MPE SC5000 Station Controller Specification

General Description

The Controller shall be capable of controlling up to six pumps and shall be field configurable to function in one of the following control modes: Level Control, Flow Control, Pressure Control or Booster Control.

The Controller shall be standard “off the shelf” equipment with published literature and fully tested hardware and operating program. An HMI must be provided with the Controller that is preprogrammed to interface with the Controller. All necessary communication ports and cables must be provided to connect the HMI to the Controller. The Controller must be field configurable from its HMI and require no special tools or software to set-up or operate.

The Controller shall be a microcontroller-based device and not require a battery to maintain the operating program. All set-up values shall be stored in non-volatile memory.

The Controller’s Enclosure shall be Din Rail mountable. All connections to the Controller’s I/O shall be made using removable “Phoenix” style combination connector/plugs. All communication ports shall use RJ45 connectors and be compatible with standard CAT 5 (or higher) patch cables.

The Controller shall be SCADA ready and have an Ethernet port reserved for connection to a SCADA system. The Ethernet Port shall utilize the Modbus TCP protocol. The Controller shall also have a communication port reserved for connection to the HMI. The Controller shall have published literature that explains the function of all SCADA Registers and Bits.

The Controller shall have Parameter Security. Each of the Controller’s communication ports shall have its own Parameter Security. The Parameter Security of each of the Controller’s communication ports shall be field configurable to be either Enabled or Disabled. If the Parameter Security for a communication port is enabled, the entry of the Security Code shall be required to change any of the Controller’s Setup Parameters. Entering the Security Code through one of the communication ports, shall unlock the Setup Parameters for that port only, and leave the locked / unlocked status of all other communication ports unchanged. The Security Code shall consist of three 16-bit numbers.

The Controller shall have a Fault indicator on the front of the Controller and on the HMI that indicates when there is something wrong with the system. There shall be a published list of Fault Codes with a description of the fault condition that is indicated by each Fault Code.

The Controller and the HMI shall be powered by a single external 24 VDC power supply and not require any other external power supplies or any external I/O modules to be a fully functioning unit.

The Controller shall be UL listed as Industrial Control Equipment, UL 508.

Control Modes

The Controller shall have a Control Mode Parameter that is field configurable that allows an operator to set the Controller to function in one of the following control modes:

Level Control, Flow Control, Pressure Control or Booster Control.

Level Control Mode

With the Master Control Mode set for “Level Control” the Controller shall function as a lift station level controller, and all logic pertaining to “Flow Control”, “Pressure Control” and “Booster Control” shall be disabled.

In the Level Control Mode, a variety of control options shall be made available in the setup menu that make the Controller customizable for a wide range of applications. It shall be capable of managing up to 6 pumps and perform in either a Pump Up or a Pump Down application. With optional Analog Outputs, it shall provide a pump speed reference for VFD speed control. The logic in the Controller shall turn the pumps on or off based on a comparison of the Liquid Level Input with the Pump On / Off Level setup parameters. The Controller’s logic shall alternate the pumps, performs Lag Pump Delays, and provides High Level and Low Level alarms. Parameters in the menu shall allow the operator to set the Number of Pumps Present, the Maximum Number of Pumps Allowed to Run At the Same Time, and the Maximum Number of Pumps Allowed to Run While On a Generator.

The Controller shall have an HMI that shows the Liquid Level, the Pump Call to Run status, the High Level and Low Level alarm status, and any Fault Codes. It shall also allow an operator to perform Level Simulation. All Setup Parameters for Level Control and I/O Setup shall be made available on its display for the operator to view or change.

For applications that maintain an operating temperature range of –0 to 50 °C (32 to 122 °F) the Controller shall have a Color Touchscreen HMI.

For applications that maintain an operating temperature range of –20 to 65 °C (-4 to 149 °F) the Controller shall have a 5 digit numerical LED HMI.

The Controller shall have a Setup Parameter that allows the operator to select one of the following Liquid Level Input sources: Analog 4-20mA Pressure Transducer, a conductance type Level Probe, Float Switches, or a Remote Level Control value set through the SCADA system.

The Controller shall support the option of having two Analog 4-20mA Pressure Transducers for the Liquid Level Input. The Controller shall also support either manually or automatically switching between the two Pressure Transducers.

The Controller shall have a Setup Parameter that allows the operator to select one of the following Pump Alternation Sequence Modes: Standard Alternation, Pump 1 Always Lead, Split Alternation - 2&4, Split Alternation - 3&3, or Split Alternation - 4&2. For all the Alternation Sequence Modes, the alternation of the pumps may be set for either “First On First Off” or “First On Last Off”. When one of the Split Alternation modes selected, the pumps shall be divided into two groups, Group 1 and Group 2. Where each group of pumps have their own alternation logic. With Split Alternation selected, there shall be the option of permitting or not permitting Group 1 pumps from running along with pumps from Group 2.

The Controller shall have a Discrete Input Function that allows for the connection of a Lead Pump Selector switch for each Group.

The Controller shall support the option of having Time Based Alternation of the pumps. Both Groups 1 and 2 shall support the option of having Time Based Alternation. The Time Based Alternation logic shall be triggered to alternate by either an Internal Time Clock or from an

External Time Clock. The Internal Time Clock alternation period shall be menu selectable. The External Time Clock shall be either a hardware device connected to a Discrete Input on the Controller, or it may be part of a SCADA system's logic, where the SCADA system would set a bit to force the alternation of the pumps.

The Controller shall provide VFD Speed Control logic that performs proportional control of the pump speed. Where VFDs are required an Optional Analog Output shall be provided for each VFD.

The Controller shall provide a Flush Cycle feature that can be setup to periodically flush the sludge build up from the bottom of the wet well and from the discharge pipe.

The Controller shall provide a Flow Calculator feature that can be setup to collect the following data: Inflow Totalizer, Pump 1 - 6 Outflow Rate and the Average Daily Inflow Total.

Flow Control Mode

With the Master Control Mode set for "Flow Control" the Controller shall function as a Flow Controller, and all logic pertaining to "Level Control", "Pressure Control" and "Booster Control" shall be disabled.

In the Flow Control Mode the Controller shall be capable of managing up to 6 pumps. It shall monitor the Level of the Supply liquid and regulate the number of pumps called to run and use a PID Controller (Proportional, Integral, Derivative) to regulate the pump speed to maintain the Flow Rate of the liquid leaving the pumping station at the Flow Rate Setpoint.

The Controller shall regulate the number of pumps called to run to maintain the Flow Rate at the Flow Rate Setpoint. At startup, the Flow Control logic shall first bring on one pump. If this one pump is unable to bring the Flow Rate up to the Flow Rate Setpoint, then another pump will be started. If the setpoint is still not reached, then the control logic will call another pump to run and then another until the Flow Rate Setpoint is met. Additionally, the logic will turn off any unneeded pumps.

The Controller shall regulate the pump speed to provide a smooth startup and to maintain the Flow Rate at the Flow Rate Setpoint. The Controller shall normally follow what is set on the Flow Rate Setpoint as it regulates the Flow Rate. During startup, if the Supply Level is normal, the control logic shall ramp the Flow Rate up to the Flow Rate Setpoint. The Controller shall also have a Flow Rate Setpoint Override feature that allows the operator the option of having the Controller automatically lower the Flow Rate if the Supply Level becomes too low. The override feature shall follow a ramp that decreases the Flow Rate as the Supply Level decreases below the normal range. The Flow Rate Setpoint Override feature shall also allow the operator the option of having the Controller automatically increase the Flow Rate if the Supply Level becomes too high. The override feature shall follow a ramp that increases the Flow Rate as the Supply Level increases above the normal range. Parameters shall be provided that allow the operator to completely define both the increase and the decrease ramps followed by the Flow Rate Setpoint Override feature and have the option of setting the parameters so that no override occurs.

The Controller shall provide First On First Off alternation of the pumps.

The Controller shall support the option of having Time Based Alternation of the pumps. The Time Based Alternation logic shall be triggered to alternate by either an Internal Time Clock or from an External Time Clock. The Internal Time Clock alternation period shall be menu selectable. The External Time Clock shall be either a hardware device connected to a Discrete Input on the Controller, or it may be part of a SCADA system's logic, where the SCADA system would set a bit to force the alternation of the pumps.

The Controller shall support the option of having two 4-20mA Pressure Transducers for the Supply Level Input. The Controller shall also support either manually or automatically switching between the two Pressure Transducers.

The Controller shall provide a Flow Meter for monitoring the Flow Rate of the liquid leaving the pumping station. The Flow Rate data from the Flow Meter shall be made available as an input to the PID Controller for use in controlling the discharge Flow Rate. The Flow Meter shall provide both the Flow Rate and a Flow Totalizer with a Reset. The Controller shall have the logic for both an Analog Flow Meter and a Pulse Flow Meter. For an Analog Flow Meter an optional Analog Input shall be supplied. For a Pulse Flow Meter an optional Discrete Pulse Capture Input shall be supplied.

The Controller shall be provided with a Color Touchscreen HMI programmed with screens that show the Wet Well Level, Flow Rate, Pump Speed Reference, Pump Run Status, High Level alarm, Low Level alarm, High Flow Rate alarm, Low Flow Rate alarm, Elapsed Run Time meters for each pump, and any Fault Codes that may be present. The HMI shall also provide the operator with the ability to perform Level Simulation, reset the Elapsed Run Time meters, and reset any Fault Codes.

The HMI shall also provide the operator with the ability to view or change the following Setup Parameters: Flow Rate Setpoint, Pump Operation Enable Level, Pump Operation Disable Level, First Pump Start Delay, Lag Pump Delays, Low Level Alarm, High Level Alarm, Low Flow Rate Alarm, High Flow Rate Alarm, Controlling Setpoint Override, Number of Pumps Present, the Maximum Number of Pumps Allowed to Run At the Same Time, and the Maximum Number of Pumps Allowed to Run While On a Generator.

Each pump shall have its own VFD, and the Controller shall provide an Analog Output for the Speed Reference for each of the VFDs.

Pressure Control Mode

With the Master Control Mode set for "Pressure Control" the Controller shall function as a Pressure Controller, and all logic pertaining to "Level Control", "Flow Control" and "Booster Control" shall be disabled.

In the Pressure Control Mode the Controller shall be capable of managing up to 6 pumps. It shall monitor the Level of the Supply liquid and regulate the number of pumps called to run and use a PID Controller (Proportional, Integral, Derivative) to regulate the pump speed to maintain the Pressure of the liquid leaving the pumping station at the Discharge Pressure Setpoint.

The Controller shall regulate the number of pumps called to run to maintain the Discharge Pressure at the Discharge Pressure Setpoint. During startup, the Pressure Control logic shall first bring on one pump. If this one pump is unable to bring the Pressure up to the Discharge

Pressure Setpoint, then another pump will be started. If the setpoint is still not reached, then the control logic will call another pump to run and then another until the Discharge Pressure Setpoint is met. Additionally, the logic will turn off any unneeded pumps.

The Controller shall regulate the pump speed to provide a smooth startup and to maintain the Discharge Pressure at the Discharge Pressure Setpoint. The Controller shall normally follow what is set on the Discharge Pressure Setpoint as it regulates the Discharge Pressure. During startup, if the Supply Level is normal, the control logic shall slowly ramp the Discharge Pressure up to the Discharge Pressure Setpoint. The Controller shall also have a Discharge Pressure Setpoint Override feature that allows the operator the option of having the Controller automatically lower the Discharge Pressure if at any time the Supply Level becomes too low. The override feature shall follow a ramp that decreases the Discharge Pressure as the Supply Level decreases below the normal range. Parameters shall be provided that allow the operator to completely define the ramp followed by the Discharge Pressure Setpoint Override feature and have the option of setting the parameters so that no override occurs.

The Controller shall provide First On First Off alternation of the pumps.

The Controller shall support the option of having Time Based Alternation of the pumps. The Time Based Alternation logic shall be triggered to alternate by either an Internal Time Clock or from an External Time Clock. The Internal Time Clock alternation period shall be menu selectable. The External Time Clock shall be either a hardware device connected to a Discrete Input on the Controller, or it may be part of a SCADA system's logic, where the SCADA system would set a bit to force the alternation of the pumps.

The Controller shall support the option of having two 4-20mA Pressure Transducers for the Supply Level Input. The Controller shall also support either manually or automatically switching between the two Pressure Transducers.

The Controller shall be provided with a Color Touchscreen HMI programmed with screens that show the Supply Level, Discharge Pressure, Pump Speed Reference, Pump Run Status, Low Supply Level alarm, High Supply Level alarm, Low Discharge Pressure alarm, High Discharge Pressure alarm, Supply Level Too Low For Pump Operation alarm, Elapsed Run Time meters for each pump, and any Fault Codes that may be present. The HMI shall also provide the operator with the ability to perform Level Simulation, reset the Elapsed Run Time meters, and reset any Fault Codes.

The HMI shall also provide the operator with the ability to view or change the following Setup Parameters: Discharge Pressure Setpoint, Pump Operation Enable Level, Pump Operation Disable Level, First Pump Start Delay, Lag Pump Delays, Low Level Alarm, High Level Alarm, Low Discharge Pressure Alarm, High Discharge Pressure Alarm, Discharge Pressure Setpoint Override Ramp, Number of Pumps Present, the Maximum Number of Pumps Allowed to Run At the Same Time, and the Maximum Number of Pumps Allowed to Run While On a Generator.

Each pump shall have its own VFD, and the Controller shall provide an Analog Output for the Speed Reference for each of the VFDs.

Booster Control Mode

With the Master Control Mode set for “Booster Control” the Controller shall function as a Booster Controller, and all logic pertaining to “Level Control”, “Flow Control” and “Pressure Control” shall be disabled.

In the Booster Control Mode the Controller shall be capable of managing up to 6 pumps. It shall monitor the Pressure of the Supply liquid and shall regulate the number of pumps called to run and use a PID Controller (Proportional, Integral, Derivative) to regulate the pump speed to maintain the liquid Discharge Pressure at the Discharge Pressure Setpoint as it leaves the pumping station.

The Controller shall regulate the number of pumps called to run to maintain the Discharge Pressure at the Discharge Pressure Setpoint. During startup, if there is sufficient Supply Pressure, the Pressure Control logic shall first bring on one pump and slowly increase the Discharge Pressure to the Discharge Pressure Setpoint. If the one pump is unable to bring the Discharge Pressure up to the Discharge Pressure Setpoint, then another pump will be started. If the setpoint is still not reached, then the control logic will call another pump to run and then another until the Discharge Pressure Setpoint is met. Additionally, the logic will turn off any unneeded pumps.

The Controller shall regulate the pump speed to provide a smooth startup and to maintain the Discharge Pressure at the Discharge Pressure Setpoint. The Controller shall also have logic and setup parameters that allow the operator to set up the system to avoid cavitation of the pumps. The Controller shall normally follow what is set on the Discharge Pressure Setpoint, as it regulates the Discharge Pressure. During startup, if the Supply Pressure is normal, the control logic shall slowly ramp the Discharge Pressure up to the Discharge Pressure Setpoint. To avoid cavitation of the pumps, the Controller shall also have a Discharge Pressure Setpoint Override feature that automatically lowers the Discharge Pressure if at any time the Supply Pressure becomes too low. The Discharge Pressure Setpoint Override feature shall follow a ramp that decreases the Discharge Pressure as the Supply Pressure decreases below the normal range. Parameters shall be provided that allow the operator to completely define the ramp followed by the Discharge Pressure Setpoint Override feature and have the option of setting the parameters so that no override occurs.

The Controller shall provide First On First Off alternation of the pumps.

The Controller shall support the option of having Time Based Alternation of the pumps. The Time Based Alternation logic shall be triggered to alternate by either an Internal Time Clock or from an External Time Clock. The Internal Time Clock alternation period shall be menu selectable. The External Time Clock shall be either a hardware device connected to a Discrete Input on the Controller, or it may be part of a SCADA system’s logic, where the SCADA system would set a bit to force the alternation of the pumps.

The Controller shall be provided with a Color Touchscreen HMI programmed with screens that show the Supply Pressure, Discharge Pressure, Pump Speed Reference, Pump Run Status, Low Supply Pressure alarm, High Supply Pressure alarm, Low Discharge Pressure alarm, High Discharge Pressure alarm, Elapsed Run Time meters for each pump, and any Fault Codes that may be present. The HMI shall also provide the operator with the ability to reset the Elapsed Run Time meters and reset any Fault Codes.

The HMI shall also provide the operator with the ability to view or change the following Setup Parameters: Discharge Pressure Setpoint, First Pump Start Delay, Lag Pump Delays, Low Supply Pressure alarm, High Supply Pressure alarm, Low Discharge Pressure alarm, High Discharge Pressure alarm, Discharge Pressure Setpoint Override Ramp, Number of Pumps Present, the Maximum Number of Pumps Allowed to Run At the Same Time, and the Maximum Number of Pumps Allowed to Run While On a Generator.

Each pump shall have its own VFD, and the Controller shall provide an Analog Output for the Speed Reference for each of the VFDs.

Description of I / O

Discrete Inputs

The Controller shall have 30 Discrete Inputs. The Discrete Inputs shall be transient protected and suitable for connection to either control logic contacts or to Level Probe (Conductance Probe) Electrodes. The Controller shall provide power for each of the Discrete Inputs and not require any external power supply. The Discrete Inputs shall be field configurable for one of the following functions:

- Collect Discrete Data for SCADA – for connection to telemetry logic contacts
- Level Probe (Conductance Probe) Electrodes 1-10 – for connection to Level Probe
- Pump 1-6 Disable – for connection to HOA Off contact, or pump fault contacts
- All Pump Disable – for connection to Phase Monitor
- On Generator - Limits number of pump called to run while on Emergency Power
- External Alternation – for connection to External Time Clock that alternates pumps
- Sequence Inputs 1-6 – for connection to an External Lead Pump Selector Switch
- Pump Cutoff – for connection to Low-Low Float Switch
- Level Alarms – for connection to either Low Level or High Level Float Switches
- Float Control – for connection to Float Switches for Float Backup Pump Control

Relay Outputs

The Controller shall have 12 Relay Outputs. The Relay Outputs shall have Form A dry contacts that are rated for 8 Amps @ 120 VAC Resistive. The Relay Outputs shall be field configurable for one of the following functions:

- Remote Control through SCADA - for control of local control panel features
- Pump 1-6 Control – for control of Pumps
- High Alarm – for control of High Alarm indication for liquid Level, Flow, or Pressure
- Low Alarm – for control of Low Alarm indication for liquid Level, Flow, or Pressure

Analog Inputs

The Controller shall have two 4-20 mA Analog Inputs, with the option of adding up to 8 additional Analog Inputs. The Analog Inputs shall be transient protected and use 12-bit analog to digital converters and shall be electrically isolated from the Controller's ground. The Analog Inputs shall be field configurable for one of the following functions:

- Collect Analog Data for SCADA – for monitoring local analog telemetry devices
- Analog Level Inputs 1 or 2 – for monitoring Analog Level Inputs
- Analog Flow Meter Inputs 1, 2 or 3 – for monitoring Analog Flow Meter Inputs
- Analog Pressure Inputs 1 or 2 – for monitoring Supply or Discharge Pressure Inputs
- Analog Current Inputs Phase A, B or C – for monitoring Pump Supply Current Inputs

Analog Outputs

The Controller shall have one 4-20 mA Analog Output, with the option of adding up to 6 additional Analog Outputs. The Analog Outputs shall be self-powered, transient protected and use 12-bit digital to analog converters and shall be electrically isolated from the Controller's ground. The Analog Outputs shall be field configurable for one of the following functions:

- Pump 1-6 Speed Reference Output – for control of VFD Speed Reverence
- Analog Level Output – for providing a Copy of the Level Input

Discrete Pulse Capture Inputs

The Controller shall have the option of adding up to 3 Discrete Pulse Capture Inputs. Each Discrete Pulse Capture Input shall provide a power supply for the input with the voltage option of either +5 VDC, +12 VDC or +24 VDC. The Discrete Pulse Capture Inputs and its power supply shall be transient protected and shall be electrically isolated from the Controller's ground. The Discrete Pulse Capture Inputs shall be capable of counting pulses at frequencies up to 60 kHz (with a Duty Cycle between 40% - 60%). Each of the Discrete Pulse Capture Inputs shall act as an input to one of three Pulse Flow Meters.

USB Host Port

The Controller shall have a USB Host Port that allows an operator to copy (Backup) all the Setup Parameters from the Controller onto a USB Flash Drive, and then later copy (Restore) the Setup Parameters back to the Controller or copy the Setup Parameter values to another Controller. The HMI, connected to the Controller shall provide the operator with the means to perform the Backup and Restore functions. The Parameter values shall be stored on the USB Flash Drive as a text file. The backup file on the USB Flash Drive shall be viewable using a computer and a text editor such as Notepad.

Controller Model

The Controller shall be an SC5000 manufactured by Motor Protection Electronics of Apopka, Florida, (407) 299-3825.

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