamic Head (TDH) on a self-priming pump will be the suction head plus the discharge head. Also the suction and discharge side gauge offsets of self-priming pumps will cancel each other if both gauges are mounted at the same elevation.

· With submersible pumps, the liquid depth over a pump must be physically measured while pumping. The liquid depth over the impeller reduces the head developed by the pump. To calculate TDH, this submergence must be subtracted from the discharge pressure.

POWER DRAW AND WETWELL DRAWDOWN METHODS OF FLOW MEASUREMENT

Power draw and wetwell draw-down can also be used to check pump capacity. However, such methods are mainly a last resort where pumps lack properly installed gauges, or the gauges were removed, or the gauges were installed without proper diaphragm seals and flushing connections so that sewage exposure has ruined them.

Measuring power draw in the field helps check electrical demand and efficiency of the installation. However, to verify adequate pump capacity, power draw has poor accuracy. Power draw measurements are not reliable for arriving at an estimate of pumping rate.

Draw-down tests of sewage pumps are often attempted in live wetwells with various degrees of success. Sometimes there is a flowmeter which needs to be recalibrated. Draw-down tests are an accepted method of wet-calibrating a flowmeter, but accurate draw-down testing is tedious and time-consuming.

Draw-down tests on a live wetwell are subject to a great variety of errors. The errors are best overcome by precise dimensional measurements and many timed repetitions. The extreme amount of time for adequate and accurate repetitions qualifies draw-down testing as a method of last resort.

INITIAL PUMP CAPACITY CHECKS

Regardless of factory testing prior to installation, at the time of start-up pump installers and operators should measure pump shut-off head and mid-depth TDH. The data should be then be re-measured once a year to track wear and schedule replacement. A comparison with this information can be also help to diagnose emergency pump troubles before opening a pump or pigging a force main.

The attached flowcheck form can be used where applicable. For any specific pump installation, a similar form can be developed.

FLOW RATE CHECK

INSTALLATION DATA.....#1.....#2

1. IMPELLER EYE ELEVATION..... _____ _____

2. SUCTION GAUGE OFFSET FROM IMPELLER EYE, ft. _____ _____

3. DISCHARGE GAUGE OFFSET, ft..... _____ _____

PRESSURE DATA

1. SHUT-OFF HEAD, ft ..... _____ _____

[Note: Field-measured shut-off heads are normally below factory curve due to wear. Estimate true flow rate by using a parallel curve sketched through the measured shut-off head.]

2. SUCTION HEAD [Note: for submersibles, use depth from water surface to pump centerline for suction head readings]

Gauge Reading @ Pump Start..... _____ _____

Reading Adjusted to Impeller Eye, ft..... _____ _____

Gauge Reading @ Pump Stop..... _____ _____

Reading Adjusted to Impeller Eye, ft..... _____ _____

3. DISCHARGE HEAD

Gauge Reading @ Pump Start..... _____ _____

Reading Adjusted to Impeller Eye, ft..... _____ _____

Gauge Reading @ Pump Stop..... _____ _____

Reading Adjusted to Impeller Eye, ft..... _____ _____

4. TOTAL DYNAMIC HEAD, ft

THD @ Pump Start..... _____ _____

TDH @ Pump Stop..... _____ _____

<u>FLOW RATE DATA @ Pump RPM of:</u> _____rpm

1. Flow rate @ Pump Start, gpm..... _____ _____

2. Flow rate @ Pump Stop, gpm..... _____ _____

3. Average Flow, gpm..... _____ _____

STATION_____

DATE_____ SIGNATURE_____

(attach pump curve)

Conversion factors:

1" Hg = 1.13 ft water column

1 psi = 2.31 ft water column