



Application - Three-Phase Motors

In-line Booster Pump Systems (continued)

- 13. Check Valves:** Spring-loaded check valves must be used on start-up to minimize motor upthrusting, water hammer, or in multiple booster (parallel) applications to prevent reverse flow.
- 14. Pressure Relief Valves:** A pressure relief valve is required and must be selected to ensure as the pump approaches shut-off that it never reaches the point that the motor will not have adequate cooling flow past it.
- 15. System Purge (Can Flooding):** An air bleeder valve must be installed on the booster sleeve so that flooding may be accomplished prior to booster start-up. Once flooding is complete, the booster should be started and brought up to operating pressure as quickly as possible to minimize the duration of an upthrust condition.
- 16. System Flush – Must Not Spin Pump:** Applications may utilize a low flow flushing operation. Flow through the booster sleeve **must not** spin the pump impellers and the motor shaft. If spinning takes place, the bearing system will be permanently damaged and the motor life shortened. Consult the booster pump manufacturer for maximum flow rate through the pump when the motor is not energized.
- 17. Open Atmosphere Booster Pump Systems:** When an open booster is placed in a lake, tank, etc. that is open to atmospheric pressure, the water level must provide sufficient head pressure to allow the pump to operate above its NPSHR requirement at all times and all demand or seasonal levels. Adequate inlet pressure must be provided prior to booster start-up.

Continuous Monitoring System Requirements Four Factors Minimum

- 1. Water Temperature:** Feed water on each booster must be continuously monitored and not allowed to exceed 86°F (30°C) at any time. IF THE INLET

TEMPERATURE EXCEEDS 86°F (30°C), THE SYSTEM MUST SHUTDOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE. If feed water temperatures are expected to be above 86°F (30°C), the motor must be derated. See Franklin's AIM Manual Hot Water Applications section for derating guidelines. (The high temperature feed water derating is in addition to any DI water derating if one was required.)

- 2. Inlet Pressure:** The inlet pressure on each booster must be continuously monitored and not allowed to drop below 20 PSIG at any time. If the pump's specified Net Positive Suction Head Requirement (NPSHR) is greater than 20 PSIG, increase the inlet pressure requirement to the greater value. Adequate inlet pressure must be provided prior to booster start-up. IF THE INLET PRESSURE DROPS BELOW THE INLET PRESSURE REQUIREMENT, THE SYSTEM MUST SHUTDOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE. NOTE: Motors where the inlet pressure exceeds 500 PSI must undergo special high pressure testing. Consult factory for details and availability.
- 3. Discharge Flow:** The flow rate for each pump must not be allowed to drop below the motor minimum cooling flow requirement. IF THE MOTOR MINIMUM COOLING FLOW REQUIREMENT IS NOT BEING MET, THE SYSTEM MUST BE SHUTDOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.
- 4. Discharge Pressure:** The discharge pressure must be monitored to maintain a down thrust load toward the motor within 3 seconds after start-up and continuously during operation. IF THE MOTOR DISCHARGE PRESSURE IS NOT ADEQUATE TO SUPPLY DOWN THRUST, THE SYSTEM MUST BE SHUTDOWN IMMEDIATELY TO PREVENT PERMANENT MOTOR DAMAGE.

Variable Speed Submersible Pump Operation, Inverter Drives

Franklin three-phase submersible motors are operable from variable frequency inverter drives when applied within guidelines shown below. These guidelines are based on present Franklin information for inverter drives, lab tests and actual installations, and must be followed for warranty to apply to inverter drive installations. Franklin two-wire and three-wire single-phase submersible motors are not recommended for variable speed operation.

WARNING: There is a potential shock hazard from contact with insulated cables from a PWM drive to the motor. This hazard is due to high frequency voltage content of a PWM drive output.

Load Capability: Pump load should not exceed motor nameplate service factor amps at rated voltage and frequency.

Frequency Range: Continuous between 30 Hz and rated frequency (50 or 60 Hz). Operations above rated frequency require special considerations, consult factory for details.

Volts/Hz: Use motor nameplate volts and frequency for the drive base settings. Many drives have means to increase efficiency at reduced pump speeds by lowering motor voltage. This is the preferred operating mode.

Voltage Rise-time or dV/dt: Limit the peak voltage to the motor to 1000V and keep the rise-time greater than 2 µsec. Alternately stated: keep dV/dt < 500V/µsec. See Filters or Reactors.



Application - Three-Phase Motors

Variable Speed Submersible Pump Operation, Inverter Drives (continued)

Motor Current Limits: Load no higher than motor nameplate service factor amps. For 50 Hz ratings, nameplate maximum amps are rated amps. See Overload Protection below.

Motor Overload Protection: Protection in the drive (or separately furnished) must be set to trip within 10 seconds at 5 times motor maximum nameplate amps in any line, and ultimately trip within 115% of nameplate maximum amps in any line.

SubMonitor: Franklin's SubMonitor protection systems ARE NOT USABLE on VFD installations.

Start and Stop: One second maximum ramp-up and ramp-down times between stopped and 30 Hz. Stopping by coast-down is preferable.

Successive Starts: Allow 60 seconds before restarting.

Filters or Reactors: Required if all three of the following conditions are met: (1) Voltage is 380 or greater and (2) Drive uses IGBT or BJT switches (rise-times < 2 μ sec) and (3) Cable from drive to motor is more than 15.2 m. A low-pass filter is preferable. Filters or reactors should be selected in conjunction with the drive manufacturer and must be specifically designed for VFD operation.

Cable Lengths: Per Franklin's cable tables unless a reactor is used. If a long cable is used with a reactor, additional voltage drop will occur between the VFD and the motor. To compensate, set the VFD output voltage higher than the motor rating in proportion to the reactor impedance (102% voltage for 2% impedance, etc.).

Motor Cooling Flow: For installations that are variable-flow, variable-pressure, minimum flow rates must be maintained at nameplate frequency. In variable-flow, constant pressure installations, minimum flow rates must be maintained at the lowest flow condition. Franklin's minimum flow requirements for 4" motors: 7.26 cm/sec. and for 6" and 8" motors: 15.24 cm/sec.

Carrier Frequency: Applicable to PWM drives only. These drives often allow selection of the carrier frequency. Use a carrier frequency at the low end of the available range.

Miscellaneous: Franklin three-phase motors are not declared "Inverter Duty" motors per NEMA MG1, Part 31 standards. However, Franklin's submersible motors can be used with VFDs without problems and/or warranty concerns provided these guidelines are followed.