Bell & Gossett
a xylem brand

WHITE PAPER
BGSBSTGIPCWHITE

Speed Based Staging in IPC

STAGING

1. When a single pump running at a Stage Speed can not obtain the setpoint for duration of Stage Proof Timer, the second pump will start.
2. This starts Stage Stabilization Timer. When this timer elapses, system is expected to maintain its setpoint at a leveled or stable speed. Before the timer elapses it is normal to observe small speed and pressure swings while PID is selecting the lowest possible speed required for two pumps running together to maintain the setpoint.
3. As soon as the Stabilization timer elapses, current speed is being used to calculate the de-stage speed value (current speed is multiplied by value in De-Stage %).
4. Both pumps will continue to run together until system demand changed in such a way that a single pump is capable of maintaining the setpoint running at a speed that is lower than Stage Speed.

DE-STAGING

1. When demand of the system changes in such a way that two pumps are running at or below the de-stage speed value for duration of De-Stage Proof Timer, the second pump will stop.
2. Again, it is normal to observe small speed and pressure swings as the PID algorithm is defining the lowest required speed for a single pump to maintain the setpoint.

ANALYSIS

Since this is the algorithm that controls number of running pumps, staging and de-staging parameters should be selected in a way that avoids the following:

- Run a single pump for extended period of time while PV is below its setpoint.
- Frequently staging, de-staging and re-staging pumps (unstable system).
- Run pumps at low speed while a single pump running at a higher speed would be capable of maintaining the setpoint.

FUNCTIONS OF STAGING AND DE-STAGING PARAMETERS

1. Stage Speed Value: It is user accessible and, generally, should be left at the B&G default value of 95 %.
2. Stage Proof Timer: It is user accessible with a default value of 30 seconds. When the value is too small, pumps may stage due to a very temporary high demand. If the value is too big, a single pump will continue to run and, although a setpoint is not being met, the second pump will not start for excessive period of time.
3. Stage Stabilization Proof Timer: It is accessible with a default value of 60 seconds which is a good starting point for majority of our systems. This timer is reset (and new de-stage speed is calculated when it elapses) every time an additional pump is started or stopped. Its value should be equal to an average time that a given system requires to regain leveled speed control of the PV after an additional pump is started or stopped. When this timer is too short (10 - 20 seconds), a de-stage speed may be calculated while system has not stabilized yet (current speed may be still decreasing). As a result, de-stage may be premature causing a pump to re-stage 30 seconds later. When this timer is too long (2 - 3 minutes), system demand may change during this time in such a way that two pumps will be running together at a low speed while a single pump at a higher speed would maintain the setpoint.

4. **De-Stage Proof Timer:** It is user accessible with a default value of 30 seconds. When a value is too small (5 - 10 seconds), it may result in de-staging a pump due to a short time duration demand drop. A pump would re-stage 30 seconds later. With an excessively long value (1 - 2 minutes), it may result in two pumps running at a low speed while a single pump running at a higher speed would be sufficient.
5. **Minimum Stage Speed:** In case that a system demand drops significantly before Stage Stabilization Timer elapses, calculated de-stage speed may have a very low value. In this case, two pumps would be allowed to run together at low speeds. In order to avoid this type of situation, Minimum Stage Speed may be employed. It is user accessible with a default value of 0 % (it is percentage of the 0 - 10 VDC analog output; i.e., with standard drive calibration Minimum Stage Speed of 50 % would be equal to 65 % of actual speed). When staged pumps run at or below Minimum Stage Speed value for 30 seconds (fixed value - no access), a pump will de-stage overriding defined above algorithm. When this value is too high (80 - 90 %), it may cause a premature de-stage followed be a re-stage. When this value is too low (0 - 20 %), it may not force a de-stage after ill acting demand of the system. A good Minimum Stage Speed value for a two pump system would be between 40 and 50 percent.

Xylem Inc.
8200 N. Austin Avenue, Morton Grove, Illinois 60053
Phone: (847) 966-3700 • Fax: (847) 965-8379
www.bellgossett.com

Bell & Gossett
a xylem brand