# ARMSTRONG

# Sequence of operation

## Parallel Sensorless pump controller

## LIST OF ABBREVIATIONS:

**ADJ:**    Field Adjustable
**AI/AO:**  Analog Input/Analog Output
**BEP:**    Best Efficiency Point (from pump curve data)
**BMS:**    Building Management System (same as BAS)
**DI/DO:**  Digital Input/Digital Output
**DP:**     Differential Pressure
**DPS:**    Differential Pressure Sensor
**HMI:**    Human Machine Interface
**PSPC:**   Parallel Sensorless Pumping Controller

## OPERATION

All individual pump controls must be set in **Auto-mode** for the system to operate automatically. Any individual pump may be set to **Hand-mode** or **Off-mode**. Any pump in **Hand-mode** or **Off-mode** will not be recognized by the automatic sequencing of the PSPC. Any pump placed in **Hand-mode** will start, and may be controlled manually, providing the supply power is available and connected.

### 1 GENERAL SEQUENCE

**1.1** The PSPC has 3 levels of password protection for the setup parameters.

**1.2** When the PSPC is set to **Local**, the system will be activated immediately.

**1.3** When the PSPC is set to **Remote**, the system will turn **ON** or **OFF** according to the status of the signal from the BMS.

**1.4** The control for pump speed is in the PSPC.

**1.5** With PSPC control, pump flow and head from individual pumping units is read by the controller and the speed of the pumps is regulated to maintain an operation point on the control curve at the system demand flow.

**1.6** The total system quadratic control curve is embedded in the PSPC. Head–design value [Hdesign] is the pump/system duty head; Head–minimum [Hmin] is the DP measure across the remote piping leg at full flow. If not known, default to 40% of the pump head. Flow–design is the full system flow which is the total design flow of the number of duty pumps. Armstrong will embed the system control curve in the PSPC; all entered values can be adjusted on site via the PSPC keypad.

**1.7** Automatic rotation of duty pumps is based on a set (adj.) time period. The PSPC will remember the elapsed rotation time in the event of a power failure. Default rotation time is set at 7-days.

**1.8** Alarms will include pump/control failure and general system failure.

**1.9** Alarms are shown in the PSPC display and will Auto-Reset when the alarm condition is corrected. In the event of multiple alarms, the display will scroll to show a different alarm every 10-seconds.

**1.10** Alarms will **Auto-Reset** once the problem is resolved. All duty service **Auto-mode** individual pump controls will start in Sensorless mode, upon PSPC failure, and adjust speed to supply the actual system needs. Unit staging will not occur until the PSPC is repaired or replaced

### 2 SENSORLESS CONTROL

**2.1** The PSPC can operate up to 4 Sensorless pumps in parallel. The number of standby pumps may be selected as 0 or 1. If 1 is chosen, a maximum of N-1 pumps will be allowed to run simultaneously (unless all are set in **Hand-mode**). Any standby pumping unit will be included in the pump automatic rotation sequence.

**2.2** The PSPC Sensorless Control Setup screen will display the following adjustable parameters: Head–design, Flow–design & Head–minimum (zero flow head)

**2.3** The PSPC will read Head and Flow from each individual pump controls, in addition to current, power, run status, fault status and speed feedback.

**2.4** When the system is activated, or recovering from a power failure, all the duty pumps are started.

**2.5** The PSPC calculates the total flow (Q) as the addition of the flow readings from each running pump. The PSPC uses the head reading from the duty 1 pump as the system head (H).

**2.6** The PSPC is capable of staging and de-staging pumps based on adjustable BEP speeds, which depends on the number of operating pumps. If the pump speed is over the BEP stage-on speed, for the number of operating pumps, the next duty pump is started. Similarly, if the pump speed is under the BEP stage-off for the number of operating pumps, the now-redundant duty pump is stopped.

**2.7** The operating speed of the pump(s) is controlled to maintain the operation point (system head & flow) on the system control curve.

**2.8** Once started a duty pump will operate for a minimum of 10-minutes (adj.).

**2.9** The PSPC monitors the flow of each operating pump and if one deviates more than 20% from the average flow, a **Pump Flow Deviation Alarm** is issued.

**2.10** Should the PSPC not receive a pump-run feedback from an activated pumping unit controls within 10-seconds, the PSPC will generate a **Pump Run Feedback Alarm**. The PSPC will attempt to **Auto-Reset** the alarm every 20 seconds.

**2.11** The PSPC will continuously monitor the status of the individual pump IVS102 controls. If the IVS102 generates a fault signal, the PSPC will generate a **Pump Controls Fault Alarm** and display the fault number.

**2.12** Should the PSPC lose communication with an individual pump IVS102 control, perhaps due to a loose or broken wire, IVS102 not properly configured or powered off, the PSPC will generate a **Pump Communication Alarm**.

## 3  CONTROLLER DISPLAY SCREEN [HMI]

**3.1** Operator screens

   **A** **Source of control:** Local or remote.

   **B** **PSPC Status:** On/Off.

   **C** **Pump information:** Running/Off/Alarm, HOA status, Pump ID 1, Pump ID 2, Stand-by, etc.

   **D** **Individual pump controls information:** Speed, Amps, Power, Volts AC, Flow and head.

   **E** Set point and error of flow & head.

   **F** Individual cumulative pump hours of operation.

   **G** System set-point & error.

**3.2** Alarm screens

   **A** Alarms with time stamp.

   **B** Alarm help.

   **C** Diagnostic indicating status (OK or bad) of PLC, memory, network and communication, PLC software version.

**3.3** Setup screens. There should be three levels of access:

   **A** **Level 0 -** No password, allows view only access.

   **B** **Level 1 -** Allows modification of all parameters, except pump PID and BMS setup. Allows Restoring previously saved values.

   **C** **Level 2 -** Allows modification of all parameters. Allows saving and restoring all parameters.

   **D** Levels 1 & 2 are password protected.

## 4  BAS COMMUNICATION (OPTIONAL)

**4.1** The PSPC shall be capable of serial communication with a BMS (Optional) with either of the following protocols:

   **A** Modbus RTU

   **B** BACnet MS/TP

   **C** LonWorks

**4.2** The following points will be available through all protocols:

   **A** Total Sensorless Flow

   **B** Sensorless Head

   **C** Total Real-Time Power Consumption

   **D** Pump Speed

   **E** Individual Pump Run Status

   **F** Alarm

   **G** Wire-to-Water system efficiency

   **H** Number of pumps operating

   **I** Lead Pump ID

   **J** Remote Start/Stop

   **K** PSPC On/Off status

   **L** **Pump controls information:** Running/Off/Alarm, HOA , Duty 1, Duty 2, Stand-by, etc.

   **M** **Pump controls information:** Speed, current, power, Volts AC, flow and head.

   **N** Pump hours of operation.

   **O** Set point and error.

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