OPERATIONS PLAN

Volume I

Operations & Maintenance Manual

Eisenhower/Johnson Memorial Tunnel FFSS Operations Plan

Project Number: C 0703-360
Sub-Account: 17810

Rev: 0
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Barnard EJMT Team	EJMT FFSS Project No. C 0703-360 Subaccount 17810 Design-Build Project OPERATIONS PLAN
Rev. 0	

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1.0 PLAN OVERVIEW

The Operations Plan for each of the major subsystems of the fixed fire suppression system is included in this document. The plan is organized by major subsystem for clarity.

Summary of Operation

The Fixed Fire Suppression System consists of six major subsystems, as follows:

- Water Supply
- Fiber Optic Linear Heat Detector
- Fire Alarm Control and CCTV
- Electrical
- Suppression
- Mechanical

The Fixed Fire Suppression System is designed to operate automatically. During normal operation, the Fire Alarm Control system continuously monitors the Fiber Optic Linear Heat Detector (FOLHD) for status, and supervises the other subsystems for abnormal conditions. The boiler system operates to maintain the Suppression system supply loop at a temperature of 100°F. During normal operation, a single boiler and a single circulation pump will operate. On a weekly basis, the boiler and circulation pump will cycle to the standby boiler and circulation pump to equalize the run time.

During a fire event, the System operates as follows:

1. When a rate of temperature change above ambient of 25°F/minute is detected by the FOLHD, a pre-alarm condition will be reported at the Fireworks workstation. The two CCTV cameras (one to the east and one to the west) nearest to the zone of alarm will automatically rotate and focus on the zone of alarm. If the zone of alarm is near the portal, only one camera will rotate.
2. When a rate of temperature change above ambient of 50°F/minute OR a fixed temperature of 160°F is detected by the FOLHD, an alarm condition will be reported at the Fireworks workstation.
3. The circulation pump will shut down.
4. The drainage valves will change state to direct water to the drainage tanks.
5. The fire pump will start.
6. The deluge valve in the zone of alarm will open and water will be delivered to the roadway.
7. During the operation of the system, the supply tank will report approximate water supply capacity at the following intervals: 60 minutes remaining; 30 minutes remaining and 0 minutes remaining. The 60 minutes remaining indication will be displayed immediately upon any alarm.

8. The system will continue to operate automatically unless manual control is taken. A second alarm will not automatically activate an additional zone. The system is designed to operate up to two zones at a time.
9. After the system is reset, the drainage valves will remain in their alarm position and continue sending water to the drainage tanks. The drainage valves must be reset manually after an alarm.

The system is provided with standby and emergency power. During a power failure, there will be minimal interruption to the operation of the system. Each of the Fire Alarm and CCTV workstations, as well as fire alarm control panels, are provided with either battery or UPS secondary power to support the systems. All other electrical equipment associated with the Fixed Fire Suppression System is backed up by generators. The existing generator in the east ventilation building will provide power to the fixed suppression equipment located on the east side. A new 350kW generator has been installed to power the equipment on the west side. When power on the west side is being fed from the existing 500kW generator, CDOT personnel must open the 1200A breaker in the West Motor Control Center labeled “Fire Protection Fire Pump”. This will prevent the load from the newly installed fire suppression system from being placed onto the existing generator.

The following sections provide detailed operating procedures for each of the subsystems of the Fixed Fire Suppression System.

2.0 FIRE ALARM and CCTV

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EJMT – Fire Alarm/FACCTV Systems Operations Plan

NORMAL OPERATIONS

During normal operations (non-abnormal or non-fire events), the FOLHD, FA, and FA CCTV Systems remain in normal conditions.

The System Operator can navigate thru the FA Fireworks Display System software screens as desired to familiarize themselves with navigating the software screens, reviewing extended messages, reviewing device and panel placements, and other information so that they feel comfortable with how the system is laid out during non-emergency situations. We would recommend that each System Operator perform this review on a quarterly basis, as a minimum, to keep fresh, as to how the System operates. Please note that the deluge control screens will initiate (turn on and turn off) the various system controlled deluge systems so it is suggested that care be exercised when reviewing these screens. The System does ask if the System Operator wants to initiate the selected command function, so there is some redundancy built into the system software to prevent accidental initiation of commands.

The System Operator can navigate thru the FA CCTV System software screens to again familiarize themselves with navigating the software screens and exercising the pan tilt zoom functions of the FA CCTV cameras. Like above, it is recommended that each System Operator perform this review on a quarterly basis; as a minimum, to keep fresh as to how the System operates.

The FOLHD System runs in the background in both normal and emergency situations, so the System operator will not have any interaction with this system unless specifically directed to access it to assist Systems Group in identifying system issues prior to responding to the site for service or maintenance purposes.

EMERGENCY OPERATIONS

Upon activation of a an emergency event (FOLHD CCTV alarm or deluge release alarm signal, alarm pressure switch activation, fire pump run signal, emergency generator run signal, empty supply water tank level signal, or other “alarm” type event), the Systems will perform their automatic pre-programmed functions without any System Operator interface. Once the System has performed its automatic pre-programmed functions, the System Operator can subsequently take Manual Control of the System as required.

In the event that the FOLHD CCTV alarm signal is received:

> The associated camera or cameras are automatically pre-positioned to the affected tunnel deluge zone and a “FA CCTV ALARM” signal is received on the FACP Panel Operators Display Panels and the FA Fireworks workstations. At this point, no water has been released to the roadway. The System Operator can manually operate the FA CCTV cameras including Pan, Tilt, and/or Zoom functions to assess the status of the affected tunnel zone(s) or adjacent tunnel zones.

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Once the System Operator has assessed the situation, the System can be reset if warranted, or the System Operator can take Manual Control of the deluge systems if warranted. We'll discuss deluge Manual Control later.

Assuming the condition restores, the FA CCTV System would revert back to Normal Operations described above.

In the event that the FOLHD deluge alarm signal is received, multiple things occur:

The FA CCTV System re-positions the FA CCTV camera or cameras to the affected zone as described above. Like above, the System operator can manually operate the FA CCTV cameras as described above. Please note that the FA CCTV cameras re-position the FA CCTV cameras to subsequent alarms in a given tunnel bore.

The FA System will automatically start the Fire Pump, shutoff the boiler circulation pumps, position the drainage system valves, and automatically release water to the roadway in the affected deluge zone until such time as the System Operator shuts off the affected deluge system and resets the FA System.

In the event that a second deluge alarm signal is received while the first deluge alarm sequence is in effect, water will be released to the roadway in the second zone as well. Please note that the System is designed to only operate two deluge zones in the automatic mode, so that could be two zones in the same tunnel bore or one in each tunnel bore. No more than two total zones are allowed to occur at the same time due to the system design and site water storage limitations.

During the deluge alarm event, the System operator can take Manual Control of the System and shut off water to the affected zone, release water to an adjacent zone, or add a second deluge zone somewhere else in the tunnel; dependent on the emergency incident. It is important to note that the System operator must start water in a second deluge zone prior to shutting off water to the automatic deluge zone to prevent "water Hammer" issues affecting the sprinkler piping. It is also important to note that the System operator can only have water flowing to two deluge zones due to the system design capacity and site water limitations. To initiate Manual Control of the System, the System Operator pulls up the Fireworks Deluge Control Screen(s) to manually turn ON a deluge zone, manually turn OFF a deluge zone, or monitor the real time status (ON or OFF) of the deluge zones.

Once the emergency situation is cleared, the System can be reset and returned to normal operations.

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In the event that a waterflow "Alarm" indication from one of the deluge system alarm pressure switches is received:

This would indicate that water could be flowing inside the plenum (if a break in the piping were to occur) or water could be flowing to the roadway if a deluge valve were to fail due to an inadvertent manual activation or equipment failure.

This condition could also be a faulty switch or inadvertent alarm. In any case, maintenance personnel should be dispatched to the affected plenum deluge valve cabinet, while the System Operator verifies if water is being introduced to the roadway via the FA CCTV System.

Once the cause of the waterflow "alarm" switch has been identified and rectified, the System can be reset and returned to normal operations.

In the event that the Fire Pump "Run" signal is received:

This would indicate that water could be flowing somewhere within the fixed fire suppression system (plenums, roadway, or other adjacent areas).

If this signal is received, maintenance personnel should be dispatched to all areas of the fixed fire suppression system piping network, while the System Operator reviews all areas of the roadways to verify water is not being introduced to the roadway via the FA CCTV System.

Once the cause of the Fire Pump "Run" signal has been identified and rectified, the System can be reset and returned to normal operations.

In the event that the Emergency Generator "Run" signal is received:

This would indicate that loss of normal 120vAC power to the Site and subsequently to the Fire Alarm/FA CCTV Systems has occurred. The FA and FA CCTV Systems are fully backed up by the Emergency Generator power. In addition, the FA System field panels have battery standby systems sized for an additional 4 hours of standby time to support the automatic functions of the Fire Alarm and FA CCTV Systems. The FA and FACCTV workstations and equipment racks have small standby UPS Systems to keep the 120vAC powered system components up and running during the start-up operation of the Emergency Generator.

If this signal is received, maintenance personnel should be dispatched to the generator to verify if/why site power has been lost and remedy the cause so that site power can be restored as soon as practical.

Once the cause of the Emergency Generator "Run" signal has been identified and rectified, the System can be reset and returned to normal operations.

In the event that the "Empty" water tank signal is received:

This would indicate that the site water storage tank has been depleted and the fixed fire suppression system will not function. The "Empty" tank level causes the Fire Pump to be locked in the OFF position, which will compromise the ability of the system to deliver water to the roadway.

This is a significant event that warrants immediate maintenance response. Additional water should be transported to the Site to allow for temporary operation of the fixed fire suppression system until such time as the water storage tank has been replenished. Please note that the water storage tank has a level sensor to indicate 60 minutes lf water left and 30 minutes of water left prior to the "empty" water tank level, to alert the System Operator of impending issues with the fixed fire suppression. These monitor points will be addressed later in this plan.

Once the cause of the Empty tank level signal has been identified and rectified, the System can be reset and returned to normal operations.

Restoring the Fire Pump Operation after Additional Water is provided:

If the empty water tank level signal has been received during a deluge release event and an additional water source (pumper truck or other) has been connected to supplement the fixed fire suppression system, the System Operator simply has to activate the Fire Pump On switch on the FACP Panels in either the East or West Control Rooms or the FMO Office to release the Fire Pump Lock-out signal and restart the Fire Pump; which will also restart water delivery to the roadway.

In the event that the Mezzanine West Control Room smoke detector alarm is received:

This would indicate that smoke has been detected in the normally un-occupied secondary control room. This event could be caused by an actual smoke obscuration event (actual fire) or could be the result of an unwarranted obscuration event (dust contamination). In either case, maintenance personnel should be dispatched to the West Control Room to verify that an actual fire is not present in the West Control Room.

Once the cause of the smoke alarm signal has been identified and rectified, the System can be reset and returned to normal operations.

In the event that the Fire Pump Room heat detector alarm is received:

This would indicate that a build up of heat in the Fire Pump Room has reached (135 F), and caused the system alarm. This event could be caused by an actual fire condition, or by a piece of equipment in the Fire Pump Room overheating, which could lead to a potential fire condition. In either case, maintenance personnel should be dispatched to the Fire Pump to verify that an actual fire is not present in the Fire Pump Room.

Once the cause of the heat alarm signal has been identified and rectified, the System can be reset and returned to normal operations.

NON-EMERGENCY OPERATIONS

The FA and FA CCTV Systems monitor numerous (off-normal and non-emergency) conditions associated with the fixed fire suppression systems. Certain signals have more impact to the fixed fire suppression system than do other signals. We'll list a variety of conditions that can affect the fixed fire suppression system's ability to operate properly, in their order of importance.

SYSTEM ABNORMAL CONDITIONS

In the event that a FOLHD fiber break signal is received:

The linear heat detection system (FOLHD) has been designed in a redundant fiber configuration such that each tunnel bore is fed by a fiber that originates from each control room (East and West); thusly providing a redundant heat detection system for each tunnel bore. While a single fiber break signal would be considered a serious situation, the tunnel coverage would not be affected by a single fiber break signal. Since there are redundant fibers monitoring each tunnel, the FA CCTV and deluge systems would remain intact and functional until the situation can be resolved. Systems Group should be notified immediately of the situation so that we can respond to the Site accordingly.

In the event that a second FOLHD fiber break signal is received for the same tunnel bore, this would indicate that the affected tunnel bore no longer has full heat detection coverage that would automatically release the deluge systems. Please note that manual control of the deluge systems would remain intact. Systems Group should be notified immediately of the situation so that a service technician can be immediately dispatched to the site for repair.

It would be a rare condition that could cause a single FOLHD fiber break and extremely rare that a second fiber break condition in the same tunnel bore were to occur.

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In the event that a Network Class A or Class B Circuit Failure signal is received:

The FA System has been designed in a redundant fiber configuration such that there is a primary (Class A) fiber and a secondary (Class B) fiber that connects the Fire Alarm Control Panels together. While a single Class A or Class B circuit failure would be considered a serious situation, the FA System would continue to operate normally with a single circuit failure present, until the situation can be resolved. Systems Group should be notified immediately of the situation so that we can respond to the Site accordingly.

In the event that the second Class A or Class B Circuit Failure signal is received, this would warrant a heightened response; however, unless a specific Fire Alarm Panel is completely disconnected from the FA network (extremely unlikely); the FA System would still continue to operate normally with even both the Class A and Class B circuit failure conditions present, so long as both conditions are not associated with the same Fire Alarm Panel. Again, Systems Group should be notified immediately of the situation so that we can respond to the Site accordingly.

In the extremely unlikely event that both the Class A and Class B circuit failures are received for the same Fire Alarm Panel, this would be warrant an immediate response to the Site from a Systems Group technician. Please note that the remainder of the Fire Alarm System would still operate normally, so only the portion of the System where the affected Fire Alarm Panel has reported both circuit failure conditions would be compromised.

In the event that an FPC (Fire Protection Cabinet) CCTV SW Tbl signal is received:

The FA CCTV System has been designed with a self-healing network topography such that a single FA CCTV network fiber break or FA CCTV switch failure will not cause the FA CCTV System to be compromised beyond the affected CCTV failure. In the case that the CCTV SW Tbl signal is received for a given FPC panel, only the affected camera(s) at the FPC Panel would be affected, depending on the nature of the cause of the Tbl condition. The remainder of the FA CCTV network should remain operational. Systems Group should be notified immediately of the situation so that we can respond to the Site accordingly.

In the event that an equipment rack (ECR or WCR) CCTV SW Tbl signal is received:

As above, the FA CCTV System has been designed to remain fully operational in the event of a CCTV SW Tbl. If one of the CCTV Switches in the East or West Equipment Racks were to report the CCTV SW Tbl signal, this could indicate a more serious situation in the FA CCTV and FA System, dependent on what the cause of this signal is. Systems Group should be notified immediately of the situation so that a service technician can be immediately be dispatched to the site for repair. Please note that portions of the FA and FA CCTV System would remain operational, again dependent on the specific cause of this signal.

In the event that a FPC (Fire Protection Cabinet) BPS Tbl signal is received:

This would indicate an abnormal condition has occurred at the FPC cabinet. This trouble could indicate a loss of 120vAC power to the FPC cabinet, an issue with the standby batteries at the FPC cabinet, a ground fault condition, or other associated trouble condition. Maintenance personnel should be dispatched to the FPC cabinet to identify what the actual trouble condition is caused by. Systems Group should be notified immediately of the situation so that we can respond to the Site accordingly.

If additional trouble signals such as CCTV Sw Tbl or Deluge Circuit Tbl conditions are received, this would indicate that the BPS power supply has a failure condition, which could affect the FA CCTV System or the associated FA System deluge valves fed from the FPC cabinet. In this case, Systems Group should be notified immediately of the situation so that a service technician can be immediately dispatched to the site for repair.

In the event that a SLC Line Opened or Shorted Data Card signal is received:

This would indicate a trouble condition has occurred on the signaling line circuit that monitors and controls the associated field devices on that SLC circuit. The signaling line circuits have been designed with redundant pathways to operate with a single fault condition on the circuit, so the field devices will not be affected by this condition, dependent on the type of condition that has occurred. Systems Group should be notified immediately of the situation so that we can respond to the Site accordingly.

If additional field device troubles are received, this would indicate a more serious condition has occurred on the signaling line circuit, which could affect the deluge operation of the valves associated with the SLC circuit. In this case, Systems Group should be notified immediately of the situation so that a service technician can be immediately dispatched to the site for repair.

In the event that a Fire Alarm Control Panel Internal Fault signal is received:

This would indicate that a Fire Alarm Control Panel has an issue with one of the associated panel modules, which could compromise the systems' ability to respond to an alarm condition. Systems Group should be notified immediately of the situation so that a service technician can be immediately dispatched to the site for repair.

OTHER ABNORMAL SUPERVISORY OR TROUBLE CONDITIONS

In the event that an Emergency Generator Tbl signal is received:

This would indicate an issue has occurred on the Emergency Generator that could affect its ability to operate in an emergency situation. Maintenance personnel should be dispatched to the Emergency Generator to identify what the actual trouble condition is caused by.

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In the event that the Fire Pump Phase Reversal signal is received:

This would indicate that an issue with the power source to the Fire Pump has occurred, which could affect its ability to operate in an emergency situation. Maintenance personnel should be dispatched to the Fire pump to identify what the actual trouble condition is caused by.

In the event that the Fire Pump Power Loss signal is received:

This would indicate that an issue with the power source to the Fire Pump has occurred, which could affect its ability to operate in an emergency situation. Maintenance personnel should be dispatched to the Fire pump to identify what the actual trouble condition is caused by.

In the event that the 60 Minute tank level signal is received:

This would indicate that the on-site water storage tank for the fixed fire suppression system has 60 minutes of water available for operation of the system. This signal indicates that the system has water available to perform its design system capacity.

In the event that the 30 Minute tank level signal is received:

This would indicate that the on-site water storage tank for the fixed fire suppression system has 30 minutes of water available for operation of the system. This signal indicates that the system has water available to perform 50% of its design system capacity.

In the event that the Boiler Tbl signal is received:

This would indicate an issue has occurred on the Boiler System that could affect its ability to operate in an emergency situation. Maintenance personnel should be dispatched to the Boiler System to identify what the actual trouble condition is caused by.

In the event that a valve tamper supervisory signal is received:

This would indicate a tamper valve on the fixed fire suppression system is in its off normal state, which could affect the system's ability to provide water to the affected event. A tamper valve signal for an individual deluge zone valve would affect that zone's ability to provide water to the affected event. If an isolation valve or valve associated with the Fire Pump signal is received, additional portions of the deluge system could be affected. In any event, maintenance personnel should be dispatched to the affected valve to identify what the actual supervisory condition is caused by.

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In the event that an IVE (Insulated valve Enclosure) Low Temperature signal is received:

This would indicate that the temperature inside the associated IVE cabinet has reached its preset low temperature (less than 40F approximate) setting, which could mean that an IVE enclosure has been left open, or that the temperature of the deluge water supply loop has reached a low temperature that could compromise the ability of the fixed fire suppression to deliver water to the deluge valves. Maintenance personnel should be dispatched to the affected valve cabinet to identify what the actual supervisory condition is caused by.

In the event that an FPC (Fire Protection Cabinet) or RCP (Remote Control Panel) High or Low temperature signal is received:

This would indicate that the internal temperature in the FPC or RCP cabinet has reached a high or low temperature that is out of the normal operating range for the equipment inside the cabinet, which could affect the ability of the panel to operate correctly. Maintenance personnel should be dispatched to the affected fire alarm cabinet to identify what the actual supervisory condition is caused by.

In the event that one of the Fire Alarm Control Panel switch signals is received:

This signal would indicate that someone has inadvertently activated one of the FACP Panel front panel switches. These switches are typically used for maintenance purposes to prevent accidental release of water to the roadway during normal servicing or maintenance activities. Please note that these certain switches do disable (prevent) the deluge system(s) from activating in an emergency situation, so these switches should never be left in an activated condition. We have provided a flashing LED adjacent to each of these switches so the operator can easily identify a switch that has been left out of normal. These switches are located in each Control Room, the Facility Manager's Office, and at each remote Control Panel in the supply plenums. The System Operator needs to dispatch maintenance to the affected switch location immediately to restore the system to its normal condition.

In the event that a device trouble condition signal is received:

Typically, this signal would be received when a device has an issue that affects its ability to perform its required function. A single device trouble condition typically would not compromise the entire system, only the associated area of the system the device is responsible for. Systems Group should be notified immediately of the situation so that we can respond to the Site accordingly.

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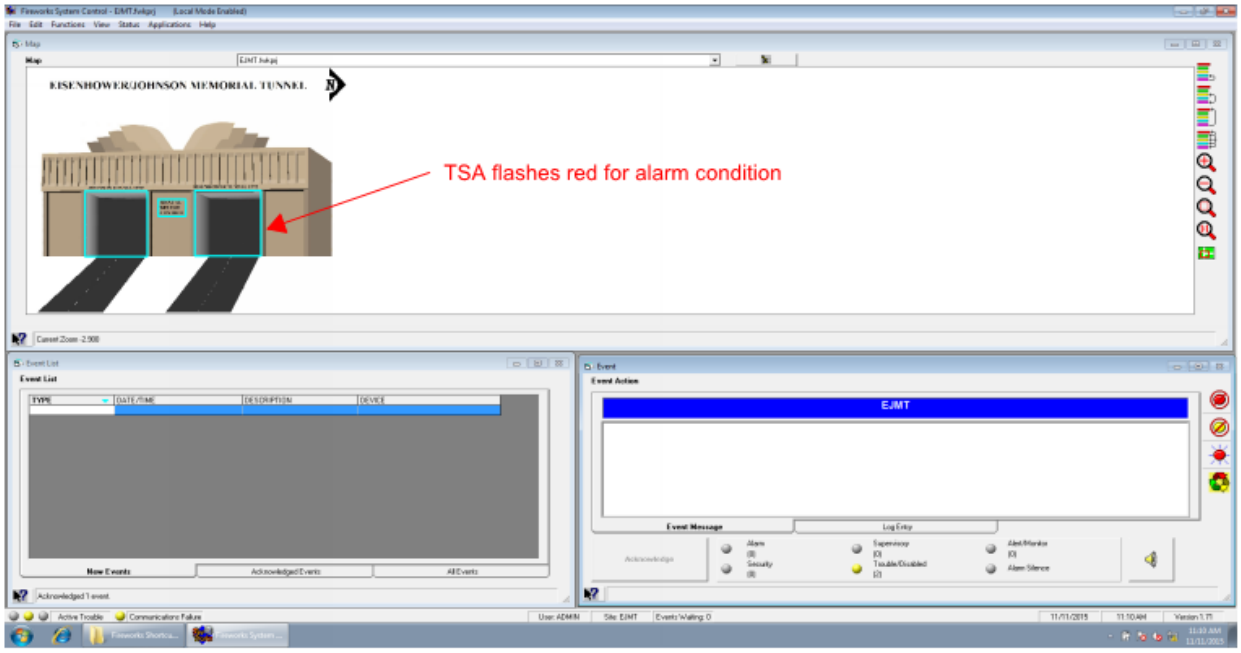
TYPICAL ALARM ACTIVATION OPERATION

Upon activation of the FOLHD System Primary or Secondary Alarm condition is received, the following events occur:

1. Flashing Red TSA (Touch Screen Area) illuminates on the Fireworks display. The System Operator can step thru the affected screens that are flashing, or can go immediately to the affected device via the Fireworks icons. See screen shots below.
2. The FA CCTV camera(s) position to affected deluge zone.
3. The affected deluge zone valve is activated. A manual input alarm is displayed indicating that the deluge valve has been activated.
4. The Fire Pump is started.
5. The Boiler Circulation Pumps are shutoff.
6. The Drainage Valve System positions to the appropriate tunnel (North or South) configuration.
7. Water is dispatched to the roadway.



Main Fireworks Screen

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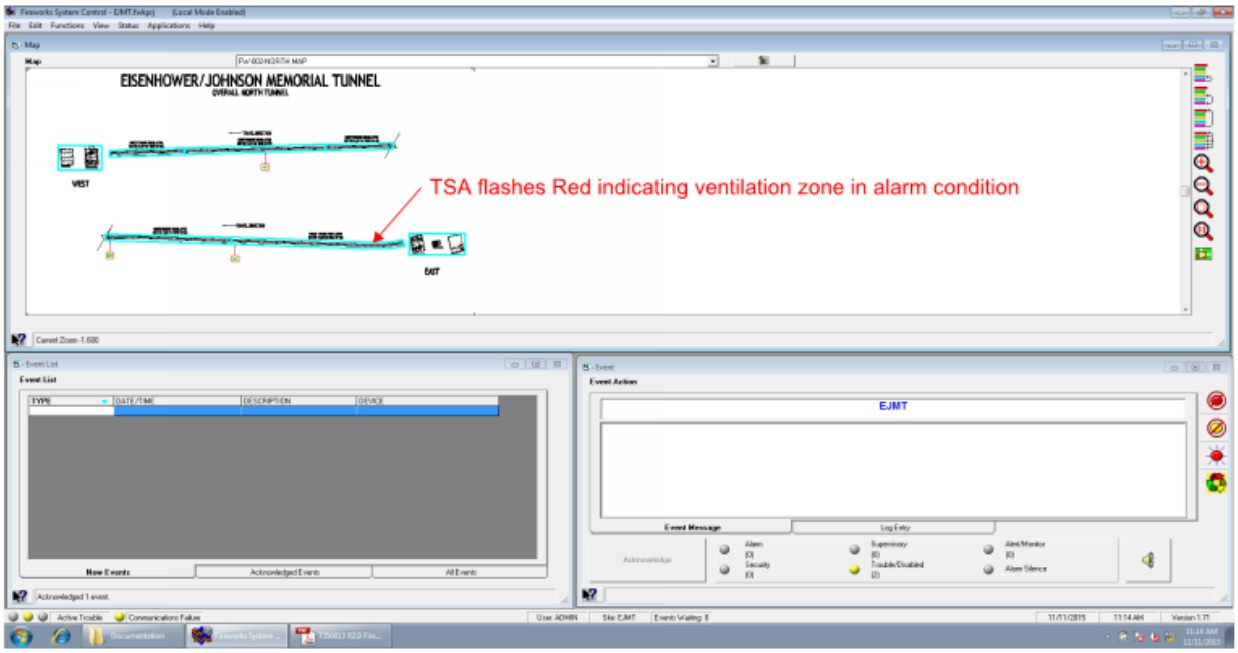
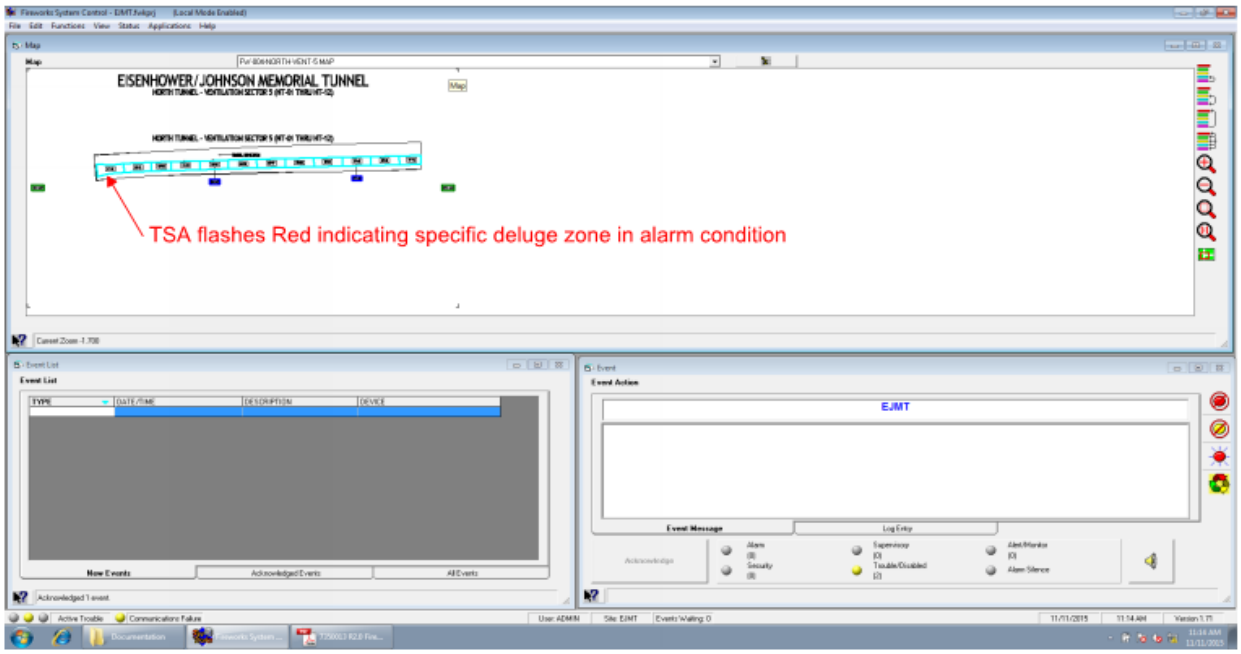


Tunnel Ventilation Screen (1st Layer)



Deluge Zones per Ventilation Zone Screen (2nd Layer)

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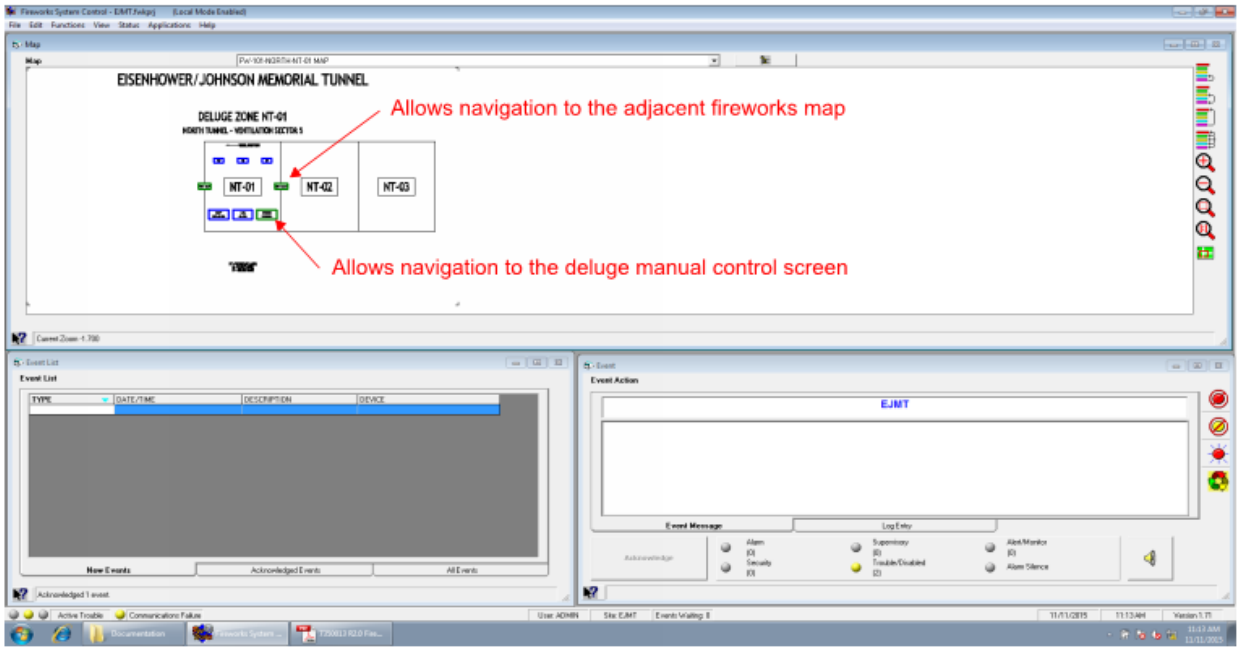
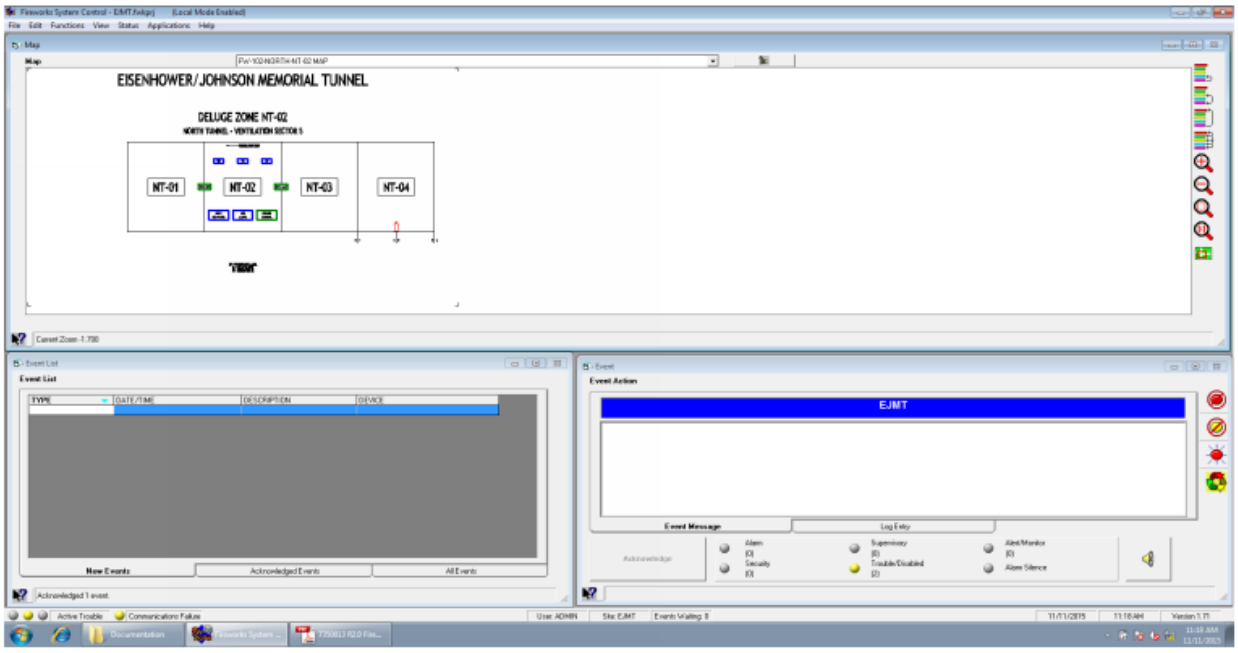


Deluge Zone Screen (3rd Layer)



Adjacent Deluge Zone Screen

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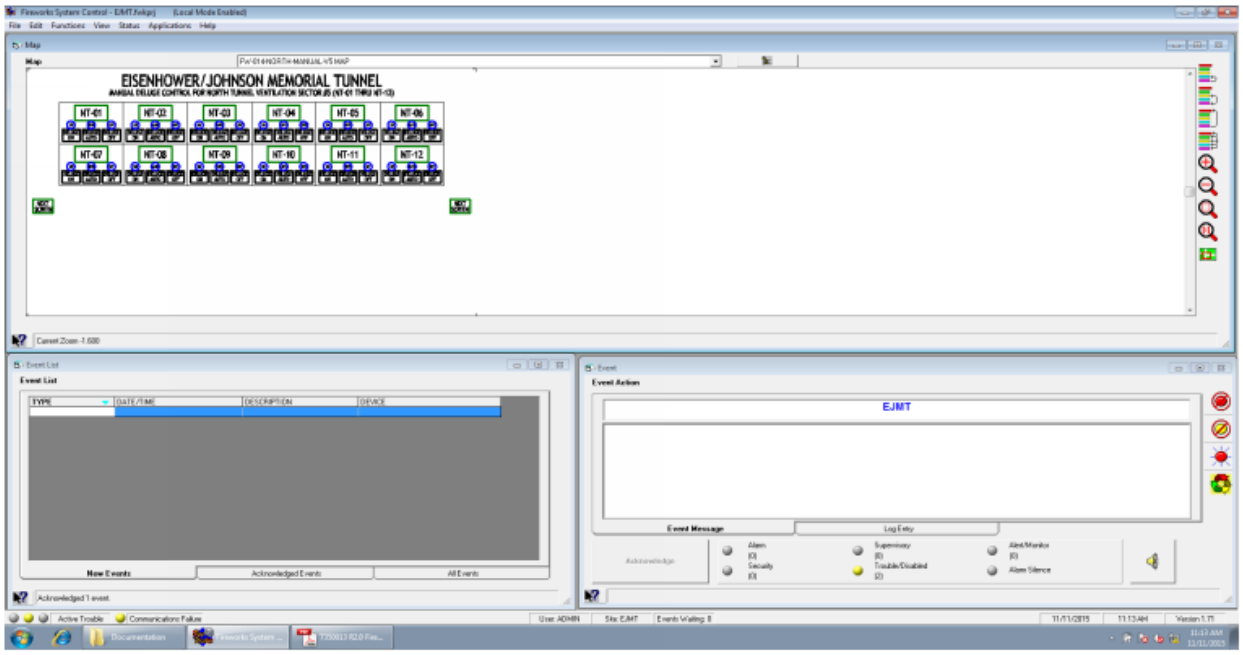
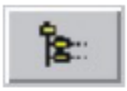
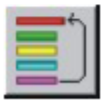


Manual Deluge Control Screen

Button	Definition
	Map Tree: Displays an explorer view of all maps, TSAs, devices, and text associated with your system. Maps, TSAs, devices, and text can be accessed directly by clicking the desired item.
	Parent Map: Branches up one map level to the current map. This is like following a TSA link in reverse, from destination map to source map. (Keyboard shortcut F9 and on the Functions menu.)
	Previous Map: Switches back to the map previously displayed. Clicking this button repeatedly toggles the display between the last two maps displayed.
	Site Map: Branches directly to the site map from any location in the map system. The site map is the main map which is displayed when no active alarms are present. (Keyboard shortcut F7 and

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	on the Functions menu.)
	Device Map: Branches directly to the map with the highest priority active device from any location in the map system. (Keyboard shortcut F5 and on the Functions menu.)
	Zoom In: Enlarges the viewing size of a map. Zooming in is much like moving toward a picture to get a better look at it.
	Zoom Out: Reduces the viewing size of a map. Zooming out is much like moving away from a picture to get a better look at it.
	Zoom Select: Used to draw a box around an area on a map to zoom in
	Zoom 1-to-1: Displays the actual size of the map
	Map Overview: Displays a pop-up window of the entire map. This can be helpful if you are zoomed in to a certain area on the map and want to see an overview of the whole map at the same time.

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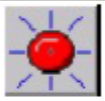
	Alarm Silence: Silences the audible notification appliances connected to the system
	Panel Silence: Silences the control panel's internal buzzer
	Drill: Forces all audible and visual notification appliances to the ON state
	Reset: Returns a control panel to normal if all of its devices have been restored
	Contacts: Opens the Contacts dialog box, which is used to contact and authenticate receiver event contacts. It is only enabled when a receiver event is selected that has associated contacts.
	Silence Workstation: Silences the workstation's internal buzzer and turns an event associated audio (AVI) file ON and OFF

Fireworks Control Buttons (Right Side of Map Viewer)

TYPICAL ALARM RESTORATION OPERATION

To restore the system after a deluge alarm event has occurred, the following steps occur:

1. The Reset icon is activated on the Fireworks display. See Screen Shot below.
2. The FOLHD Alarm condition(s) are reset on the first reset.
3. The Reset icon is again activated on the Fireworks display.
4. The deluge manual input alarm is reset, which turns OFF the water to the roadway and resets the deluge control valve.
5. The FA CCTV cameras return to their normal non-alarm “HOME” positions.
6. At this point, the system should be showing NO alarm conditions; however, several additional steps need to be performed to return the System back to its normal operating condition.

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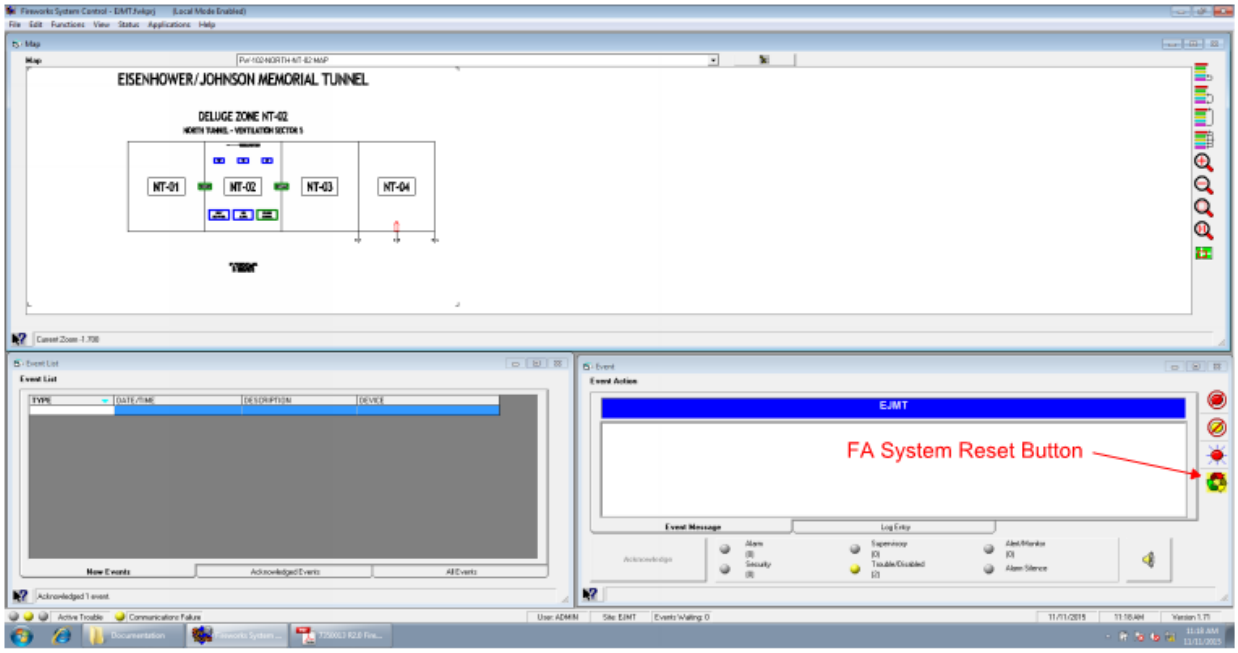
Fax: 303-650-5667

7. Depending on which tunnel has been activated, the associated Drainage Valve switch needs to be activated. This switch activation restores the drainage control valves to their normal position. This manual switch restoration switch allows the System to keep the drainage valves in their active position until the drainage tank wastewater can be dealt with and allow the remainder of the System to go back to its normal operating condition. Please note that these affected drainage valves will remain active (causing a supervisory active signal) to remain on the panel until the drainage valve switch has been activated.

8. The Boiler Circulation Pump switch needs to be activated. Like above, this switch restores the boiler circulation pumps to their normal operation. This manual switch allows the boiler circulation pumps to remain off while the remainder of the deluge system water valves are restored to normal. Typically, this Boiler Circulation Pump switch would be activated several minutes after a water discharge event has occurred.



Fireworks Reset Button Location

TYPICAL MANUAL CONTROL OPERATION – FA CCTV SYSTEM

The FA CCTV System allows the System Operator to adjust the FA CCTV camera views at any time. The FA CCTV cameras will automatically position to their pre-set positions dependent on the alarm condition received. At that point, the System Operator can again take manual control of the FA CCTV cameras as desired until another alarm is received, or the system is reset. The additional alarm condition would cause the FA CCTV cameras to re-position to that pre-set position or to their "HOME" positions if the System is reset.

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TYPICAL MANUAL CONTROL OPERATION – FA SYSTEM

The FA System allows manual control of the system during alarm events and also during normal non-alarm operation as required by the situation.

Assuming the System is in alarm, with active deluge system flowing water, the System Operator can take manual control of the system and activate and additional deluge zone or turn off the deluge zone that was activated. This is done as follows:

1. The Manual Deluge Control screen is brought up on the Fireworks display system. See Screen Shots below.
2. The existing deluge valve that is flowing water is indicated by a RED circle in the deluge zone box.
3. The operator can subsequently select an additional deluge zone to be activated by selecting the "DELUGE ON" box in the desired zone. The System asks if you are sure that you want to activate the output. By clicking YES, the deluge zone is then activated.
4. Once the next zone is activated, the Red circle in the deluge zone box illuminates.
5. The System Operator can also turn OFF the zone by activating the DELUGE OFF box for the desired zone.
6. Once the deluge zone has been turned off, the Yellow circle will illuminate.

It is important to note that the System operator can turn deluge zones ON and OFF as warranted by the emergency situation, with the knowledge that the fixed fire suppression is designed to operate with two (2) active deluge zones at any time. It is important to note that activating a second zone would be done by activating the DELUGE ON box for the second zone.

If the Operator needs to activate an additional zone when 2 zones are already active, the System Operator activates the third zone by hitting the Deluge ON box and then subsequently operates the DELUGE OFF button for the zone that needs to be turned off to prevent any water hammer issues. It is important to note that activating a second zone would be done by activating the DELUGE ON box for the second zone.

Once the emergency situation is cleared, the System Operator can subsequently restore the automatic and manual control functions of the System as follows:

1. Turn off the affected deluge zone(s) by activating the DELUGE OFF box for the automatic and/or manual controlled zone.
2. The Yellow Deluge Off light(s) will illuminate.

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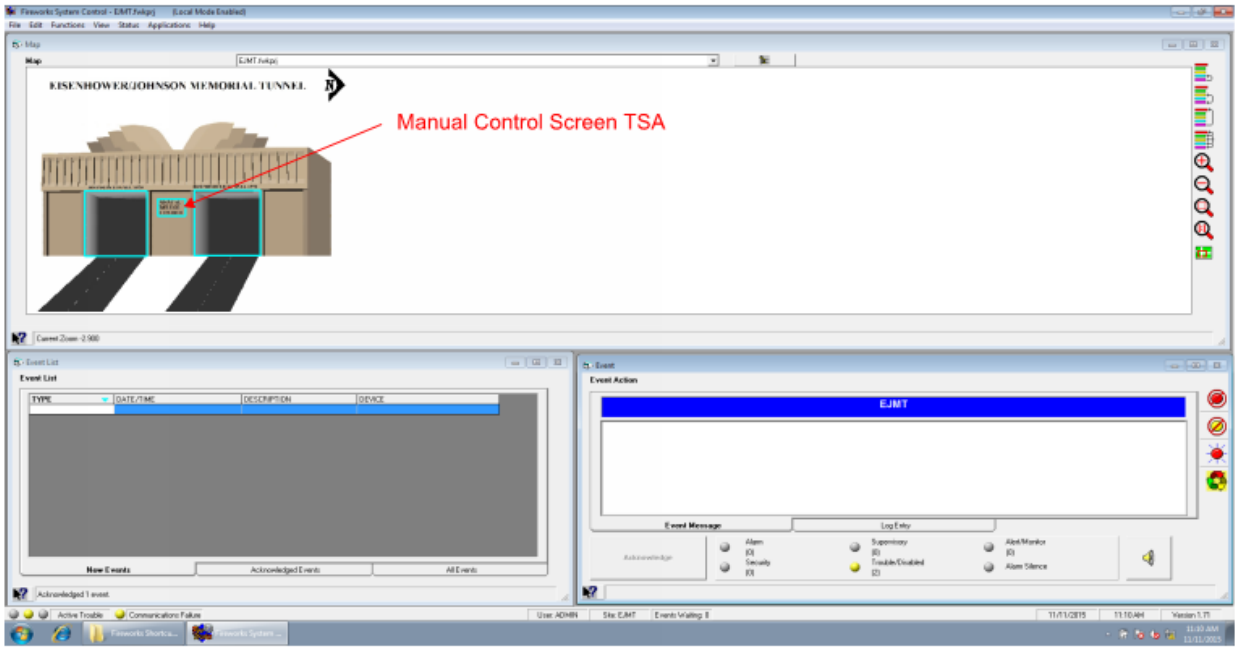
3. The System Operator initiates a reset on the System, which will clear the automatic controlled deluge valves.

4. The System operator then selects the DELUGE AUTO button for the affected zone(s) and the yellow light switches from the OFF position to the AUTO position.

5. The System Operator then resets the system again, which will restore the automatic and manual functions to normal.

6. Please note that the Boiler Circulation Pump and Drainage Valve switches would need to be activated as described above to fully restore the System to normal.



Manual Control Screen Navigation from Main Fireworks Screen

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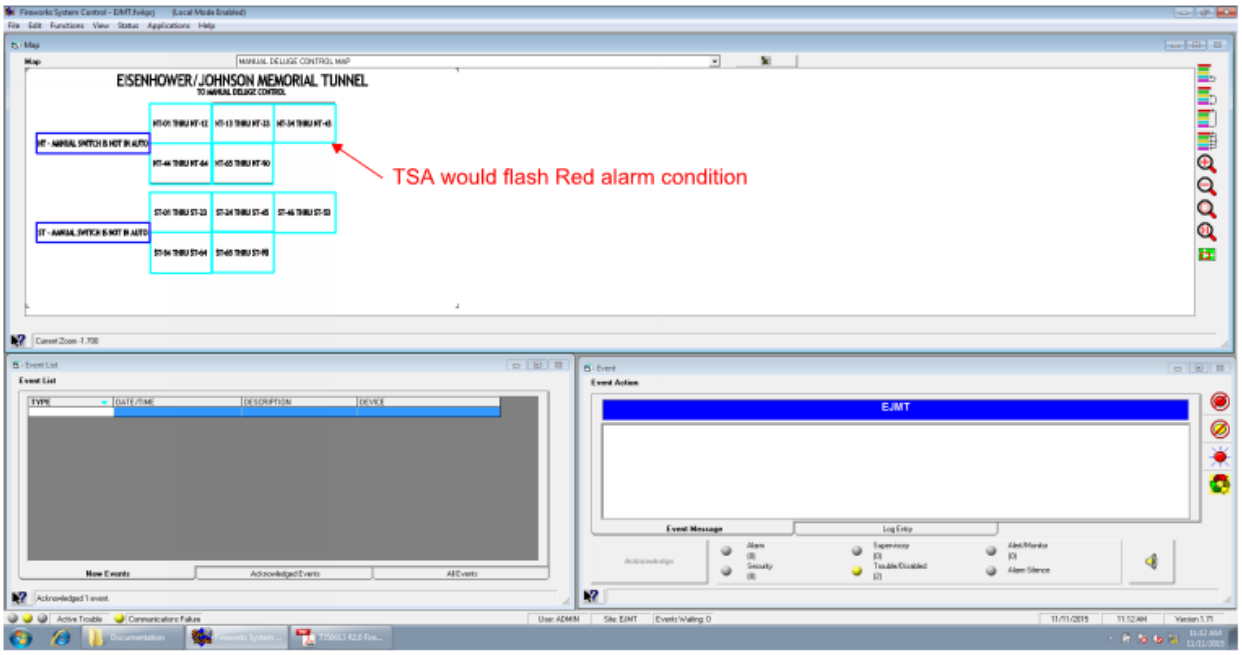
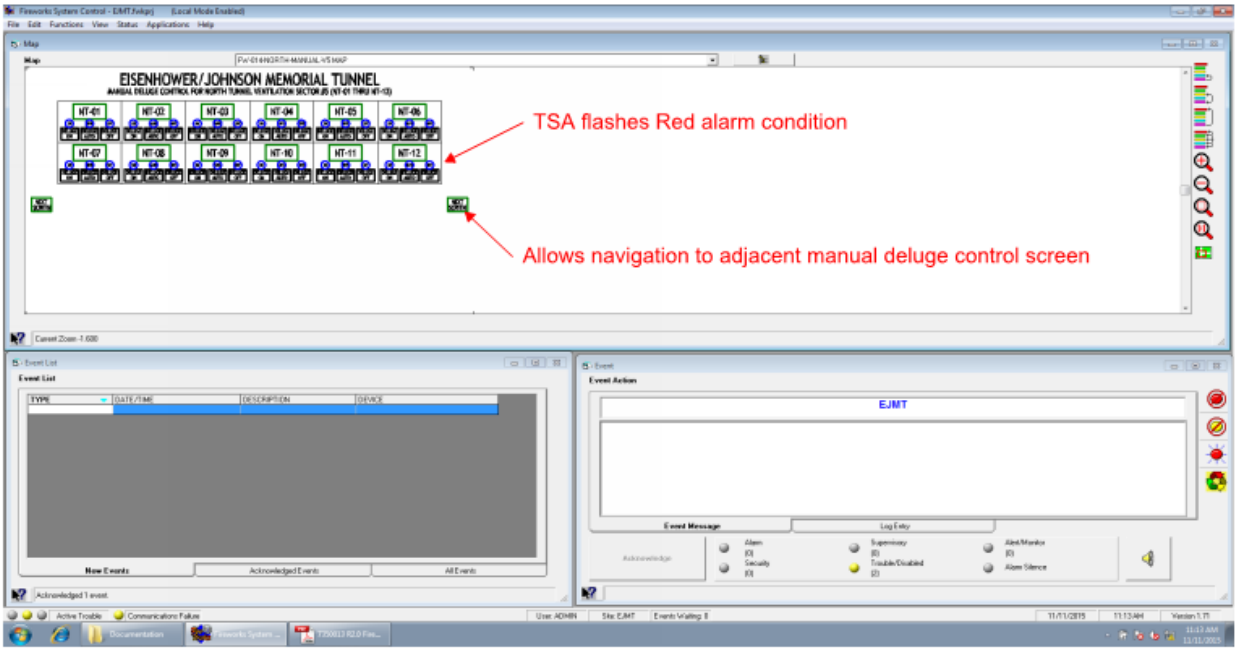


Manual Deluge Control Screen by Ventilation Zone (1st Layer)



Manual Deluge Control Screen (2nd Layer)

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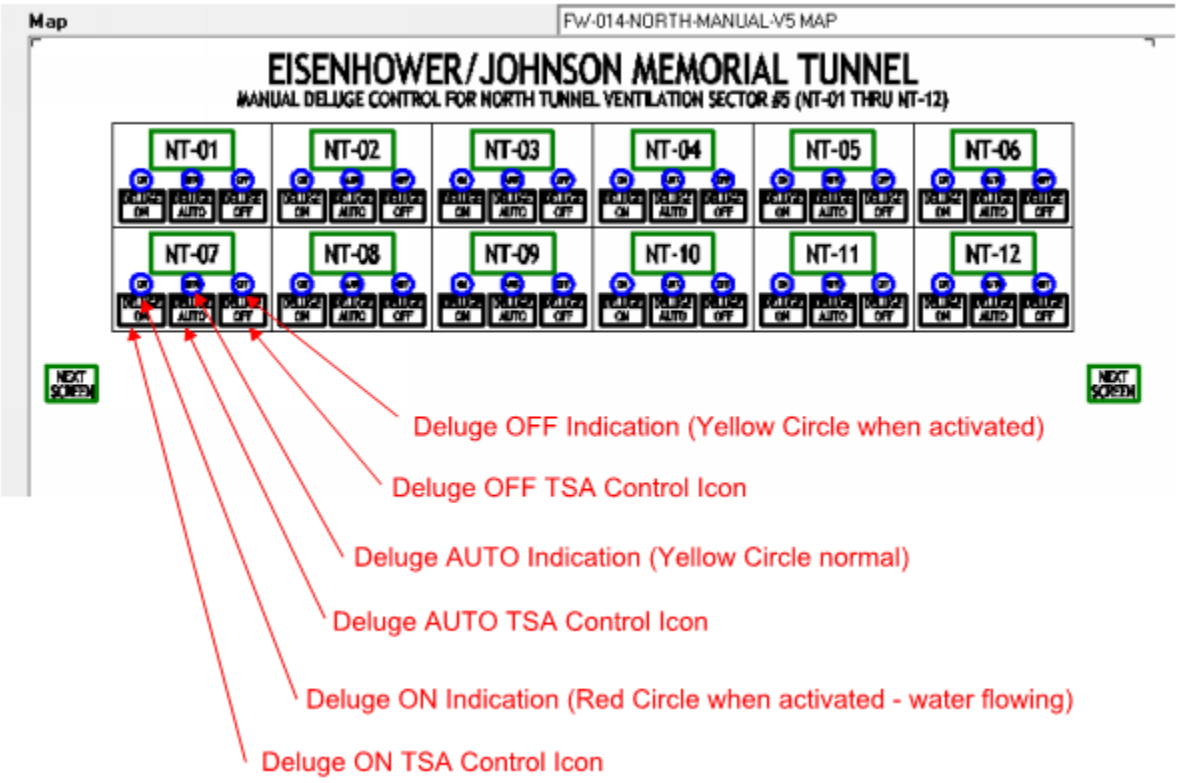


Manual Deluge Control Screen TSA/Indicators

End of Operations Plan

3.0 FIRE SUPPRESSION

Western States Fire Protection Co.

Protecting Lives and Property

7026 S. Tucson Way
Centennial, CO 80112
(303) 792-0022 Fax (303) 792-9049

Operations Plan

EJMT FFSS Design Build Project
Project No. C 0703-360, Subaccount 17810

Prepared by:
John Hulett
Project Manager
26 November 2015

OPERATIONS PLAN
INDEX

EJMT FP DRAWING NARRATIVE

The fixed fire suppression system (FFSS) is supplied by the existing water storage tank fed from straight creek, north of the west portal. A new 10-in underground pipe will be installed from the existing tank to within close proximity of the portal where the existing 8-in domestic and standpipe is supplied. The line will tee into the existing at this point and reduce down to 8-in to supply the new 1,250 gpm electric fire pump located in the west ventilation building.

The water supply to the fire pump was hydraulically calculated. This calculation assumes the worst case scenario with the tank empty. The additional 5 psi static pressure available when the tank is full was not utilized. The adjusted water supply to the fire pump suction flange is 56.9 psi static pressure with 49.6 psi at 1,250 gpm. This adjustment includes the additional 500 gpm hose allowance for the existing standpipe system. The total flow for this calculation is 1,750 gpm.

The 115 psi @ 1,250 gpm fire pump is sized to provide the required pressure and flow for any two deluge systems flowing at the same time. The most demanding system is the Eisenhower 3 nozzle system with a flow of 1,264.7 gpm. All deluge system hydraulic calculations provide at least a 10% pressure safety factor to allow for minor installation changes.

The fire pump assembly will be provided with both a flow meter and a test header. The flow meter allows testing the performance of the fire pump by flowing water back to the pump suction. The test header is required for the acceptance test and to verify the water supply from the tank every 5 years. The flow meter can be used 4 out of 5 years with the benefit of not flowing and wasting water outside the building from the test header.

A new wall hydrant will be provided close to a new fire department connection (fdc) at the northwest corner of the west ventilation building. The wall hydrant can supply a fire pumper truck that can supplement the water pressure within the FFSS through the FDC. The wall hydrant will also serve as the pump test header when required. An FDC will not be provided at the east ventilation building because there is no water supply from which a pump truck could draw to supply additional water to the FFSS. Just to clarify, a fire pumper truck is not required for the operation of the system but a responding fire department could assist in the event of a fire by supplementing or replacing the fire pump.

During winter months a water truck may not be able to access the water tank for re-supply. An arrangement of valves with a bypass that is normally closed will be provided to allow a water truck located below at the northwest ventilation building to fill the water supply tank utilizing the fire pump.

In the event of a power outage, the fire pump controller is equipped with an automatic transfer switch to allow operation from the emergency generator. Additionally the fire pump controller is of the soft start type to reduce the inrush demand on the emergency generator.

There are 183 deluge systems providing coverage over the tunnel roadway. There are 90 systems in the Eisenhower tunnel and 93 systems in the Johnson tunnel. Three (3) of the deluge valves are located within the fire pump room. The remainders of the deluge valves are located on the 6-in. X 18,100 ft. Loop located within the supply plenums and the fan deck of the ventilation buildings. The capacity of the 6-in. Loop is approximately 30,000 gallons.

Ten (10) 6-in. Isolation valves will be provided on the 6-in x 18,100 ft. Loop. These valves will allow system repairs if required to occur without draining the entire system. Each of these valves will have a tampers switch. In the event a valve is closed, a trouble signal will be displayed at the fire control panel (fcp).

Boilers, expansion tanks, and circulation pumps will be provided within the fire pump room to heat the 6-in. Loop piping. The system heat will provide protection of the zone deluge valves located within insulated valve enclosure (ive) cabinets installed around each zone valve in the plenum. The valve enclosure will be heated by convective heat transfer from the circulating hot water in the 6-in. Wet supply loop. The heated water will be directed east thru the supply plenum of the eisenhower tunnel where it will cross through the east ventilation building on the fan deck and return west within the supply plenum of the johnson tunnel.

In the event of a fire, the water supply to the deluge systems can then travel east thru both supply plenums to the activated deluge system allowing water to discharge from the nozzles.

There are four different types of deluge systems within the project. Each system is designed to provide at least 0.16 gallons per square foot over the roadway while two systems are flowing. The hydraulic calculations provided are for the most demanding area for each system type. The location was determined by changing the hydraulic location until the most demanding condition was found.

The differences between each of the system types include the size, nozzle type, spacing, pressure, and flow. Each system is similar in that it provides the density of 0.16 gallons per square foot. All of the deluge systems will have a manual isolation valve with a tamper switch. In the event a valve is closed, a trouble signal will be displayed at the fire

Control panel (fcp). In the event a deluge system is actuated, a pressure switch will indicate an alarm at the fcp.

The deluge valve assemblies are located approximately every 100 feet in the eisenhower supply plenum and 96 feet in the johnson supply plenum. Each deluge system is controlled by a 4-in. Flow control valve. This valve is held in the closed position by a small prime line. The upstream system water pressure holds the valve closed and when a solenoid valve is opened by a 24 volt current from the fcp. The flow control valve will open. When the solenoid valve is closed, the valve will close. Additionally, the flow control valve can operate like a pressure reducing valve allowing for adjustment of the downstream pressure. With this feature, a higher upstream pressure will not over flow which would effectively reduce the minimum water supply duration of one hour.

A 4-in. Cross main will supply the branch lines that supply the assorted nozzles. The 4-in. Cross main will need to penetrate the plenum wall for each tunnel system to allow access to the exhaust plenum vents. With each deluge system located below the valve assembly all cross mains and branch lines will be required to drain automatically to avoid trapped water that could freeze within the pipe. The branch line pipe will automatically drain from nozzles. The cross main will require a ½- in ball drip that will automatically drain to the plenum floor. The ball drip will automatically open after the system is shut down and the pipe is no longer pressurized.

The eisenhower tunnel has two types of deluge systems. Both systems have the same large bete nozzles with the difference being three (3) nozzles verses (4) nozzles. The three nozzle system requires more pressure at each nozzle to provide the 0.16 gallons per square foot to the roadway below. The location of the nozzles is determined by the existing plenum vents within the exhaust plenum.

The Johnson tunnel deluge systems utilize twelve (12) smaller BETE nozzles to provide the 0.16 gallons per square foot to the roadway below. The location of the nozzles is determined by the existing vents within the supply and exhaust plenum.

The ventilation building deluge systems utilize twelve (12) horizontal sidewall sprinklers as nozzles to provide the 0.16 gallons per square foot to the roadway below. The branch lines supplying the nozzles at the portals will be exposed on the wall just below the lights. To address concerns regarding corrosion from anti-ice spray that can become airborne from the roadway at the ventilation buildings, we are providing galvanized pipe for the branch lines and nozzles with a corrosion resistant coating.

Custom brackets and trapeze supports will be provided within the supply plenum to support the 6-in. Loop piping. These supports will be located at a maximum of 12.5 ft. On center. The entire 6-in. Loop piping will be provided with 1-½-in fiberglass insulation with a k-value of 0.23. Additionally, rigid 1-½-in insulated pipe supports will be provided for all hangers and supports.

The valve assembly for each deluge system will be inside an air tight ive. The ive's are provided with 3-in rigid insulation with an r-value of 18. The ive's will have an access door allowing for ease of inspection, testing, and maintenance.

The 6-in. Loop piping and its supply will be seismically braced. Calculations are provided within the drawings for the most demanding longitudinal and lateral brace requirements. Longitudinal braces will be provided at 100 ft. Maximum distances within the supply plenum and will be located as close as possible to the valve assemblies. Each of the custom brackets and trapeze supports within the plenum serve as lateral braces at 12.5 ft. Maximum on center. The loop and supply piping within the portals will be braced by standard methods with longitudinal braces at 80 ft. Maximum and lateral braces at 40 ft. Maximum and located within 1 ft. In a change of direction. All risers or vertical piping will be provided with four-way bracing in accordance with nfpa-13.

A 4-in. Pressure relief valve will be provided at the southeast ventilation building to provide protection of system components from the potential of water hammers that may occur. Water hammer is used to describe a pressure surge that is caused when a fluid is forced to stop or change direction suddenly. The potential for water hammer exist when a deluge valve is closed.

Each tunnel, and their respective air plenums, curve north and south through the mountain and change in elevation increasing from east to west. The curvature of the tunnels occurs slightly over a large distance making the installation of additional fittings and swing joints unnecessary. The deflection is minimal but must be addressed.

In addition, the air plenums are subject to freezing temperatures in the winter months. To prevent the water in the pipe from freezing, hot water starting at 100°f with a maximum design boiler temperature of 130°f, will be circulated through the 6-in. Main supply loop. Main piping will be installed when temperatures have the potential to be -30°f. The worst case temperature change was calculated to be from -30°f to 130°f. Due to drastic changes in temperature, the 6-in. Pipe will expand and contract. When the pipe is to be installed during the cold weather seasons or when cold water from the storage tank is introduced into the pipe during a fire or testing situation, the steel pipe will shrink. When the hot water is circulated through the pipe, the steel pipe will expand. The expansion from the change in temperature will cause a parallel deflection that is addressed in this design.

To accommodate changes in the pipe length and direction, expansion and deflection will be addressed continually for every stick of pipe along the entire length of the tunnel by using Victaulic style 75 flexible couplings and Victaulic style 155 expansion joint 6-in. Nipples. Through product data as well as expansion and deflection calculations for a 25 ft. Section of pipe, a solution was determined to provide expansion joints to accommodate the expansion and deflection within each 25 ft. Section of pipe.

Expansion joints shall be installed at each end of pipe approximately every 25 ft. An expansion joint will consist of (2) style 75 couplings with (1) style 155 6-in. Schedule 40 nipple, 4 inches in length between the couplings. Each expansion joint will be installed in cold weather conditions, thus each coupling shall be installed to separate the two ends of the pipe to allow for maximum possible separation. When the pipe expands due to hot water, there will be zero deflection between each piece of pipe. The expansion joint will provide 0.346-in. Of expansion which exceeds the required thermal expansion length of 0.3216-in.

When angular deflection is required, an additional coupling and nipple shall be added to accommodate the angular deflection between the couplings that are provided for the expansion joint. This coupling will not be able to deflect in the parallel direction and will not be used as an expansion coupling.

In addition, two brackets shall be provided for each 25 ft. Length of pipe. Both brackets shall be braced to allow minimal deflection between each 25 ft. Stick of pipe. A longitudinal brace shall be installed every 100 ft. with the braced support closest to the insulated valve enclosure to limit movement at the deluge valve assemblies and to provide the required seismic bracing.

OPERATIONS
Sequence of Events

Normal Conditions

1. At least one circulation pump shall be running in the boiler/pump room located in the Northwest portal.
2. No alarm or trouble should be indicated at the fire alarm control panel or FACP. One FACP is located in the command center, another in the office next to the command center, and the third one on the stair mezzanine located within the Northwest portal.
3. The fire pump should not be running. Do not push the green button on the fire pump control panel without verifying the circulation pumps are off line.
4. All fire pump room valves are to be left in their normal positions. A laminated guide to these valves will be located on the fire pump. Changing the normal settings of these valves should provide a trouble signal to the FACP.
6. All valves within the IVE shall be in their normal positions. Laminated instructions will be provided at each IVE indicating the normal position of these valves. If the system isolation valve is closed, a trouble signal will be provided at the FACP.

Fire Event

A Linear Heat Detector (LHD) at the ceiling of tunnel monitors the ceiling temperature. When the threshold of heat is reached the fixed fire suppression system (FFSS) is triggered and the following sequence begins.

1. The heat triggered location is indicated at the fire alarm control panel or FACP. One FACP is located in the command center, another in the office next to the command center, and the third one on the stair mezzanine located within the Northwest portal.

2. The camera's automatically rotate and focuses on that location within the roadway.

3. The heat circulation pump located within the boiler/pump room located in the Northwest portal is turned off by the FACP.

4. The fire pump located within the boiler/pump room located in the Northwest portal is turned on by the FACP.

5. The deluge valve located within the insulated valve enclosure (IVE) in the supply plenum above the roadway that was triggered by heat is opened by the FACP.

6. Water flows out of the open nozzles to the roadway system that was triggered by heat. For example ST-07 is within the South Tunnel and is the seventh system East of the West roadway entrance. Each system is approximately 100 feet long.

7. The water that normally drains from the roadway to the East is diverted. The normally open and labeled roadway drain valve located between the roadways in the basement water treatment plant on the east side is closed by the FACP. See Systems group operations plan.

8. The normally closed drain valve on East side is opened allowing water that drains from the roadway to be diverted to underground tanks. See systems group operations plan.

9. The FACP monitors the underground water supply tank located on the service road North of the West portal. This tank supplies all water to the facility and a one hour water supply for the FFSS. The water level is monitored and when the tank is full there is one hour of water to fight the fire. The tank is monitored to indicate when there is only 30 minutes left to fight the fire. When the tank is empty, the fire pump will be shut down automatically so enough water remains in the system piping to prevent freezing.

10. In the event of a fire, call Western States Fire Protection with a code red at 303-792-0022..

Manual Override
Winds in the tunnel can affect which system actuates. Heat from a fire may actuate a downwind system that is not over the fire. If this occurs, the FACP allows the operator to open another system. The system is designed to turn on and off systems with no more than two systems operating at one time for up to one hour. Training on the FACP will be provided by Systems Group on how to manually override the system.

After a Fire Event

1. Call Western States Fire Protection at 303-792-0022 (This should have already happened)

2. Go to fire pump room at Northwest Portal. Verify the circulation pumps have automatically restarted allowing warm water to circulate in the fire protection loop to prevent freezing.

3. Within the Supply plenum above the roadway visually inspects the inside of the IVE's that enclosed the deluge valves that were opened. Visually inspect the ball drips located on the cross mains between the IVE and the nozzles to verify they automatically drain the trapped pipe.

4. During the colder months it is very importantl to restore circulating hot water to quickly prevent freezing.

5. Check water supply tank level.

6. Return the drain valves on East side to their normal positions. See Systems group plan.

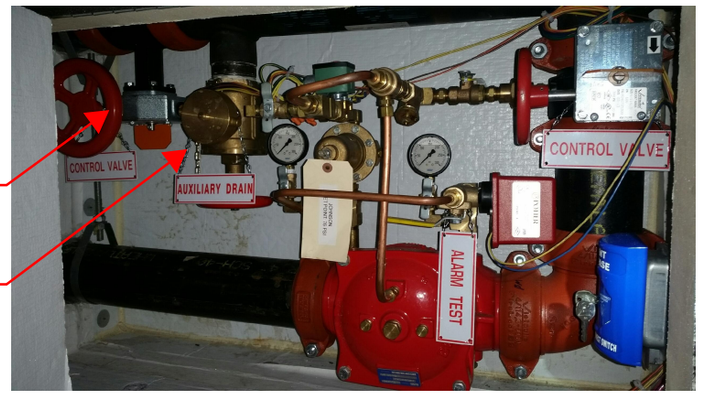
7. Schedule water truck to haul away captured roadway water within the underground water tanks on the east side.

Blowout
In the event water is entering the roadway differently than normal. Although it is unlikely it is possible the 6" loop piping within the supply plenums sprung a leak. Please call Western States Fire Protection at 303-792-0022 so we can evaluate and repair. If more than a leak and the pipe is gushing, go to the boiler/pump room located in the Northwest portal and close the fire pump bypass valve and fire pump discharge valve. These valves are labeled and also shown on the laminated valve positions within the pump room.

LOOP ISOLATION VALVES

THE 6" LOOP IS APPROXIMATELY 18,000' LONG WITH A CAPACITY OF 30,000 GALLONS.
NORMALLY THE CIRCULATION PUMPS FLOW WATER CLOCKWISE AROUND THE LOOP.
IN THE EVENT OF A FIRE, THE FLOW WILL SPLIT TO THE OPEN DELUGE SYSTEMS.
ISOLATION VALVES HAVE BEEN PROVIDED FOR SERVICING THE LOOP. THE ISOLATION VALVES WHICH SHOULD NORMALLY BE OPEN ALLOW THE LOOP TO BE DIVIDED INTO 11 SECTIONS.

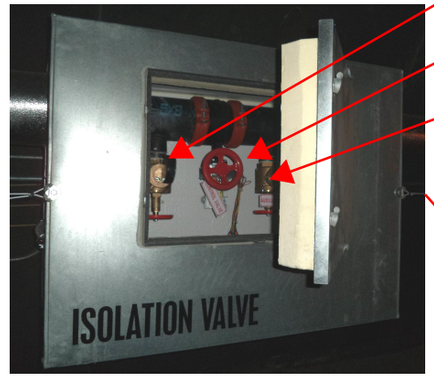
LOOP ISOLATION VALVES



6" ISOLATION VALVE

2 1/2" DRAIN VALVE

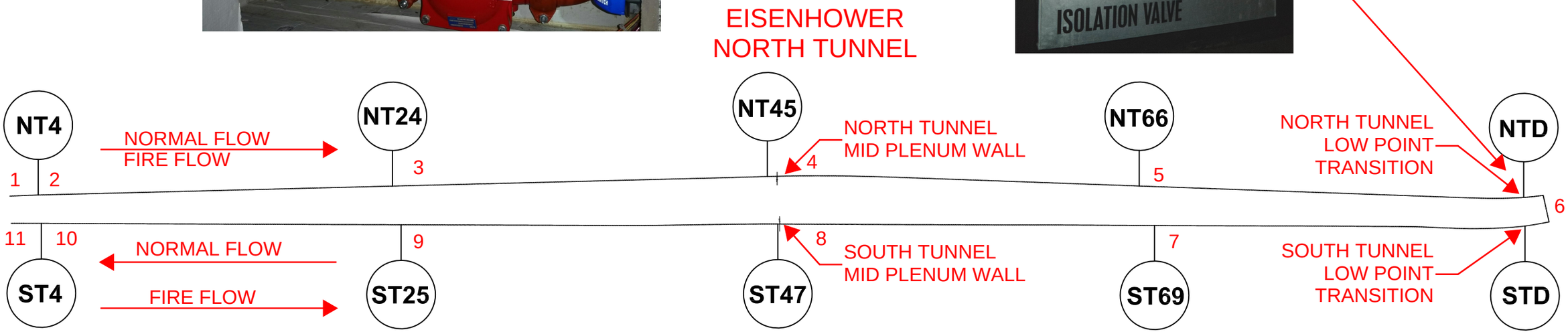
TRANSITION ISOLATION VALVES



2 1/2" DRAIN VALVE

6" ISOLATION VALVE

2 1/2" DRAIN VALVE



NORTH

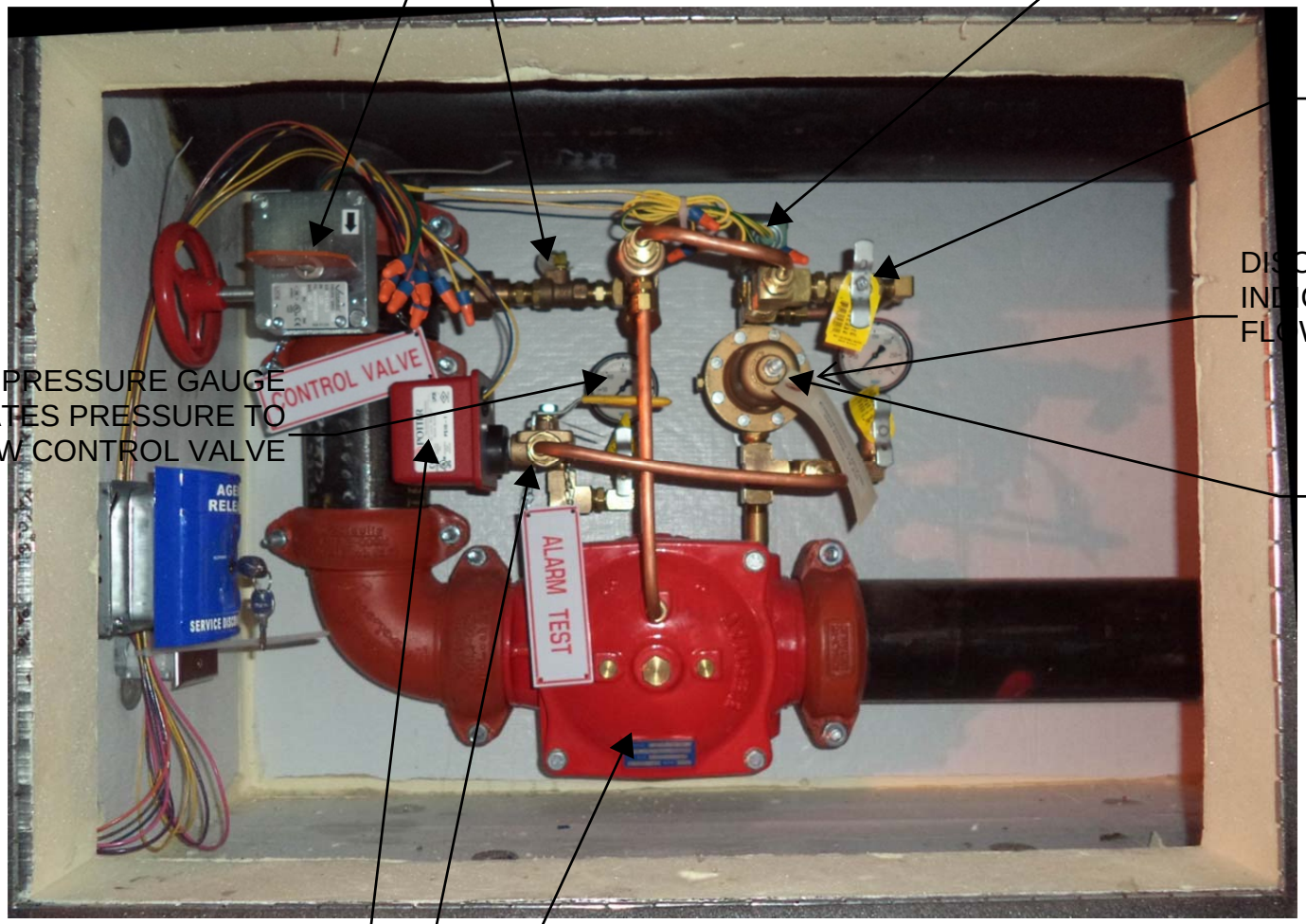
DELUGE SYSTEM FLOW CONTROL VALVE ASSEMBLY

LOCATED WITHIN THE INSULATED VALVE ENCLOSURE (IVE)

SYSTEM ISOLATION VALVE WITH TAMPER SWITCH "NORMALLY OPEN"

PRIME LINE ISOLATION VALVE NORMALLY OPEN "PRESSURIZATION OF THE PRIME LINE KEEPS THE FLOW CONTROL VALVE CLOSED"

SOLENOID VALVE - NORMALLY CLOSED WHEN ELECTRICALLY ACTUATED THE PRIME LINE LOSES PRESSURE AND THE FLOW CONTROL VALVE OPENS



MANUAL RELEASE VALVE IS NORMALLY CLOSED OPENING THIS VALVE WILL CREATE FLOW TO THE ROADWAY BELOW

DISCHARGE PRESSURE GAUGE INDICATES PRESSURE WHEN THE FLOW CONTROL VALVE IS OPEN

PRESSURE GAUGE INDICATES PRESSURE TO FLOW CONTROL VALVE

REGULATOR IS FACTORY SET TO PROVIDE THE REQUIRED DISCHARGE PRESSURE AND FLOW

FLOW CONTROL VALVE IS A PRESSURE REGULATING VALVE THAT CAN BE REMOTELY OPENED AND CLOSED BY THE SOLENOID VALVE

PRESSURE SWITCH INDICATES FLOW AT THE FIRE ALARM PANEL WHEN THE FLOW CONTROL VALVE IS OPENED

ALARM TEST VALVE - NORMALLY CLOSED VALVE IS USED TO TEST THE PRESSURE SWITCH

SOUTH TUNNEL CONTROL VALVE ASSEMBLIES ARE OPPOSITE OF NORTH TUNNEL

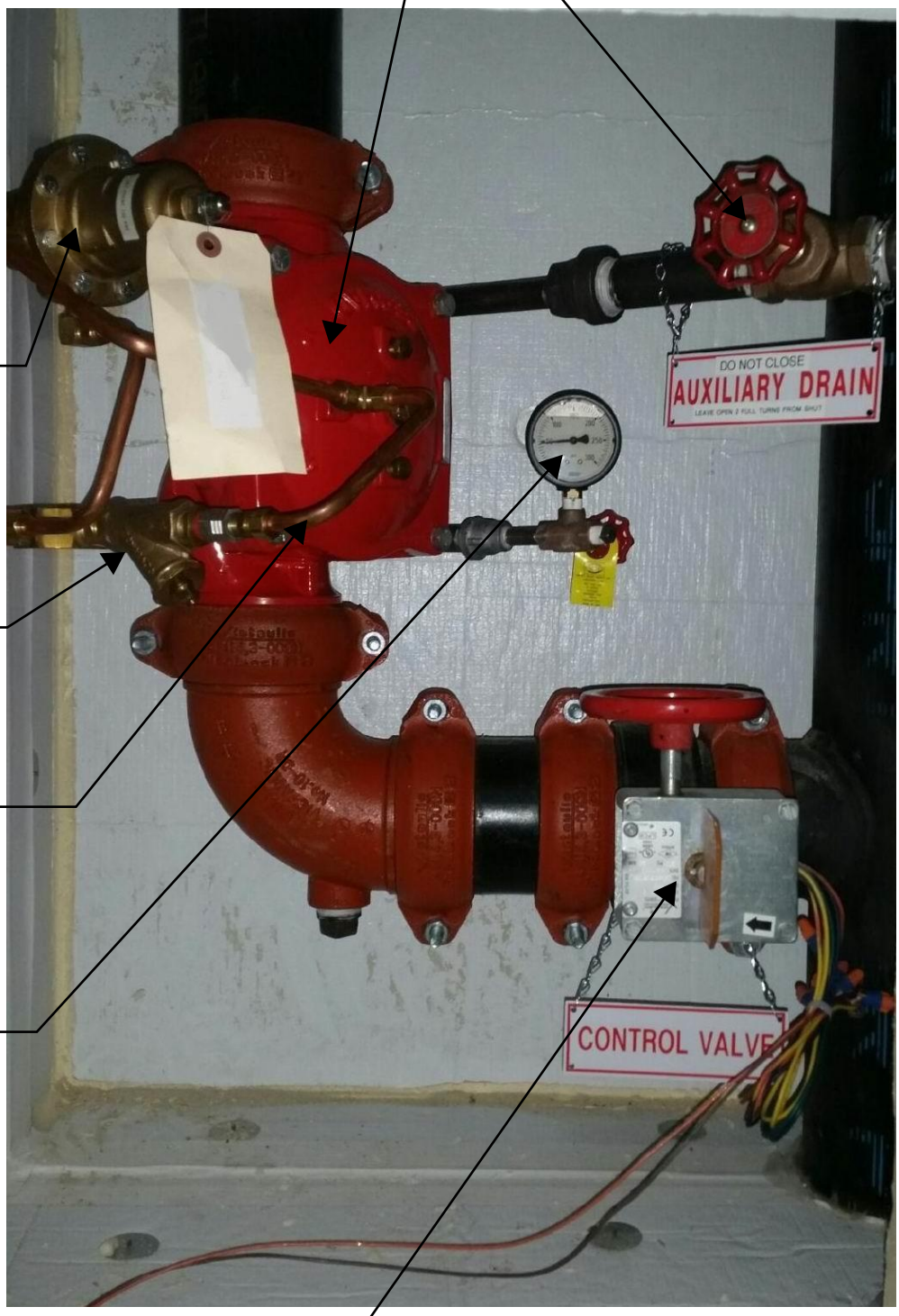
PRESSURE RELIEF VALVE ASSEMBLY

LOCATED WITHIN THE INSULATED VALVE ENCLOSURE (IVE)

PRESSURE RELIEF VALVE ALLOWS HIGH PRESSURE TO BE RELEASED FROM THE FFSS WHEN PRESSURE EXCEED SYSTEM WORKING PRESSURE

LOW POINT AUXILIARY DRAIN "NORMALLY OPEN" 2 FULL TURNS

PRESSURE REGULATOR IS FACTORY SET TO RELIEVE THE FFSS WHEN PRESSURE EXCEEDS 255-265 PSI



STRAINER

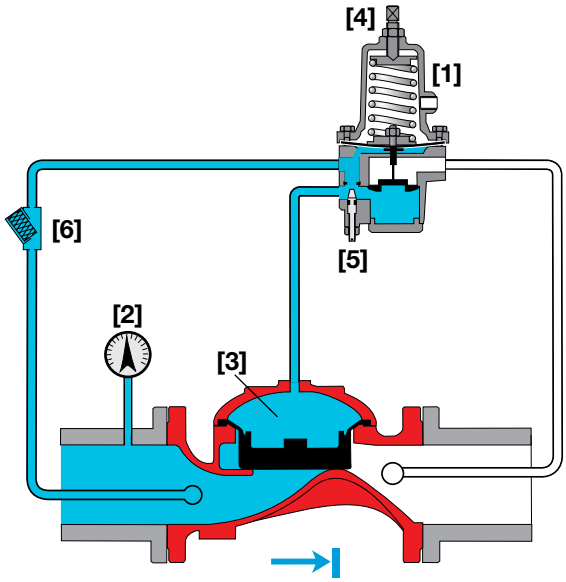
PRIME LINE "PRESSURIZATION OF THE PRIME LINE KEEPS THE PRESSURE RELIEF VALVE CLOSED"

SUPPLY PRESSURE GAUGE

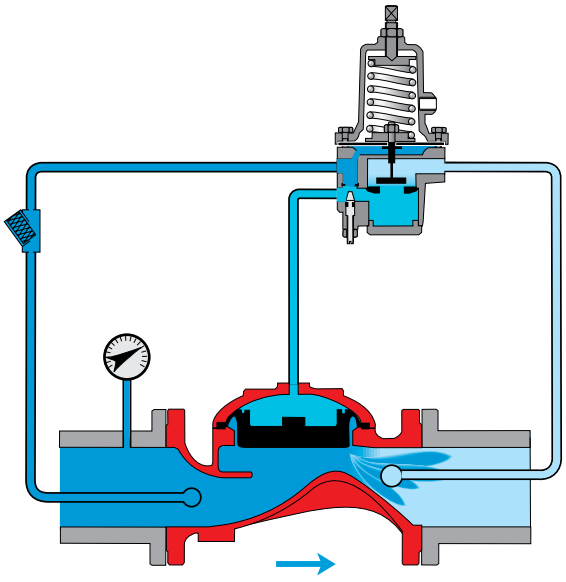
SYSTEM ISOLATION VALVE WITH TAMPER SWITCH "NORMALLY OPEN"

Operation

The BERMAD Model FP 430-UF remains closed as long as the sensed upstream pressure is lower than the adjustable set point. When the Pressure Relief Pilot **[1]** senses upstream pressure **[2]** that is higher than the pilot setting, it acts upon the control chamber **[3]** causing the main valve to modulate open, relieving excess pressure to either a reservoir or sump, thus preventing system over pressure. The Pressure Relief Pilot is equipped with an adjusting screw **[4]** to preset the desired upstream pressure, and an integral adjustable needle valve **[5]** to control the main valve closing speed. The valve's unique design provides quick reaction to system demand and keeps pressure loss at a minimum. The control system is equipped with a control strainer **[6]**.



Valve Closed



Valve Open (pressure-relief)

Engineer Specifications

The Pressure Relief Valve shall be UL-Listed, FM-Approved, and hydraulic pilot controlled. The main valve shall be an elastomeric type globe valve with a rolling-diaphragm.
Valve actuation shall be accomplished by a fully peripherally supported, one-piece balanced rolling-diaphragm, vulcanized with a rugged radial seal disk. The diaphragm assembly shall be the only moving part.
The valve shall have an **unobstructed flow path**, with no stem guide or **supporting ribs**.
The valve shall have a removable cover for quick in-line service enabling all necessary inspection and servicing.
The pilot system shall be field adjustable, with adjustable valve closing speed integrated into the main valve, hydraulically tested and supplied as an assembly consisting of:

- Relief pilot valve UL-Listed and FM-Approved as part of the assembly with built-in, internal needle valve
- "Y" strainer

The control trim shall be supplied as an assembly, pre-assembled and hydraulically tested at an ISO 9000 and 9001 certified factory.

4.0 ELECTRICAL

Sturgeon Electric Company, Inc.

12150 East 112th Avenue

Henderson, CO 80640

303-286-8000

Electrical System

Overview-

The new EJMT fire suppression system includes additions and modifications to the existing electrical systems in both the east and west portal buildings. The major electrical components of the fire suppression system include: three (3) new electrical panels, electrical connection to fire alarm panels and fire protection cabinets including 500 va XFMRS, fiber optic linear heat detection systems, video camera, three (3) work stations, and associated flat screens displays. The electronic equipment associated with these systems also have battery backup. Additionally, a new generator has been installed at the west portal building to provide backup electrical power for these major components in the event of a power failure. The existing east portal building generator provides backup electrical power for system electronic equipment powered from the east electrical distribution system.

West Portal Building-

The power for the fire suppression equipment on the west side of the tunnel comes from the switch gear in the west side electrical room. Fed from an existing 1200a breaker, power is run to a 250a bussed gutter mounted in the west end pump room. From this gutter power is run to the fire pump controller and 150a 3 pole ATS Switch. Power runs from this switch to the generator and to the new EMWH1 Panel.

This new 480v 3phase panel powers all other equipment associated with the fire suppression system on the west side including: the boiler skid, fire protection cabinets, remote control cabinets, zone valves, and the new EMWL1 208Y/120V, 100A, 3-phase panel. This low voltage panel provides power to the boiler room lighting, fiber optic linear heat detection system, video cameras, work station, and associated flat screen displays in the west portal building.

From EMWH1 two (one per tunnel) a runs of ¾" IMC containing 480v, 30a, 3-phase circuits have been installed from the west portal building to power the fire protection cabinets, remote control cabinets, and valve cabinets located in the west half of each plenum. A small step-down transformer installed at each remote control panel and fire protection cabinet will provide the 120v power needed to control and monitor all the fire suppression remote mounted equipment.

Two additional runs of ¾" IMC have been installed to provide power from EMWL1 to the cameras and to the sprinkler system. Additionally, a 1" length of IMC has been installed containing single mode and multimode fiber optic cable. This fiber connects the cameras and fire protection system to the control room

A new 350kw (de-rated to 238kw) generator has been installed to provide standby power to all fire suppression equipment described above. In addition to the generator, all electrical system equipment has a battery backup. These batteries will keep all equipment powered during and AC power transition between utility and generator sources.

When power on the West side of the tunnel is being fed from the existing 500kw generator CDOT personnel must open the 1200amp breaker in the West Motor Control Center labeled "Fire Protection Fire Pump". This will prevent the load from the newly installed fire suppression system from being placed onto the existing 500KW Transformer. Once this breaker is open the fire suppression system will run on the new 350kw Generator

Sturgeon Electric Company, Inc.

12150 East 112th Avenue

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303-286-8000

East Portal Building

The new fire suppression system equipment located in the east portal building requires very little power. Three new circuit breakers have been installed in panel EV to power two (2) 480v, 3-phase circuits needed for fire suppression system equipment that have been installed in the east half of each plenum, and a 30KVA 480v-208/120v Transformer and 208y/120V, 100A, 3-phase panel. This low voltage panel powers the fire alarm panel, fiber optic linear heat detection system, video cameras, work stations, and associated flat screen displays in the east portal building. A small step-down transformer installed at each panel will provide the 120v power needed to control and monitor all the fire suppression system remote mounted equipment.

The same conduit system (three ¾" and one 1" IMC) from the west plenum has been installed in the east plenum.

The fire alarm panels, fiber optic linear heat detection system, video cameras, two work stations, and flat screen displays are backed up by the existing emergency power system. Located in the main electrical room is a 480Y/277V, 1,200A generator backed up panel with spare space and capacity for all the fire suppression system components that are powered from the east portal building. In addition to the generator, all electrical system equipment is battery backed up. These batteries will keep all equipment powered during an AC power transition between utility and generator sources.

Water released during a fire event will be collected in existing and new collection tanks. New valves have been installed in the existing sewer treatment room and new manhole 2 to divert water into these tanks. These valves will be controlled by the fire protection system. Finally, as part of the fire suppression project, a new level sensor has been installed in the collection tank system and monitored by the fire alarm system.

Sturgeon Electric
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MYR GROUP

OPERATIONS MANUAL:
350kW Generator

PROJECT:
EISENHOWER/JOHNSON MEMORIAL TUNNEL
FIRE SUPPRESSION SYSTEM
PROJECT# C 0703-360

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** Respect * Integrity * Responsiveness **
** Creativity * Initiative * Team Work * Safety **

Operator Manual

Generator Set

Cummins NPower GF Series

Section 3 - Operation

The following describes the function and operation of the PowerCommand® Control (PCC).

The PCC controls the starting and stopping sequence of the engine through the ECM (mounted on the engine). Referenced in separate manuals as indicated in Figure 3-1. The function and operation of the Electronic Control Module (ECM) and how it interfaces with PCC control is also identified in the manuals.

This section covers pre-start checks, starting and stopping and operating the generator set. Each operator should read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set and the PCC control. Refer to Section 6 for operating recommendations.

WARNING

Before operating the generator set become familiar with the equipment and how it is operated (including all controls, manually operated valves and alarm devices). Safe and efficient operation can only be achieved if the unit is operated correctly.

Before starting, be sure the following checks have been made and the unit is ready for operation.

WARNING

It is the owner/operator's responsibility to complete site specific emission requirements to ensure compliance with the US EPA SI NSPS.

Emissions on this Generator Set must be dialed-in at the job-site per the following requirements before operation:

GTA855E refer to manual 4325956 and AEB 10.124 and 24.52

KTA19SLB refer to AEB 28.07

3.1 Operator's Pre-Start Checks

3.1.1 Lubrication

Check the engine oil level. Keep the oil level as near as possible to the dipstick high mark without overfilling.

NOTE: *Generator sets may be shipped dry. They must be filled with the correct type and quantity of oil before use. Be sure to check oil level before initial start. Failure to fill to the recommended level can result in equipment damage.*

3.1.2 Coolant

Check the engine coolant level and ensure that the level is always maintained at the coolant expansion tank. Fill the cooling system to the bottom of the fill neck in the radiator fill or expansion tank. Do not check while the engine is hot.

3.1.3 Fuel

Make sure that the fuel tank is filled to the normal level and that the fuel system is primed and all the valves required for operation are open. Make sure that there are no leaks and that all fittings are tight.

3.1.4 Ventilation

Make sure the generator set cooling inlet/outlet and exhaust ventilation openings are unobstructed and operational.

Remove all loose debris from the surrounding area of the generator set. Air flow from the radiator fan can blow loose items around and into ventilation openings.

3.1.5 Exhaust Outlet

Make sure that exhaust components are secured and not warped; that not combustible materials are near the system, and gases are discharged away from building openings. Make sure that there are no leaks and that all fittings are tight.

WARNING

Exhaust gas is deadly! Exhaust gasses contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- Dizziness
- Nausea
- Headache
- Weakness and sleepiness
- Throbbing in temples
- Muscular twitching
- Vomiting
- Inability to think coherently

If you, or anyone else, experience any of these symptoms, get out into the fresh air immediately! If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspection of the complete exhaust system.

3.1.6 Batteries

Make sure that the batteries are charged, that the electrolyte is at the correct level and that all connections are correct.

3.1.7 Emergency Stop Button

Push this button in for emergency shutdown of the generator set. This will stop the generator set immediately and prevent starting of the set from any location (local and remote).

To reset:

1. Pull the button and allow it to pop out.
2. Turn the **Off/Manual/Auto** switch to **O** (Off).
3. Press the front panel Fault Acknowledge/Reset button.
4. Return **Off/Manual/Auto** switch to desired position.

IMPORTANT: *Emergency Stop shutdown can be reset only at the PCC front panel.*

3.2 Control Panel

There are several PowerCommand® Control options available. For more information on a specific option model, refer to the PowerCommand® Control manual shipped with the unit.The following chart lists each option available and shows a figure depicting the option's configuration.

Table 3-1 PowerCommand® Control Options

Description	Part Numbers	Figure Number
PCC 1.1 (1302) Owner Manual	900-0661	Figure 3-1
PCC 2.2 (2300) Operator Manual	900-0665	Figure 3-2
PCC 3.3 (3300) Owner Manual	A029M414	Figure 3-3

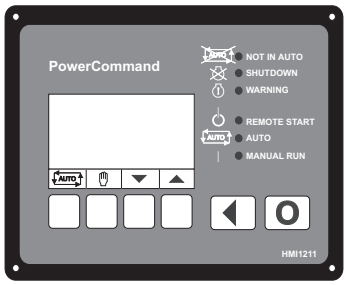


Figure 3-1 PCC 1.1 (1302)

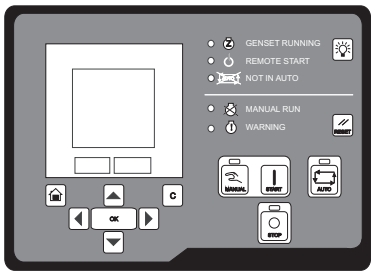


Figure 3-2 PCC 2.2 (2200)

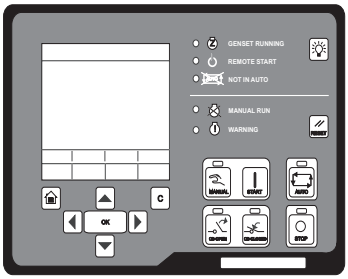


Figure 3-3 PCC3.2 (3200)

NOTE: *1302 Control with HMI211 Figure 3-1 is provided on GTA855 and GTA19 Mechanical Engines as standard. 1302 Control with HMI220 Figure 3-2 is provided on GTA28, 38, 50 Mechanical Engines as standard.*

WARNING

Contacting high voltage components can cause severe personal injury or death by electrocution. Do not open the generator output box while the generator set is running. Read and observe all warning and cautions in your generator set manuals.

CAUTION

Only technically qualified personnel should open the control housing. Voltages are present which can cause electrical shock, resulting in personal injury. Even with the power removed, improper handling of components can cause electrostatic discharge and damage circuit board components.

3.3 Electronic Control Module (ECM)

The PCC controls the starting and stopping sequence of the engine. On electrical engines the ECM drives and monitors engine functions and energizes the starter solenoid through start relay K4 and disconnects the starter. The ECM governs engine speed and performs all engine control, monitoring, and diagnostic functions.

NOTE: *The PCC displays engine oil pressure, coolant temperature, coolant level and speed. The ECM also monitors engine coolant temperature using a different sensor.*

If the ECM shuts down the engine, it will send a signal to the PCC, which will display, ENGINE WARNING (Code 1311). Each digit of the three digit numerical fault code will be displayed as flashes. There will be a brief pause between digits and a longer pause before the repetition.

NOTE: *Code 123 may be indicating higher than expected engine coolant temperature. If overheating is suspected, measure coolant temperature with a gauge while the engine is warming up. If the temperature exceeds 107° C (225° F) service the cooling system as necessary. If temperature is not higher than expected but shutdown recurs, the coolant sensor may be faulty.*

NOTE: *Refer to the troubleshooting instructions for each model specific Genset Controls manual as outlined in Table 3-1.*

See your Authorized Cummins Distributor regarding the wiring harness and software required for performing engine diagnostics using a PC (laptop).

3.4 Sequence of Operation

The generator set is run Automatically using a Remote Start signal or Manually using the generator set control panel buttons. LEDs are provided on the operator panel to indicate the operating Run mode of the generator set. The PowerCommand® controls initiate a starter cranking signal and will perform an automatically sequenced manual start; all under a complete engine protection system combined with full monitoring capability. If a fault is sensed at Start-up, the engine is locked out and will not start.

The choice of Auto or Manual Run mode is decided by authorized personnel during the generator set initial setup. An access code is required to switch between the Auto, Manual Run, or Off modes, and this facility may be permitted or denied by the authorized personnel during the initial setup of the generator set.

3.5 Starting the Generator Set

CAUTION

One operator should be in complete charge, or working under the direction of someone who is in complete charge. Remember that, upon starting the generator set, cables and switchgear will become energized, possibly for the first time. Furthermore, equipment that does not form part of the generator set installation may become electronically charged. Only authorized and competent personnel should carry out this work.

CAUTION

Do not use the Emergency Stop switch to shut down the generator set unless a serious fault develops. The Emergency Stop push-switch must not be used for a normal shut-down as this will prevent a cooling down run in which the lubricating oil and engine coolant carry the heat away from the engine combustion chamber and bearings in a safe manner.

CAUTION

Avoid off-load running for other than short periods. A minimum loading of 30% is recommended. This loading will help to prevent the build up of carbon deposits in the injectors, do to unburnt fuel, and reduce the risk of fuel dilution of the engine lubricating oil. The engine must be shut down as soon as possible after the appropriate functions have been checked.

Before attempting to start the generator set, the operator should read through this entire manual, together with the Health and Safety manual and the specific engine manual provided as part of the documentation package supplied with the generator set. It is essential that the operator be completely familiar with the generator set and the PowerCommand® controls.

The following sub-sections cover the systems used to start and stop the generator set. Before starting the generator set, make sure that exhaust and fuel fittings are tight and properly positioned, and proper maintenance and pre-start checks have been performed.

During starting, automatic checks are carried out for the integrity of various protection systems. The PowerCommand® control will not allow the generator set to continue the starting sequence if the integrity of a sensor is considered to be in doubt.

The generator set can be configured for a number of starting cycles (one to seven) with set times for crank and rest periods for all starting modes (manual/ remote). The default setting is for three start cycles, composed of fifteen seconds of cranking and 30 seconds of rest.

NOTE: *The number of starting cycles, and the crank and rest times are set from within the Setup menu. Trained and experienced service personnel are required to change the default setting. Contact your authorized distributor.*

NOTE: *Generator sets may be shipped dry. They must be filled with the correct type and quantity of oil before use. Be sure to check oil levels before initial start. Failure to fill to the recommended level can result in equipment damage.*

NOTE: *Check the coolant level and ensure the level is always maintained at the coolant expansion tank. Fill the cooling system to the bottom of the fill neck in the radiator fill or expansion tank. Do not check when the engine is hot.*

CAUTION

It is essential that Cummins Power Generation's recommendations for the correct type and concentration of anti-freeze and DCA inhibitor are complied with. Warranty claims for damage will be rejected if the incorrect mix has been used. Consult your authorized distributor for the correct anti-freeze specifications and concentration for your operating conditions.

NOTE: *Some radiators have two fill necks, both of which must be filled after the cooling system has been drained.*

CAUTION

Do not attempt to remove a radiator pressure cap while the generator set is running, or is still hot. Hot coolant is under pressure in the radiator system. Contact with hot coolant can result in severe burns. Always allow it to cool before releasing the pressure and removing the cap.

3.5.1 Starting at Operator Panel (Manual Run Mode)

WARNING

Make sure that all Pre-start Checks are carried out before starting the generator set. Do not attempt to start the generator set until it is safe to do so. Warn all others in the vicinity that the generator set is about to start.

To start the generator set in the Manual Run mode, press the Manual button on the Operator Panel, and then press the Start button within ten seconds. Failure to press the Start button within this time will result in the generator set changing to the Off mode.

(Refer also to Selecting Manual Run Mode in the appropriate controls manual. See Table 3-1 to determine the unit's control manual.).

The PowerCommand® control will initiate a starter cranking signal and will perform an automatically sequenced manual start, under a complete engine protection system combined with full monitoring capability. This will activate the engine control system and the starting procedure. The starter will begin cranking, and after a few seconds the engine will start and the starter will disconnect.

Should the engine fail to start, the starter will disengage after a specified period of time and the control will indicate a Fail to Start shutdown.

To clear a Fail to Start shutdown, press the Stop button and then press the Reset button. Before attempting to re-start, wait a minimum of two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt, refer to the Troubleshooting Section of this manual and the appropriate controls manual. See Table 3-1 to determine the unit's control manual.

To disable Manual mode, change to Auto or Off mode. If the generator set is running when it leaves Manual mode, it will continue to run if Auto mode has been selected and the remote start signal is active. If there is no active remote start signal, the generator set will stop.

3.5.2 Starting from Remote Location (Auto Mode)

WARNING

Make sure that all Pre-start Checks are carried out before starting the generator set. Do not attempt to start the generator set until it is safe to do so. Warn all others in the vicinity that the generator is about to start.

To start the generator set in the Auto Run mode, select the Auto button from the Operator Panel. (Refer also to the Selecting Manual Run mode in the appropriate manual. See Table 3-1.

Only on receipt of a Remote Start signal, and after a Time Delay to Start, will the PowerCommand® control initiate the starting sequence as above.

The Remote Start LED will be illuminated.

There are two start modes that are selectable for the Remote Start input; one for non-emergency start and the other for emergency start. In the non-emergency start, the control will complete the warm-up at idle. In the emergency mode, the generator set will omit the warm-up stage and proceed directly to rated speed and voltage.

In response to the Remote Start signal, if the control detects the loss of Utility voltage, the control illuminates the Remote Start indicator and initiates the starting sequence as described in Starting at Operator Panel (Manual Run Mode), except for the following:

- In Auto position, the control will complete the Time Delay to Start (0 to 300 seconds) for a non-emergency start signal only.

NOTE: *If the mode change access code feature has been enabled, enter the access code when prompted. For more on Entering the Mode Change Access Code see the appropriate control manual. See Table 3-1 to determine the unit's control manual.*

To disable Auto mode, change to Manual or Stop mode. Refer to Stopping.

3.6 Cold Starting with Loads

WARNING

Make sure that all Pre-start Checks are carried out before stating the generator set. Do not attempt to start the generator set until it is safe to do so. Warn all others in the vicinity that the generator set is about to start.

Use an oil pan heater and a coolant heater if a separate source of power is available. The optional heater will help provide reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating.

Cummins recommends equipping diesel standby generator sets (life safety systems) with engine water jacket coolant heaters to maintain the coolant at a minimum of 32 °C (90 °F) and, for most applications, accept the emergency load in ten seconds or less. Although most Cummins generator sets will start in temperatures down to -32 °C (-25 °F) when equipped with engine water jacket coolant heaters, it might take more than ten seconds to warm the engine up before a load can be applied when ambient temperatures are below 4 °C (40°F).

To advise the Operator of a possible delay in accepting the load, the Low Coolant Temp (code 1435) message, in conjunction with illumination of the Warning LED, is provided. The engine cold sensing logic initiates a warning when the engine water jacket coolant temperature falls below 21°C (70 °F). In applications where the ambient temperature falls below 4°C (40°F), a cold engine may be indicated even though the coolant heaters are connected and functioning correctly. Under these conditions, although the generator set may start, it may not be able to accept load within ten seconds. When this condition occurs, check the coolant heaters for correct operation. If the coolant heaters are operating correctly, other precautions may be necessary to warm the engine before applying a load.

3.7 Stopping the Generator Set

NOTE: *The access code may be required before initiating the Off button sequence. Refer to Entering the Mode Change Access Code in the appropriate controls manual. See Table 3-1 to determine the unit's control manual.*

CAUTION

Run the generator set at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

3.7.1 Stopping at Operator Panel (Manual Mode)

If the generator set was started at the Operator Panel in Manual mode, Press the Stop button once to put the generator set into a Cooldown run, after which the set will enter the Off mode.

Pressing the Stop button twice will stop the generator set immediately, without a Cooldown run, after which the set will enter the Off mode.

NOTE: *If possible, hot shutdown under load should be avoided to help prolong the reliability of the set. A hot shutdown may result in a Hot Shutdown Warning.*

3.7.2 Stopping from Operator Panel (Auto Mode)

If the Generator set was started in Auto mode, press the Stop button once to stop the generator set immediately, without a Cooldown run, after which the generator set will enter the Off mode.

If possible re-start the generator set in Manual mode with the circuit breaker open, and allow to stop with a Cooldown run.

NOTE: *If possible, hot shutdown under load should be avoided to help prolong the reliability of the set. A hot shutdown may result in a Hot Shutdown Warning.*

3.7.3 Stopping from Remote Location (Auto Mode)

If the control received a remote stop signal, the generator set completes its normal shutdown sequence incorporating a Cooldown run. (The remote stop signal is actually the removal of the remote start signal to the control).

The generator set will stop after completing the following Cooldown sequence:

- Time Delay to Stop function (zero to 600 seconds)
- Cooldown at Idle 0 to 10 minutes or longer, if necessary to obtain normal operating temperature before shutdown.

The set will remain in Auto mode, and subject to a remote start signal, unless the Stop button is pressed. If the Stop button is pressed the set will enter the Off mode.

NOTE: *The InPower service tool or access to the Setup menu is required to enable and change the time delay start/stop settings. Contact your authorized distributor for assistance.*

3.7.4 Emergency Stop (Code 1433 or 1434)

The Local Emergency Stop button is located on the front of the Operator Panel. This is a mechanically latched switch that will unconditionally stop the engine when pressed, bypassing any time delay to stop. Push this button in for Emergency Shutdown of the engine.

NOTE: *If the engine is not running, pushing the button in will prevent the starting of the engine, regardless of the start signal source (Manual or Auto - remote).*

When the Stop button is pressed, the display panel will indicate the Shutdown condition by illuminating the red Shutdown status LED and displaying the following message on the graphical LCD display:

Fault Number: 1433 LOCAL EMERGENCY STOP

A Remote Emergency Stop button may be incorporated within the installation. If this Remote Emergency Stop button is activated the following message will be displayed:

Fault Number: 1434 REMOTE EMERGENCY STOP

To reset:

1. Pull, or twist and pull, the button out.
2. Press the Stop button on the Operator Panel to acknowledge this action.
3. Press the Reset button
4. Press the Auto or Manual Run button, as previously determined. (See Selecting Operating Modes in the appropriate controls manual.)

CAUTION

Do not use an Emergency Stop button to shut down an engine unless a serious fault develops. The Emergency Stop button must not be used for a normal shutdown as this will prevent a Cooldown run in which the lubricating oil and engine coolant carry away heat from the engine combustion chamber and bearings in a safe manner.

NOTE: *Make sure the remote start control is not active or, when the Emergency Stop is reset, the generator set could start running.*

CAUTION

Make sure the cause of the Emergency Stop is fully investigated and remedied before a fault reset and generator start are attempted.

NOTE: *An external Emergency button is located in close proximity to the Operator Panel viewing window.*

3.8 Paralleling Operation

Available with control PCC 3.3. Refer to PCC 3.3 control manual for further instruction. See Table 3-1 for controls manual number.

OTPCJ	4000	1, 3R	X	X	X	X	X	OT PT CT

2.6 Automatic Transfer Switch Typical Function

Automatic transfer switches perform the basic function of transferring the load to the available power source. The controller monitors each source for allowable voltage and frequency range.

The transfer switch(es) identified on the cover of this manual are designed for each, all or a combination of the following applications (If you are unsure which of these your transfer switch uses, refer to the Specifications section of this manual):

2.6.1 Open Transition with Sync Check

Open transition with sync check executes an open transition (OT) transfer when both sources of power are within specified tolerances of frequency, voltage and relative phase difference. If both sources meet the tolerances, a fast transfer occurs.

2.6.2 Programmed Transition

Programmed transition executes a programmed transition (PT) transfer by disconnecting the load from the source of power, pausing in the neutral position of the transfer switch (between switched positions) to allow transient voltages from the load to diminish, and then the load is switched to the other source.

2.6.3 Closed Transition

Closed transition executes a load transfer by momentarily paralleling both sources (a maximum of 100ms) before switching sources.

2.7 Utility-to-Generator Set Operation

In utility-to-generator set applications, the transfer switch performs the following functions:

1. Senses the interruption of the Source 1 power (Utility).
2. Sends a start signal to the generator set (Source 2).
3. Transfers the load to the Source 2 power.
4. Senses the return of Source 1 (Utility).
5. Retransfers the load to Source 1.
6. Sends a stop signal to the generator set.

2.8 Utility-to-Utility Operation

In utility-to-utility applications, the transfer switch performs the following functions:

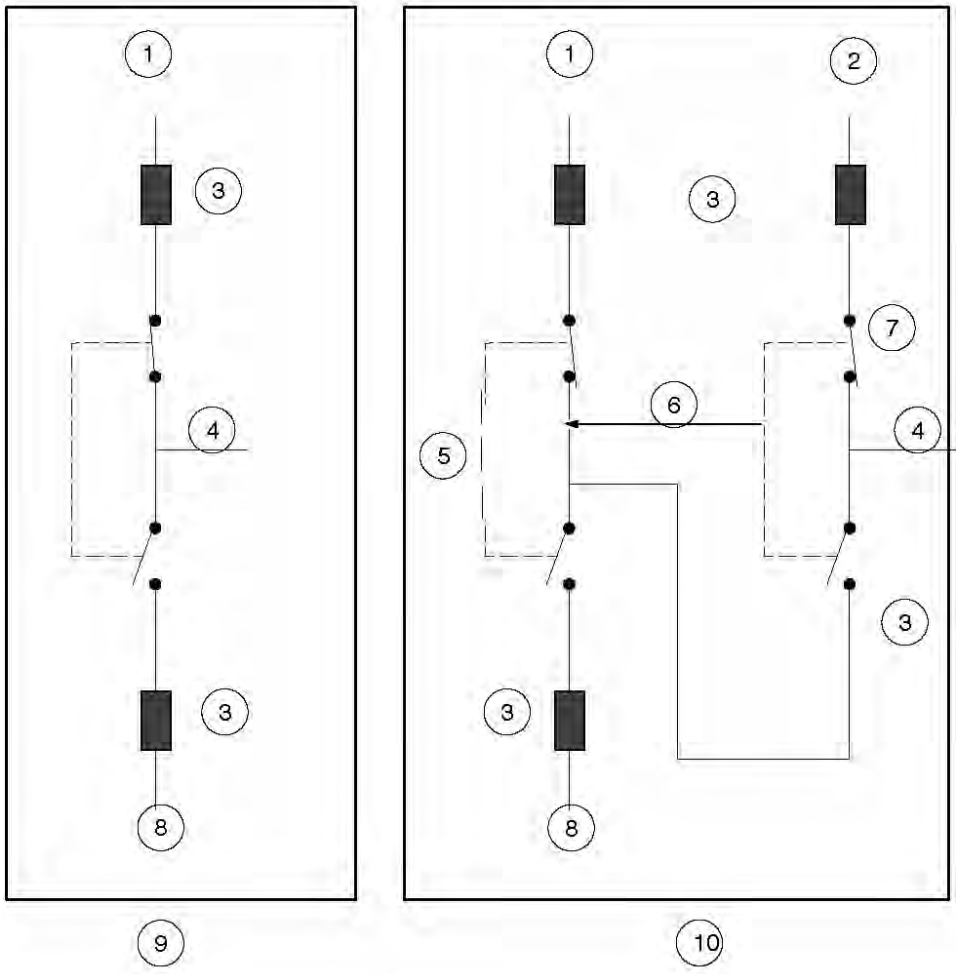
1. Senses the interruption of the Source 1 power (Utility).
2. Transfers the load to the Source 2.
3. Senses the return of Source 1 (Utility).

4. Retransfers the load to Source 1.

2.9 Generator-to-Generator Operation

In generator-to-generator applications, there are two possible configurations.

- Prime Power (Plant-to-Plant) Operation - Two generator sets provide all of the power (utility power is not available).
- Dual Standby - Two generator sets are used to back up utility power.



No.	Description	No.	Description
1	Generator set B	6	Standby start signal
2	Utility	7	Utility-to-Gen ATS
3	Over current protective device	8	Generator set A
4	Load	9	Gen-to-Gen configuration in Prime Power mode
5	Gen-to-Gen ATS	10	Gen-to-Gen configuration in Dual Standby mode

FIGURE 2. GENERATOR-TO-GENERATOR CONFIGURATION IN PRIME POWER AND DUAL STANDBY MODES

2.9.1 Prime Power (Plant-to-Plant) Operation

In prime power applications, utility power is not available. The system includes one transfer switch and two generator sets. One generator set is always running and supplying power to the load while the other generator set is the backup generator set. An external power supply is not needed in this application.

2.9.1.1 Preferred Source Selection

Under normal operation, one genset is designated as the preferred source and supplies power to the load. The second genset is the backup power source. If the preferred genset fails, the backup genset starts and the transfer switch transfers the load to the backup genset.

At any time, the PC service tool or the Test sub-menu can be used to designate either genset (Source 1 or Source 2) as the preferred genset. The Preferred Source menu is included in the Test submenus.

If the preferred genset is changed and the backup genset becomes the preferred genset, the transfer switch transfers the load to the new preferred genset when it becomes available. The unit that is carrying the load is always considered the preferred source.

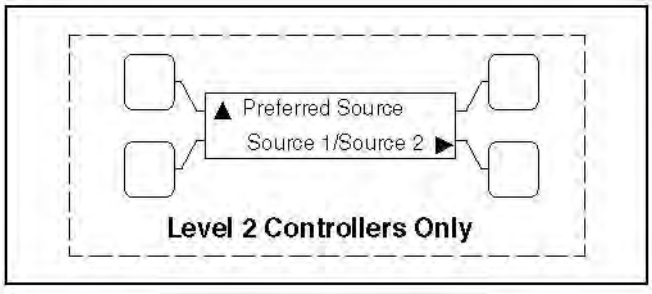


FIGURE 3. PREFERRED SOURCE SUBMENU

2.9.1.2 Automatic Changeover

The transfer switch can be set up to change the preferred source automatically by enabling the changeover timer. The Time Delay submenus under Setup or the PC service tool can be used to enable the changeover timer and specify a changeover delay time period. The Changeover menus are included in the Time Delay submenus.

The automatic changeover timer automatically changes the preferred source and transfers the load to the new preferred genset after a TDEN time delay. After the transfer is complete, the control initiates a cool-down period (TDEC) on the old preferred genset before shutting it down. The old preferred genset is now the new backup genset. The changeover timer is now timing for the next changeover and the cycle continues as long as the changeover timer is enabled.

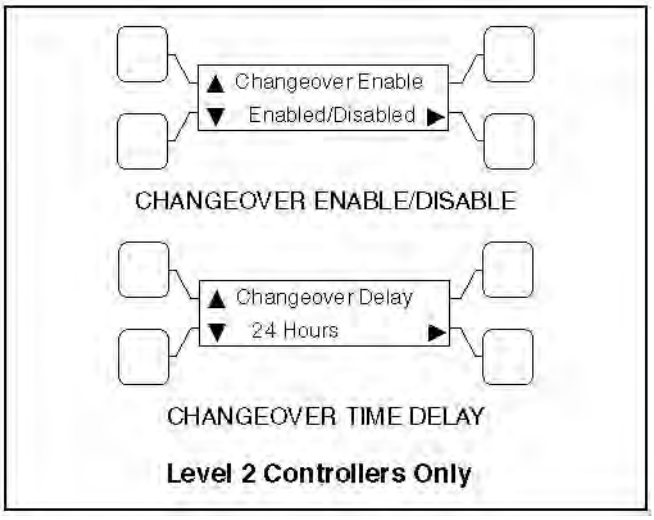


FIGURE 4. CHANGEOVER SUBMENUS

2.9.2 Dual Stand-By Operation

In dual stand-by applications, utility power is available. The system includes two transfer switches (a Utility-to-Generator ATS and a Generator-to-Generator ATS) and two generator sets. Utility power supplies power to the load and both generator sets are backup generator sets.

Under normal operation, the utility is supplying power to the load through the lead transfer switch. The lead transfer switch is a utility-to-generator set switch. The two generator sets are connected to the generator set-to-generator set transfer switch. The load side of this switch is connected to the generator set side of the lead transfer switch.

Upon loss of utility power to the lead transfer switch, a standby start signal is sent to the generator set-to-generator set transfer switch to start the preferred generator set. When the lead transfer switch senses generator voltage, it transfers the load to that generator set. If the preferred generator set fails to start, a signal is sent to the backup generator set to start. The PC Service tool or the Test sub-menu on the generator set-to-generator set transfer switch can be used to set the preferred source.

If the Stand-By Start is inactive, upon initial power–up (or reset), or during software initialization, the transfer switch control will not start either generator set. When a Stand-By Start command is received by the Generator-to-Generator ATS from a Utility-to-Generator ATS (or other device), the preferred generator set immediately starts. If the preferred generator set does not start, the control starts the backup generator set. The load is connected to the generator set when it becomes available.

If the preferred generator set becomes available while the backup generator set is active, a time delay re-transfer (TDEN) period is initiated and the load is re-transferred back to the preferred generator set. A time delay cool-down (TDEC) period is initiated before turning off the backup generator set. When the Stand-By Start becomes deactivated, a TDEC period is initiated and the active generator is turned off.

2.9.2.1 Preferred Source Selection

Under normal operation, one genset is designated as the preferred source and the second genset is designated as the backup power source. If both the utility power and the preferred genset fails, the backup genset starts and the genset-to-genset transfer switch transfers the load to the backup genset.

At any time, the PC service tool or the Test sub-menu on the genset-to-genset transfer switch can be used to designate either genset (Source 1 or Source 2) as the preferred genset. If the preferred genset is changed and the backup genset becomes the preferred genset, the transfer switch transfers the load to the new preferred genset if it is needed and when it becomes available.

2.9.2.2 Alternating Preferred Source

In an attempt to keep the running time equally distributed between both generator sets, the control can be set to alternate between the generator sets when utility power fails. The selected preferred generator set starts with the first power outage. The second power outage starts the backup generator set, which now becomes the preferred generator set. Upon subsequent outages, the preferred generator set alternates.

Only utility outages and tests or exercises initiated at the lead transfer switch result in the generator sets being alternated. The designated preferred generator set will not change if it fails and the backup generator set takes over the load. This alternating preferred source can only be enabled with the PC Service tool. When enabled, a generator set can be designated as the preferred source for a maximum of two weeks. Time adjustments can be made in one-hour increments with the Test submenu.

2.10 Control Level 1 and Level 2

Two controls are available. The type of power source switched and the desired features determine the control levels available.

The control board level can be viewed, using the digital display. This menu is included in the About submenus.

NOTICE
The digital display comes standard with level 2 controls and is optional with level 1 controls.

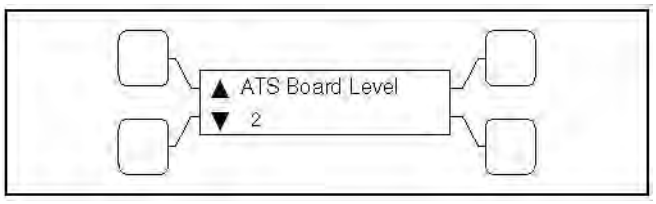
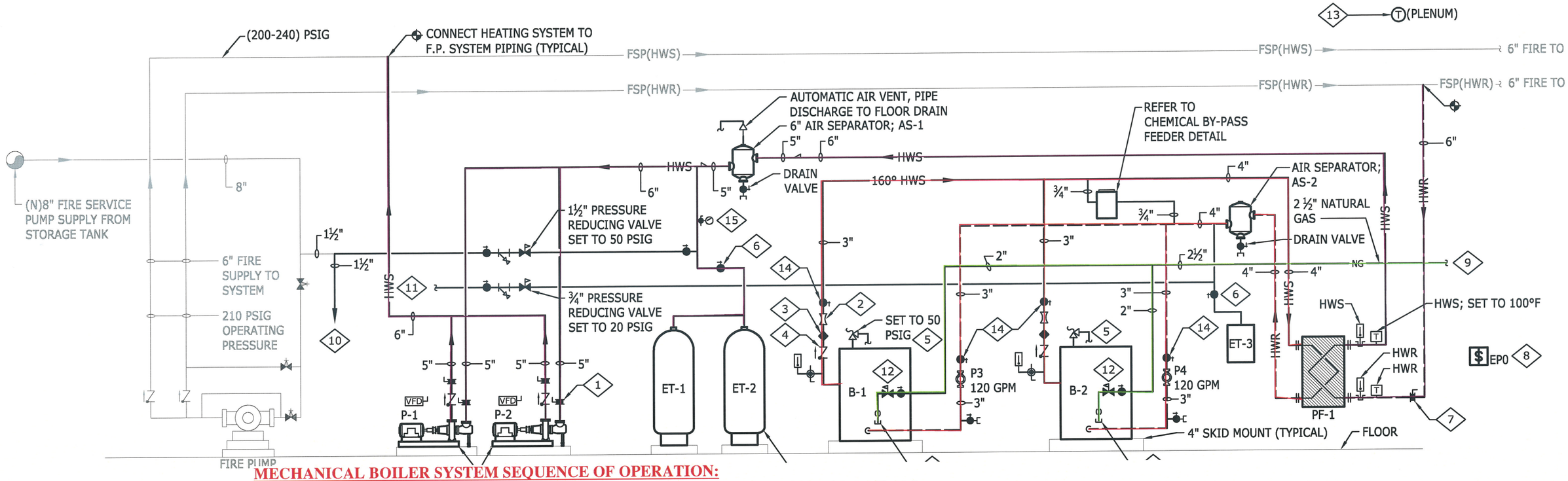


FIGURE 5. CONTROL LEVEL SUBMENU

5.0 MECHANICAL



MECHANICAL BOILER SYSTEM SEQUENCE OF OPERATION:

The Boiler System shall operate to maintain the Fire Suppression Distribution Piping Above Freezing.

The Boiler System shall operate anytime the ambient temperature of plenum is less than 45 degrees.

Upon Boiler Control System Enable, start the lead Primary Distribution Pump (P1 or P2 Adjustable). P1 and P2 operate in a Lead-Standby configuration. If lead pump fails upon enable, then the standby pump will automatically start and an alarm shall be sent to Fire Alarm System as a General System Failure.

The primary pumps shall distribute a constant flow rate to the system. Lead Pump and Lag pump will rotate to equalize pump run time. Primary pumps P-1 and P-2 will shut down during Fire Event.

The Boiler controller will operate the Boilers B-1 and B-2 in a lead-lag manner to deliver 160 degree water to the plate & frame heat exchanger. The boilers operate to achieve a Fire Service water temperature setpoint of 100 degrees. The lag boiler will activate if the Fire Service water temperature drops to 95 degrees and an alarm will be generated.

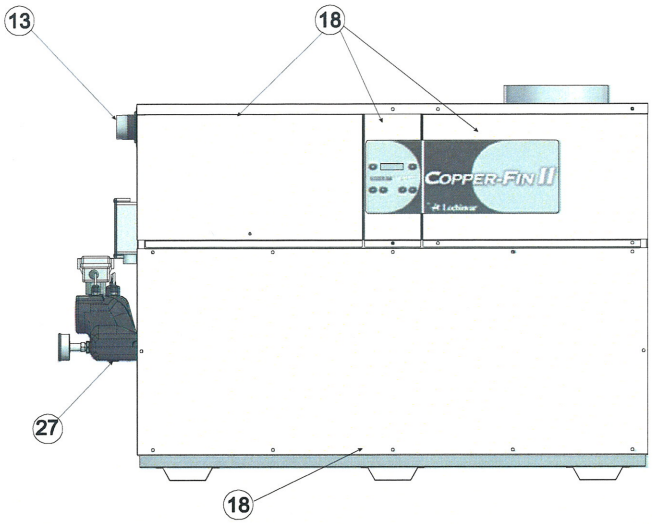
An alarm will be generated if either boiler or boiler pump fails to operate.

Upon a fire event, the boiler system will deactivate.

Boiler system shall be off if ambient temperature is above 50 degrees.

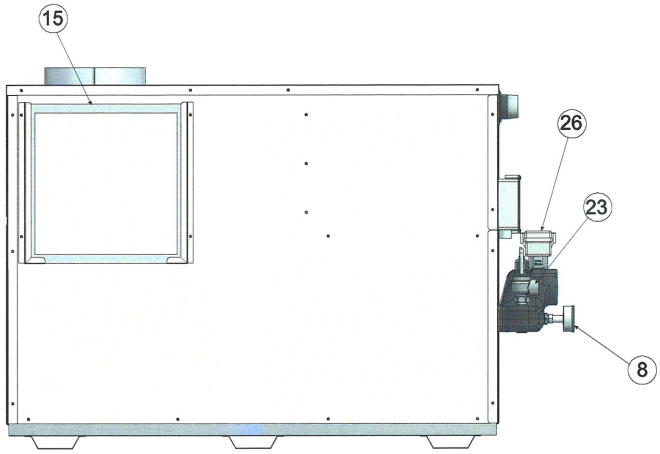
The Inlet Air and Boiler Flue Fans VF-1 and VF-2 are interlocked to assure fan operation when either boiler is required to operate. Fans shall be proven on before boilers are allowed to operate. Vent fan VFDs operate to maintain flue pipe negative pressure (Field Adjustable). Failure to prove will generate an alarm.

The Copper-fin II - Replacing the Inlet Air Filter

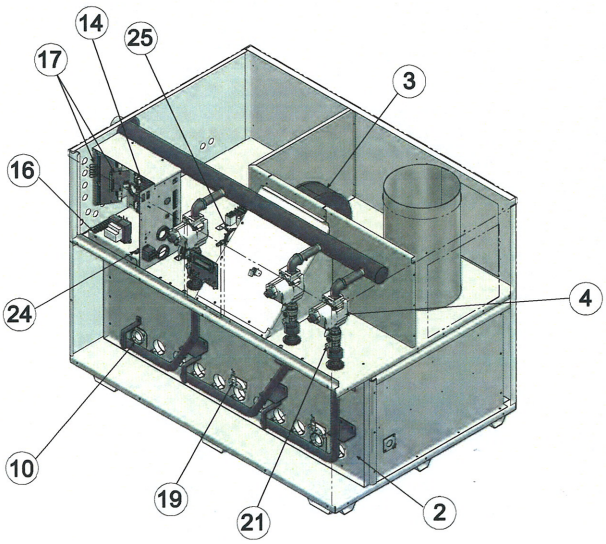


Models 992 - 2072 Front View

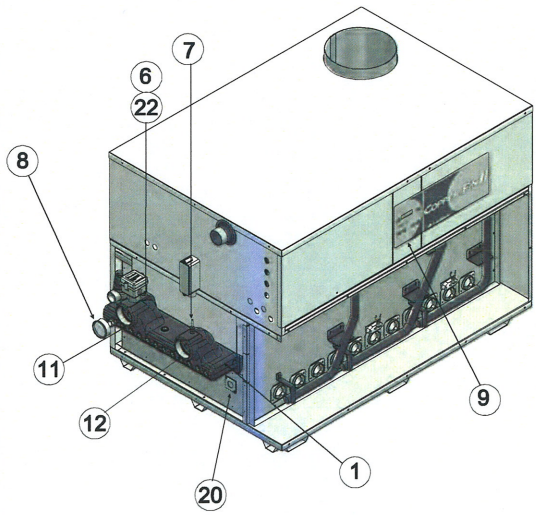
Keynote 15: Inlet Air Filter.
In order to remove the filter, push up from the bottom and pull filter out through the top of the rack. Install new filter in from the top of the filter rack.



Models 992 - 2072 Rear View



Models 992 - 2072 Right Side (inside unit)



Models 992 - 2072 Left Side (inside unit)

WASTE PIPING DRAINAGE CONTROL:
The existing waste piping from the tunnels has been modified by the addition of Control Valves in the East Sewer Treatment Room and the Waste Manhole outside of the East Portal Building.

The Control Valve are controlled through the Fire Alarm System.

The valves are arranged to allow waste to flow to the existing indoor sedimentation tanks during normal operation. If the valves lose power during normal operation they will fail to allow flow to the sedimentation tanks.

SEQUENCE OF OPERATION:

- **If fire event occurs in Eisenhower Tunnel, then V-2 & V-3 shall be closed; V-1 shall be open; V-4 shall remain open.**
- **If fire event occurs in Johnson Tunnel, then V-1 shall be closed; V-2 shall remain open; V-4 shall be closed; V-3 shall be open.**
- **If fire event occurs in either tunnel the valves in Manhole MH-2 (V5 and V6) shall position to flow the waste to the retention tanks. V6 is closed and V5 is open during FFSS event.**

(E)12" WASTE PIPE FROM EISENHOWER TUNNEL

(E)12"

AUTOMATIC VALVE V-1 (1)

NC

AUTOMATIC VALVE V-2 (1)

NO

AUTOMATIC VALVE; NC V-3 (2)

12"

6"

AUTOMATIC VALVE V-4 (1)

NO

(E)12"

(E)12" WASTE PIPE FROM JOHNSON TUNNEL

(E)12" SEWAGE BYPASS

(E)18" SEWAGE WASTE PIPE TO (E)MANHOLE

(E)18" TO CREEK

(E)MANHOLE (MH-1)

(N)MANHOLE (MH-2) WITH V-5 & V-6. REFER TO CIVIL SHEET C6.0.

4d

5

6

7

8

8a

9

C/L

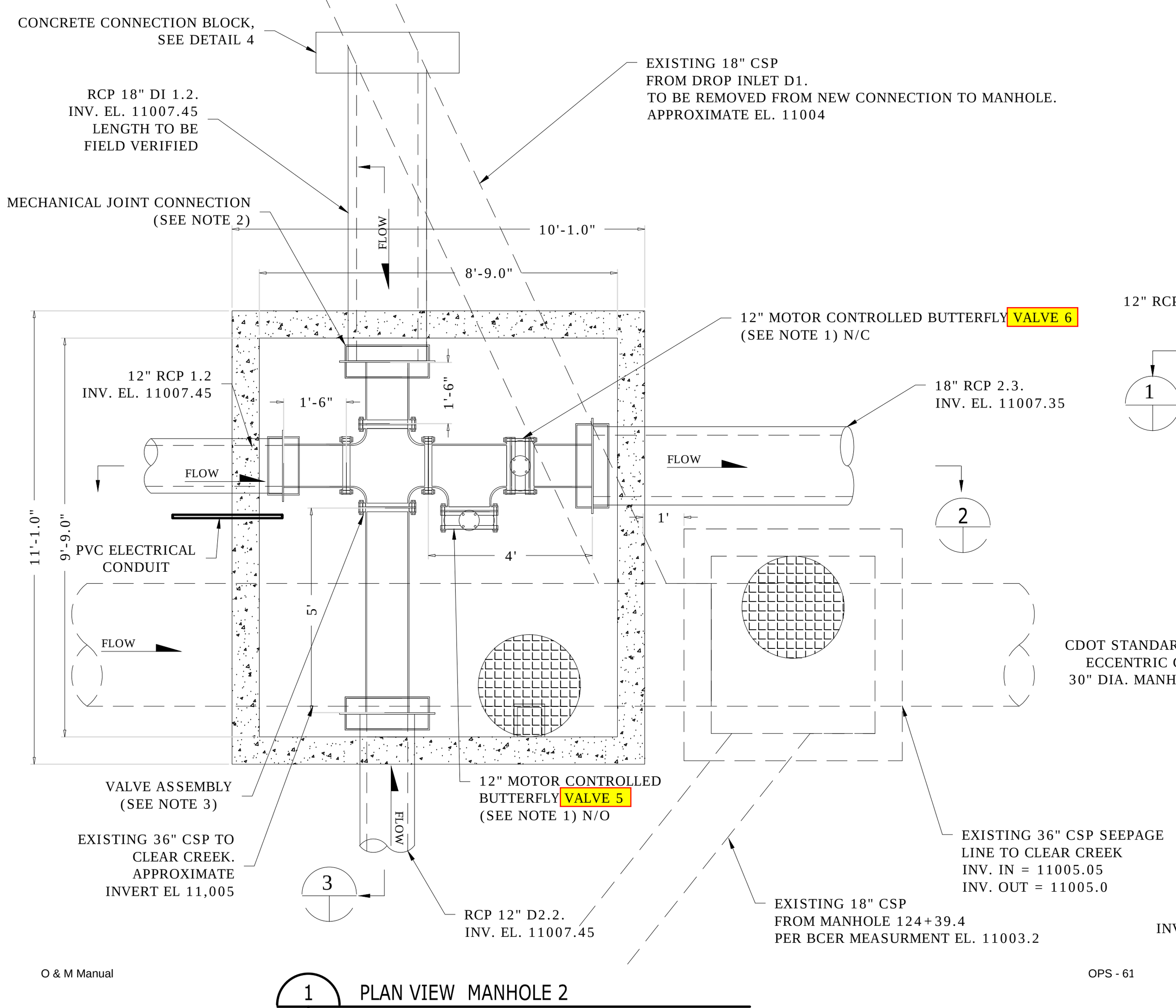
N

1 MECHANICAL LOWER LEVEL PLAN - EAST

SCALE:1/8" = 1'-0"

8' 4' 0 8'

SCALE: 1/8" = 1'-0"



1 PLAN VIEW MANHOLE 2

KEYSTONE FIGURE 777/778 ELECTRIC ACTUATOR
INSTALLATION AND MAINTENANCE INSTRUCTIONS

MECHANICAL TRAVEL STOPS

WARNING
Mechanical travels stops should only be used during manual operation. If the travel limit switch is set incorrectly and the motorised actuator action is limited by the mechanical travel stop, the actuator life will be significantly reduced and will fail prematurely.

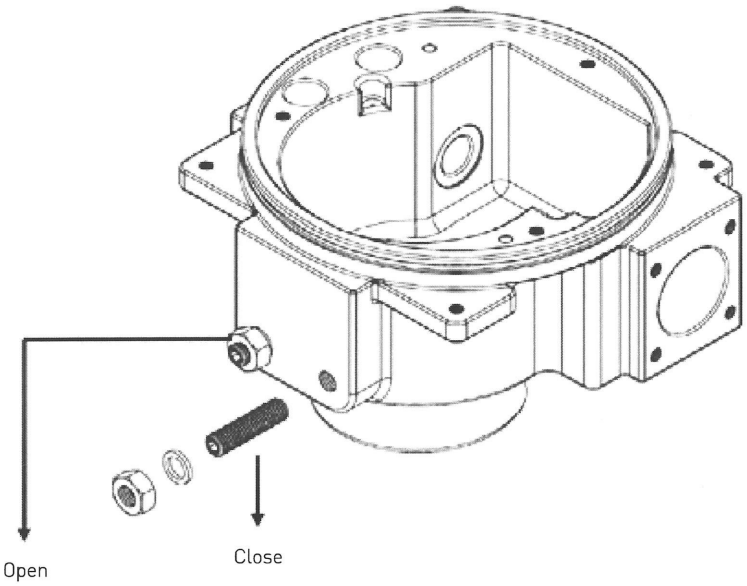
The mechanical stops are factory set, though in some cases adjustment may be required once the actuator is fitted to a valve and travel switches and cams have been adjusted.

Note:
For modulating units please refer to the specific product literature.

For on/off motorised end of travel adjustment please refer to "Limit switch and cam setting".

For manual operation of on/off units

a. Turn power off.
b. Loosen locknut and unwind it a few turns.
c. Use manual override to turn the actuator to desire limit position.
d. Tighten the mechanical stop screw until it reaches the shaft, and reverse one cycle.
e. Tighten locknut.
f. Check that the electrical limit switches are still engaged prior to reaching the mechanical travel stop.



To manually operate the Drainage System Control Valves:
Turn power off to actuator.
Loosen open and closed locknuts.
Open or close valve manually with handwheel.
With the power off, the valve will not return to its original position: Make note of original position prior to manual operation.

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PENTAIR VALVES & CONTROLS
www.pentair.com/valves

WASTE PIPING DRAINAGE CONTROL:

The existing waste piping from the tunnels has been modified by the addition of Control Valves in the East Sewer Treatment Room and the Waste Manhole outside of the East Portal Building.

The Control Valve are controlled through the Fire Alarm System.

The valves are arranged to allow waste to flow to the existing indoor sedimentation tanks during normal operation. If the valves lose power during normal operation they will fail to allow flow to the sedimentation tanks.

SEQUENCE OF OPERATION:

- **If fire event occurs in Eisenhower Tunnel, then V-2 & V-3 shall be closed; V-1 shall be open; V-4 shall remain open.**
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- **If fire event occurs in either tunnel the valves in Manhole MH-2 (V5 and V6) shall position to flow the waste to the retention tanks. V6 is closed and V5 is open during FFSS event.**

WASTE PIPING DRAINAGE FLUSHING:

A cleanout tee and port have been added to the drainage piping to facilitate high-pressure water jetting used to scour and remove buildup of sludge, sand, dirt, gravel, and scale. When used as part of a regularly scheduled maintenance program, this service can assist in keeping your drainage conveyance piping and valves functioning properly and at their designed volume capacity.

We recommend a monthly contracted high-pressure water jetting through the cleanout tee, extending to all control valve locations, to ensure free operation of the valve discs within the inside diameter of the piping.

(E)12" WASTE PIPE FROM EISENHOWER TUNNEL

4d

(E)12"

5

6

C/L

7

8

AUTOMATIC VALVE V-1 (1)

NC

AUTOMATIC VALVE V-2 (1)

NO

AUTOMATIC VALVE; NC V-3 (2)

(E)12" SEWAGE BYPASS

(E)18" SEWAGE WASTE PIPE TO (E)MANHOLE

(E)18" TO CREEK

(E)MANHOLE (MH-1)

(N)MANHOLE (MH-2) WITH V-5 & V-6. REFER TO CIVIL SHEET C6.0.

12"

6"

8a

AUTOMATIC VALVE V-4 (1)

NO

(E)12"

9

(E)12" WASTE PIPE FROM JOHNSON TUNNEL

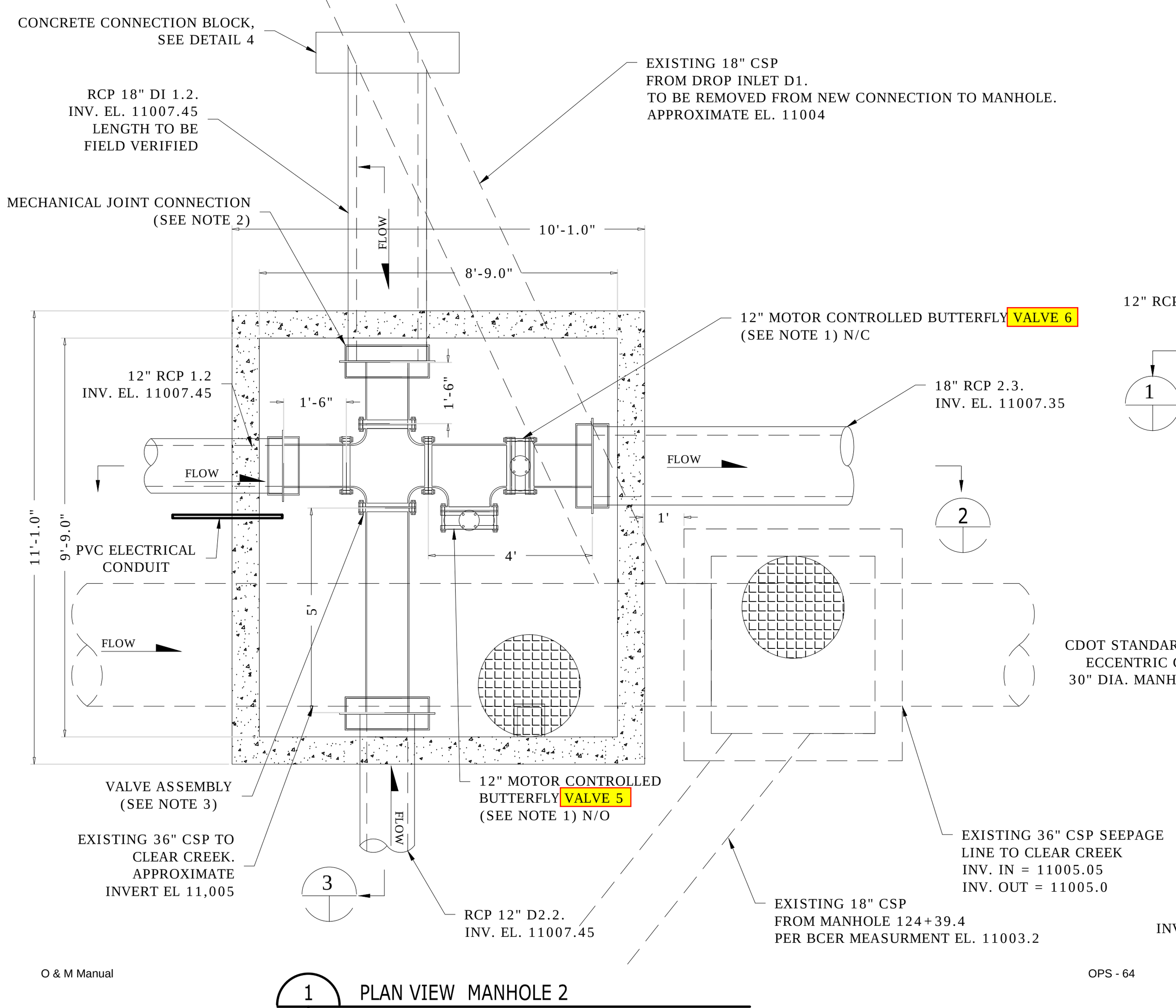
N

1 MECHANICAL LOWER LEVEL PLAN - EAST

SCALE:1/8" = 1'-0"

8' 4' 0 8'

SCALE: 1/8" = 1'-0"



1 PLAN VIEW MANHOLE 2

KEYSTONE FIGURE 777/778 ELECTRIC ACTUATOR
INSTALLATION AND MAINTENANCE INSTRUCTIONS

MECHANICAL TRAVEL STOPS

WARNING
Mechanical travels stops should only be used during manual operation. If the travel limit switch is set incorrectly and the motorised actuator action is limited by the mechanical travel stop, the actuator life will be significantly reduced and will fail prematurely.

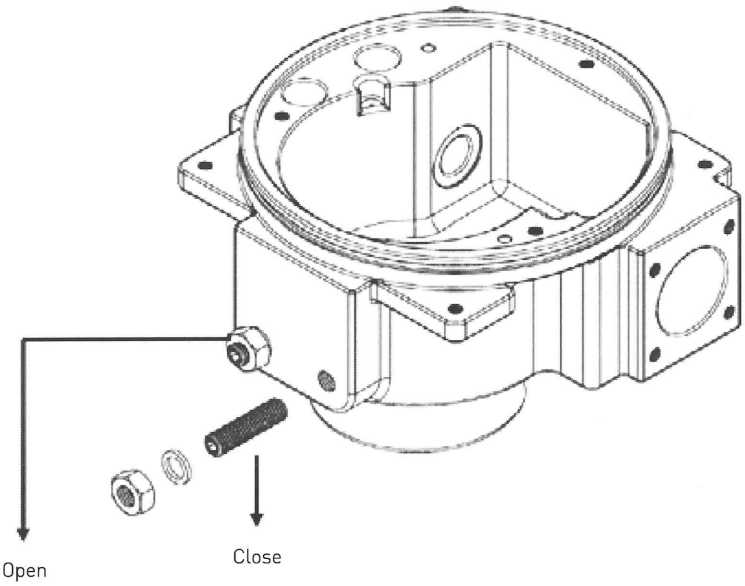
The mechanical stops are factory set, though in some cases adjustment may be required once the actuator is fitted to a valve and travel switches and cams have been adjusted.

Note:
For modulating units please refer to the specific product literature.

For on/off motorised end of travel adjustment please refer to "Limit switch and cam setting".

For manual operation of on/off units

a. Turn power off.
b. Loosen locknut and unwind it a few turns.
c. Use manual override to turn the actuator to desire limit position.
d. Tighten the mechanical stop screw until it reaches the shaft, and reverse one cycle.
e. Tighten locknut.
f. Check that the electrical limit switches are still engaged prior to reaching the mechanical travel stop.



To manually operate the Drainage System Control Valves:
Turn power off to actuator.
Loosen open and closed locknuts.
Open or close valve manually with handwheel.
With the power off, the valve will not return to its original position: Make note of original position prior to manual operation.

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EXHIBIT A – QUARTERLY MAINTENANCE SCHEDULE

System	Activity	Planned Duration	QTR 1			QTR 2			QTR 3			QTR 4		
			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FOLHD	Clean or check cleanliness of fiber optic connections that plug into FOLHD system.	2 Hrs		●										
FOLHD	Restart the FOLHD detector to verify SYSTEM READY light activates indicating normal detector operation	2Hrs		●										
FOLHD	Perform QUICK START test of detector software, by connecting a computer to the detector and running scans all connected channels.	2 Hrs		●										
FOLHD	Perform calibration of the FOLHD fiber to insure the system remains within its operational parameters. This is done by subjecting the FOLHD fiber to a specific heat source at a specific location on the FOLHD fiber (the FOLHD fiber calibration boxes in the center roadway bays).	4Hrs											●	
FOLHD	Disconnect each leg of the FOHLD fiber to verify proper transmission of the fiber channel signals to the FA System and the Fireworks display system.	2 Hrs											●	
Fire Alarm	Fireworks database upgrades to be performed on an as needed basis, if required.	4Hrs											●	
Fire Alarm	Fireworks database review and disk clean-up. This is a general PC "health" review to and clear any logged database issues over the course of normal operation.	4 Hrs											●	
Fire Alarm	Fireworks History Log Review. This is a general review of the logged activities that occur on the system to identify possible issues to be addressed with the installed equipment. This review will be done in conjunction with the Fireworks database review and disk clean-up.	8Hrs											●	
Fire Alarm	Re-Mapping of the FA System device loops, to review communication status of all installed devices, to be performed during the 1st and last year of the Warranty period.	8Hrs								●				
Fire Alarm	Review of the Fireworks UPS Systems diagnostics	2 Hrs								●				
Fire Alarm	Review the device "sensitivity" of the smoke detectors installed, to review level of cleanliness. Detectors to be cleaned, as required.	1Hr								●				
Fire Alarm	Replace the CO element in the combo heat/CO detector. The CO element needs to be replaced every 7 years, so this device CO element will be replaced at the Owner's expense in the last year of warranty.	1Hr							Note 2					

System	Activity	Planned Duration	QTR 1			QTR 2			QTR 3			QTR 4		
			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Fire Alarm	Replace the sealed batteries in the Fire Alarm and UPS Systems. The sealed lead acid batteries are maintenance free so no normal maintenance is required. These batteries do require replacement every 5 years, so they will be replaced at the Owner's expense in the last year of warranty.	16Hrs							Note 1					
FA CCTV	Workstation database upgrades to be performed on an as needed basis, if required.	4Hrs											●	
FA CCTV	Workstation database review and disk clean-up. This is a general PC "health" review to and clear any logged database issues over the course of normal operation.	8Hrs											●	
FA CCTV	Network Video Server database review and disk clean-up. This is a general PC "health" review to and clear any logged database issues over the course of normal operation.	8Hrs											●	
FA CCTV	Review of the Workstation and Equipment Rack UPS Systems diagnostics	4Hrs											●	
FA CCTV	Replace the sealed batteries in the FACCTV and Equipment Rack UPS Systems. The sealed lead acid batteries are maintenance free so no normal maintenance is required. These batteries do require replacement every 5 years, so they will be replaced at the Owner's expense in the last year of warranty.	4Hrs								Note 1				
Deluge Systems Pump Run	Monthly - Fire pump run for 10 minutes	1 Hr	●	●	●	●	●	●	●	●	●	●	●	●
Deluge Systems Pump Test	Annual - Fire Pump Test	4 Hrs				Note 3								
Deluge Systems North Tunnel	Annual - Complete 100% Inspection of I.V. boxes, hangers, exposed piping, sprinklers, valves, gauges, and other system components. (90 Systems)	8 Hrs				Note 3								
Deluge Systems North Tunnel	Annual - Test Every Tamper Switch, Pressure Switch, and Solenoid Valve (90 Systems and No Flow)	16 Hrs				Note 3								
Deluge Systems North Tunnel	Annual - Flow Test 20% of Deluge Systems (18 Systems)	16 Hrs				Note 3								
Deluge Systems North Tunnel	Annual - Integrated System Testing of two Deluge Systems types flowing two systems at two locations (4 Systems)	16 Hrs				Note 3								
Deluge Systems South Tunnel	Annual - Complete 100% Inspection of I.V. boxes, hangers, exposed piping, sprinklers, valves, gauges, and other system components. (93 Systems)	8 Hrs				Note 3								

System	Activity	Planned Duration	QTR 1			QTR 2			QTR 3			QTR 4		
			JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Deluge Systems South Tunnel	Annual - Test Every Tamper Switch, Pressure Switch, and Solenoid Valve (93 Systems and No Flow)	16 Hrs				Note 3								
Deluge Systems South Tunnel	Annual - Flow Test 20% of Deluge Systems (19 Systems)	16 Hrs				Note 3								
Deluge Systems South Tunnel	Annual - Integrated System Testing of two Deluge Systems types flowing two systems at two locations (4 Systems)	16 Hrs				Note 3								
Deluge Systems	Annual - Attach visible tags on all components tested.	72 Hrs					●							
Electrical	Annual - Elec. Gear - Panelboards (East and West Elec. Rooms)	1Hr					●							
Electrical	Annual - Elec. Gear - Transformers (West Electrical Room)	1Hr					●							
Electrical	Annual - Visual inspection of conduit and wiring, to include FPC/RCP Transformers	4Hrs					●							
Electrical	Annual - Visual inspection of the hanger system of the FOLHD system and CCTV cameras	2Hrs					●							
Electrical	Semi-Annual - Generator Service by Cummings Technician	4Hrs					●							
Electrical	Annual - Generator Service by Cummings	4Hrs											●	
Mechanical	Boilers						●							
Mechanical	Boiler Pumps						●							
Mechanical	System Circulation Pumps						●							
Mechanical	Flue and Vent Fans						●							
Mechanical	Piping and Valves						●							

Notes:

1. Batteries will be replaced at Owners expense during the final quarter of Year 5 of the AMP Plan.
2. CO detector element will be replaced at Owners expense during the final quarter of Year 5 of the AMP Plan.
3. Deluge systems to be tested in 2nd quarter (May) of each year as follows:

a. Two (2) each sprinkler zones in the NT and the ST will be tested in a full integrated systems test (Fire pump, Boiler Cir Pump, drainage valve fully operational)

b. Sixteen (16) additional zones in the NT and seventeen (17) additional zones in the ST will be tested similar to the zones described in Note 3.a.; except that the Fire

c. Remaining NT and ST deluge zones will be tested each year by simulating the FOLHD alarm and without introducing water to the roadway.

d. Proposed schedule for the deluge testing is as follows:

1. Bore Closure NT - 2 days (Mon-Tues) with alternate days (Wed-Thurs) of same week.
2. Alternate days will be utilized to conduct the remaining NT deluge zones during daytime hours, as applicable.
3. Bore closure ST - 2 days (Mon-Tues) with alternate days (Wed-Thurs) of same week. The ST bore closures will be scheduled the following week after the NT
4. Alternate days will be utilized to conduct the remaining ST deluge zones during daytime hours, as applicable.