MANUAL FOR MODEL M700 FIRE PUMP CONTROLLERS

This manual provides General Information, Installation, Operation, and Maintenance for METRON Model M700 Soft Start/Stop Fire Pump Controllers.

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PART I: GENERAL DESCRIPTION

The basic function of the Fire Pump Controller is to start the pump motor to maintain the water system pressure. This may be accomplished by automatically starting the pump motor upon drop in pressure in the water main or from a number of other demand signals. They can be started by remote manual means, but cannot be stopped remotely. The controllers can be set to stop automatically or require manual stop after an automatic start.

PART II: FUNCTIONS

A. Automatic Starting From:

1. Drop in line pressure
2. Deluge valve operation (Option D)
3. Loss of remote alarm power (Option P)

B. Alarm and Signals:

1. **Remote indication of pump operation**: One (1) set of normally open (N.O) and normally closed (N.C.) contacts located in the controller operate when pump is running.
2. **Loss of power to the controller**: One (1) Single Pole Double Throw (SPDT) contact located in the controller operates for loss of power, loss of phase, or low voltage.
3. **Phase reversal of power to controller**: One (1) SPDT contact located in the controller operates for phase reversal of the power to the controller.
4. **Motor Current exceeds 125% of Normal**: One (1) SPDT contact located in the controller operates when the motor current exceeds 125% of normal.
5. **Power On pilot light on controller**: This light is on when both the isolation switch and circuit breaker of the controller are closed and the power monitor is detecting correct primary power and control power thus indicating that the controller is ready for operation.
6. **Phase Reversal pilot light**: This pilot light is on whenever there is a change in the normal phase sequence of the power to the controller.
7. **Drive Fault pilot light**: The pilot light is illuminated whenever there is a fault or failure condition within the solid state drive.
8. **Engine Lockout (Option E)**: When an engine drive system is used as a backup, a N.O. auxiliary contact on the motor contactor is provided to prevent the engine from starting if the electric motor is running.
9. **Electric Motor Lockout (Option M)**: The electric motor lockout is generally used in conjunction with engine lockout above. If the engine is running due to a power outage, or other reasons, the electric motor can be locked out until the engine is stopped.

C. Sequential Starting (Option S): This optional feature is provided for multiple fire pump installations. This provision delays the start of the pump motor by a preset time interval so that all pumps do not start at the same time.

D. Principal Components of Controller:

1. Isolation Switch
2. Circuit Breaker
3. Overcurrent Monitor
4. Motor Contactors
5. Solid State Drive
6. Pressure Switch

The incoming line voltage is connected directly to the isolation switch. From the isolation switch the power is fed to the motor contactors via the circuit breaker. Both the isolation switch and circuit breaker are normally closed when the controller is in its normal operating condition. The contactors are operated either mechanically or electrically to start the motor.

PART III: INSTALLATION

The Fire Pump Controller has been assembled and wired at the factory with the highest workmanship standards. All wiring and functions have been thoroughly tested to assure correct operation when properly installed. After installation has been completed, perform the initial **Installation Start-Up Procedure**, **Part IV**, before placing the controller in its operation mode.

The enclosure must be well grounded according to local or NFPA 70 (NEC) standards. Make sure that all applicable external control wires are connected to appropriate terminals as shown in controller Layout & External Hookup drawing. Failure to make the proper connections will cause the controller to malfunction. The contact ratings of the remote alarm circuits of the controller are shown on the controller Layout & External Hookup drawing. Note: If deluge valve circuit (Option D) is provided, the terminals for this circuit must be jumpered if there are no external circuits connected (see controller Layout & External Hookup drawing for terminal location).

PART IV: INITIAL INSTALLATION START-UP PROCEDURE

A. **General**: Refer to controller Layout & External Hookup drawing for nomenclature of all controls. Refer to schematic for location of remote alarm contacts.

The controls and their functions are as follows:

1. **Isolation Switch:** This switch is connected in the circuit between the power source connection and the circuit breaker. Its function is to disconnect the main power to the controller.

2. **Circuit Breaker:** The circuit breaker is located between the motor contactors and the isolation switch. Its function is to protect the incoming line from damage due to a short circuit in the load.

3. **Overcurrent Monitor:** The overcurrent monitor (1OCM) senses the motor current through a set of current transformers (CTs) in the controller. When the motor current exceeds 125% of normal a yellow LED illuminates on the monitor and a set of dry contacts change state. When the motor current exceeds 300% the monitor begins timing based on how much the current exceeds 300% of normal and a red LED begins flashing. The greater the current the shorter the time period such that at 600% of normal the monitor activates in approximately 14 seconds. When the monitor activates (at the end of timing), a set of normally open contacts close which energize the shunt trip in the circuit breaker causing it to trip. This method of motor overcurrent protection is mandated in NFPA 20 Chapter 7.

4. **Current & Voltage Display (CVD1):** The CVD1 display unit provides a continuous display of controller voltage and motor current. A Select pushbutton is provided to toggle the display between three phase voltage readings and three phase current readings. Also, if the Select pushbutton is held for 3 seconds the unit will display the highest motor current since the last reset. This value can be reset by holding the Select button for 15 seconds. This feature is especially useful for monitoring the motor starting current. The unit, in conjunction with the 1OCM will display the value of motor current that caused the 1OCM to trip. After the 1OCM goes into a locked rotor tripped condition, the display module will display the last current that caused the 1OCM to trip until the reset pushbutton is pressed.

5. **Emergency Contactor Handle:** This is a mechanical control used to bypass the electrical circuits in the fire pump controller. This feature is intended to be used in case of any malfunction that would prevent the controller from operating normally, and it will start the motor directly across the line bypassing the soft start feature.

6. **Start Button:** This push-button starts the pump motor by energizing the control logic that operates the solid state drive and motor contactors in the appropriate sequence as described in detail under **Sequence of Operation**.

7. **Soft Stop Button:** This push-button is used to stop the pump motor by closing the soft stop circuit signaling the solid state drive to slow the motor until it stops. The solid state drive provides a controlled ramp-down voltage that will slow the motor until an adjustable turn off point is reached.

8. **Coast Stop Button:** This push-button is used to stop the motor without the inherent delay of the soft stop circuit. When operated this push-button will open its N.C. contacts removing power to the control circuitry. Power to the motor is removed instantaneously because the motor contactors de-energize when the push-button is operated.

B. Pre-Operation Check Inspection:

1. Close isolation switch and measure voltage at load terminals of the isolation switch. Voltage should be the same as incoming line voltage.

2. Close circuit breaker and measure voltage at line side of motor contactor. Voltage measurement should be the same value measured in Step 1. The "Power On" pilot light, on the enclosure door flange, should be illuminated. In addition, the red "Phase Reversal" pilot light should not be illuminated. If the "Phase Reversal" pilot light is illuminated, check that all three phases are present, and of the correct voltage. If all power is correct, turn the controller isolation switch OFF. Reverse any two of the three phase wires connected to terminals L1, L2, or L3, of the power monitor (1PM), then turn the isolation switch and circuit breaker back ON. The "Phase Reversal" pilot light should not be illuminated.

3. Push "Start" push-button motor accelerating contactor 2MC should close. After time delay, 2TR times out, bypass contactor 1MC will close. Measure the voltage at motor lead termination lugs of contactor 1MC. It should be the same as in step number 1. The dry (volt free) Pump Running contacts will change indicating a pump running condition for a remote alarm panel. At this time the motor should be checked to insure proper rotation.

4. Push "Soft Stop" push-button, and the bypass contactor (1MC) will open. At the end of the time delay, determined by the Solid State Drive, the motor accelerating contactor (2MC) will open removing power from the solid state drive.

5. Lower the water pressure at water inlet to controller so pressure switch operates. Contactors should operate in same sequence as described in Step number 3, above. Allow water pressure to return to normal using jockey pump to restore the pressure. If controller is set for manual stop (as is standard for controllers when shipped from factory), push "Soft stop" push-button. If controller is set for automatic stop, overrun period timer (1TR) should be set for at least 10 minutes. After timer 1TR times out, the motor contactors should operate in the same sequence described above, under step number 4.

6. Push the "Start" push-button. The contactors will operate in the same sequence as described above, under step number 3. When the starting operation has completed its cycle and 1MC has operated, press the "Coast stop" push-button. The motor contactors will open immediately removing power from the load connections of the motor contactors.

7. Turn circuit breaker off.

C. Sequential Starting (Option S): The sequential start timer (3TR) provides a time delay that begins when the pressure switch contacts close. When time delay of timer 3TR ends, the motor accelerating contactor (2MC) will close and the start sequence will begin. Where sequential starting is used, set the sequential start timers of each pump for approximately ten (10) second intervals. Perform Initial Start-Up Procedure for appropriate controller and check for sequential timing on automatic starts. Sequential starting is bypassed when the "Start" push-button is used.

PART V: OPERATION OF CONTROLLER

After the Initial Installation Start-up procedure, described under Part IV, is completed, the controller is ready for normal automatic operation.

A. **General:** The isolation switch and circuit breaker should be closed. For a sequential start controller the sequential start timing relay 3TR should be set for approximately ten (10) seconds. Local requirements may dictate different time settings for the sequential start timers. For controllers set for automatic stop, set the running period timer for at least 10 minutes running time. To activate the automatic stop feature, the jumper on the Manual Stop Jumper terminals must be installed.

B. **Emergency Manual Operation:** Emergency manual operation is provided in case of failure of control circuitry. This handle is manually moved and latched in the "On" position. If the handle is not manually latched in the "On" position it will automatically return to "Off" position when released. The handle should be moved from the "Off" position to the "On" position in as quick a motion as possible to prevent burning the contacts. The circuit breaker should be opened to disconnect the motor in lieu of releasing emergency handle to remove the power from the motor. This handle is for emergency use only. An electrical interlock switch, operated by the emergency start handle, is used to operate the contactor electrically when all electrical circuitry is functioning properly. This electrical interlock is provided to prevent inadvertent slow closing of contactor and burning of contacts.

PART VI: SEQUENCE OF OPERATION

A. **Introduction:** The explanation of the sequence of operation will start with the assumption that the controller has been properly installed, all external connections have been correctly made and the isolation switch and circuit breaker are closed. In other words, the controller is operational. The "Power On" pilot light should be illuminated. All circuity on the primary side of the control transformer 1CPT will be referred to as the primary circuit. All circuitry on the secondary side of the transformer 1CPT will be referred to as the secondary circuit. The abbreviation N.O. indicates a Normally Open Contact and N.C. indicates a Normally Closed Contact.

B. **Manual Operation:** For manual operation there is a "Start" push-button switch on the controller door flange. There are also field terminals for an optional remote start switch located elsewhere and provided by others. These switches have normally open (N.O.) contacts which close to energize 3CR. 3CR locks in on its own N.O. contact and stays energized until the "Soft stop" or the "Coast stop" push-buttons are operated. Timer 4TR is also energized at this time. It provides a slight delay prior to energizing relay 5CR. An additional N.O. contact of 3CR closes and energizes 2CR and 2TR via a N.C. contact of 6CR. When the coil of 2CR is energized, its N.O. contact, in the primary circuit, closes and energizes the Motor Accelerating Contactor (2MC) through the N.C. contacts of 5CR. An additional N.O. contact of 2CR closes signalling the solid state drive to start. The motor is now energized through the solid state drive and will slowly increase in speed. When the time delay of timer 2TR ends, its N.O. contact closes energizing relay 10CR via a closed N.O. contact of 2CR. The N.O. contact of 10CR in the primary circuit closes, energizing the coil of the Bypass Contactor (1MC). When the contacts of 1MC close, the solid state drive is bypassed applying full power to the motor placing it in a full run condition.

To stop the controller manually, the "Soft stop" push-button switch is operated. When the N.O. contact of the "Soft stop" push-button closes, the coil of relay 6CR is energized locking in on its own N.O. contact. The coil of timer 5TR is also energized at this time. When 6CR energizes, the N.C. contact in the primary circuit opens removing power from the coil of 1MC and closes a N.O. contact bypassing the closed N.O. contact of 2CR. The power to the motor is now controlled by the solid state drive. At the same time, a N.C. contact of 6CR in the secondary circuit opens removing power from the coil of 2CR. The speed of the motor will slowly decrease until timer 5TR times out. After timer 5TR times out, its N.C. contact opens to remove power from the coil of relay 6CR. When relay 6CR de-energizes, it opens its N.O. contact, removing power from the coil of 2MC, stopping the

motor.

In lieu of pressing the "Soft stop" push-button the "Coast stop" push-button can be pressed. When the "Coast stop" push-button is pressed the supply circuit to the control logic is de-energized permitting 2CR and 10CR to drop out. This removes power from the motor contactors 1MC and 2MC disconnecting power from the motor immediately.

C. **Automatic Operation / (Pressure Switch):** On drop of water pressure, the N.C. contact in the pressure switch closes energizing relay 12CR. Relay 12CR closes its N.O. contact to energize relay 2CR via the N.C. contacts of 6CR and the starting sequence previously described above, under Manual Operation, takes place.

In controllers with sequential starting, relay 12CR closes its N.O. contact to energize timer 3TR. After timer 3TR times out, its N.O. contact closes energizing relay 2CR and the starting sequence previously described above, under Manual Operation, takes place.

On controllers set for automatic stop, an overrun period timer (1TR) is used to keep the motor running for a preset time period after pressure has returned to a normal condition. This is accomplished by keeping 2CR locked in on its own contact through the N.C. contacts of relay 6CR. When the pressure has returned to normal, power will be applied to 1TR via the N.C. contact of 12CR and the closed N.O. contacts of 1MCA and 2CR. When the time delay of 1TR ends, the N.O. contact of the timer will close applying power to the coil of 6CR through the "Manual Stop Jumper" and the N.C. contacts of 3CR. When the coil of 6CR is energized, the controller will soft stop the motor as described above, under Manual Operation.

On controllers set for manual stop only, a jumper that is in series with the coil of 6CR is removed requiring the "Soft stop" or "Coast stop" push-button to be depressed to initiate the stop sequence described above, under Section B - Manual Operation.

D. **Remote / Pump Running Signal:** One (1) N.O. and one (1) N.C. contact are available for remote indication that the pump is running.

E. **Remote / Loss of Power, Loss of Phase, Low Voltage:** One (1) (SPDT) contact is available for remote indication of loss of power, loss of phase, or low voltage.

F. **Remote / Phase Reversal:** One (1) SPDT contact is available for remote indication of phase reversal of the incoming power to the controller.

G. **Deluge Valve Start / (Option D):** When the Deluge Valve Switch which is attached to field terminals 12 and 13 opens, relay 7CR will be de-energized. The N.C. contact of 7CR will close and start the electric motor in the same manner as for drop in water pressure described above, under Section C.

H. **Engine Lockout / (Option E):** A N.O. auxiliary contact on the motor contactor is provided to prevent an engine type controller from starting if the electric motor is running. Circuitry for this is provided in engine controllers supplied with Option "E".

I. **Electric Motor Lockout / (Option M):** Terminals are available to connect to an external switch to lockout the electric motor. This may be necessary to prevent the motor from starting when the engine is running or when a low suction cut-off feature is used, etc. The external switch will close to energize 9CR. A N.C. contact of 9CR will break the circuit to the pressure switch so that an auto start is not possible. A N.O. contact of 9CR closes to energize 6CR via a N.C. contact of 9TR causing a soft stop sequence to begin, if the motor is running, as described above under Manual Operation. After the motor has stopped, the N.C. contact of timer 9TR opens to remove power from the coil of 6CR. With the Electric Motor Lockout feature energized it is still possible to start the motor manually.

J. **Power Failure Start / (Option P):** On loss of reliable source of 120VAC, relay 8CR will be de-energized. The N.C. contact of 8CR will close and start the electric motor in the same manner as

for drop in water pressure described above, under Section C.

PART VII: NOMENCLATURE

1CR	Phase Reversal Auxiliary Relay
2CR	Control Relay
3CR	Manual Start Relay
5CR	Drive Fault Relay
6CR	Controlled stop Relay
7CR	Deluge Valve Start Relay (Option D)
8CR	Power Failure Start Relay (Option P)
9CR	Motor Lockout Relay (Option M)
10CR	1MC Delay Relay
11CR	Soft Stop Relay
12CR	Pressure Switch Relay
1TR	Overrun Period Timer
2TR	Bypass Delay Timer
3TR	Sequential Start Timer (Option S)
4TR	Drive Fault Timer
5TR	Stop Reset Timer
9TR	Motor Lockout Timer
1MC	Bypass Contactor
2MC	Motor Accelerating Contactor
1MCA	1MC Auxiliary Contact
2MCA	2MC Auxiliary Contact
1PL	Power On Pilot Light
2PL	Phase Reversal Pilot Light
4PL	Drive Fault Pilot Light
1IS	Isolation Switch
1CB	Circuit Breaker
1PS	Pressure Switch
1CS	Soft Stop Push-button
2CS	Start Push-button
3CS	Coast Stop Push-button
1CPT	Control Power Transformer
1PM	Power Monitor
1PR	Phase Loss Relay
2PR	Phase Reversal Relay
1OCM	Overcurrent Monitor
CVD1	Current/VoltageDisplay