<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.1 Functional Description</td>
<td>28-1</td>
</tr>
<tr>
<td>28.1.1 System Description</td>
<td>28-1</td>
</tr>
<tr>
<td>28.2 Design Data</td>
<td>28-4</td>
</tr>
<tr>
<td>28.2.1 Gravity Belt Thickener Polymer System</td>
<td>28-4</td>
</tr>
<tr>
<td>28.2.2 Centrifuge Polymer System</td>
<td>28-5</td>
</tr>
<tr>
<td>28.3 Equipment Controls</td>
<td>28-7</td>
</tr>
<tr>
<td>28.4 Process Control</td>
<td>28-25</td>
</tr>
<tr>
<td>28.4.1 Liquid Polymer</td>
<td>28-25</td>
</tr>
<tr>
<td>28.4.2 Dry Polymer</td>
<td>28-26</td>
</tr>
<tr>
<td>28.4.3 Polymer Feed Rate</td>
<td>28-28</td>
</tr>
<tr>
<td>28.4.4 Process Optimization</td>
<td>28-29</td>
</tr>
<tr>
<td>28.5 Normal Operation</td>
<td>28-31</td>
</tr>
<tr>
<td>28.5.1 Liquid Polymer Make-up Systems</td>
<td>28-31</td>
</tr>
<tr>
<td>28.5.2 Dry Polymer Make-up Systems</td>
<td>28-32</td>
</tr>
<tr>
<td>28.5.3 Polymer Metering Pumps</td>
<td>28-33</td>
</tr>
<tr>
<td>28.5.4 Gravity Belt Thickener</td>
<td>28-33</td>
</tr>
<tr>
<td>28.6 Alternate and Emergency Operation</td>
<td>28-35</td>
</tr>
<tr>
<td>28.6.1 Alternate Operation</td>
<td>28-35</td>
</tr>
<tr>
<td>28.6.2 Emergency operation</td>
<td>28-35</td>
</tr>
<tr>
<td>28.7 Shutdown Considerations</td>
<td>28-37</td>
</tr>
<tr>
<td>28.7.1 Liquid Polymer System</td>
<td>28-37</td>
</tr>
<tr>
<td>28.7.2 Dry Polymer System</td>
<td>28-38</td>
</tr>
<tr>
<td>28.7.3 Gravity Belt Thickener</td>
<td>28-39</td>
</tr>
<tr>
<td>28.7.4 Centrifuge Pumps</td>
<td>28-39</td>
</tr>
<tr>
<td>28.8 Startup Considerations</td>
<td>28-41</td>
</tr>
<tr>
<td>28.8.1 Liquid Polymer System</td>
<td>28-41</td>
</tr>
<tr>
<td>28.8.2 Dry Polymer System</td>
<td>28-42</td>
</tr>
<tr>
<td>28.8.3 Gravity Thickener and Centrifuge Polymer Feed</td>
<td>28-43</td>
</tr>
<tr>
<td>28.9 Safety Considerations</td>
<td>28-45</td>
</tr>
</tbody>
</table>

CDM Camp, Dresser & McKee
Chapter 28  Polymer System

28.1  Functional Description

Polymers provide a means by which sludge particles, created as part of the treatment process, can be coagulated together to form a flocculated sludge that enhances that sludge’s ability to thicken or be dewatered.

The treatment facility has been provided with the means of preparing and providing polymer addition to the sludge in either the liquid or dry polymer form. This polymer will act as the chemical aid for thickening of waste activated sludge and dewatering of sludge at the facility’s four centrifuges.

Polymers (polyelectrolytes) are either high, medium or low charge long chain molecules with many ionizable sites along the chain. There are three basic types of polymers: cationic, anionic, and non-ionic depending upon whether the net charge on the molecular chain is positive, negative or neutral respectively. Because most primary and waste activated sludges are negatively charged, a positively charged polymer, cationic, will generally be required. Polymers are manufactured in the dry or liquid forms, and these polymer systems at the treatment facility are designed for liquid or dry polymer use.

The characteristics of sludges are as different as the treatment facilities that generate them and the reaction of specific polymers to particular sludges varies greatly. With the assistance of a polymer manufacturer's representative, a treatment plant can identify the type and concentration of polymer that is best for attaining the degree of thickening and dewaterability desirable. The following information provides some insight into the polymer systems that have been installed, the individual components, and the means by which to achieve optimum process control through startup and operation.

28.1.1  System Description

Two individual polymer make-up systems have been provided. One system has been provided to aid in the coagulation and flocculation of waste activated sludge on the gravity belt thickeners (refer to Figure 28-1). The second system has been provided to aid in the coagulation and flocculation of sludge in the centrifuges (refer to Figure 28-2). Each system is similar in function and capable of using either dry or liquid polymer. A description of each of these polymer preparation systems follow.

Dry Polymer System

CDM Camp, Dresser & McKee
The dry polymer feed system is designed to feed and dissolve dry polymer into a solution of known concentration and delivering the solution to polymer mix/age tanks for additional mixing and aging. From the thickening mix/age tanks, the polymer is metered by one of five gravity belt thickeners (GBT) polymer feed pumps for thickening. From the dewatering mix/age tanks, the polymer is transferred by one of five centrifuge polymer feed pumps to the centrifuges for sludge dewatering.

Dry polymer from bags (50 lb. bags for the thickening and 1200 lb. bags for the dewatering system) is placed in a loading hopper which allows the contents of the bag to fall into a storage hopper. Because of the dust that forms from loading 50 lb bags of dry polymer into the thickening make-up system, a dust collector and filter are provided above the hopper to collect and trap the polymer dust. The 1200 lb bags of polymer are directly attached to the dewatering make-up system hopper and therefore does not require dust collection equipment.

From the storage hopper, the polymer travels towards a feeder which, based upon the adjustment and calibration made by the operator, controls the quantity of dry polymer that is conveyed by an auger to the cyclone wetting device where the dry polymer finally comes into contact with water.

Now that the polymer has achieved a “wetted” state, an eductor at the bottom of the cone delivers the wetted polymer to the mix/age tank. It is important that the polymer is completely dissolved to prevent the polymer from forming globules. Polymer, due to its viscous nature, tends to adhere to the inside walls of pipes and pumps. If these clumps of polymer are not completely dissolved, the situation of lines being plugged or pumps “freezing” only becomes more apparent.

To further insure that the polymer is completely dissolved, the water that is supplied for dilution at the wetting cone and eductor can be supplied as protected water that is cool, warm or hot, depending upon the type and condition of the polymer.

To enhance the procedure of preparing polymer and to insure its availability, the storage hopper where the dry polymer is contained, will automatically start and operate to prepare a batch of polymer solution. In this automatic mode, the dry polymer feed system will receive a signal from a level transmitter located in one of the two polymer mix/age tanks. When this transmitter identifies a low level of polymer solution in one tank, this “Low Level” signal will automatically switch from withdrawal of dilute polymer solution from the empty tank to the waiting full dilute polymer solution tank. Each tank is provided with motorized tank outlet valves that will switch from the closed to open position on the full tank and from the open to closed position on the empty tank. Once the valve positions have been switched, the “Low Level” signal will activate the dry polymer feed system to begin preparing a fresh solution of polymer. With two mix/age tanks per system, an adequate supply of polymer solution is always insured since one
tank can be feeding polymer while the second tank is preparing a new batch of solution. This sequence between mix/age tank batching is called "flip/flop."

Finally, the batch size and concentration will be controlled by the speed of the feeder, the water flow rates to the mix/age tanks and the length of operation as dictated by a timer.

**Liquid Polymer System**

Liquid polymer refers to concentrated liquid polymer or polymer in an emulsified state. The basis behind the operation of the liquid polymer system is the transfer of liquid polymer from a polymer storage tank or drums to the polymer mix/use tanks. At the mix/age tanks, additional dilution, mixing and aging of the polymer is achieved, prior to delivery at the point of application.

Just as is done with the dry polymer system, the liquid polymer system is activated by a level transmitter in the mix/age tanks. When the polymer solution drops to the "low level", the mix/use tanks are switched and a signal is sent to the polymer transfer pump which activates the pump to begin filling the empty mix/use tank. Batch size and concentration will be controlled by the speed of the pump and the length of time of operation, which is dictated by a timer setting. In the case of the liquid polymer system, the polymer is diluted in the transfer line and in the mix/use tanks with cold water from the transfer dilution water valve station and the make-up water valve station.
28.2 Design Data

28.2.1 Gravity Belt Thickener Polymer System

**Dry Feed System Feeder**
- Number: 1
- Manufacturer/Model: Acrison/Polymer Model 512
- Type: Prepackaged automatic dry polymer wetting and liquid polymer feed make-up system
- Feed Rate (lb/hr, max): 54
- Volumetric Feed Rate (lb/min @ 60 lb/cf): 0.9
- Volumetric Feeder Motor Size, (hp): 1/2
- Total Hopper Capacity (cu ft): 6
- Wetting Water Flow (gpm): 20
- Quick Fill Water Flow (gpm): 70
- Water Pressure (psi): 40
- Water Temperature (F): 65-150

**Dry Feed System Dust Collector**
- Motor Speed (rpm): 3600
- Motor Size (hp): 3/4
- Filter Cloth Area (sq ft): 30

**Liquid Polymer Transfer Pumps**
- Number: 1
- Manufacturer/Model: Robbins Myers/Moyno Series 300
- Pump Type: Progressive Cavity
- Capacity (gpm): 0.24 to 2.56
- Pump Speed (rpm): 160 to 1725
- Motor Size (hp): 3/4

**GBT Polymer Mix/Use Tanks**
- Number: 2
- Working Volume (gals): 1480 (ea)
- Total Volume (gals): 1690 (ea)

**GBT Polymer Mix/Use Tank Mixers**
- Number: 2 (one per tank)
- Mix Speed (rpm): 400 (Max)

**CDM** Camp, Dresser & McKee
### Mixing Time

- **Motor Size (hp)**
- **Motor Speed (rpm)**
- **No. of Impellers**

### 28.2.2 Centrifuge Polymer System

#### Dry Feed System Feeder

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
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</tr>
<tr>
<td>Manufacturer/Model</td>
<td>Acrison/Polymer Model 512</td>
</tr>
<tr>
<td>Type</td>
<td>Pre-packaged automatic dry polymer wetting and liquid polymer feed make-up system</td>
</tr>
<tr>
<td>Feed Rate (lb/hr, max)</td>
<td>54</td>
</tr>
<tr>
<td>Volumetric Feed Rate (lb/min @ 60 lb/cf)</td>
<td>0.9</td>
</tr>
<tr>
<td>Volumetric Feeder Motor Size (hp)</td>
<td>1/2</td>
</tr>
<tr>
<td>Total Hopper Capacity (cu ft)</td>
<td>6</td>
</tr>
<tr>
<td>Wetting Water Flow (gpm)</td>
<td>20</td>
</tr>
<tr>
<td>Quick Fill Water Flow (gpm)</td>
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</tr>
<tr>
<td>Water Pressure (psi)</td>
<td>40</td>
</tr>
<tr>
<td>Water Temperature (F)</td>
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</table>

#### Liquid Polymer Storage Tanks

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Tanks</td>
<td>1</td>
</tr>
<tr>
<td>Working Capacity (gals)</td>
<td>5,235</td>
</tr>
<tr>
<td>Total Capacity</td>
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#### Liquid Polymer Transfer Pumps

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Pumps</td>
<td>2</td>
</tr>
<tr>
<td>Manufacturer/Model</td>
<td>Robbins Myers/Moyno Series 1000</td>
</tr>
<tr>
<td>Pump Type</td>
<td>Progressive Cavity</td>
</tr>
<tr>
<td>Capacity (gpm @ TDH ft)</td>
<td>5 @ 115</td>
</tr>
<tr>
<td>Pump Speed (rpm)</td>
<td>500 (Max)</td>
</tr>
<tr>
<td>Motor Size (hp)</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Centrifuge Polymer Mix/Use Tanks

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Tanks</td>
<td>2</td>
</tr>
</tbody>
</table>

**CDM** Camp, Dresser & McKee
Manufactuer/Model
Working Capacity (gals) 3,000
Total Capacity 3385

**Centrifuge Polymer Mix/Use Tank Mixers**

- Number of Mixers 2 (one/tank)
- Manufacturer/Model
- Application Mix concentrated polymer solution with dilution water
- Mixing Speed (rpm) 400 (Max)
- Mixing Time Contents blended in less than 15 minutes
- Motor Size (hp) 3
- Motor Speed (rpm) 150
- Number of Impellers 2

**Gravity Belt Thickener Dilute Polymer Feed Pumps**
- Number of Pumps 5
- Manufacturer/Model Robbins Myers/ Moyno Series 1000
- Pump Type Progressive cavity, variable speed, single stage
- Capacity (gpm) 5 to 5.0
- Pump Speed (rpm) 100 to 532
- Motor Size (hp) 1.5/1800

**Centrifuge Dilute Polymer Feed Pumps**
- Number of Pumps 5
- Manufacturer/Model Robbins Myer/Moyno Series 1000
- Pump Type Progressive cavity, Variable speed, Single stage
- Capacity (gpm) 3 to 15
- Pump Speed (rpm) 53 to 366
- Motor Size (hp/rpm) 2/1800
28.3 Equipment Controls

The following controls and their functions are associated with the equipment described above. Controls are listed from the device and/or its control panel (LOCAL), through the Motor Control Center (MCC), to the Local Control Panel (LCP) and the remote Computer Processing Unit (CPU). Devices controlled by the CPU are accessed from either the Central Operator's Console (COC) or the Distributed Operator's Console (DOC).

*Thickening Polymer Make-up Systems*

**LOCAL:**
If the local control panel HAND ENABLE switch is in the OFF position, all other panel switches are in the AUTO position, the DRY/ LIQUID selector switch is in the DRY position, the level control and panel power ON/OFF selector switches are in the ON position and the SYSTEM START pushbutton is depressed the dry polymer batch cycle will begin once a low level in the mix/use tank is indicated.

If the local control panel HAND ENABLE switch is in the OFF position, all other panel switches are in the AUTO position, the DRY/ LIQUID selector switch is in the LIQUID position, the level control and panel power ON/OFF selector switches are in the ON position and the SYSTEM START pushbutton is depressed the liquid polymer batch cycle will begin once a low level in the mix/use tank is indicated.

Alarm annunciators and status indicators (red-RUN, green-OFF, white-ENERGIZED) are provided for system monitoring. Refer to the manufacturer's service manual for specific panel alarms and status indicators.

**LCP-6**
Status indicating annunciator (SYSTEM ON, MIX/USE TANK SWITCHOVER) and alarm annunciators (POLYMER SYSTEM TROUBLE, MAKE-UP TANK LOW/LOW LEVEL)

**DOC/COC**
Status indicating annunciator (SYSTEM ON, MIX/USE TANK SWITCHOVER) and alarm annunciators (POLYMER SYSTEM TROUBLE, MAKE-UP TANK LOW/LOW LEVEL)
**Dewatering Polymer Make-up Systems**

**LOCAL:** If the local control panel HAND ENABLE switch is in the OFF position, all other panel switches are in the AUTO position, the DRY/LIQUID selector switch is in the DRY position, the level control and panel power ON/OFF selector switches are in the ON position and the SYSTEM START pushbutton is depressed the dry polymer batch cycle will begin once a low level in the mix/use tank is indicated.

If the local control panel HAND ENABLE switch is in the OFF position, all other panel switches are in the AUTO position, the DRY/LIQUID selector switch is in the LIQUID position, the level control and panel power ON/OFF selector switches are in the ON position and the SYSTEM START pushbutton is depressed the liquid polymer batch cycle will begin once a low level in the mix/use tank is indicated.

Alarm annunciators and status indicators (red-RUN, green-OFF, white-ENERGIZED) are provided for system monitoring. Refer to the manufacturer's service manual for specific panel alarms and status indicators.

**LCP-7:** Status indicating annunciator (SYSTEM ON, MIX/USE TANK SWITTOVER) and alarm annunciators (POLYMER SYSTEM TROUBLE, MAKE-UP TANK LOW/LOW LEVEL)

**DOC/COC:** Status indicating annunciator (SYSTEM ON, MIX/USE TANK SWITTOVER) and alarm annunciators (POLYMER SYSTEM TROUBLE, MAKE-UP TANK LOW/LOW LEVEL)

**Concentrated Polymer Transfer Pumps**

**LOCAL:** If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from the Centrifuge Polymer Make-up System.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).
MCC-SP-1: If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

**GBT Polymer Feed Pump No.1 & 5**

**LOCAL:**
If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from Gravity Belt Thickener Local Panel.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

**MCC-SP-1:**
If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

**LCP-6:**
If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the START position, the pump is started. If the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the AUTO position, the pump is started by the gravity belt thickener and stopped by the gravity belt thickener sludge feed pump.

If the the RATIO CONTROLLER on the GBT LOCAL PANEL is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the the RATIO CONTROLLER on the GBT LOCAL PANEL is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the...
controller and tile flow pacing signal from the LCP.

A ratio controller is implemented in the controller that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. Tile calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO selector switch is in the HAND position, the pump cannot be operated remotely.

**GBT Polymer Feed Pump No. 2**

**LOCAL:**

If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from Gravity Belt Thickener Local Panel.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

**MCC-SP-1:**

If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

**LCP-6:**

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the START position, the pump is started. If the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the AUTO position, the pump is started by the gravity belt thickener and stopped by the gravity belt thickener
sludge feed pump. If the GBT NO. 1/NO. 2/COMP selector switch on the LCP is in the 'No. 1' position, then control is based on GBT No. 1. If the GBT NO. 1/NO. 2/COMP selector switch on the LCP is in the 'No.2' position, then control is based on GBT No.2.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the AUTO position, the pump is started by the gravity belt thickener and stopped by the gravity belt thickener sludge feed pump. If the GBT NO. 1/NO. 2/COMP selector switch on the LCP is in the COMP position, then control is selected via the keyboard in the control room. If the GBT NO. 1/NO. 2/COMP selector switch on the DOC is in the 'No. 1' position, then control is based on GBT No. 1. If the GBT NO. 1/NO. 2/COMP selector switch on the DOC is in the 'No.2' position, then control is based on GBT No. 2.

If the the RATIO CONTROLLER on the GBT LOCAL PANEL is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the RATIO CONTROLLER on the GBT LOCAL PANEL is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller and the flow pacing signal from the LCP. If the GBT NO. 1/NO. 2/COMP SELECTOR SWITCH on the LCP is in the 'No.1' position, then the RATIO CONTROLLER on LP -1 is used. If the GBT NO. 1/NO. 2/COMP SELECTOR SWITCH on the LCP is in the 'No.2' position, then the RATIO CONTROLLER on LP -2 is used. If the GBT NO. 1/NO. 2/COMP SELECTOR SWITCH on the LCP is in the COMP position, then control is selected via the keyboard in the control room. If the GBT NO. 1/NO. 2/COMP selector switch on the DOC is in the 'No.1' position, then the RATIO CONTROLLER on LP -1 is used. If the GBT NO. 1/NO. 2/COMP selector switch on the DOC is in the 'No.2' position, then the RATIO CONTROLLER on LP -2 is used.

A ratio controller is implemented in the controller that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.
If the LOCAL/REMOTE selector switch is in the LOCAL position, the pump cannot be operated remotely.
GBT Polymer Pump No. 3

LOCAL: If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from Gravity Belt Thickener Local Panel.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

MCC-SP-1: If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

LP-6: If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the START position, the pump is started. If the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the AUTO position, the pump is started by the gravity belt thickener and stopped by the gravity belt thickener sludge feed pump. If the GBT NO. 2/NO. 3/COMP selector switch on the LCP is in the 'No.2' position, then control is based on GBT No.2. If the GBT NO. 2/NO. 3/COMP SELECTOR SWITCH on the LCP is in the 'No.3' position, then control is based on GBT No.3.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the AUTO position, the pump is started by the gravity belt thickener and stopped by the gravity belt thickener sludge feed pump. If the GBT NO. 2/NO. 3/COMP selector switch on the LCP is in the COMP position, then control is selected via the keyboard in the control room. If the GBT NO. 2/NO. 3/COMP selector switch on the DOC is in the 'No.2' position, then control is based on GBT No.2. If the GBT NO. 2/NO. 3/COMP selector switch on the DOC is in the 'No.3' position, then control is based on GBT No.3.
If the RATIO CONTROLLER on the GBT LOCAL PANEL is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the RATIO CONTROLLER on the GBT LOCAL PANEL is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller and the flow pacing signal from the LCP. If the GBT NO. 2/NO. 3 COMP selector switch on the LCP is in the 'No. 2' position, then the RATIO CONTROLLER on LP-2 is used. If the GBT NO. 2/NO. 3 COMP selector switch on the LCP is in the 'No. 3' position, then the RATIO CONTROLLER on LP-3 is used. If the GBT NO. 2/NO. 3 COMP selector switch on the LCP is in the COMP position, then control is selected via the keyboard in the control room. If the GBT NO. 2/NO. 3 COMP selector switch on the DOC is in the 'No. 2' position, the RATIO CONTROLLER on LP-2 is used. If the GBT NO. 2/NO. 3 COMP SELECTOR SWITCH on the DOC is in the 'No. 3' position, then the RATIO CONTROLLER on LP-3 is used.

A ratio controller is implemented in the controller that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the LOCAL/REMOTE SELECTOR SWITCH is in the LOCAL position, the pump cannot be operated remotely.

**GBT Polymer Feed Pump No. 4**

**LOCAL:**

If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from Gravity Belt Thickener Local Panel.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

CDM Camp, Dresser & McKee 28-14
MCC-SP-1: If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

LCP-6: If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the START position, the pump is started. If the LOCAL START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the AUTO position, the pump is started by the gravity belt thickener and stopped by the gravity belt thickener sludge feed pump. If the GBT NO. 3/NO. 4/COMP selector switch on the LCP is in the 'No.3' position, then control is based on GBT No.3. If the GBT NO. 3/NO. 4/COMP selector switch on the LCP is in the 'No.4' position, then control is based on GBT No.4.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the GBT LOCAL PANEL is in the AUTO position, the pump is started by the gravity belt thickener and stopped by the gravity belt thickener sludge feed pump. If the GBT NO. 3/NO.4/COMP selector switch on the LCP is in the COMP position, then control is selected via the keyboard in the control room. If the GBT NO.3/NO.4/COMP selector switch on the DOC is in the 'No.3' position, then control is based on GBT No.3. If the GBT NO.3/NO.4/COMP selector switch on the DOC is in the 'No.4' position, then control is based on GBT No.4.

If the RATIO CONTROLLER on the GBT LOCAL PANEL is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the RATIO CONTROLLER on the GBT LOCAL PANEL is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller and the flow pacing signal from the LCP. If the GBT NO. 3/NO. 4/COMP selector switch on the LCP is in the 'No.3' position, then the RATIO CONTROLLER on LP-3 is selected. If the GBT NO. 3/NO. 4/COMP selector switch on the LCP is in the 'No.4' position, then the RATIO CONTROLLER on LP-4 is used. If the GBT NO. 3/NO. 4/COMP selector switch on the LCP is in the COMP position, then control is selected via the keyboard in the control room.
room. If the GBT NO. 3/NO. 4/COMP selector switch on the DOC is in the ‘No.3’ position, the the RATIO CONTROLLER on LP-3 is used. If the GBT NO. 3/NO. 4/COMP selector switch on the DOC is in the ‘No.4’ position, then the RATIO CONTROLLER on LP-4 is used.

A ratio controller is implemented in the controller that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the LOCAL/REMOTE selector switch is in the LOCAL position, the pump cannot be operated remotely.

**Centrifuge Polymer Feed Pump No. 1 & 5**

**LOCAL:**
If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from LCP-7.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

**MCC-SP-1:**
If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

**LCP-6:**
If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by the centrifuge.
sludge feed pump and the centrifuge.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the local START/STOP/AUTO/COMP selector switch on the DOC is in the START position, the pump is started. If the local START/STOP/AUTO/COMP selector switch on the DOC is in the STOP position, the is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the local START/STOP/AUTO/COMP selector switch on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump and the centrifuge.

If the FLOW INDICATING CONTROLLER on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the COMP position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the RATIO CONTROLLER on the DPU is in the MANUAL position, the ratio value used is from the FLOW INDICATING CONTROLLER. If the RATIO CONTROLLER on the DOC is in the AUTO position, the ratio value used is from the keyboard.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO selector switch is in the HAND position, the pump cannot be operated remotely.

Centrifuge Polymer Feed Pump No. 2

LOCAL: If the local control panel LOCAL/REMOTE selector switch is in the

CDM Camp, Dresser & McKee 28-17
REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from LCP-7.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

MCC-SP-1: If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

LCP-7: If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump and the centrifuge. If the CENTRIF No.1/No.2 selector switch on the LCP is in the ‘No. 1’ position, centrifuge sludge feed pump No.1 is used. If the CENTRIF No.1/No.2 selector switch on the LCP is in the ‘No.2’ position, centrifuge sludge feed pump No.2 is used.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the START/STOP/COMP selector switch on the DOC is in the START position, the pump is started. If the START/STOP/COMP selector switch on the DOC is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the START/STOP/COMP selector switch on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump and centrifuge. If the CENTRIF NO. 1/NO.2 selector switch on the DOC is in the ‘No. 1’ position, centrifuge...
sludge feed pump No.1 is used. If the CENTRIF NO. 1/NO.2 selector switch on the DOC is in the 'No.2' position, centrifuge sludge feed pump No.2 is used.

If the FLOW INDICATING CONTROLLER on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the COMP position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the RATIO CONTROLLER on the DOC is in the MANUAL position, the ratio value used is from the FLOW INDICATING CONTROLLER. If the RATIO CONTROLLER on the DOC is in the AUTO position, the ratio value used is from the keyboard.

If the FLOW INDICATING CONTROLLER on the LCP is in the AUTO position and the CENTRIF No.1/No.2 selector switch on the LCP is in the 'No. 1' position, the flow pacing signal used is the centrifuge No. 1 flow. If the CENTRIF No.1/No.2 selector switch on the LCP is in the 'No.2' position, the flow pacing signal used is the centrifuge No.2 flow. If the FLOW INDICATING CONTROLLER on the LCP is in the COMP position, the pacing signal is selected via the keyboard in the control room. If the CENTRIF NO. 1/NO.2 selector switch on the DOC is in the 'No. 1' position, the flow pacing signal used is the centrifuge No. 1 flow. If the CENTRIF NO. 1/NO.2 selector switch on the DOC is in the 'No.2' position, the flow pacing signal used is the centrifuge No.2 flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO selector switch is in the HAND position, the pump cannot be operated remotely.

Centrifuge Polymer Feed Pump No. 3
LOCAL:

If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from LCP-7.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

MCC-SP-1:

If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

LCP-7:

If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump and the centrifuge. If the CENTRIF No. 2/No. 3 selector switch on the LCP is in the 'No.2' position, centrifuge sludge feed pump No.2 is used. If the CENTRIF No. 2/No. 3 selector switch on the LCP is in the 'No.3' position, centrifuge sludge feed pump No.3 is used.

DOC:

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the is controlled via the keyboard in the control room. If the START/STOP/AUTO/COMP selector switch on the DOC is in the position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the DOC is in the STOP position, the pump is stopped.
If the LOCAL/REMOTE selector switch is in the REMOTE position and the LOCAL START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the START/STOP/AUTO/COMP selector switch on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump and centrifuge. If the CENTRIF NO.2/NO.3 selector switch on the DOC is in the 'No.2' position, centrifuge sludge feed pump No.2 is used.

If the CENTRIF NO.2/NO.3 selector switch on the DOC is in the 'No.3' position, centrifuge sludge feed pump No.3 is used.

If the FLOW INDICATING CONTROLLER on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the COMP position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the RATIO CONTROLLER on the DOC is in the MANUAL position, the ratio value used is from the FLOW INDICATING CONTROLLER. If the RATIO CONTROLLER on the DOC is in the AUTO position, the ratio value used is from the keyboard.

If the FLOW INDICATING CONTROLLER on the LCP is in the AUTO position and the CENTRIF NO.2/NO.3 selector switch on the LCP is in the 'No.2' position, the flow pacing signal used is the centrifuge No.2 flow. If the CENTRIF NO.2/NO.3 on the LCP is in the 'No.3' position, the flow pacing signal used is the centrifuge No.3 flow. If the FLOW INDICATING CONTROLLER on the LCP is in the COMP position, the pacing signal is selected via the keyboard in the control room. If the CENTRIF NO.2/NO.3 selector switch on the DOC is in the 'No.2' position, the flow pacing signal used is the centrifuge No.2 flow. If the CENTRIF NO.2/NO.3 selector switch on the DOC is in the 'No.3' position, the flow pacing signal used is the centrifuge No.3 flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases,
chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO selector switch is in the HAND position, the pump cannot be operated remotely.

**Centrifuge Polymer Feed Pump No. 4**

**LOCAL:**

If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from LCP-7.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

**MCC-SP-1:**

If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

**LOCAL:**

If the local control panel LOCAL/REMOTE selector switch is in the REMOTE position, and the HAND/OFF/AUTO selector switch is in the AUTO position, the pump will be controlled from LCP-7.

If the local control panel LOCAL/REMOTE selector switch is in the LOCAL position, and the HAND/OFF/AUTO selector switch is in the HAND position, the pump may be started and stopped locally by depressing the START and STOP pushbuttons. The pumps speed may be controlled locally by the speed.
potentiometer. Status indicators are provided (red-RUN, amber-FAIL).

**MCC-SP-1:**

If the ON-OFF disconnect switch is in the ON or CLOSED position, power is available and the local panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

**LCP-7:**

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the local START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

**DOC:**

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump and the centrifuge. If the CENTRIF No. 3/No.4 selector switch on the LCP is in the "No.3" position, centrifuge sludge feed pump No.3 is used. If the CENTRIF No. 3/No.4 selector switch on the LCP is in the "No.4" position, centrifuge sludge feed pump No.4 is used.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the is controlled via the keyboard in the control room. If the START/STOP/AUTO/COMP selector switch on the DOC is in START the position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the DOC is in the STOP position, the pump is stopped.

If the LOCAL/REMOTE selector switch is in the REMOTE position and the local START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the START/STOP/AUTO/COMP selector switch on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump and centrifuge. If the CENTRIF No. 3/No.4 selector switch on the DOC is in the "No.3" position, centrifuge sludge feed pump No.3 is used. If the CENTRIF No. 3/No.4 selector switch on the DOC is in the
'No.4' position, centrifuge sludge feed pump No.4 is used.

If the FLOW INDICATING CONTROLLER on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller. If the FLOW INDICATING CONTROLLER on the LCP is in the COMP position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the RATIO CONTROLLER on the DOC is in the MANUAL position, the ratio value used is from the FLOW INDICATING CONTROLLER. If the RATIO CONTROLLER on the DOC is in the AUTO position, the ratio value used is from the keyboard.

If the FLOW INDICATING CONTROLLER on the LCP is in the AUTO position and the CENTRIF No. 3/No.4 selector switch on the LCP is in the 'No.3' position, the flow pacing signal used is the centrifuge No.3 flow. If the CENTRIF No. 3/No.4 selector switch on the LCP is in the 'No.4' position, the flow pacing signal used is the centrifuge No.4 flow. If the FLOW INDICATING CONTROLLER on the LCP is in the COMP position, the pacing signal is selected via the keyboard in the control room. If the CENTRIF No. 3/No.4 selector switch on the DOC is in the 'No.3' position, the flow pacing signal used is the centrifuge No.3 flow. If the CENTRIF No. 3/No.4 selector switch on the DOC is in the 'No.4' position, the flow pacing signal used is the centrifuge No.4 flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.
28.4 Process Control

28.4.1 Liquid Polymer

There are basically two types of liquid polymers available for use at the plant, one being a mannich and the other an emulsion or dispersion. Mannichs are dilute, unstable polymer products with an active solids content of approximately 5% and a short shelf life (3 to 6 months) when compared to other polymer types. Emulsions and dispersions are stronger polymer solutions that are more stable and have active solids concentrations of 30 to 50%. It is recommended that only emulsion or dispersion liquid polymer solutions be used due to the mannichs lower shelf life and its possible incompatibility with the dry type polymer residuals remaining in the pumps and mix/use tank that may produce a scale buildup due to chemical and pH differences.

To produce a half percent polymer solution (.5%) in the mix/use tank, the operator must know:

1. How many makeup gallons are required?
2. What is the liquid polymer active solids concentration?

- liquid polymer active
- solids concentration = 50% (or .5 as a decimal)
- Gallons of mixed polymer = 1,450 gallons (gravity belt thickener tank)
- Mixed polymer concentration = 0.5% (or .005 as a decimal)
- Pounds liquid polymer = 1,450 gal x .005 poly as a decimal x 8.34 lb/gal
  = 60.5
- Gallons of liquid polymer required = \( \frac{60.5 \text{ gal} \cdot 0.5\% \text{ liquid polymer as decimal}}{8.34 \text{ lbs/gal.}} \)
  = 14.5
- Gallons of water for make-up = 1,450 gals (total) - 14.5 gal liq poly
  = 1,434.5

When the operator identifies that changes are required in the polymer quantities or the active solids concentration of the polymer being used, the polymer supplier can provide

CDM Camp, Dresser & McKee 28-25
information regarding the new values that would need to be inserted in the above calculations.

28.4.2 Dry Polymer

Before operating the dry polymer system, the operator must first perform various calculations to determine the proper settings for the system equipment to obtain the desired polymer dosage at the points of application. The example presented below illustrates the procedure that is necessary to calibrate the dry polymer feed system.

During the operating mode, the polymer feeder delivers dry polymer to the wetting cone at a constant rate. While polymer is being conveyed to the mix/use tank, water is sprayed into it, wetting the polymer particles.

The amount of dry polymer delivered to the wetting cone, and ultimately to the mix/use tank, is controlled by the feeder timer. Once operation is initiated, dry polymer is fed at a constant rate while water is fed at a fixed rate in sufficient quantity to fill the mix tank. This produces a polymer solution strength in proportion to the feeder rate setting.

The type of feeder furnished for the polymer system meters dry polymer on a volume basis, not a weight basis. Therefore, the rate of feed in pounds per hour (as needed for chemical computations) is dependent on several factors such as bulk density (lbs/cu. ft.) of dry polymer, granular size, etc. Because of these variations, each brand and type of polymer will feed at a different rate. It is therefore necessary to calibrate the feeder for each type of polymer being fed, and set the volumetric feeder timer appropriately. This is done as outlined below:

1. Fill the hopper with approximately 100-200 pounds of the polymer for which the feeder is to be calibrated. Make sure there is no residual polymer from previous use.

2. Set the volumetric feeder timer for three minutes.

3. Pre-weigh a container to collect a sample obtaining a tare weight. Place this container under the sampling chute located below the feeder discharge spout.

4. Close the water supply valve to the wetting device as it is not required.
   
   Caution: Do not allow polymer to enter the wetting cone.

5. Turn the power to the unit on. Turn the feeder selector switch to the
manual mode. Collect the polymer discharged for approximately a 3 minute period (the longer the running time, the more accurate the sample).

6. Weigh the sample collected and subtract the weight of the container. Record the results as pounds of polymer per seconds (lbs/sec).

7. Repeat Steps 5 and 6 several times.

8. Determine the weight per second of the sample by adding the total weight of the sample and dividing that sum by the total number of seconds that were taken to extract the sample.

   - lbs/sec = \frac{15 \text{ lbs} \ 12 \text{ oz sample weight}}{195 \text{ secs sample time}}
   = \frac{15.75}{195}
   = 0.08

   - lbs/min = 0.08 \times 60 \text{ sec/min}
   = 4.85

9. Determine the amount of dry polymer required to batch a 0.5% concentration of polymer solution.

   - poly required (lb/batch) = 1,450 \text{ gal} \times 0.005 \times 8.34 \text{ lb/gal}
   = 60.5

10. Determine the volumetric feeder timer setting to batch the required polymer dosage.

    = \frac{\text{Poly Required, lbs/batch}}{\text{Dry Polyfeed Rate, lbs/min}}
28.4.3 Polymer Feed Rate

During normal operating conditions, the polymer metering pumps are regulated in accordance with: (1) the required polymer dosage, (2) the flow rate to the process, and (3) the strength of the polymer solution being fed. When operating in the REMOTE mode (normal operations) polymer pump speed is based on the sludge flow rate to the centrifuge or gravity belt thickeners. The polymer pump speed is controlled as a function of its ratio control station setting and the related process sludge flow rate.

Once the type and optimum polymer dosage is established, the feeding pumps ratio set points can be calculated and set as shown in the example below.

The amount of polymer required can be calculated by knowing the amount of sludge to process and estimating the quantity of polymer that would be required to react with the sludge: pounds polymer per ton of dry sludge solids (lbs polymer/ton d.s.)

The following calculation can be used to estimate the polymer requirements for either thickening of waste activated sludge or dewatering of combined waste activated and primary sludge.

- lbs/min sludge
  
  \[ \text{lbs} / \text{gal} = \text{sludge flow (gpm)} \times \text{conc (decimal)} \times 8.34 \]
  
  \[ = 150 \text{ gpm} \times 0.05 \times 8.34 \text{ lbs/gal} \]
  
  \[ = 62.5 \]

- tons/min sludge
  
  \[ \text{tons} / \text{min} = \frac{62.5}{2,000} \text{ lbs/ton} \]
  
  \[ = 0.031 \]
- lbs/min polymer
  = 0.031 tons/min x 12 lbs polymer/ton dry solids
  = 0.375

- gal/min polymer = 0.0175 lbs/min 0.005 poly 8.34 lbs/gal
  = 0.9

- gal/hour polymer = 0.9 gal/min poly x 60 min/hr
  = 540

The feed rate calculated is the amount of polymer solution which must be delivered to
the application point by the polymer pump.

The actual ratio controller set point required to produce the polymer feed rate calculated
above, can be estimated when the maximum polymer pump capacity is known. The
pump speed is estimated as below and the speed achieved by manually adjusting the
polymer controller to the desired setting. By placing the controller in AUTO, it will work
to achieve a speed relative to the sludge flow rate by interpretation of a programmed
ratio setting. The desired pump speed is calculated as follows:

% pump speed (of max) = \( \frac{540}{\text{gal/hr polymer max}} \times \frac{100}{\text{polymer pump rate}} \)

= \( \frac{540}{\text{gal/hr polymer}} \times \frac{100}{900 \text{ gal/hr}} \)

= 0.60 x 100

= 60%

During the LOCAL mode of operation, the polymer feed pumps will operate
continuously, and their speed will be set by the operator, based on: (1) the desired
polymer dosage, (2) the actual process flow rate, and (3) the concentration of the
polymer solution being fed.

The procedures outlined above are also applicable for manual control. However, due to
sludge flow and solids concentration fluctuations it may be necessary to overdose with
polymer to prevent under conditioning of sludge prior to thickening or dewatering
operations.

28.4.4 Process Optimization

CDM Camp, Dresser & McKee 28-29
The use and benefit to be derived from a particular polymer can only be determined by tests performed in the laboratory (jar tests), in a pilot plant, or in full-scale operation. A polymer that works well under certain conditions may not work elsewhere under similar or different conditions. For this reason, it is advantageous to set up a series of polymer tests for both thickening and dewatering to compare the results and costs. This can be accomplished by inviting several different polymer vendors to conduct jar tests at the plant using samples of their products. The results including dosage, performance data, and cost (in dollars per ton of dried sludge solids) can be compared to choose the optimum type of polymer for process use. The thickened or dewatering sludge feed and product quality should be monitored closely over the period of time it takes for all of the vendors to complete their tests to ensure that all of the products are tested on sludge of the same quality. Otherwise, the test results become difficult to compare.

When applying polymers to sludge feed, the operator should be careful not to under- or over-dose the polymer. At low polymer dosages, insufficient particle destabilization is likely to occur due to deficient charge sites or bridging. At high polymer dosages, restabilization can occur, due to the presence of too many charge sites or bridges, causing sludge mats that pool free water. Jar testing, or experience with plant operations, can determine the type and appropriate polymer dose.
28.5 Normal Operation

In the day-to-day operation of the gravity belt thickening process and the centrifuge process, the operator has the option available of using either the dry polymer or liquid polymer system.

Many issues hinge on which type and concentration of polymer to use: availability of polymer, characteristics of sludge being thickened or dewatered, most recent jar test results, process equipment status, etc. Regardless of the condition, accurate determinations as to required concentrations and necessary volumes of polymer must be made to insure that adequate polymer solution is available and that the proper concentration of "thickened sludge" or "dewatered cake" is achieved.

It is critical that the operations staff develop and closely monitor a daily status sheet on the quantities of sludge to be thickened and dewatered. They need to be aware of the volume of polymer, both in a dry and liquid form, that is available so that sludge processing is not interrupted. Processing of sludge on a daily basis is imperative towards the proper operation of the treatment facility. The inability to address sludge processing would be very detrimental to the plant process and, obviously, would have a major impact on all treatment processes.

28.5.1 Liquid Polymer Make-up Systems

The dewatering process liquid polymer system consists of two liquid polymer progressive cavity transfer pumps and a bulk liquid polymer storage tank. The thickening process system consists of one progressive cavity transfer pump taking suction from 55 gallon liquid polymer drums or alternatively from the bulk liquid polymer storage tank.

Liquid polymer is pumped by the respective transfer pump to the mix/use tanks for dilute polymer make-up. When the individual make-up system is in the LIQUID control mode, the transfer pump is activated by a signal from a level transmitter in the mix/use tank. The polymer control panel will activate at a predetermined "low level" signal to start the transfer pumps and consequently begin refilling the mix/use tank with dilution water. The dilute polymer make-up cycle is initiated and controlled by the mix/use tank(s) level control probes. The cycle is essentially identical to the dry polymer except for the operation of the dry polymer feeder.

Because there are a variety of liquid polymer solutions available, each manufacturer offers various solution strengths, solids concentrations, and molecular weights and charges. The percentage value of the liquid polymer being used must be known in order to prepare a proper dilution. The value of liquid polymer needed and the related proportion of water must be identified with assistance from the polymer supplier.
Additionally, the operator may rely on past experience with the particular polymer and the sludge coagulation needs.

28.5.2 Dry Polymer Make-up Systems

There are two dry polymer make-up systems: one for the dewatering process and one for the thickening process. Both systems are similar in operations with minor differences. The thickening system is configured to accept 50 pound bags of dry polymer loaded into a loading hopper. During loading of the bags a dust collector blower and filter bag arrangement mounted locally to the make-up system prevents the release of fugitive dust. The dewatering system utilizes 1200 pound bags and a monorail and hoist to allow direct attachment to the make-up system hopper, this system does not require a dust control filter and blower. Both systems are provided with low level indicators to alert the operator of pending supply exhaustion.

Make-up of dilute polymer is initiated by the level probes in the mix/use tanks. A low level will switch the two mix/use tanks by opening the full tank’s motorized supply valve and closing the empty tank’s motorized supply valve. The valves provide dilute aged polymer to the polymer metering pumps within the basement. Additionally, the low level indication will initiate the feeding of dry polymer to the cyclone wetting device and begin filling the empty mix/use tank with tepid protected water. Wetted polymer is discharged to the make-up unit’s receiving tank for fast mixing of a concentrated polymer solution. The polymer solution is pumped by the make-up unit’s transfer pump to the mix/use tank for dilute polymer make-up. At a predetermined level, the tank mixer will energize and mix the dilute polymer solution for a pre-set time period after tank filling has completed.

With the local control panel in the AUTO and DRY control modes, which will be the desired method of operation of the dry polymer system, a variety of preset time delays will actuate the various components of the dry polymer system. Once the dry polymer system is activated, a time delay will energize the atomizing and scrubber blowers. Additionally, two solenoid valves on the water supply line will open to allow water to flow to the wetting device for an established time period and to begin the quick fill of the mix/use tank. Following this, the volumetric dry feeder will begin to operate for a preset time, transferring dry polymer into the cyclone wetting device and slurry receiving tank below the wetting device. After the dry feeder times out, the blowers and mix water will continue to operate for a preset time to purge the polymer slurry from the receiving tank and transfer line. A second time delay will allow the second water supply solenoid to continue to flow to the mix/use tank for a preset time thereby filling the tank and completing the batch process. During the filling of the mix/use tank, a mixer will automatically energize on tank level and time out once the make-up operations has completed.
When calculating the dry chemical to water ratio, any flushing water used prior to or following the preparation of the polymer solution does not necessarily need to be considered into the formula. However, it can be calculated by identifying the period of time allocated for flushing water before and after polymer preparation and multiplying this value by the dilution water rate.

28.5.3 Polymer Metering Pumps - Gravity Belt Thickener

The five polymer metering pumps that control the flow of polymer to the gravity belt thickener are progressing cavity type pumps. Control of the pumps can be exercised locally or at the respective gravity belt thickener (GBT) local panel.

With the pump's local control panel in the LOCAL and HAND mode, the pumps are manually started and stopped and the speed of the pump is adjusted by a potentiometer by the operator. By placing the pump local control panel in the REMOTE and AUTO mode control is transferred to the GBT control panel. At the GBT local panel with the controller in the AUTO mode and the START/STOP selector switch in the START position, the metering pumps will regulate feed to the gravity belt thickeners based upon the individual pump ratio controller setting and the sludge feed rate to the GBT.

When operating the polymer pumps in the AUTO mode certain interlock functions are enabled. These interlocks are important to the protection of subsequent equipment and for the continued proper operation of the thickening process. The polymer feed pumps are provided with run permissives that will not allow the polymer pump to start until a gravity belt thickener run condition is provided. Additionally, the polymer pump must be running in order to start the GBT sludge feed pumps. Lastly when the polymer pump is started it will open the corresponding dilution water solenoid valve adding dilution water to the polymer feed to the GBT.

An alternate polymer pump is provided for each of the gravity belt thickeners. The alternate pump will be controlled while in the AUTO control mode similarly as the dedicated polymer pump with the same permissives and start functions. Selection of the alternate pump is made from LCP-6 or from the DOC by the operator.

28.5.4 Polymer Metering Pumps - Centrifuges

The five polymer metering pumps that control the flow of polymer to the centrifuges are progressing cavity type pumps. Control of the pumps can be exercised locally or at LCP-7.

With the pump's local control panel in the LOCAL and HAND mode, the pumps are manually started and stopped and the speed of the pump is adjusted by a
potentiometer by the operator. By placing the pump local control panel in the REMOTE and AUTO mode control is transferred to LCP-7. At LCP-7 with the controller in the AUTO mode and the START/STOP selector switch in the START position, the metering pumps will regulate feed to the centrifuge based upon the individual pump ratio controller setting and the sludge feed rate to the centrifuge.

When operating the polymer pumps in the AUTO mode certain interlock functions are enabled. These interlocks are important to the protection of subsequent equipment and for the continued proper operation of the dewatering process. The polymer feed pumps are provided with run permissives that will not allow the polymer pump to start until a centrifuge run condition is provided. The centrifuge run condition permissive is enabled after sufficient start-up time has elapsed for the machine to accept polymer and sludge. This time delay is defined by the centrifuge supplier and beyond the operator’s control. Additionally, the polymer pump must be running in order to start the centrifuge sludge feed pumps. Lastly, when the polymer pump is started it will open the corresponding dilution water solenoid valve adding dilution water to the polymer feed to the GBT.

An alternate polymer pump is provided for each of the centrifuges. The alternate pump will be controlled while in the AUTO control mode similarly as the dedicated polymer pump with the same permissives and start functions. Selection of the alternate pump is made from LCP-7 or from the DDC by the operator.
28.6 Alternate and Emergency Operation

28.6.1 Alternate Operation

In addressing alternatives in the operation of the polymer system, the operator is presented with many choices throughout the individual components and processes that make-up the polymer system. To begin, depending on the processing needs, availability of both dry and liquid polymers, and the compatibility of the polymer with the end use; the operator may choose operate either the wet or dry polymer make-up system. Availability or adaptability of a particular polymer to a specific process may be a problem, but the operator is, nevertheless, presented with several avenues of polymer application.

In analyzing the dry polymer system, the operator has only one dry polymer feeder assembly available per system. Therefore, the loss of the components on this system would render the entire dry polymer system inoperable.

The liquid polymer transfer system for the centrifuge polymer system has redundancy with two liquid polymer pumps with common suction and discharge headers to allow for alternating use.

The liquid polymer transfer system for the GBT polymer make-up system has the ability to withdraw liquid polymer either from 55 gallon drums or from the bulk liquid polymer storage tank. A stand-by transfer pump is not provided for the GBT system.

For the gravity belt and centrifuge polymer systems the dry and the liquid polymer systems utilize two mix/use tanks. Under normal operation, the tanks flip-flop between batching and feeding. Of course, in the case of alternate operation, modifications could be made in the method of operation to allow for sudden limitations in available mix/use tanks. The process may have to be operated on an abbreviated scale, but the ongoing processing of sludge could continue.

By the same token, each polymer feed system has five polymer feed pumps to meter polymer to the gravity belt thickeners and to the centrifuges. Each system has common suction and discharge headers to allow for a polymer feed pump to be taken out of service while still providing normal operating capabilities.

28.6.2 Emergency Operation

Loss of Power

When normal electrical service has been interrupted and the emergency generator comes on-line, power is automatically supplied to all equipment associated with the
polymer system. However, as dewatering operations are not likely to continue during operation on emergency power, there is not a need to operate the system. Most equipment associated with the polymer system are provided with momentary type START/STOP switches that will not allow the equipment to restart upon the restoration of power (emergency or normal). This equipment must be manually restarted from the local or remote device panels.

In certain instances if the polymer make-up system is interrupted in middle of its make-up cycle by a power outage the cycle may need to be reset prior to completing its batching. The manufacturer's service manual should be consulted for further information relative to its control panel functions.

**Equipment Failure**

Should the elements of the polymer system fail to operate properly, the equipment should be checked out using manufacturer's information as a guide. If it is determined that the unit must be shut down to facilitate repair, the operator should follow the shutdown procedure in Section 28.7.

Whether for thickening of waste activated sludge or dewatering of sludge, the addition of polymer is critical. It is only through polymer addition that the sludge is able to coagulate for proper water removal. Consequently, the loss of the polymer system would severely impact the sludge thickening and dewatering operation. Downtime of a large segment of this process should be kept to a minimum.
28.7 Shutdown Considerations

Since neither the dry nor liquid polymer systems will be operated on a continuous basis, it is important that the units be cleaned and flushed at the completion of each day's operation. Residual polymer, in either the dry or liquid form, should not be permitted to accumulate on equipment or inside valves or piping for an extended period. If polymer remains on a component and is permitted to harden, it becomes extremely difficult to remove. Valves may become very difficult to open or close and pumps will become clogged. In these instances, to avoid damaging the pump the operator may find it necessary to disassemble and clean the pump before it will operate properly.

28.7.1 Liquid Polymer System

At the completion of the last polymer batch for the day, the polymer system should be taken out of the AUTO mode in preparation for system flushing and shutdown.

1. Close the valves on the discharge of the liquid polymer storage tanks.
2. Verify that the polymer solution that was prepared in the mix/use tank has been removed.
3. Open the valving controlling flushing water and allow the water to flow into the suction lines of the polymer transfer pumps.
4. Verify that the discharge valves on the mix/use are closed. It is desirable to fill the mix/use tanks with water and clean any residual polymer from the tank, as well as allowing the mix/use tank to act as a flushing water source, verify that the discharge valves on the mix/use tanks are closed.
5. Activate the liquid polymer transfer pumps and begin pumping flushing water through the pumps and piping and into the mix/use tanks.
6. Activate the mixers on the mix/use tank in HAND to remove any residual polymer solution from the mixer shaft and impellers as well as providing some turbulence of water on the walls of the mix/use tank to further facilitate cleaning.
7. Cleaning of the polymer system from the mix/use tanks to the gravity belt thickener and belt filter press will be covered in Section 28.7.3.
28.7.2 Dry Polymer System

At the completion of the last polymer solution batch for the day, the dry polymer system should be taken out of AUTO mode in preparation for system flushing and shutdown.

1. If the dry polymer make-up system for the gravity belt thickener is going to be out of service for any extended length of time (several days), it is important that the dry polymer feed hopper be emptied of any dry polymer. Any moisture in the vicinity of the dry polymer hopper may cause the dry polymer particles to cake and clump. The 1200 lb bag system used on the dewatering make-up system is not as prone to the effects of moisture due to its attachment.

2. Verify that the discharge isolation valve and other valving on the feed line to the mix/use tank are open to allow flushing water into the tank.

3. Activate the make-up water system to allow water to flow through the wetting device.

4. Since it is desirable to fill the mix/use tanks with water and clean any residual polymer from the tank, as well as allowing the mix/use tank to act as a flushing water source, verify that the discharge valves on the mix/use tanks are closed.

5. Activate the mixers on the mix/use tank in HAND to remove any residual polymer solution from the mixer shaft and impellers, as well as providing some turbulence of water on the walls of the mix/use tank to further facilitate cleaning.

NOTE: Based upon certain operating conditions, the operator may need to shutdown the mixer(s) on the mix/use tanks. The local control should be placed in the OFF position and the MCC circuit breaker should be locked out and tagged.

6. Cleaning of the polymer system from the mix/use tanks to the gravity belt thickener and centrifuge press will be covered in Section 28.7.3.

If the dry polymer feeder assembly will be out of service for an extended period of time:

7. Inspect the hopper and verify that no dry polymer remains.

8. Place all local controls in the OFF position.
9. Place the control switches at the polymer control panel in the OFF position.

10. Shut off the power supply at the MCC panel, lockout the switch, and tag.

28.7.3 Gravity Belt Thickener and Centrifuge Polymer Feed Pumps

The procedure for cleaning and flushing the pumps feeding polymer to the gravity belt thickener and the centrifuge assumes that processing of sludge to either of these units has ceased and that the units are prepared for cleaning and flushing.

1. Open the motorized discharge valves of the mix/use tanks.

2. Verify that the valving on the suction and discharge of the feed pumps is open.

3. Activate the gravity belt thickener and/or centrifuge polymer feed pumps. Supplemental flushing water for either set of pumps is available on the suction side of each pump.

CAUTION: Generally, the flushing water pressure is not regulated and may equal the plant water system discharge pressure. Introducing this pressurized source of water at the pumps may cause damage to components sensitive to its effects: low pressure gauges, pressure switches, sensors, pump seals, etc. Every effort must be taken to minimize the effect that the high pressure may have on these and other components by component isolation and restriction of the flushing water supply.

4. When pumping flushing water from the mix/use tank, monitor the level of water in the tanks to insure that adequate water is available and that the tanks do not empty and damage the pumps.

If the polymer feed pumps will be out of service for an extended period of time:

5. Stop the pump to be taken off line and close the suction and discharge valving.

6. Place the local control in the OFF position.

7. Place the control switch at the polymer, dewatering, or thickening control panel (where applicable) in the OFF position.
8. Shut off the circuit breaker at the MCC panel, lockout the switch, and tag.

When the operator is satisfied that adequate flushing of the system has taken place, the pumps and mixers should be shutdown and the mix/ use tanks should be drained. The individual components should then be returned to their "startup" mode in preparation for the next sludge processing procedure.
28.8 Startup Considerations

The following provides guidelines on the startup of the various components of the polymer transfer and metering system. Since the system will be in a "Startup" mode each day, some of the steps outlined will not be necessary. Nevertheless, each of these approaches is based upon a complete startup of each system and its components.

28.8.1 Liquid Polymer System

1. Verify that the local controls of the polymer transfer pump(s) and mix/use tank mixers are in the OFF position.

2. Verify that the following controls are in the OFF position at the polymer control panel (per tank):
   - Mix/use Tank Level Control
   - Distribution Valve
   - Water Valve
   - Discharge Valve
   - Polymer Transfer Pump(s)
   - Mixers

3. Unlock and remove tags from the MCC switches and place the disconnect switches in the ON position.

4. Verify that all valving on the suction and discharge of the polymer transfer pump(s) is aligned correctly.

5. Verify that all valving on the make-up water system is aligned correctly.

6. Place the following components in the AUTO mode to begin the liquid polymer transfer system:
   - Mix/use tank level control
   - Distribution valve
   - Water valve
   - Discharge valve
   - Polymer transfer pumps
   - Mixers

7. Place the DRY/LIQUID selector switch in the LIQUID position and depress the SYSTEM START pushbutton to start the sequence. The process will only commence when the low level in the mix/use tank is
28.8.2 Dry Polymer System

1. Verify that the local controls of the dry polymer feeder assembly are in the OFF position.

2. Verify that the following controls are in the OFF position at the polymer control panel (per tank):
   - Mix/use tank level control
   - Distribution valve
   - Water valve
   - Discharge valve
   - Mixers

3. Unlock and remove tags from the MCC switches and place the disconnect switches in the ON position.

4. Load hopper with dry polymer.

5. Verify that the hopper vibrator is placed in the AUTO position.

6. Identify and verify that the desired feed rate of dry polymer is set.

7. Verify that the valving for the make-up water system and the polymer distribution system are positioned correctly.

8. Place the following switches in the AUTO mode in preparation for beginning the make-up of the polymer solution:
   - Mix/use Tank Level Control
   - Distribution Valve
   - Water Valve
   - Discharge Valve
   - Mixers

9. Place the DRY/LIQUID selector switch in the DRY position and depress the SYSTEM START pushbutton to start the sequence. The process will only commence when the low level in the mix/use tank is reached.

Once the make-up system begins its batching operations the operator should proceed.

CDM Camp, Dresser & McKee 28-42
as follows:

10. Verify that the blower starts and the make-up water begins flowing through the wetting device and into the mix/ use tanks.

11. Verify that the dry polymer feeder starts and that the flow of dry polymer into the wetting device begins.

12. Verify that the volumetric dry feeder times out and stops, and that the blowers stop.

13. Verify that when the mix/use tanks mixer blades are submerged, the mixer starts and then stops after the preselected time.

14. Monitor the level of polymer solution in the mix/use tank and verify that the water feed to the tank shuts down at the designated level.

15. If desired, the system should begin batching the second polymer mix/age tank, if empty.

28.8.3 Polymer Feed Pumps

The following will only address preparations for startup of the gravity belt thickener and centrifuge polymer feed pumps. The operator will need to consult the appropriate sections of the O&M Manual for information on startup of the gravity belt thickeners and centrifuges and their associated sludge pumps.

1. Verify that the local controls of the gravity belt thickener and centrifuge polymer feed pumps are in the OFF position.

2. Verify that the gravity belt thickener polymer feed pumps at the sludge thickener control panel and the centrifuge polymer feed pumps at LCP-7 are in the OFF position.

3. Unlock and remove tags from the MCC switches and place switches in the ON position.

4. Verify that all valving on the suction and discharge of the feed pumps for both systems is aligned correctly.

5. Place the polymer metering pumps for the gravity belt thickener and centrifuge in the AUTO mode.
Once the pump has been called to start by the run permissives, the operator should proceed as follows:

6. Set the dilution water flow for the polymer solution feed at the desired flow rate. Generally, 3 to 5% of the total sludge flow to the respective GBT or centrifuge.
28.9 Safety Considerations

The following hazards are associated with the operation of the polymer system.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>Acids and Alkalis (Polymer)</td>
<td>8.4.2</td>
</tr>
<tr>
<td>Electrical</td>
<td>8.4.5</td>
</tr>
<tr>
<td>Electrically Powered Equipment</td>
<td>8.4.6</td>
</tr>
</tbody>
</table>
City of New Bedford, Massachusetts
Wastewater Treatment Plant

Figure 28-2
Centrifuge Polymer Flow Diagram
## Chapter 29
Potassium Permanganate System

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.1 Functional Description</td>
<td>29-2</td>
</tr>
<tr>
<td>29.2 Design Data</td>
<td>29-3</td>
</tr>
<tr>
<td>29.3 Equipment Controls</td>
<td>29-4</td>
</tr>
<tr>
<td>29.4 Process Controls</td>
<td>29-19</td>
</tr>
<tr>
<td>29.5 Normal Operation</td>
<td>29-21</td>
</tr>
<tr>
<td>29.6 Alternate and Emergency Operation</td>
<td>29-22</td>
</tr>
<tr>
<td>29.6.1 Alternate Operation</td>
<td>29-22</td>
</tr>
<tr>
<td>29.6.2 Emergency Operation</td>
<td>29-22</td>
</tr>
<tr>
<td>29.7 Shutdown Considerations</td>
<td>29-23</td>
</tr>
<tr>
<td>29.8 Startup Considerations</td>
<td>29-25</td>
</tr>
<tr>
<td>29.9 Safety Considerations</td>
<td>29-27</td>
</tr>
</tbody>
</table>
29.1 Functional Description

Potassium permanganate is a strong oxidizing agent which is applied to oxidize odor-producing compounds created when sludge is held or stored for a period of time. The chemical is delivered at the treatment plant in a dry granular form and a specific quantity is mixed with water in a make-up/use tank. This solution can then be applied at the following locations:

- Influent feed line to the gravity thickener distribution box.
- Influent feed line to the sludge storage tanks (the discharge of the thickened primary sludge pumps).
- Sludge feed line of the centrifuges.
- Downstream of the centrifuge feed pumps.
- Sludge feed line of the gravity belt thickener.
- Direct injection into the TWAS well.

These application points allow the operator an element of versatility in applying the potassium permanganate solution, although application of the chemical prior to the sludge entering the sludge storage tanks would be more advantageous for several reasons. Application at this point would allow the permanganate to be applied and distributed to the sludge throughout the volume of the storage tank. In addition, chemical application at the thickened primary sludge discharge line would assure that adequate mixing would take place. Whereas, the injection of potassium permanganate immediately following the centrifuge feed pumps, would provide very little time for adequate mixing and distribution of the chemical as compared to its injection directly into the tanks.
29.2 Design Data

**Permanganate Make-up/Use Tank**

<table>
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<tr>
<th>Specification</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Number of Tanks</td>
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<tr>
<td>Total Capacity, gallons each tk</td>
<td>1,480 ea.</td>
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<tr>
<td>Dimensions, dia/ht, ft</td>
<td>6.0/8.0</td>
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<tr>
<td></td>
<td>1,270 ea.</td>
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**Permanganate Make-up/Use Tank Mixer**

<table>
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<th>Specification</th>
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<tbody>
<tr>
<td>Number of mixers</td>
<td>2 (1 per tank)</td>
</tr>
<tr>
<td>Application</td>
<td>Mix dry potassium permangate crystals into solution</td>
</tr>
<tr>
<td>Mixing speed, rpm/max</td>
<td>350</td>
</tr>
<tr>
<td>Mixing time</td>
<td>Contents blended in less than 1 hour</td>
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<tr>
<td>Motor speed, rpm/max</td>
<td>1,800</td>
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<tr>
<td>Motor size, hp</td>
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**Permanganate Feed Pumps**

<table>
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<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Number of pumps</td>
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</tr>
<tr>
<td>Pump type</td>
<td>Hydraulic diaphragm, Simplex, Variable speed</td>
</tr>
<tr>
<td>Capacity, gph</td>
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<tr>
<td>Pump speed, strokes/min</td>
<td>116</td>
</tr>
<tr>
<td>Motor size, hp</td>
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</tr>
</tbody>
</table>
29.3 Equipment Controls

The following controls and their functions are associated with the equipment described above. Controls are listed from the device and its control panel (LOCAL), through the Motor Control Center (MCC), to the Local Control Panel (LCP) and the remote Central Processing Unit (CPU). Devices controlled by the CPU are accessed from either the Central Operator's Console (COC) or the Distributed Operator's Console (DOC).

Potassium Permanganate Feed Pump Nos. 1 & 7

LOCAL:

With the respective feed pump panel ON/OFF selector in the ON position, the LOCAL/AUTO selector switch in the LOCAL position, and the HAND/OFF/AUTO selector switch in the HAND position, the pump may be started and its speed manually controlled at the pump control panel. START and STOP pushbuttons and speed potentiometers are provided. If the LOCAL/AUTO selector switch is in the AUTO position and the H-O-A switch is in the AUTO position, the pump will be controlled by the respective flow (RAS or Effluent and pacing signal) controller. If the H-O-A switch is placed in the OFF position, the pump is stopped. Red-RUN and green-OFF status lights, accumulative running time meters, and reset pushbuttons are provided.

Pump stroke length is adjustable at the respective pump.

MCC-SP-1:

If the ON/OFF disconnect switch is in the ON or closed position, power is available and the local chemical pump control panel is energized.

LCP-7

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump. Also provided are pump ON, OFF, AUTO & COMP status lights; and a pump TROUBLE alarm annunciator.
If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the ON/OFF/AUTO selector switch on the DOC is in the START position, the pump is started. If the ON/OFF/AUTO selector switch on the DOC is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the ON/OFF/AUTO selector switch on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump.

If the FLOW INDICATING CONTROLLER on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the flow indicating controller on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller. If the flow indicating controller on the LCP is in the COMPUTER position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the ratio controller on the DOC is in the MANUAL position, the ratio value used is from the flow indicating controller. If the ratio controller on the DOC is in the AUTO position, the ratio value used is from the keyboard.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO selector switch is in the HAND position, the pump cannot be operated remotely.

Also provided are pump ON, OFF, COMP & RATIO status lights; a pump TROUBLE alarm annunciator; pump speed and chemical usage indicators.
Potassium Permanganate Feed Pump No. 2

LOCAL:
With the respective feed pump panel ON/OFF selector in the ON position, the LOCAL/REMOTE selector switch in the LOCAL position, and the HAND/OFF/AUTO selector switch in the HAND position, the pump may be started and its speed manually controlled at the pump control panel. START and STOP pushbuttons and speed potentiometers are provided. If the LOCAL/REMOTE selector switch is in the AUTO position and the H-O-A switch is in the AUTO position, the pump will be controlled by the respective flow (RAS or Effluent and pacing signal) controller. If the H-O-A switch is placed in the OFF position, the pump is stopped. Red-RUN and green-OFF status lights, accumulative running time meters, and reset pushbuttons are provided.

Pump stroke length is adjustable at the respective pump.

MCC-SP-1
If the ON/OFF disconnect switch is in the ON or closed position, power is available and the local chemical pump control panel is energized.

LCP-7
If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump. If the CENTRIF NO. 1/CENTRIF NO. 2 selector switch on the LCP is in the NO. 1 position, centrifuge sludge feed pump NO. 1 is used. If the CENTRIF NO. 1/CENTRIF NO. 2 selector switch on the LCP is in the NO. 2 position, the centrifuge sludge feed pump NO. 2 is used.

DOC:
If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the START/STOP/AUTO/COMP selector switch on the DOC is in the START position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the DOC is in the STOP position, the pump is stopped.
If the HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the CENTRIF NO. 1/1CENTRIF NO. 2 selector switch on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump. If the the CENTRIF NO. 1/1CENTRIF NO. 2 selector switch on the DOC is in the NO. 1 position, centrifuge sludge feed pump No. 1 is used. If the CENTRIF NO. 1/1CENTRIF NO. 2 selector switch on the DOC is in the NO. 2 position, centrifuge sludge feed pump No. 2 is used.

If the flow indicating controller on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller If the flow indicating controller on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller if the flow indicating controller on the LCP is in the COMPUTER position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room If the ratio controller on the DOC is in the MANUAL position, the ratio value used is from the flow indicating controller if the the ratio controller on the DOC is in the AUTO position, the ratio value used is from the keyboard.

If the flow indicating controller on the LCP is in the AUTO position and the CENTRIF NO. 1/1CENTRIF NO. 2 selector switch on the LCP is in the NO 1 position, the flow pacing signal used is the centrifuge No 1 flow. If the CENTRIF NO. 1/1CENTRIF NO. 2 selector switch on the LCP is in the NO 2 position, the flow pacing signal used is the centrifuge No 2 flow. If the flow indicating controller on the LCP is in the COMPUTER position, the pacing signal is selected via the keyboard in the control room. If the CENTRIF NO. 1/1CENTRIF NO. 2 selector switch on the DOC is in the NO.1 position, the flow pacing signal used is the centrifuge No 1 flow. If on the DOC is in the NO 2 position, the flow pacing signal used is the centrifuge No 2 flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.
A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO SELECTOR SWITCH is in the HAND position, the pump cannot be operated remotely.

Also provided are pump ON, OFF, COMP & RATIO status lights; a pump TROUBLE alarm annunciator; pump speed and chemical usage indicators.

Potassium Permanganate Feed Pump No. 3

LOCAL:

With the respective feed pump panel ON/OFF selector in the ON position, the LOCAL/REMOTE selector switch in the LOCAL position, and the HAND/OFF/AUTO selector switch in the HAND position, the pump may be started and its speed manually controlled at the pump control panel. START and STOP pushbuttons and speed potentiometers are provided. If the LOCAL/REMOTE selector switch is in the AUTO position and the H-O-A switch is in the AUTO position, the pump will be controlled by the respective flow (RAS or Effluent and pacing signal) controller. If the H-O-A switch is placed in the OFF position, the pump is stopped. Red-RUN and green-OFF status lights, accumulative running time meters, and reset pushbuttons are provided.

Pump stroke length is adjustable at the respective pump.

MCC-SP-1:

If the ON/OFF disconnect switch is in the ON or closed position, power is available and the local chemical pump control panel is energized.

LCP-7

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump. If is in the NO. 2
position, centrifuge sludge feed pump No. 2 is used. If the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the LCP is in the NO. 3 position, centrifuge sludge feed pump No. 3 is used.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and THE START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the DOC is in the START position, the pump is started if the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the DOC is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and THE START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump. If the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the DOC is in the NO. 2 position, centrifuge sludge feed pump No. 2 is used. If the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the DOC is in the NO. 3 position, centrifuge sludge feed pump No. 3 is used.

If the flow indicating controller on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the flow indicating controller on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller if the flow indicating controller on the LCP is in the COMPUTER position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the ratio controller on the DOC is in the MAN position, the ratio value used is from the flow indicating controller. If the ratio controller on the DOC is in the AUTO position, the ratio value used is from the keyboard.

If the flow indicating controller on the LCP is in the AUTO position and if the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the LCP is in the NO. 2 position, the flow pacing signal used is the centrifuge No. 2 flow. If the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the LCP is in the NO. 3 position, the flow pacing signal used is the centrifuge No. 3 flow.
If the flow indicating controller on the LCP is in the COMPUTER position, the pacing signal is selected via the keyboard in the control room. If the CENTRIFIG NO. 2/CENTRIFIG NO. 3 selector switch on the DOC is in the NO 2 position, the flow pacing signal used is the centrifuge No. 2 flow. If the CENTRIFIG NO. 2/CENTRIFIG NO. 3 selector switch on the DOC is in the NO 3 position, the flow pacing signal used is the centrifuge No. 3 flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local/HAND/OFF/AUTO selector switch is in the LOCAL position, the pump cannot be operated remotely.

Also provided are pump ON, OFF, COMP & RATIO status lights; a pump TROUBLE alarm annunciator; pump speed and chemical usage indicators.

Potassium Permanganate Feed Pump No. 4

LOCAL:

With the respective feed pump panel ON/OFF selector in the ON position, the LOCAL/REMOTE selector switch in the LOCAL position, and the HAND/OFF/AUTO selector switch in the HAND position, the pump may be started and its speed manually controlled at the pump control panel. START and STOP pushbuttons and speed potentiometers are provided. If the LOCAL/REMOTE selector switch is in the AUTO position and the H-O-A switch is in the AUTO position, the pump will be controlled by the respective flow (RAS or Effluent and pacing signal) controller. If the H-O-A switch is placed in the OFF position, the pump is stopped. Red-RUN and green-OFF status lights, accumulative running time meters, and reset pushbuttons are provided.

Pump stroke length is adjustable at the respective pump.

MCC-SP-1:

If the ON/OFF disconnect switch is in the ON or closed position,
power is available and the local chemical pump control panel is energized.

**LCP-7**

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the LCP is in the NO. 3 position, centrifuge sludge feed pump No. 3 is used. If the CENTRIF NO. 2/CENTRIF NO. 3 selector switch on the LCP is in the NO. 4 position, centrifuge sludge feed pump No. 4 is used.

**DOC:**

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the DOC is in the START position, the pump is started. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the DOC is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the CENTRIF NO. 3/CENTRIF NO. 4 SELECTOR SWITCH on the DOC is in the AUTO position, the pump is started and stopped by the centrifuge sludge feed pump. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the DOC is in the NO. 3 position, centrifuge sludge feed pump No. 3 is used. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the DOC is in the NO. 4 position, centrifuge sludge feed pump No. 4 is used.

If the flow indicating controller is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the flow indicating controller on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller. If the flow indicating
controller on the LCP is in the COMPUTER position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the ratio controller on the DOC is in the MANUAL position, the ratio value is used from the flow indicating controller. If the ratio controller on the DOC is in the AUTO position, the ratio value used is from the keyboard.

If the flow indicating controller on the LCP is in the AUTO position and the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the LCP is in the NO. 3 position, the flow pacing signal used is the centrifuge NO. 3 flow. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the LCP is in the NO. 4 position, the flow pacing signal used is the centrifuge NO. 4 flow. If the flow indicating controller is in the COMPUTER position, the pacing signal is selected via the keyboard in the control room. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the DOC is in the NO. 3 position, the flow pacing signal used is the centrifuge No. 3 flow. If the CENTRIF NO. 3/CENTRIF NO. 4 selector switch on the DOC is in the NO. 4 position, the flow pacing signal used is the centrifuge No. 4 flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO selector switch is in the HAND position, the pump cannot be operated remotely.

Also provided are pump ON, OFF, COMP & RATIO status lights; a pump TROUBLE alarm annunciator; pump speed and chemical usage indicators.

Potassium Permanganate Feed Pump No. 5

LOCAL: With the respective feed pump panel ON/OFF selector in the ON position, the LOCAL/REMOTE selector switch in the LOCAL position, and the HAND/OFF/AUTO selector switch in

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300-177-05-MN
the HAND position, the pump may be started and its speed manually controlled at the pump control panel. START and STOP pushbuttons and speed potentiometers are provided. If the LOCAL/REMOTE selector switch is in the AUTO position and the H-O-A switch is in the AUTO position, the pump will be controlled by the respective flow (RAS or Effluent and pacing signal) controller. If the H-O-A switch is in the OFF position, the pump is stopped. Red-RUN and green-OFF status lights, accumulative running time meters, and reset pushbuttons are provided.

Pump stroke length is adjustable at the respective pump.

**MCC-SP-1:**
If the ON/OFF disconnect switch is in the ON or closed position, power is available and the local chemical pump control panel is energized.

**LCP-7:**
If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started if the START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

**DOC:**
If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room if HS-C on the DPU is in the START position, the pump is started if HS-C on the DPU is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the ON/OFF/AUTO selector switch on the DOC is in the AUTO position, the pump is started and stopped by other equipment. If the four position CENTRIF NO. 4/ TPS LINE NO. 2/TPS LINE NO. 2/GRAVITY THICKENER SELECTOR SWITCH on the DPU is in the NO 4 position, centrifuge sludge feed pump No 4 is used if the four position CENTRIF NO. 4/ TPS LINE NO. 2/TPS LINE NO. 2/GRAVITY THICKENER SELECTOR SWITCH on the DPU is in the LINE NO 1 position, thickened primary sludge pumps 1, 2, 3 and 4 are used if the four position CENTRIF NO. 4/ TPS LINE NO. 2/GRAVITY THICKENER
SELECTOR SWITCH on the DPU is in the 'Line No 2' position,
thickened primary sludge pumps 5, 6, 7 and 8 are used. If the
four position CENTRIF NO. 4/TPS LINE NO. 2/TPS LINE NO.
2/GRAVITY THICKENER SELECTOR SWITCH on the DPU is
in the GRAVITY THICKENER position, primary sludge pumps 1
to 8, primary scum pumps 1 and 2, WAS pumps 1, 2 and 3 are
used.

If the flow indicating controller on the LCP is in the MANUAL
position, the speed setpoint may be manually controlled via the
controller. If the flow indicating controller on the LCP is in the
AUTO position, the speed setpoint is controlled by flow pacing,
with the ratio value entered via the controller. If the flow
indicating controller on the LCP is in the COMPUTER position,
the speed setpoint is controlled by flow pacing, with the ratio
value entered via the keyboard in the control room. If the ratio
controller on the DCP is in the MANUAL position, the ratio
value used is from the flow indicating controller. If the ratio
controller on the DCP is in the AUTO position, the ratio value
used is from the keyboard.

If the flow indicating controller on the LCP is in the AUTO
position and the four position CENTRIF No. 4/TPS LINE No.
1/TPS LINE No. 2/GRAVITY THICKENER selector switch on
the LCP is in the NO. 4 position, the flow pacing signal used is
the centrifuge No 4 flow. If the four position CENTRIF No.
4/TPS LINE No. 1/TPS LINE No. 2/GRAVITY THICKENER
selector switch on the LCP is in the LINE NO 1 position, the
flow pacing signal used is the thickened primary sludge flow. If
the four position CENTRIF No. 4/TPS LINE No. 1/TPS LINE No.
2/GRAVITY THICKENER selector switch on the LCP is in
the LINE NO 2 position, the flow pacing signal used is the
thickened primary sludge 2 flow. If the four position CENTRIF
No. 4/TPS LINE No. 1/TPS LINE No. 2/GRAVITY THICKENER
selector switch on the LCP is in the GRAVITY THICKENER
position, the flow pacing used is the primary sludge flow. If the
flow indicating controller on the LCP is in the COMPUTER
position, the pacing signal is selected via the keyboard in the
control room. If the four position CENTRIF No. 4/TPS LINE No.
1/TPS LINE No. 2/GRAVITY THICKENER selector switch on
the DCP is in the NO. 4 position, the flow pacing signal used is
the centrifuge No 4 flow. If the four position CENTRIF No. 4/TPS
LINE No. 1/TPS LINE No. 2/GRAVITY THICKENER selector
switch on the DCP is in the LINE NO 1 position, the flow pacing
signal used is the thickened primary sludge 1 flow. If the four
position CENTRIF No. 4/TPS LINE No. 1/TPS LINE No. 2/GRAVITY THICKENER selector switch on the DOC is in the LINE NO 2 position, the flow pacing signal used is the thickened primary sludge 2 flow. If the four position CENTRIF No. 4/TPS LINE No. 1/TPS LINE No. 2/GRAVITY THICKENER selector switch on the DOC is in the GRAVITY THICKENER position, the flow pacing used is the primary sludge flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If the local HAND/OFF/AUTO selector switch is in the HAND position, the pump cannot be operated remotely.

Also provided are pump ON, OFF, COMP & RATIO status lights; a pump TROUBLE alarm annunciator; pump speed and chemical usage indicators.

Potassium Permanganate Feed Pump No. 6

LOCAL:

With the respective feed pump panel ON/OFF selector in the ON position, the LOCAL/REMOTE selector switch in the LOCAL position, and the HAND/OFF/AUTO selector switch in the HAND position, the pump may be started and its speed manually controlled at the pump control panel. START and STOP pushbuttons and speed potentiometers are provided. If the LOCAL/REMOTE selector switch is in the AUTO position and the H-O-A switch is in the AUTO position, the pump will be controlled by the respective flow (RAS or Effluent and pacing signal) controller. If the H-O-A switch is placed in the OFF position, the pump is stopped. Red-RUN and green-OFF status lights, accumulative running time meters, and reset pushbuttons are provided.

Pump stroke length is adjustable at the respective pump.

MCC-SP-1:

If the ON/OFF disconnect switch is in the ON or closed position, power is available and the local chemical pump control panel is energized.
LCP-7:

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the START position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the LCP is in the STOP position, the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the AUTO position, the pump is started and stopped by other equipment. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the TWAS position, TWAS pumps 1 and 2 are used. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the LINE NO 1 position, thickened primary sludge pumps 1, 2, 3 and 4 are used. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the LINE NO 2 position, thickened primary sludge pumps 5, 6, 7 and 8 are used. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the GRAVITY THICKENER position, primary scum pumps I and 2, WAS pumps 1, 2 and 3 are used.

DOC:

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the START/STOP/AUTO/COMP selector switch on the DOC is in the START position, the pump is started. If the START/STOP/AUTO/COMP selector switch on the DOC is in the STOP position, then the pump is stopped.

If the local HAND/OFF/AUTO selector switch is in the AUTO position and the START/STOP/AUTO/COMP selector switch on the LCP is in the COMPUTER position, the pump is controlled via the keyboard in the control room. If the ON/OFF/AUTO selector switch on the DOC is in the AUTO position, the pump is started and stopped by other equipment. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the TWAS position, TWAS pumps 1 and 2 are used. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the LINE NO. 1 position, thickened primary sludge
pumps 1, 2, 3 and 4 are used if the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the LINE NO 2 position, thickened primary sludge pumps 5, 6, 7 and 8 are used. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the GRAVITY THICKENER position, primary sludge pumps 1 to 8, primary scum pumps 1 and 2, WAS pumps 1, 2 and 3 are used.

If the flow indicating controller on the LCP is in the MANUAL position, the speed setpoint may be manually controlled via the controller. If the flow indicating controller on the LCP is in the AUTO position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the controller. If the flow indicating controller on the LCP is in the COMPUTER position, the speed setpoint is controlled by flow pacing, with the ratio value entered via the keyboard in the control room. If the ratio controller on the DOC is in the MAN position, the ratio value used is from the flow indicating controller. If the ratio controller on the DOC is in the AUTO position, the ratio value used is from the keyboard.

If the flow indicating controller on the LCP is in the AUTO position and the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the TWAS position, the flow pacing signal used is the TWAS flow. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the LINE NO 1 position, the flow pacing signal used is the thickened primary sludge flow 1. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the LINE NO 2 position, the flow pacing signal used is the thickened primary sludge flow 2. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the LCP is in the GRAVITY THICKENER position, the flow pacing signal used is the primary sludge flow. If the flow indicating controller on the LCP is in the COMPUTER position, the pacing signal is selected via the keyboard in the control room. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the TWAS position, the flow pacing signal used is the TWAS flow. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the LINE NO 1 position, the flow pacing signal used is the thickened primary sludge flow 1.
NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the LINE NO 2 position, the flow pacing signal used is the thickened primary sludge 2 flow. If the four position gravity thickener TPS LINE NO. 1/TPS LINE NO. 2/TWAS selector switch on the DOC is in the GRAVITY THICKENER position, the flow pacing used is the primary sludge flow.

A ratio controller is implemented in software that performs the calculation (flow) x (ratio) + bias. As the flow increases, chemical feed increases, as flow decreases, chemical feed decreases.

A calculation is performed in software to determine the amount of chemical used. The calculation (pump speed) x (pump stroke) generates usage rate value. Pump stroke is manually entered via the keyboard.

If THE local HAND/OFF/AUTO SELECTOR SWITCH is in the HAND position, the pump cannot be operated remotely.

Also provided are pump ON, OFF, COMP & RATIO status lights; a pump TROUBLE alarm annunciator; pump speed and chemical usage indicators.
29.4 Process Controls

When handling a blended combination of thickened primary and waste activated sludge at a wastewater treatment plant, odor control is always a concern. These sludges, by their very nature, can create a serious odor problem and steps must be taken to limit the unpleasant odors emanating from the sludge feed system. For this reason, the potassium permanganate (KMnO₄) feed system was designed to address these odor concerns.

The potassium permanganate solution is made on a batch basis by educting the potassium permanganate crystals from the storage drum and adding these crystals to water at the make-up/use tank. Typically, the solution is made at a concentration of 3% to 5%. The solubility of potassium permanganate limits the amount of dry crystals that can be added to water to make a solution. Permanganate added in excess of its solubility results in undissolved crystals in the bottom of the make-up/use tank and waste. Typically, permanganate solution should be made less than 6% concentration. The operator may determine that he is over using permanganate by the appearance of crystals on the tank floor. More appropriately, the required quantity of crystals should be added at the time of batch make-up to prevent this condition. By targeting a batch concentration (3%), the below calculations may provide the required quantity of crystals at batch make-up.

\[
\text{Required, lbs} = \text{Batch size, gals} \times \text{Batch concentration, \%} \times 8.34 \text{ lbs/gal}
\]

\[
\text{Required, lbs} = 1200 \text{ gals} \times 0.03 \text{ \%} \times 8.34 \text{ lbs/gal}
\]

\[
\text{Required, lbs} = 300
\]

Since the potassium permanganate is used for odor control, the quantity that is applied is based upon the operator's belief that odors are being eliminated. Until the operator attains the ability to identify the quantity of potassium permanganate needed for his particular odor problem, a good "starting point" to achieve proper odor control would be one pound (1 lb) of potassium permanganate for each 1,000 gallons of sludge, or four gallons of permanganate solution (at 3% solution strength) for each 1,000 gallons of sludge.

Over time, the operator may find that the solution can be just as effective at a lower concentration, thereby lowering chemical costs while still achieving odor control. In addition, seasonal changes and temperature variations will impact potential odor problems since the hot temperatures of summer would create more of a need to suppress odors than the colder fall or winter temperatures.

In the design of the potassium permanganate system, some guidelines were established in anticipating the quantities of sludge generated per day and the subsequent quantity of potassium permanganate required for odor control. These
Ideas can be implemented during startup, followed by modifications as the plant operation progresses.
29.5 Normal Operation

Due to the sensitivity of the neighborhood to odors being generated by the wastewater treatment plant and the severity of odors common to primary and waste activated sludges, the potassium permanganate system will probably be operated on a regular basis. By injecting the permanganate solution into the sludge being fed to the sludge holding tank, and the supplemental injection points, odors can be kept to a minimum.

As discussed previously, the operator can begin with a solution of approximately one pound of potassium permanganate for every 1,000 gallons of sludge. Through experience, the operator can make modifications to the solution concentration and dosing rate to achieve optimum odor control results.
29.6 Alternate and Emergency Operation

29.6.1 Alternate Operation

The potassium permanganate system consists of two make-up/use tanks and seven metering pumps. The arrangement allows for operation of the system with only one make-up/use tank and with less than the bank of seven potassium permanganate pumps. In addition, the intent of the system is such that it need only be utilized during times of nuisance odor problems; problems that would be more pronounced in the warmer months. However, if there is a need to operate in a limited mode, extra equipment would be available to continue the odor control operation. Alternate operation would also include varying the injection points.

29.6.2 Emergency Operation

Loss of Power

When normal electrical service has been interrupted and the emergency generator comes on-line, power is not automatically supplied to all equipment associated with the potassium permanganate system.

Equipment Failure

Should the elements of the potassium permanganate system fail to operate properly, the equipment should be checked out using manufacturer’s information as a guide. If it is determined that the unit must be shut down to facilitate repair, the operator should follow the shutdown procedure in Section 29.7.

To avoid potential complaints from the neighborhood surrounding the treatment plant, the plant staff should minimize the amount of time that the potassium permanganate system is out of service. Although the system is not critical towards achieving wastewater treatment, the inability to operate this system could result in numerous complaints from the general public; a situation that should always be avoided and provisions made to correct as quickly as possible.
29.7 Shutdown Considerations

Since sludge thickening, blending, and dewatering is a continuous process at the wastewater treatment facility and odor control is such a vital concern at the plant and adjoining neighborhood, the potassium permanganate system will probably be required to operate on a fairly continuous basis. However, if the operations staff needs to take the system out of service, either in whole or in part, the following procedure outlines the steps involved:

1. Inspect the make-up/use tank and empty any remaining potassium permanganate solution from the tank through the chemical waste drain.

2. Close the waste drain and begin filling the make-up/use tank with make-up water to begin the flushing procedure.

3. Activate the mixer on the make-up/use tank by pressing the START pushbutton. This will allow the walls of the make-up/use tank to be washed with water.

4. If the operator plans to flush a metering pump and piping, verify that the valving is correct from the make-up/use tank, through the metering pump, to a sludge storage tank that is out-of-service. From the sludge storage tank, this flushing water can be pumped to the influent to the headworks. Remember to valve to an empty sludge storage tank to avoid diluting sludge already in a sludge storage tank.

5. Activate the metering pump by pressing the START pushbutton.

6. Depending upon how much flushing is required, the operator should continue to allow make-up water to flow into the make-up/use tank for pumping and flushing.

NOTE: Flushing of the pipes can be supplemented by adding dilution water to the discharge line of the metering pump.

7. Close the valving controlling the flow of make-up water into the make-up/use tank.

8. Pump the remaining water in the make-up/use tank from the tank and place the mixer START/STOP pushbutton in the STOP position.

9. Before the water is completely pumped from the tank, place the metering pump speed control to the ZERO position and the START/STOP pushbutton to the STOP position.
10. Empty any remaining flushing water through the chemical waste drain.

11. If a metering pump, as well as a make-up/use tank, is being taken out of service, close the appropriate valves to isolate the system.

12. Place the MCC circuit breakers for the metering pump(s) and mixer(s) in the OFF position.
29.8 Startup Considerations

The following outlines the steps involved in placing the potassium permanganate system online:

1. Verify that the local controls for the mixers on the make-up/use tanks and the local controls for the potassium permanganate metering pumps are in the OFF position.

2. At the remote control panel, verify that the potassium permanganate metering pumps’ H-O-A switch is in the OFF position and control switch is in the STOP position.

3. Unlock and remove tags from the MCC circuit breakers for the mixers and metering pumps and place in the ON position.

4. Verify that the valving configuration is correct from the make-up use tank, through to the metering pumps and the appropriate injection points. Also verify that dilution water valving is correct.

5. Place the H-O-A switch for the metering pump in the AUTO position and the START/STOP switch in the START position.

6. Activate the make-up water system to begin filling the make-up/use tank in preparation for the addition of potassium permanganate crystals.

7. Insert the potassium permanganate eductor system into the drum of potassium permanganate crystals and attach the flexible hoses to the hard piping.

8. Activate the water system for the eductor and begin transferring the crystals into the make-up/use tank.

9. Once the mixer impellers are submerged, activate the mixer by pressing the START pushbutton.

10. Once the proper amount of potassium permanganate crystals are educted into the make-up/use tank, shutdown the water to the eductor.

11. Allow the mixer to continue to operate for 20 to 30 minutes until the crystals are completely dissolved.

12. Interlock the potassium permanganate pump with the thickened primary sludge pumps, the centrifuge, or the gravity belt thickener, depending upon which source will receive the potassium permanganate solution.
13. Identify a desired speed control set point for the metering pump.

14. Once the thickened primary sludge pump, the belt filter press, or the gravity belt thickener is activated, verify that the potassium permanganate pump begins operation for the same period of time.
29.9 Safety Considerations

Potassium permanganate, also known as potassium acid or potassium salt, is dark purple or bronze in color, highly corrosive, and is processed in a crystallized form. In regards to health hazards, the dust of potassium permanganate may cause irritation to the nose and skin and will stain and harden the outer skin layers. If the chemical is ingested, even in concentrations of 1%, burning of the throat may result. Other symptoms include nausea, vomiting, and stomach pains. In higher concentrations (4% and above), kidney damage may occur.

When working with the chemical, the operator should wear gloves, an apron, goggles, and a dust mask. If the chemical should come in contact with the skin or eyes, the area should be flushed with water for at least 15 minutes. The individual should then seek medical attention.

The operator is encouraged to read the sample material data safety sheet following this section and the following sections of the O&M manual for additional insight into the hazards associated with working in a potassium permanganate environment:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acids and Alkalis</td>
<td>8.4.2</td>
</tr>
<tr>
<td>Electrical</td>
<td>8.4.5</td>
</tr>
<tr>
<td>Electrically Powered Equipment</td>
<td>8.4.6</td>
</tr>
</tbody>
</table>
LEGEND

FI  FLOW INDICATOR
LE  LEVEL ELEMENT
PI  PRESSURE INDICATOR (GAGE)
PIS PRESSURE INDICATING SWITCH
PCV PRESSURE CONTROL VALVE
PSV PRESSURE SAFETY VALVE
SV  SOLENOID VALVE

City of New Bedford, Massachusetts
Wastewater Treatment Plant

CDM Camp Dresser & McKee

Figure 29-1
Potassium Permanganate System Flow Diagram
Chapter 30
Lime/Cement Systems

30.1 Functional Description ........................................................................ 30-2
30.1.1 System Description ........................................................................ 30-3
30.2 Design Data ......................................................................................... 30-4
30.3 Equipment Controls ........................................................................... 30-6
30.4 Process Control .................................................................................. 30-10
30.5 Normal Operation ............................................................................... 30-12
30.6 Alternate and Emergency Operation .................................................. 30-13
30.6.1 Alternate Operation ........................................................................ 30-13
30.6.2 Emergency Operation ..................................................................... 30-14
30.7 Shutdown Considerations .................................................................... 30-16
30.7.1 Lime/Cement Conveyance System Shutdown................................. 30-17
30.7.2 Lime/Cement Day Tank Shutdown .................................................. 30-18
30.8 Startup Considerations ....................................................................... 30-19
30.8.1 Lime/Cement Conveyance System Startup .................................... 30-19
30.8.2 Lime/Cement Day Tank Startup .................................................... 30-19
30.9 Safety Considerations ........................................................................ 30-20
30.1 Functional Description

A lime/cement system has been provided for use in the sludge stabilization process. If sufficient quantities of lime or cement are added to the sludge cake and the sludge's pH is maintained at 12.0 or higher for a minimum of two hours the sludge is classified as stabilized and meeting the PSRP sludge regulations. The highly alkaline environment significantly reduces the pathogen levels within the sludge. Disease causing bacteria, viruses and parasites must be removed or destroyed prior to sludge disposal.
30.1.1 System Description

The lime/cement system is located in the Sludge Processing Building and consists of two lime/cement truck unloading stations, two lime/cement storage silos, two lime/cement pneumatic transporter systems, two lime/cement day tanks and two lime/cement volumetric feeders. Lime/cement is delivered to the plant in trucks specially equipped to blow the lime/cement into the lime/cement storage silos. Each silo has a truck unloading station associated with it that automatically energizes the silo's dust collector fan when the delivery hose is connected. The dust collector fan shuts down automatically after a time delay when the hose is disconnected. The dust collector shaker automatically starts after the fan stops and automatically stops after a timed delay. The silos are equipped with four bin level switches which monitor product level within the silo. The silos are equipped with bin activators to prevent material from bridging at the bottom discharge. The product from each silo is pneumatically conveyed to one of two lime/cement day tanks via a dense phase transporter system and a pneumatically operated diverter valve. Each lime/cement day tank is also equipped with a dust collector and a bin activator. Each day tank has three level switches to monitor product level within each tank. In addition, the day tanks are equipped with a volumetric feeder which will proportionally feed lime/cement into the sludge/lime/cement mixer based on the weight of the sludge being discharged into the mixer. This bulk handling system can handle either cement or lime to stabilize the sludge cake. Lime can be provided in two dry forms: quick lime (CaO) and hydrated lime (Ca(OH)₂). It is suggested to use a minimum 92% grade of lime to ensure high pH levels.
30.2 Design Data

Lime/Cement Storage Silos

Number of Silos: 2  
Manufacturer: RDP  
Silo Capacity: 2,016  
between HH & LL, cf  
Silo Diameter, ft: 12  
Straight Wall Length, ft: 39  
Bin Activator Manufacturer: Metalfab  
Bin Activator Motor, hp: 1.5

Lime/Cement Storage Silo Dust Collectors

Manufacturer: DCE, Inc.  
Model: Unimaster UMA350HAD  
Capacity, cfm: 350  
Dust Collector Blower Motor, hp: 7.5  
Dust Collector Shaker Motor, hp: 0.25

Lime/Cement Pneumatic Transport System

Number of Transport Vessels: 2  
Manufacturer: Dynamic Air Conveying  
Systems:  
Transport Vessel Volume, cf: 10  
Number of Transport: 2  
Compressors:  
Manufacturer: Kellog  
Compressor Capacity, cfm/psi: 50  
Compressor Motor, hp: 2  
Number of air dryers: 2

Lime/Cement Day Tanks

Number of Day Tanks: 2  
Tank Capacity: 159  
between HH & L, cf  
Tank Diameter, ft: 8  
Straight Wall Length, ft: 3  
Bin Activator Motor, hp: 1.5

Lime/Cement Day Tank Dust Collectors

Manufacturer: DCE, Inc.
<table>
<thead>
<tr>
<th><strong>Model</strong></th>
<th><strong>Siloair VS20 KS3</strong></th>
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<tbody>
<tr>
<td>Dust Collector Blower Motor, hp</td>
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</tbody>
</table>

**Lime/Cement Volumetric Feeder**

<table>
<thead>
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<th><strong>Number of Units</strong></th>
<th><strong>2</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Manufacturer</strong></td>
<td>RDP</td>
</tr>
<tr>
<td><strong>Max. Capacity, lbs/hr</strong></td>
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</tr>
<tr>
<td><strong>Speed, rpm</strong></td>
<td>Variable</td>
</tr>
<tr>
<td><strong>Motor, hp/rpm</strong></td>
<td>1/1800</td>
</tr>
</tbody>
</table>
30.3 Equipment Controls

**Lime/Cement Storage Silo Dust Collectors**

**LOCAL:** STOP/START momentary type pushbuttons

**Truck Unloading Station**

**CONTROL PANELS 1 & 2:** White-ON pilot light; H-O-A select switches for dust collector fan and shaker; red-ON status lights for fan and shaker.

**Lime/Cement System**

**CONTROL PANELS 1 & 2:** Alarm annunciators: dust collector fan motor-OVERLOAD, dust collector shaker motor-OVERLOAD

**LCP-8:** Alarm annunciator: TROUBLE.

**MCC (MCC-SP-1 & 2):** Lime/Cement Silo ON/OFF disconnect switch

**Lime/Cement Storage Silos and Bin Activators**

**LOCAL:** START/STOP momentary type pushbuttons for bin activators; HIGH-HIGH, HIGH, LOW, and LOW-LOW silo level switches.

**Truck Unloading Station**

**CONTROL PANELS 1 & 2:** Amber-HIGH-HIGH level alarm with horn and silence pushbutton.

**Lime/Cement System**

**CONTROL PANELS 1 & 2:** H-O-A select switch for bin activator; red-ON status light for bin activator; alarm annunciators: silo HIGH-HIGH LEVEL, silo LOW-LOW level.

**LCP-8:** Alarm annunciators: silo HIGH-HIGH level, silo LOW-LOW level.

**MCC (MCC-SP-1 & 2):** Lime/Cement Silo ON/OFF disconnect switch.
**Lime/Cement Transporters and Diverter Gates**

**LOCAL:**
- Power ON/OFF select switch;
- AUTO/CONTROL/LOCAL/REMOTE select switch; Day Silo 1/OFF/2 select switch; system control interface keypad.

**Lime/Cement System**

**CONTROL PANELS 1 & 2:**
- Red-ON status light for transport system; AUTO START/AUTO STOP pushbuttons for transport system;
- red-OPEN diverter valve to day tank 1 and 2 pilot lights;
- alarm annunciator: transport system control panel TROUBLE.

**LCP-8:**
- Alarm annunciator: lime/cement system no. 1 & 2 TROUBLE.

**Lime/cement conveying air compressors and air dryers**

**LOCAL:**
- START/STOP momentary type pushbuttons for compressors; low oil and high pressure switches.

**Lime/cement transporter**

**CONTROL PANELS 1 & 2:**
- Status light for air compressor receiver (amber-
  PRESSURE NORMAL); alarm annunciator: air compressor receiver-LOW PRESSURE.

**LCP-8:**
- Alarm annunciator: lime/cement system no. 1 & 2 TROUBLE.

**MCC (MCC-SP-1 & 2):**
- Lime/cement conveying air compressor ON/OFF disconnect switch.

**Lime/cement day tank & dust collectors**

**LOCAL:**
- START/STOP momentary type pushbuttons.

**Lime/cement system**

**CONTROL**
- H-O-A select switches for dust collector fan and
PANELS 3 & 4: shaker; red-ON status lights for fan and shaker alarm annunciators; dust collector fan motor OVERLOAD, dust collector shaker motor OVERLOAD

LCP-8: ALARM ANNUNCIATORS: DAY TANK HIGH-HIGH LEVEL, DAY TANK LOW-LOW LEVEL, LIME/CEMENT SYSTEM No. 1 & 2 TROUBLE.

MCC: Lime/cement day silo ON/OFF disconnect switch.

(MCC-SP-1 & 2):

Lime/cement day tanks and bin activators

LOCAL: START/STOP momentary type pushbutton for bin activators; HIGH-HIGH, HIGH, and LOW day silo level switches.

Lime/cement system

CONTROL PANELS 3 & 4: H-O-A select switches for bin activator; red-ON pilot lights for bin activator; amber-DAY TANK HIGH LEVEL, DAY TANK LOW LEVEL, DAY TANK HIGH-HIGH LEVEL status lights; alarm annunciators: DAY TANK HIGH LEVEL, DAY TANK LOW LEVEL, DAY TANK BIN ACTIVATOR MOTOR OVERLOAD.

LCP-8: Alarm annunciator: lime/cement system no. 1 & 2 TROUBLE.

MCC (MCC-SP-1 & 2):

Lime/cement day silo ON/OFF disconnect switch.

Lime/cement volumetric feeders

LOCAL: LOCAL/OFF/REMOTE selector switch; START/STOP pushbuttons; red-ON status light; adjustable speed potentiometer with SPEED INDICATOR.

Lime/cement system

CONTROL PANELS 3 & 4: H-O-A select switch for volumetric feeder control panel; red-IN remote status light for volumetric feeder; alarm annunciator: volumetric feeder-ZERO SPEED.

LCP-8: Alarm annunciator: LIME/CEMENT SYSTEM No. 1 & 2-TROUBLE.
MCC
(MCC-SP-1 & 2): lime/cement day silo ON/OFF disconnect switch.
30.4 Process Control

Lime/cement storage silo

The lime/cement storage silo dust collector fan and shaker can be operated manually or automatically by means of a H-O-A selector switch located on the local lime/cement truck unloading station. With the control switch in AUTO, the dust collector fan automatically starts when the lime/cement delivery truck fill hose is connected to the fill pipe Quick-connect and stops when the hose is disconnected from the fill pipe Quick-disconnect. Subsequently after a timed delay the dust collector shaker automatically starts and after another time delay the shaker stops. With the fan and shaker controller in the hand position, the fan and shaker can be manually stopped and started independently. The truck unloading panel is provided with a HIGH-HIGH level annunciator to alert the person responsible for unloading the truck that the lime/cement storage silo is full and that loading operations should be stopped. The lime/cement storage silos are provided with four level probes located at different levels within the silos to monitor HIGH-HIGH, HIGH, LOW and LOW-LOW levels at the lime/cement system control panels no. 1 & 2. HIGH-HIGH silo level is annunciacted at the truck unloading station, Lime/cement system CONTROL PANELS 1 & 2 and at LCP-8. Low silo level is annunciacted at lime/cement system CONTROL PANEL 1 & 2 and at LCP-8.

The silos are also equipped with bin activators. Control of the bin activators is controlled by the filling cycle of the lime/cement transport system controller.

Lime/cement pneumatic transport system

The lime/cement pneumatic transporter system can be operated manually or automatically. Remote operation of this system is not provided.

Lime/cement day tanks

The lime/cement day tank dust collector fan and shaker can be operated manually or automatically by means of a H-O-A selector switch on the day tank system control panel located in the solids handling control room. With the control switch in AUTO, the dust collector fan automatically starts when the lime/cement is being transported from the storage silo to the day tank and stops when the day tank is full and transporting stops. With the fan and shaker controller in the hand position, the fan and shaker can be manually stopped and started independently.

The lime/cement day silos are provided with three level probes located at different levels within the silos to monitor HIGH, LOW and LOW-LOW levels at the lime/cement system control panels. The HIGH and LOW-LOW silo levels are annunciacted at the lime/cement system CONTROL PANEL NO.3 & 4 and in LCP-8. The high day silo alarm will shutdown the lime/cement transport system.
The day silos are also equipped with bin activators. Control of the bin activators is interlocked with the lime/cement volumetric feeder to automatically start upon volumetric feeder startup and to automatically stop upon volumetric feeder shutdown.

**Lime/cement volumetric feeders**

The lime/cement volumetric feeder can be operated locally or remotely. With the feeder control switch in remote, the feeder will be controlled from the lime/cement day tank control panel located in the solids handling control room. In the remote mode, the volumetric feeder will be paced off the flat belt weigh conveyor 4-20 ma weigh signal. With the control switch in the local position, the volumetric feeder can be stopped/started and the speed adjusted locally at the feeder.
30.5 Normal Operation

The lime/cement handling system is designed such that only one of two trains needs to operate to handle maximum loads.

The normal operating mode of the lime/cement handling system is in the automatic mode, with all equipment in the AUTO position. The operator must ensure that all manual valves, gates, etc. are in the proper position before start-up of the system.

A selector switch is provided on each transporter system control panel to transfer from either silo to either day tank. The transport cycle occurs in three stages: loading; pressurizing and transporting. The loading cycle is initiated by the low level probe in the day tanks. During the loading cycle the transporter vessel's inlet butterfly valve opens and the vent valve that vents back into the silo opens. Once the Inlet butterfly valve is open, the knife gate opens and the vessel begins filling. When the knife gate is completely open, the bin activator will cycle on/off for an adjustable time. The vessel is provided with HIGH and LOW LEVEL probes. On high level the vessel is full and the bin activator will stop and the knife gate will close. Once the knife is closed completely, the inlet butterfly valve will close. At this time the pressurizing cycle begins and the air module and pulse jet solenoid valves (one on top and one on the bottom of the vessel) will open and the vessel and air conveying lines will become pressurized. If a minimum pressure is not monitored after a preset time frame, a low pressure fault will occur and the transport will be aborted. If conveying pressure is reached, material transfer will occur. There will be no electrical signal distinguishing between the pressurizing and transporting cycles because the pulse jet solenoid valves will maintain conveying pressure and the air control module will maintain conveying line air pressure. When the material has been completely transported, the vessel pressure will instantly fall below the pressure up value for the pressure set point and the loading cycle will begin again. The cycle will stop when the high level signal from the day tank is reached. In manual operation, the manual load pushbutton will start the vessel loading cycle. The vessel will continue to load until the button is released or the vessel high level is reached. The manual transport pushbutton.
30.6 Alternate and Emergency Operation

30.6.1 Alternate Operation

In the event of failure of one lime/cement systems, alternate operation is provided for by stand-by lime/cement equipment. Lime/cement system configurations allow for either component to run without effecting the sludge handling process.

In the event that no lime/cement system was available, liquid sludge could be pumped to tank trucks for processing at an off-site treatment plant. As can be seen, the assured continued operation of the lime/cement systems are important to the overall treatment facility operation.

The lime/cement systems are designed to operate part-time, 5 days per week. If required, the operating time can be extended to full time and/or 7 days per week to ensure that the sludge is adequately processed/stabilized.

Operation of the lime/cement systems in manual may necessitate the overdosage of lime/cement to ensure the proper pH control in the stabilization process. It is recommended that factors limiting automatic control of the lime/cement systems be identified and corrected as soon as possible.
30.6.2 Emergency Operation

Emergency operations will generally be caused by one of two conditions: Loss of power or equipment failure.

Loss of power

If the normal source of power is interrupted, alternative power is provided to equipment essential to maintaining the wastewater facility in a state of readiness for restart following restoration of normal power.

However, the sludge processing building is not considered essential to the operation of the wastewater treatment plant during the interim period when normal power is not available. Therefore, the lime/cement systems are not provided with alternate power. The lime/cement systems are equipped with momentary controls that must be manually restarted upon restoration of normal power.

Equipment failure

Due to the complexity of mechanical equipment used in the lime/cement systems and the importance each has in the system operations, alarms and shutdown interlocks are provided that serve to protect the system from excessive damage associated with equipment failures. Additionally, an "emergency stop" pushbutton is provided at the main control panels that when depressed shall shutdown the associated equipment and all upstream equipment in the event of an operator detected emergency.

Prior to equipment restart following an automatic or manual emergency shutdown, a thorough investigation to determine the "root" of the failure must be made. The manufacturer's service manuals should be consulted for specific troubleshooting and repair procedures.

Alarms

Malfunctions associated with the lime/cement conveyance systems produce audible and visual alarms at their lime/cement conveyance system control panels, with indication of trouble at LCP-8 and at the operator's panel in the sludge processing building's control room.

Lime/cement silo HIGH-HIGH level alarms will be displayed at the truck unloading control panel by a pilot light. The alarm silence pushbutton on the truck unloading control panel will silence the alarm horn locally. When the silo level drops below the HIGH-HIGH level the alarm light will De-energize.

The lime/cement CONTROL PANELS NO. 1 & 2 will monitor their respective silo level alarms and motor overload alarms. the lime/cement CONTROL PANELS NO.
3 & 4 will monitor their respective day tank level alarms and motor overload alarms, as well the respective volumetric feeder ZERO speed and motor overload alarms. A common trouble alarm will be sent from Both CONTROL PANELS 1 & 2 TO LCP-8 FOR plant monitoring. CONTROL PANELS 3 & 4 will also send a common alarm to LCP-8 for plant monitoring.
30.7 Shutdown Considerations

It is important to note that before attempting to shut down one of the components in the lime/cement system when sludge still needs to be processed, the standby unit or train should be prepared for operation and started as discussed in Section 30.8.
30.7.1 Lime/Cement Conveyance System Shutdown

1. The lime/cement conveyance system should be taken out of service after the transporter has emptied.

   NOTE: Lime has an affinity for moisture. Humid air or washdown water may cause any residual dry lime product to harden in the transport lines. It is important to remove all residuals.

2. Place the ON/OFF selector switch for the transport system control panel on the lime/cement system local control panel in the OFF position.
30.7.2 Lime/Cement Day Tank Shutdown

1. Close the diverter gate that feeds the lime/cement day tank to be taken out of service.

2. At the transporter system control panel, place the SILO 1/OFF/SILO 2 selector switch in the appropriate position.

3. Inspect the day tank fill sequence to ensure that the out of service day tank is not being filled.
30.8     Startup Considerations

30.8.1 Lime/Cement Conveyance System Startup

1. Ensure that there is adequate lime available in the silo for transport.

2. Ensure that the day tank is able to receive the lime.

3. Determine the availability of transport air and valve the transporter appropriately.

4. Open all lime feed valves to the transporter and transport lines.

5. Place the ON/OFF selector switch for the transport system control panel on the lime/cement system local control panel in the ON position.

6. Observe the first transport sycoles to ensure that there are no problems with the system.

30.8.2 Lime/Cement Day Tank Startup

1. Open the diverter gate that feeds the lime/cement day tank to be place in service.

2. At the transporter system control panel, place the SILO 1/OFF/SILO 2 selector switch in the appropriate position.

3. Inspect the day tank fill sequence to ensure that the in-service day tank is now being filled.
30.9 Safety Considerations

Lime dust, when held in contact with the skin, can cause burns. Lime sludge will also cause burns. Safety equipment and protective clothing should always be worn when handling lime or working around the lime system equipment. The eyes should always be protected from lime sludge splashing and lime dust. Care should be taken to avoid being splashed by lime from the slaker because of the high temperature of the slaker contents.

If any contact is made with dry lime or lime sludge, the affected area should be immediately flushed with liberal amounts of water. Flushing should be continued for at least 15 minutes. Medical help should be sought, particularly if the eyes are involved.

The following additional hazards are associated with the operation of the lime system. Refer to Chapter 8 for safety information relative to working with lime.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Reference</th>
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<tbody>
<tr>
<td>Acids and Alkalis</td>
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<td>Process Chemicals (Lime)</td>
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<td>Electrical</td>
<td>8.4.5</td>
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<tr>
<td>Electrically Powered Equipment</td>
<td>8.4.6</td>
</tr>
</tbody>
</table>
Chapter 31
Tank Drainage Systems

31.1 Functional Description ...........................................31-2
31.2 Design Data .......................................................31-4
31.3 Equipment Controls ..............................................31-5
31.4 Process Control ....................................................31-6
31.5 Normal Operation ..................................................31-10
   31.5.1 Gravity Drainage Systems .................................31-11
   31.5.2 Pumping Drainage Systems ...............................31-13
   31.5.3 Recycle Sewer ..............................................31-14
31.6 Alternate and Emergency Operations ............................31-15
   31.6.1 Alternate operation ........................................31-15
   31.6.2 Emergency operation .....................................31-16
31.7 Shutdown Considerations ........................................31-17
   31.7.1 Drainage Pumps ............................................31-17
   31.7.2 Sample Pumps .............................................31-18
   31.7.3 Automatic Samplers ......................................31-19
   31.7.4 Magnetic Flow Meters ..................................31-20
31.8 Startup Considerations ..........................................31-21
   31.8.1 Drainage Pumps ............................................31-21
   31.8.2 Sample Pumps .............................................31-22
   31.8.3 Automatic Samplers ......................................31-23
   31.8.4 Magnetic Flow Meters ..................................31-24
31.9 Safety Considerations ...........................................31-25
### Table of Contents

**Chapter 31  Tank Drainage Systems** .................................................. 31-1

31.1 Functional Description .................................................................. 31-2
31.2 Design Data .................................................................................. 31-4
31.3 Equipment Controls ....................................................................... 31-5
31.4 Process Control ............................................................................ 31-6
31.5 Normal Operation .......................................................................... 31-10
  31.5.1 Gravity Drainage Systems ..................................................... 31-11
  31.5.2 Pumping Drainage Systems ................................................... 31-13
  31.5.3 Recycle Sewer ....................................................................... 31-14
31.6 Alternate and Emergency Operations ........................................... 31-15
  31.6.1 Alternate operation .............................................................. 31-15
  31.6.2 Emergency operation .......................................................... 31-16
31.7 Shutdown Considerations .............................................................. 31-17
  31.7.1 Drainage Pumps .................................................................... 31-17
  31.7.2 Sample Pumps ...................................................................... 31-18
  31.7.3 Automatic Samplers ............................................................. 31-19
  31.7.4 Magnetic Flow Meters .......................................................... 31-20
31.8 Startup Considerations .................................................................. 31-21
  31.8.1 Drainage Pumps .................................................................... 31-21
  31.8.2 Sample Pumps ...................................................................... 31-22
  31.8.3 Automatic Samplers ............................................................. 31-23
  31.8.4 Magnetic Flow Meters .......................................................... 31-24
31.9 Safety Considerations .................................................................... 31-25

**Chapter 33  Plant Water Supply System** .......................................... 33-1

33.1 Functional Description .................................................................. 33-2
33.2 Design Data .................................................................................. 33-3
33.3 Equipment Controls ....................................................................... 33-5
33.4 Process Control ............................................................................ 33-6
33.5 Normal Operation .......................................................................... 33-8
33.6 Alternate and Emergency Operations ........................................... 33-10
  33.6.1 Alternate Operation .............................................................. 33-10
  33.6.2 Emergency Operations ........................................................ 33-11
33.7 Shutdown Considerations .............................................................. 33-13
33.8 Startup Considerations .................................................................. 33-15
33.9 Safety Considerations .................................................................... 33-16
Chapter 31 Tank Drainage Systems
31.1 Functional Description

Three prominent non-process flow stream collection and conveyance systems are provided at the water pollution control facility: a tank drainage system, process sidestream recycle sewer and a tank underdrain system.

Tank Drainage

The decommissioning of tanks for routine maintenance and inspection is an integral part of a good preventive maintenance program. To facilitate removal and draining of tanks for such service, a tank drainage network has been provided. Two methods of drainage are provided: pumped and gravity.

The main gravity network consists of buried 12-inch drain lines fed from individual tank drain lines. The drain lines convey tank drainage collectively to the plant headworks and introduce it into the influent flow ahead of the mechanical bar screens. The gravity drain line will also receive pumped flow from the WAS pumps. The WAS pumps are necessary to pump out the sludge sump of the final settling tanks (the tank is provided with gravity drainage also). To fully drain the aeration basins, an alternative to the gravity drainage system is required. The basin will drain by gravity to the basin's drain outlet opening at which time the Aeration Basin Drain Pumps must be used to finalize tank draining. The Anaerobic Selectors must be drained solely by the use of the aeration basin drain pumps. The basin drain pumps pump only to the primary effluent channel for return to the operational aeration basins. Refer to Figure 31-1, Tank Drainage System Schematic.

Tank draining may be further assisted by use of the respective treatment process support pumps (i.e., primary sludge pumps, WAS pumps, TPS pumps, centrifuge feed pumps, etc.). By using these pumps, product loss is minimized thereby reducing the need to handle or remove these solids for a second time by returning them to the Headworks.

Recycle Sewer

To facilitate the collection of treatment process sidestreams, a buried conveyance system (Recycle Sewer) separate from the drainage network is provided. Process sidestreams are returned through the 24-inch Recycle Sewer to the Headworks Building. Within the Headworks Building, the recycle flow rate is measured and deposited into the plant influent either up or downstream of the mechanical bar screens. Refer to Figure 31-2.

The recycle sewer serves as the conduit to collect and convey those sidestreams that are high in solids content and/or may contribute to the overall hydraulic or solids
loading to the treatment plant. Specific sidestreams that may contribute a significant load on the treatment plant include the gravity thickener supernatant, gravity belt thickener filtrate, and centrifuge centrate. Other flows that can or will contribute on a sporadic basis include the sludge and scum holding tanks overflow, chlorine contact tank skimmings, chemical fill station catch basins and sanitary sewers from all plant buildings. Of the before mentioned flows, the gravity thickener overflow will contribute significantly to the hydraulic loading of the plant while the filtrate and centrate may contribute significantly to the solids loading.

Treatment process sidestreams are generally high in solids and their potential impact on subsequent downstream processes must be ascertained. Therefore, these flows are sampled and measured prior to being deposited into the plant influent. Located in the basement of the Headworks Building, a sample pump takes suction from the 24-inch recycle sewer line prior to the recycle flow magnetic flow meter. The recycle sewer sample is collected in the composite sampler located in the Influent Sample Room. Recycle flow is indicated at the local control panel (LCP-1) and at the Central Operators' Console (COC).

**Tank Underdrain System**

A tank underdrain system is provided to prevent an empty tank from floating during high ground water conditions. The underdrain system is a series of interconnected underground perforated 4 inch pipes laid in a grid pattern under all process tankage. The pipes penetrate into the tanks through wall mounted pressure relief type flap valves. When the tanks are full of process liquids, the flap valve will be held in a closed position preventing wastewater loss to the underdrain system. When a tank is empty, high ground water can be relieved into the tank thereby preventing structural damage associated with tank floating. The following tanks are connected to the tank under drain system:

- aeration tanks,
- anaerobic selector tanks,
- final settling tanks,
- gravity thickeners and gravity thickener pump station periphery,
- primary settling tanks,
- sludge processing building periphery
- chlorine contact tanks,
- headworks building periphery
- effluent pumping station periphery.
### 31.2 Design Data

**Aeration Basin/Selector Drain Pumps**

| Number | 2 |
| Type | Non-clog constant speed centrifugal |
| Manufacturer/Model | Fallbanks Morse/B5444 |
| Design Capacity | 1200 GPM @ 25 ft. TDH |
| Maximum Solids Handling, inches | 3 |
| Motor, hp/rpm | 15/880 |
| Manufacturer | U.S. Electric |
| Electrical Service, v/ph/Hz | 460/3/60 |

**Recycle Flow Meter**

| Number | 2 |
| Manufacturer/Model | Krohne/IFS4000 |
| Type | Magnetic |
| Size, in. | 18 |
| Flow Range, mgd | 0-8 |

**Recycle Sample Pump**

| Number | 1 |
| Manufacturer/Model | Vanton |
| Type | Centrifugal, semi-open impeller |
| Motor, hp/rpm | 1.5/1800 |
| Capacity, gpm @ ft TDH | 20 @ 30 |

**Recycle Sampler**

| Number | 1 |
| Type | Refrigerated composite sampler |
| Manufacturer/Model | ISCO/2900R/2920 |
31.4 Process Controls

Drainage System

Process control with respect to tank draining requires that the potential effects on upstream and downstream processes be taken into consideration before commencing tank draining. The need to modify a treatment process to accept the flow should be anticipated and the modifications made to minimize these effects. Consideration must also be given to affected support systems such as sensors, level detectors, samplers and hydraulic capacity of lines and pumps.

Separate drainage systems and drainage methods have been designed to drain the aerated grit tanks, aeration basins, anaerobic selectors, gravity thickeners, primary settling tanks, final settling tanks, sludge storage tanks and chlorine contact tanks.

Drain water from these various tanks is either withdrawn by the respective system pumps or drained by gravity to the plant influent through a 12-inch drain line. The 12-inch drain line discharges to the 24-inch Recycle Sewer that enters into the Headworks Building. Drain line flow enters the recycle sewer downstream of the recycle flow meter, therefore the rate of flow is not measured or sampled.

Tank drainage that is returned to the Headworks Building is pumped with the treatment plant influent flow for further treatment. Tank drainage removed by the respective system process pumps (i.e., Primary Sludge, Thickened Primary Sludge, Waste Activated Sludge Pumps, etc.) is conveyed to a point of discharge that will have the least impact on the treatment process.

The anaerobic selector basins and aeration basins have a dedicated pump station for tank drainage. The station consists of two constant speed aeration basin tank drain pumps located in the aeration basin gallery. The two locally controlled centrifugal pumps convey tank drainage from the anaerobic selector basins and the aeration basins to the primary effluent channel. Refer to Figure 31-1, Tank Drainage System Schematic.

The following table (Table 31-1) provides drainage information on individual unit processes, their respective drainage methods and drainage destinations. The table and the Contract plans can assist the operator to better understand the drainage operations:

CDM Camp, Dresser & McKee
Recycle Sewer

The recycle sewer system provides a means by which miscellaneous treatment process sidestreams, building drainage and sanitary wastes may be conveyed to the plant headworks for further treatment. The system comprises a main 24 inch concrete recycle sewer line running from the Sludge Processing Building parking lot to the Headworks Building. At the headworks, the recycle flow is measured and sampled prior to discharge into the plant influent. The recycle flow may be discharged into the influent channel either upstream or downstream of the mechanical barscreens. Refer to Figure 31-2.

The recycle sewer line receives sanitary waste flow from all plant building restroom and shower facilities and drainage from floor drains and rain scuppers. It is important to note that all floor drains and therefore washdown waters or other liquids spilled within the buildings will be conveyed by the recycle sewer to the plant headworks.

NOTE: Chemical containment area spills will not be routed to the recycle sewer line but must be handled by pumping to holding facilities for further disposal. The recycle sewer should not be considered a disposal alternative for containment area spills.

Provisions have been made to accept building drainage and sanitary waste flows from the adjacent U.S. Naval Reserve Training Building and the Vocational Technical High School. Additionally, future sanitary facility connections have been provided (but not connected) in the general vicinity of the Harbor Pier located at the Eastern side of the plant and in the vicinity of the yacht club parking lot located at the Northeast side of the plant. As a result of these connections (current and future) significant sanitary waste flows can be expected during the peak season.

Chemical unloading stations are provided with catch basins to contain chemicals and washdown waters during chemical unloading operations. These catch basin flows are conveyed to the recycle sewer for return to the head of the plant. Such washdown waters and spilled chemicals present minimal effect on the treatment process due to the overall volume of the recycle sewer flows. It is important that the recycle sewer line not be used to convey mass quantities of chemicals to the treatment process.

A significant portion of the recycle flow will be comprised of process sidestreams: gravity thickener overflow, gravity belt thickener filtrate and centrifuge centrate. Sludge holding tank and secondary scum storage tank overflows will also be conveyed to the plant headworks through the recycle line.

CAUTION: The use of the overflow lines to decant from the sludge or scum tanks or continuously using the overflow lines to enable overfilling the tanks is strongly discouraged. Line pluggages may occur and a high strength waste stream will be re-introduced into the plant.
Recycle flow is measured by an 18 inch magnetic flow meter prior to its discharge to the influent channel. The meter has an 8 mgd range and will read out at the local control panel and COC. Since the influent pumps pump both recycle and influent flows, the recycle flow rate is used to calculate actual plant flow by subtracting its signal from the influent pump discharge flow meter to obtain an actual influent flow rate. This is necessary for automatic plant flow pacing capabilities and for accurate reporting purposes.

A recycle flow sample pump and sampler are provided to aid in the determination of actual recycle flow loading contributions to the plant treatment processes. Recycle flows should be sampled and analyzed on a daily basis in conjunction with the influent sample analysis. The same parameters should be tested for. Refer to Chapter 4, Table 4-1 for the Recommended Sampling and Analysis Schedule.
31.5 Normal Operation

The following is a brief discussion on the miscellaneous drainage networks and the gravity drainage procedures. Reference to the above Table 31-1 and Contract drawings should be made before commencing drainage operations.

**Tank Underdrain System**

The operator should be aware of the tank underdrain system, which is provided for the aeration tanks, anaerobic selector tanks, final settling tanks, gravity thickeners, primary settling tanks, and chlorine contact tanks. This underdrain system is designed to prevent an empty tank from floating during high ground water conditions. Pressure relief type flap valves are installed in all the above tanks to allow ground water to enter the empty tanks and prevent structural damage associated with tank floating.

If it becomes necessary to drain any of the above referenced tankage during high ground water conditions, the operator must continually monitor the tank being drained. Additionally, groundwater may continue to enter the tanks during the winter high groundwater season presenting a tank storage problem. If this water is not removed promptly, other winter storage preparations must be made.
31.5.1 Gravity Drainage Systems

The following unit processes contain multiple tankage (more than one tank), each tank can be isolated from flow. Once the particular tank or basin has been isolated from influent and effluent flows, treatment processes must be terminated (mechanical mixers, rake arms, collectors, low pressure air, chemical addition). Consideration must also be given other support systems such as D.O. and pH probes, sample lines, and plant water lines.

**Aerated Grit Tanks** -- The aerated grit tanks use 6-inch plug valves operated at the grit slurry pump suction headers. By opening a drain valve, the tank contents drain through the 6-inch grit tank drain lines to the 24-inch drain line. Grit tank drainage is introduced into the recycle sewer following the magnetic flow meters and sample pumps.

**Primary Setting Tanks** -- The primary settling tanks use 6-inch plug valves operated at the primary sludge pump suction header. By opening a drain valve, the tank contents drain to the 8-inch drain primary settling tank line to the 12-inch drain line and plant influent.

**Aeration Basins** -- Drain valves have been strategically placed in the basins and are key operated from the floor box operators located on the deck. The aeration basins each are provided with two 8-inch plug valves. The plug valves at the effluent end of the basins drain to an 8-inch line to the buried 12-inch drain line. The aeration basins can also be drained by the aeration basin drainage pumps to the primary effluent channel. Refer to the following section on pumping drainage systems.

**Final Settling Tanks** -- The final settling tanks each have two 8-inch gate valves at their effluent ends that drain into a 12-inch line to the Drain line. The settling tanks can also be drained by using the RAS and WAS pumps. Refer to the following section on pumping drainage systems.

**Chlorine Contact Tanks** -- Each chlorine contact tank uses a 8-inch plug valve that is commonly headered to the 8-inch drain line to the 12-inch buried drain line. The valves are key operated from the floor box operators located on the deck. The chlorine contact tanks can also be drained by using the Plant Water Pumps and pumping to open hydrants or in-service tankage. Refer to the following section on pumping drainage systems.

**Gravity Thickeners** -- The gravity thickeners use 8-inch plug valves operated at the thickened primary sludge (TPS) pump suction headers. By opening a drain valve the tank contents are permitted to drain to the 8-inch header drain line to the buried 12-inch drain line and plant influent. The thickener drain line permits draining of both the gravity thickener and each thickener's primary sludge feed lines from the distribution system.
box. Draining the feed lines to each thickener during tank shutdown prevents solids from settling and potentially plugging the line.
31.5.2 Pumping Drainage Systems

The primary settling tanks, final settling tanks, gravity thickeners, anaerobic selector basins, aeration basins and sludge storage tanks are drained by operation of the appropriate pumps.

**Primary Settling tanks** -- The primary sludge pumps can withdraw tank drainage directly from the clarifier sludge withdrawal line and pump the liquid to the operational gravity thickener or, alternatively, back into the primary influent distribution box.

**Final Settling tanks** -- The final clarifier contents can be pumped by the RAS pumps to the activated sludge process or by WAS pumps to the 12-inch drain line. Each clarifier also has two 8-inch gate valves for gravity drainage to the 12-inch drain line.

**Anaerobic Selector Basins** -- The anaerobic selectors each are provided with one 8-inch plug valve. The valves are key operated from their respective platforms.

**Aeration Basins** -- The aeration basins each have two 8-inch plug valves. The plug valves on the influent end of each basin are tied into the 8-inch line to the aeration basin drainage pumps. Drainage is pumped by the aeration basin drainage pumps to the primary effluent channel.

**Gravity Thickener** -- Gravity thickener sludge is pumped by the gravity thickener pumps to the sludge holding tanks or to the 12-inch Drain line. The remaining liquid can be recycled to the operational gravity thickeners through the sludge pump bypass line into the influent feed lines to the thickeners (refer to Chapter 18).

**Sludge Storage Tank** -- The sludge storage tanks contents can be pumped to the online centrifuges for processing. It is possible to transfer a large portion of one storage tank's contents to the other storage tanks by pumping with the centrifuge feed pumps to the tank(s) (refer to contract schematics for piping alternatives).
31.5.3 Recycle Sewer

Minimal control may be exercised by the operator of the recycle sewer system. The system is provided for the conveyance of process sidestream flows and sanitary waste to the plant headworks for further treatment. However, the operator may exercise control over the source of flows into the recycle sewer by monitoring the various discharges: miscellaneous building sewers and drains, gravity belt thickener filtrate, centrifuge centrate, gravity thickener overflow, and other waste flows.
31.6 Alternate and Emergency Operations

31.6.1 Alternate operation

Some of the basins or tanks have more than one method of draining. Alternate methods of draining are presented in sections 31.5.2 and 31.5.2 for the respective tank.

There is no alternate method of operation for the aeration basin drainage pumps.
31.6.2 Emergency operation

There are two types of emergency situations which the operator is likely to
counter during operation of the wastewater treatment plant: loss of power or
mechanical failure of one or more components of the systems.

Loss of Power

If the normal source of power is interrupted, the emergency generator will start
automatically and supply standby power to equipment necessary to maintain the
plant in a state of readiness for restart following restoration of normal power.

Generally, it is not considered essential to remove tanks from service for routine
reasons during periods when normal power is not available. Therefore, the pumping
equipment normally used in the draining and pumping process (excluding the
influent pumps) will not receive priority power usage while on emergency power but
may be manually started if the power is available.

Equipment Failure

Should any element of the tank drainage system fail to operate properly, the
drainage line or equipment should be checked out and corrected using the
manufacturers' service manuals as a guide. Limited equipment redundancy is
provided for the aeration basin drainage pumps. In the event a pump fails the
malfunctioning pump must be removed from its on-line position and the backup pump
brought into service.

In the event of a blockage of one of the drain lines, cleanouts have been placed at all
points that the line must turn. The cleanouts may be used to clear long sections of
collection pipe.

In the event of a failure of the automatic composite sampler, recycle sewer samples
may be obtained by hand. These samples will be grab samples; however, composites
samples can be created by the operator obtaining recycle flow rates from
the COC or LCP. Further information relative to samples and their preparation can
be found in Chapter 4, Sampling and Analysis Program.
31.7 Shutdown Considerations

31.7.1 Drainage Pumps

To shut down a drainage pump, the operator should follow the procedure outlined below.

1. Stop the pump by depressing the local STOP pushbutton. Lock-out the STOP pushbutton.
2. The pump inlet and discharge valves should be closed.
3. Isolate the pump casing seal water supply system.
4. If the pump is to be out of service for a prolonged period of time, the pump volute should be drained.
5. Set the pump ON/OFF disconnect switch, located at the Motor Control Center, to the OFF position.
6. Attach a LOCK-OUT tag to this switch.
31.7.2 Sample Pumps

To shut down a sample pump, the following procedures should be considered:

1. Close the pump suction and discharge valves.
2. Place the ON/OFF switch in the OFF position.
31.7.3 Automatic Samplers

To shut down the automatic sampler, the operator should turn the ON/OFF switch to the OFF position. If the unit is to remain off for an extended period of time, the operator should also turn off the refrigerator by means of the refrigerator ON/OFF selector switch. Refer to Chapter 4, Sampling and Analysis Program for additional information on manual grab and composite sampling.
31.7.4 Magnetic Flow Meters

The magnetic flow meters should not be shut down as long as wastewater is admitted to the plant. These units are used to record influent wastewater and recycle flows to the plant, which is necessary information in calculating process control. Also, the influent flow meter is used in pacing the influent sampler, chemical feed, and return activated sludge flow. While the recycle flow meter is used to generate the actual influent flow rate signal.

Should these meters need to be taken out of service for maintenance purposes, the out-of-service time must be minimized in order not to affect the process control of the plant.

To shut down a flow meter, the operator should consider the following procedures:

1. Set the circuit breakers to the OFF position.
2. Note time and reason for shutdown for future reporting purposes
3. Effect repairs and minimize meter down time.
31.8 Startup Considerations

31.8.1 Drainage Pumps

The following items must be checked prior to startup of the aeration basin drainage pumps:

1. Open the appropriate pump suction and discharge and seal water supply valves.
2. Perform any preventive maintenance tasks and inspect all pump components required by the manufacturer's manual.
3. Remove the LOCK-OUT tag from the MCC disconnect switch and set the switch to the ON or closed position.
4. Energize the pump from the local START pushbutton station.
5. Check that the electrical motor is not overheating or producing any unusual noise or vibration.
6. Running motor amperage readings should be taken and compared against manufacturer's data for normal motor operations.
7. Periodically check pump for leaks, unusual noise, or equipment temperature rise.

NOTE: Inspect pump for proper direction of rotation after installation of new motor or electrical work requiring reconnection of wires at the motor or panelboard.
31.8.2 Sample Pumps

To start a sample pump, the following procedures should be considered:

1. Consult the manufacturer's service manual and conduct any required maintenance task.
2. Open the pump suction and discharge valves.
3. Place the ON/OFF switch in the ON position.
31.8.3 Automatic Samplers

To start the automatic sampler, the operator should consider the procedures described below:

1. Check the Lighting Panel to ensure that appropriate circuit breakers are in the ON position.

2. Verify that the sample line is flowing and that the sample pump is operating properly.

3. Check or set the desired sample volume (consult the manufacturer's instructions).

4. Check or set cycle timer for desired sequence if timed cycle sampling is desired (consult the manufacturer's instructions).

5. Select type of sample desired, timed cycle or flow proportional (consult the manufacturer's instructions).

6. Turn refrigerator switch to ON position.

7. Turn sampler selector switch to ON position (consult the manufacturer's instructions).

8. Verify that the sampler is operating properly. If problems occur, check the manufacturer's maintenance manual.
31.8.4 Magnetic Flow Meters

To start the magnetic flow meter, the operator should consider the following procedures:

1. Set the circuit breaker to the ON position.
2. Observe the unit for proper recording/operation. Calibrate as necessary.
Chapter 32
Plant Air Systems

32.1 Functional Description .............................................. 32-2
32.2 Design Data .............................................................. 32-5
    32.2.1 High Pressure Air System ................................. 32-5
    32.2.2 Low Pressure Air System ................................. 32-6
32.3 Equipment Controls .................................................. 32-7
32.4 Process Control ....................................................... 32-10
32.5 Normal Operation ..................................................... 32-11
32.6 Alternate and Emergency Operation ............................. 32-13
    32.6.1 Alternate Operation .......................................... 32-13
    32.6.2 Emergency Operation ...................................... 32-13
32.7 Shutdown Considerations .......................................... 32-14
32.8 Startup Considerations ............................................. 32-14
32.9 Safety Considerations .............................................. 32-15
32.1 Functional Description

There are two distinct types of air systems provided for various uses at the New Bedford water pollution control facility: high pressure air systems and low pressure air systems.

High Pressure Air Systems

High pressure air is made available at various locations throughout the facility. Its use is principally intended for the operation of pneumatic equipment and to provide energy for other equipment (as a motive force).

There are three main high pressure air systems of particular interest to the operations personnel. Each system will operate at its respective optimum operating pressure pre-set by the manufacturer based on start-up and equipment air requirements. Generally, normal air pressure operating ranges may typically be found to be set between 80 and 120 pounds per square inch gauge (psig).

Each compressor will operate automatically, during which starting and stopping are controlled by air pressure switches mounted on the compressor air receiver. The receivers are used as “reservoirs” of compressed air to prevent depleting the air pressure in the high pressure air lines. Due to the large volume of air required, the Administration Building’s Emergency Generator/Maintenance Shop compressors supply air to a bank of five receivers. Where necessary, air dryers are provided to protect process equipment from moisture that develops from the pressurization of moisture laden air. The removal of moisture is critical to the operation of the lime transport system; consequently, properly sized air dryers are provided for this system. Figure 32-1 shows a schematic of the lime transport high pressure air system.

The high pressure air compressors and their designated uses are provide at the following locations:

1. Sludge Processing Building, Basement
   a. Pneumatically operated sludge screw conveyor slide gates
   b. Air hose stations

2. Sludge Processing Building, Compressor Room
   a. Dense phase lime transporter system
   b. Air pad chemical truck unloading station
   c. Lime silo vent filter shakers
   d. Lime silo rotary air lock seals
   e. Air hose stations

3. Administration Building, Maintenance Garage Compressor Room
a. Emergency generator compressed air starting system
b. Air hose stations (and parts washer)

Additional high pressure air systems are provided throughout the treatment plant for various purposes. These include the following:

- Air hose stations
- HVAC damper/flouver control
- Laboratory high pressure air and vacuum

**Low Pressure Air Systems**

Low pressure air generally has single dedicated uses and therefore is made available at specific locations throughout the facility. Its use is generally limited to providing aeration (increase the dissolved oxygen (DO) level) and mixing of wastewater. There are basically two different types of low pressure pumps: positive displacement air blowers and centrifugal air blowers. Low pressure air is introduced into the liquid process flow through either coarse bubble (positive displacement blowers) or fine bubble diffuser systems (centrifugal blowers).

There are five low pressure air systems at the facility. Each system will operate at its respective optimum operating pressure and volume pre-set by design factors and the manufacturer based on start-up and process air requirements. The low pressure air blowers and their designated uses are provided as follows:

**Low Pressure Air Blowers**

<table>
<thead>
<tr>
<th>Blower Type</th>
<th>Designated Air Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerated Grit Tank Blowers (three)</td>
<td>Grit tank mixing/aeration</td>
</tr>
<tr>
<td>Primary Influent Channel Blowers (two)</td>
<td>Aerated grit tank effluent and primary influent channel mixing/aeration</td>
</tr>
<tr>
<td>Secondary Influent Channel Blowers (four)</td>
<td>Aeration basin influent, effluent and FST influent channel mixed liquor suspension</td>
</tr>
<tr>
<td>Sludge Storage Tank Blowers (five)</td>
<td>Thickened sludge mixing/aeration</td>
</tr>
<tr>
<td>Aeration Basin Centrifugal Blowers (three)</td>
<td>MLSS dissolved oxygen and mixing</td>
</tr>
</tbody>
</table>

The aerated grit tanks utilize low pressure air to provide sufficient "mixing" to help keep organic material in suspension while allowing the heavier grit particles to settle. This mixing also "scours" the grit particles to help remove organic material from the particles. The raw wastewater is "freshened" during this process as its dissolved oxygen level is slightly increased. Further information may be found in Chapter 11 relative to the aerated grit system and Chapter 17 relative to grit handling systems.

Low pressure air (supplied by rotary lobe, positive displacement blowers) is injected into the aerated grit tank effluent channel, primary influent channel, secondary
Influent channel, and the sludge holding tanks to promote mixing, maintain a uniform mixture, and to minimize odors by preventing septicity in the sludge holding tanks. The latter is accomplished by raising the DO level of the contents of the sludge holding tanks. For further information relative to the primary treatment process refer to Chapter 12, secondary treatment process refer to Chapter 13, and thickened sludge holding refer to Chapter 20.

Each blower is equipped with an inlet filter, an inlet silencer, a discharge silencer, flexible connectors, a check valve, a pressure relief valve, and butterfly valves on the discharge lines to isolate a blower when necessary. Flow measurement is provide on the aerated grit tank effluent channel air supply line (to facilitate flow balancing) and to the aerated grit tanks. Each of the blowers is also equipped with a butterfly type unloading valve which must be opened manually before the blower is started. This valve allows the motor to start and accelerate to operating speed with the blower motor unloaded.

A separate low pressure system is provided for the aeration of mixed liquor suspended solids in the secondary treatment process. Three centrifugal blowers provide air through fine bubble diffusers for the microorganisms’ use in metabolizing raw wastewater. The blowers are capable of automatically varying their output to meet the demands of the microbes.

The centrifugal blowers are equipped with an inlet filtration system, inlet silencers, discharge silencers, flexible connectors and butterfly valves on the discharge lines to isolate a blower when necessary. Each of the blowers is also equipped with a motorized butterfly type unloading valve which will automatically open before the blower is started. This valve allows the motor to start and accelerate to operating speed with the blower motor unloaded. Flow measurement is provide at multiple points along the air distribution header. There are flow measurement devices on the main air supply line to each basin (six in total) and devices on each drop leg to the individual grids (to facilitate flow balancing). Air flow is adjusted to the basins based on the basin’s dissolved oxygen content relative to the controller set point. As the demand changes, it changes the relative position of a motorized air supply butterfly valve on the respective basin’s air supply header. This valve change will produce a change in the blower’s inlet guide vanes thereby increasing or decreasing the blower’s output.

The following figures will provide additional assistance in understanding the low pressure air systems:

- Figure 32-2 Aerated Grit Tank LPA Flow Diagram
- Figure 32-3 Channel aeration LPA Flow Diagram
- Figure 32-4 Sludge holding Tank LPA Flow Diagram
- Figure 32-5 Aeration Basin air Flow Schematic
### 32.2 Design Data

#### 32.2.1 High Pressure Air Systems

**Lime Transport Air Compressors**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>2</td>
</tr>
<tr>
<td>Type</td>
<td>Single-stage, water cooled, rotary screw compressor</td>
</tr>
<tr>
<td>Manufacturer/Model</td>
<td>CompAir-Kellog / 6050CL</td>
</tr>
<tr>
<td>Capacity, scfm @ psig</td>
<td>240 @ 110 (full load pressure)</td>
</tr>
<tr>
<td>Pressure Range, psi</td>
<td>110 to 120</td>
</tr>
<tr>
<td>Motor, hp/rpm</td>
<td>50 / 1750</td>
</tr>
<tr>
<td>Electric Service, v/ph/Hz</td>
<td>480 / 3 / 60</td>
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</tbody>
</table>

**Lime Transport Compressor Air Dryer**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>Refrigerated air dryer, mechanical</td>
</tr>
<tr>
<td>Manufacturer/Model</td>
<td>Stylair / SHL-12</td>
</tr>
<tr>
<td>Drying Performance, deg F @ psig</td>
<td>-40 @ 100</td>
</tr>
<tr>
<td>Desiccant Type</td>
<td>Activated Alumina</td>
</tr>
<tr>
<td>Desiccant Quantity, lbs/tower</td>
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**Truck Unloading Pneumatic Gate Air Compressor**

<table>
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<tbody>
<tr>
<td>Number</td>
<td>1</td>
</tr>
<tr>
<td>Type</td>
<td>Single-stage, water cooled, rotary screw compressor</td>
</tr>
<tr>
<td>Manufacturer/Model</td>
<td>CompAir-Kellog / 6050CL</td>
</tr>
<tr>
<td>Capacity, scfm @ psig</td>
<td>100 @ 110 (full load pressure)</td>
</tr>
<tr>
<td>Pressure Range, psi</td>
<td>110 to 120</td>
</tr>
<tr>
<td>Motor, hp/rpm</td>
<td>25 / 1750</td>
</tr>
<tr>
<td>Electric Service, v/ph/Hz</td>
<td>480 / 3 / 60</td>
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</table>

**Truck Unloading pneumatic Gate Compressor Air Dryer**

<table>
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<th>Parameter</th>
<th>Specification</th>
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<tr>
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<tr>
<td>Type</td>
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</tr>
<tr>
<td>Manufacturer/Model</td>
<td>Stylair / SHL-12</td>
</tr>
<tr>
<td>Drying Performance, deg F @ psig</td>
<td>-40 @ 100</td>
</tr>
<tr>
<td>Desiccant Type</td>
<td>Activated Alumina</td>
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<tr>
<td>Desiccant Quantity, lbs/tower</td>
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Emergency Generator Starting Air Compressor

<table>
<thead>
<tr>
<th>Number</th>
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<tbody>
<tr>
<td>Type</td>
<td>Two-stage, reciprocating</td>
</tr>
<tr>
<td>Manufacturer/Model</td>
<td>Curtiss-Toledo / D97</td>
</tr>
<tr>
<td>Pressure Range, psi</td>
<td>80 to 120</td>
</tr>
<tr>
<td>Number of Receivers</td>
<td>5</td>
</tr>
<tr>
<td>Receiver Size, gals</td>
<td>200</td>
</tr>
<tr>
<td>Motor, hp/rpm</td>
<td>15 / 1750</td>
</tr>
<tr>
<td>Electric Service, v/Ph/Hz</td>
<td>480 / 3 / 60</td>
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</tbody>
</table>

32.2.2 Low Pressure Air Systems

Grit Tank Blowers

<table>
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<tr>
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<tbody>
<tr>
<td>Type</td>
<td>Rotary / Positive Displacement</td>
</tr>
<tr>
<td>Manufacturer/Model</td>
<td>Roots / RCS-J Whispair</td>
</tr>
<tr>
<td>Design capacity, cfm (ea.)</td>
<td>150 / 400</td>
</tr>
<tr>
<td>Blower operating speed, rpm</td>
<td>1100 / 2200</td>
</tr>
<tr>
<td>Pressure Rise, psig</td>
<td>8</td>
</tr>
<tr>
<td>Motor, HP</td>
<td>15 / 30</td>
</tr>
<tr>
<td>Motor speed, rpm</td>
<td>900 / 1800</td>
</tr>
<tr>
<td>Volts/phase/hertz</td>
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</tr>
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</table>

Primary Channel Aeration Blowers

<table>
<thead>
<tr>
<th>Number</th>
<th>2</th>
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</thead>
<tbody>
<tr>
<td>Type</td>
<td>Positive Displacement</td>
</tr>
<tr>
<td>Manufacturer/model</td>
<td>Roots / 616 RCS-JH Whispair</td>
</tr>
<tr>
<td>Inlet capacity, acfm</td>
<td>1189</td>
</tr>
<tr>
<td>Blower discharge pressure, psia</td>
<td>20</td>
</tr>
<tr>
<td>Motor manufacturer</td>
<td>Siemens</td>
</tr>
<tr>
<td>HP/rpm</td>
<td>40 / 1800</td>
</tr>
<tr>
<td>Volt/Ph/Hz</td>
<td>460 / 3 / 60</td>
</tr>
</tbody>
</table>

Secondary Channel Aeration Blowers

<table>
<thead>
<tr>
<th>Number</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Positive Displacement</td>
</tr>
</tbody>
</table>
Manufacturer/model | Roots / 418 RCS-JV Whispair
Inlet capacity, cfm | 774-940
Blower discharge pressure, psig | 5
Motor manufacturer | Siemens
HP/rpm | 40 / 1800
Volt/phHz | 460 / 3 / 60

**Sludge Storage Tank Blowers**

Number | 5
Type | Positive Displacement
Manufacturer/model | Roots / 409R CS-JV Whispair
Inlet capacity, cfm | 545
Blower discharge pressure, psia | 23
Motor manufacturer | Siemens
HP/rpm | 30 / 1800
Volt/phHz | 460 / 3 / 60

**Aeration Basin Blowers**

Number | 3
Type | Horizontal, single stage, centrifugal
Manufacturer/model | Roots / 24" 16C-V
Inlet volume, acfm | 15571
Blower discharge pressure, psig | 23.7
Motor, manufacture | Siemens
HP/rpm | 800 / 1774
Volt/phHz | 4160 / 3 / 60

### 32.3 Equipment Controls

The following controls and their functions are associated with the equipment described above. Controls are listed from the device and/or its control panel (LOCAL), through the Motor Control Center (MCC), to the local control panel (LCP) and the remote central processing unit (CPU). Devices controlled by the CPU are accessed from either the Central Operator's Console (COC) or the Distributed Operator's Console (DOC).

**High Pressure Air Compressors**

LOCAL: START/STOP maintaining-type pushbutton station;
MCC: If the local ON/OFF station is in the ON position and the START pushbutton is pressed, the blower is started. If the local STOP pushbutton is pressed, the blower is stopped. The OFF position will not allow the blower to be started locally.

LCP-1: Blower status indicating lights.

CPU: Blower status indication.

*Aerated Grit Tank Blowers*

LOCAL: START/STOP maintaining-type pushbutton station; HIGH TEMPERATURE and LOW PRESSURE shutdown switches.

MCC: If the FAST/SLOW/OFF selector switch is in either the FAST or SLOW position and the local START pushbutton is pressed, the blower is started. If the local STOP pushbutton is pressed, the blower is stopped. The OFF position will not allow the blower to be started locally.

LCP-1: Blower LOW and HIGH speed status indicating lights.

CPU: Blower LOW and HIGH speed status indication.

*Channel and Sludge Holding Tank Blowers*

LOCAL: START/STOP maintaining-type pushbutton station; HIGH TEMPERATURE and LOW PRESSURE shutdown switches.

MCC: If the ON/OFF selector switch is in the ON position and the local START pushbutton is pressed, the blower is started. If the local STOP pushbutton is pressed, the blower is stopped. The OFF position will not allow the blower to be started locally.

LCP-1: Blower ON and OFF status indicating lights.

CPU: Blower ON and OFF status indication.
Aeration Blowers Inlet Guide Vane Control

LCP-3: If the vane controller AUTO/COMPUTER/MANUAL selector switch is in the AUTO position and the REMOTE/LOCAL selector switch on LCP-3 is in the LOCAL position, the vane position set point may be manually entered via the controller.

CPU: If the vane controller AUTO/COMPUTER/MANUAL selector switch on LCP-3 is in the COMPUTER position, the position set point may be manually entered via the keyboard in the control room. If the vane controller AUTO/COMPUTER/MANUAL selector switch on the CPU is in the MANUAL position, the set point value used is from the vane controller selector switch. If the vane controller AUTO/COMPUTER/MANUAL selector switch is in the AUTO position, the set point value used is the master blower position signal.

The aeration blowers inlet guide vanes are monitored and a common alarm is generated upon alarm condition.

Aeration Blowers Master Control

LOCAL: START/STOP maintaining type pushbutton station. Vendor supplied control panel.

MCC-AB-1 & MCC-AB-2: If the ON/OFF disconnect switch is in the ON or CLOSED position, power is available, and the local control panel is energized. Status lights indicate whether the equipment is running or stopped. While running, total accumulative run time is displayed.

LCP-3: If a blower control panel LOCAL/REMOTE selector switch is in the LOCAL position, the blower will be controlled manually. If the selector switch is placed in the remote position, control of the pump is through the LCP-3 and the computer.

The blower control panels are provided with alarm status, indicator lamps and shutdown interlocks for PRESSURE and TEMPERATURE. Activation of any of the alarms will cause the effected component to shut down and announce the condition as a FAILURE condition on the LCP-3 and computer. Alarm condition reset pushbuttons are provided to enable restart following corrections of a failure contingency.

The air flow control valve positions are compared to each other.
and the most open valve position is determined.

If the inlet vane controller LOCAL/COMPUTER selector switch on LCP-3 is in the LOCAL position, the position set point may be manually entered via the controller.

**CPU:**

If the inlet vane control LOCAL/COMPUTER selector switch on LCP-3 is in the COMPUTER position, the position set point may be manually entered via the keyboard in the control room. If the MAN/AUTO selector switch on the CPU is in the MAN position, the set point value used is from the inlet vane controller. If the MAN/AUTO selector switch on the CPU is in the AUTO position, the set point value used is from the keyboard.

### 32.4 Process Control

The high and low pressure air systems must be operated at levels sufficient to generate the amount of air necessary for process operation. Generally, this is automatically handled by the systems themselves, for instance, the high pressure air system is controlled by pressure, and the system operates as necessary to maintain this pressure.

The low pressure air system operation varies. With the exception of the aeration basin tank blowers, the amount of air required is determined by the mixing requirements of the various tanks using air. This is manually controlled and further information can be found in the relevant process sections as noted above.

The automatic operation of the aeration basin tank blowers is dictated by the amount of dissolved oxygen (DO) present in the aeration basins in relation to the DO controller set point. As the microbial activity increases and decreases the DO departs from the set point of the controller in one direction or another. This departure is met with a corresponding change in the basin air supply header motorized butterfly valve position. The butterfly valve affects the position of the centrifugal blowers' inlet guide vanes thereby increasing or decreasing its output, and the amount of flow passing through the tank(s).
32.5 Normal Operation

**High Pressure Air System** -- The high pressure air system will normally operate in the automatic demand mode; whereas, the compressors will be energized and de-energized by the action of receiver mounted pressure switches. The dual head compressors are provided with pressure switches that will energize the LEAD compressor head on a low pressure condition detected within the receiver and shutdown the compressor head on achieving the working pressure. If the LEAD compressor head can not provide sufficient air pressure to achieve the working pressure and the pressure is reduced within the receiver further, the LAG compressor head will be energized by its pressure switch. The LEAD and LAG compressors will continue to operate until the working pressure is achieved. No alternation of the compressors is provided; however, the LEAD/LAG function may be changed by adjustment of the respective pressure switches.

**Low Pressure Air System** -- The low pressure air blowers will normally be operated manually on a continuous basis; no automatic demand type startup controls are provided. The only manual operation of the blowers includes the adjustment of air flow to each of the aerated grit tanks and the balancing of flow between the primary influent channel and aerated grit channel effluent diffusers. All other blower air flow should be left in the full open position.

The design of this system is for each blower to supply low pressure air to a single application point. Each blower has a design capacity intended to satisfy the demands of the process needs. All blowers are provided with the capability to vary the blower speed and thereby its output. Pulleys and V belts have been supplied, and are manually interchangeable to vary the blower capacity to 100%, 85% and 70% of maximum. The aerated grit tank blowers are provided with two speed motors. The blower speed may be changed easily by stopping the blower and depressuring the alternately speed pushbutton at the MCC and re-starting the blower.

The number of blowers in operation, as well as each blower's speed is contingent on several factors. For greater detail on the specific process requirements of the aerated grit, sludge holding, and channels refer to the respective Chapters. Some of the factors that should be considered by the operator when deciding the air requirements of the system are as follows:

1. Number of tanks/ channels in use.
2. The amount of thickened sludge contained in each tank.
3. The duration of storage - actual and projected.
5. Malodorous indication.
6. Quantity of grit removed.
7. Quantity of organics removed with the grit.
The operator will want to maximize storage space while minimizing the number of tanks being used. Air will not be supplied to a tank that is not being used.

The volume of sludge being stored in a tank will influence the speed or output capacity under which a blower is operated. A tank that is 1/4 to 1/2 full will not require the same amount of air as a full tank will require. The aerated grit tank air requirement is constant, once set little adjustment is necessary, unless a tank is placed into or taken out of operation.

Duration of storage will be a certain consideration. Aeration, as mentioned earlier, serves two purposes. The air diffusers agitate the sludge as an aid in maintaining a uniform mixture, while keeping solids in suspension. While in the aerated grit tank the air diffusers maintains a rolling effect necessary to remove inorganic solids and keep lighter organic solids in suspension.

Sufficient air must be provided to the diffusers so that both actions take place and disallows any stratification. The air supply must also be sufficient enough to maintain aerobic conditions. If proper oxygen transfer is not continuously available, the sludge will become anaerobic and promote septicity.

In the sludge tanks, ambient temperatures may enhance odorous conditions. As temperatures rise, BOD requirements may increase.

The aeration system will help purge the sludge of H₂S (hydrogen sulfide) gas. The air from these tanks is exhausted through the odor control system (see Chapter 23). During daily tank inspections, the operator may find that the sludge is extremely malodorous or that the odor system is not removing all of the gaseous odors. This may not be a problem of the odor control system as much as a problem with the sludge.

The operator will test the sludge for BOD and Total Solids. Operator experience in process operation will serve as one of the operators greatest aids.
32.6  Alternate and Emergency Operation

32.6.1  Alternate operation

*High Pressure Air System* -- There are no alternate methods of high pressure air system operation. In the event of a failure of the operating compressor the second compressor or head may be operated until repairs are facilitated. However, long term operation without the availability of the other compressor will necessitate close observation by the plant staff in the event that a failure of the remaining unit occur.

*Low Pressure Air Blower* – Each low pressure air system is provided with a redundant low pressure air blower which may be considered a “spare” blower. The redundant blower can be utilized as a backup to the operating blowers in the low pressure air system. Care must be taken to ensure that the proper valves are open before switching blowers.

32.6.2  Emergency Operation

There are two types of emergency situations which the operator is likely to encounter during operation of the wastewater treatment plant: loss of power or mechanical failure of one or more components of the systems.

*Loss of Power*

If the normal source of power is interrupted, the emergency generator will start automatically and supply standby power to equipment necessary to maintain the plant in a state of readiness for restart following restoration of normal power.

If the normal source of electrical power is interrupted, alternative emergency power is provided for the low pressure air system. However, equipment essential to the operation of the facility should take precedence when determining the load on the generators and the need to run equipment for process control. The blowers and compressors are provided with emergency electrical service but the operator must manually re-start the blower following the transition from normal to emergency power and back.

*Equipment Failure*

If any of the components of the low or high pressure air systems fail to operate properly, the operator should shut down the equipment and, if possible, replace its operation with a standby unit. The equipment removed from service can then be cleaned and dismantled for inspection and repair, using the manufacturer’s instructions as a guide.
32.7 Shutdown Considerations

The operator should follow these general considerations when shutting down the blower equipment:

1. Shut down the blower at the local pushbutton control station.
2. Place the disconnect switch in the OFF position, lock out and tag, at the MCC.
3. Close the butterfly valve on the blower discharge.
4. Restart additional blower or increase operating blower speed to maintain adequate air flow requirements.

32.8 Startup Considerations

The operator should follow these general considerations when starting the blower equipment:

1. Ensure the proper pulley and belt arrangement is in place for the anticipated blower capacity requirements. Inspect V belts for condition and tension.
2. Inspect the blower for proper lubrication as recommended by the manufacturer. Check the remainder of the system for readiness to receive air flow.
3. Remove the lockout and tag from the MCC and place the disconnect switch in the ON position.
4. Open the manual blow off valve.
5. Open the butterfly valve on the blower discharge.
6. Start the blower at the local pushbutton control station.
7. Close the manual blow off valve.
8. Check the system for leaks.
9. Ensure proper operation of all related equipment.
32.9 Safety Considerations

Chapter 8 describes in detail the safety considerations and requirements with which the plant operating staff should be familiar. The following additional hazards are related to the plant air systems:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Section</th>
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</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>8.4.5</td>
</tr>
<tr>
<td>Electrically Powered Equipment</td>
<td>8.4.6</td>
</tr>
<tr>
<td>Non-Atmospheric Pressures</td>
<td>8.4.13</td>
</tr>
</tbody>
</table>
Chapter 33
Plant Water Supply System

33.1 Functional Description ........................................33-2
33.2 Design Data ......................................................33-3
33.3 Equipment Controls ............................................33-5
33.4 Process Control ..................................................33-6
33.5 Normal Operation ...............................................33-8
33.6 Alternate and Emergency Operations .......................33-10
  33.6.1 Alternate Operation .........................................33-10
  33.6.2 Emergency Operations ....................................33-11
33.7 Shutdown Considerations .....................................33-13
33.8 Startup Considerations .......................................33-15
33.9 Safety Considerations ........................................33-16
33.1 Functional Description

Water is supplied throughout the treatment plant by two separate systems: Plant and Potable water. Each system has a separate source and must never be inter or cross connected. This chapter will address the plant water system. Information on the potable water system may be found in Chapter 37, Plumbing Systems.

The plant water system utilizes chlorinated water taken from the effluent side of the hypochlorite contact tank and supplied to its respective distribution system through a sophisticated pumping system. This water is intended for chemical make-up and conveyance, pump cooling and flushing, tank cleaning, aeration basin foam control, GBT spray water, centrifuge flush water, etc. This water is not fit for consumption and every possible precaution has been exercised to separate this system from the potable water system.

Reduced Pressure Backflow Preventers (R.P.B.P.) have been utilized to prevent any cross contamination from the plant water system. These devices should be checked frequently for any signs of failure. If a failure is suspected it should be immediately reported and repaired. The R.P.B.P. is a testable device and must be tested by a certified individual as required by the state Department of Environmental Protection.

A plant water system consisting of four vertical turbine pumps, two hydropneumatic storage tanks, manual as well as automatic strainers, flow meters, controls and appurtenances required for a complete system has been installed. The pumping system is located in the Final Settling Tank Gallery.

Chlorinated secondary plant effluent water is taken from the effluent end of the hypochlorite contact tank(s). The water is supplied by gravity through a 14-inch plant water (PW) line to the plant water pump skid. A manually cleaned duplex strainer protects the pumps by removing particles 1/8-inch or greater. An automatic strainer will remove particles 1/32-inch or greater from the pumps discharge thereby protecting equipment utilizing plant water for cooling, seals or other machinery with critical tolerances.

The plant water is pumped into the distribution system by a base pump at a rate of 0 to 400 gpm at 70 psig. Additional pumps will automatically start and stop in response to the distribution system demand. Plant water flow is measured at the skid discharge by a magnetic flow meter. The meter will display system flow up to 3000 gpm.

The plant water system supplies water to yard hydrants, wash stations, seal water to pumps, pipe line flushing, make-up and conveyance water for chemical feed systems, aeration basin foam control and other systems. This water is not potable and all stations must be labeled accordingly (refer to Figure 33-1, Plant Water Flow Schematic.)
### 33.2 Design Data

#### Plant Water System

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
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<tr>
<td>Type</td>
<td>Continuous duty, skid mounted plant water support system</td>
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<tr>
<td>Manufacturer/Model</td>
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<tr>
<td>Capacity, gpm</td>
<td></td>
</tr>
<tr>
<td>#1 pump</td>
<td>0 to 400</td>
</tr>
<tr>
<td>#1 &amp; 2 pumps</td>
<td>401 to 1200</td>
</tr>
<tr>
<td>#1, 2, 3 &amp; 4 pumps</td>
<td>1201 to 2000</td>
</tr>
<tr>
<td>System Design Pressure, psig</td>
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</tr>
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<td></td>
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</table>

#### Base Pump No. 1

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</tr>
<tr>
<td>Type</td>
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<tr>
<td>Manufacturer/Model</td>
<td>Floway Pumps/8JKL-2 Stg.</td>
</tr>
<tr>
<td>Capacity, gpm @ ft TDH</td>
<td>400 @ 175</td>
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<tr>
<td>Number of Stages</td>
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</tr>
<tr>
<td>Motor Manufacturer</td>
<td>US</td>
</tr>
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<td>Hp/rpm</td>
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#### Pump Nos. 2, 3 & 4

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<tbody>
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</tr>
<tr>
<td>Type</td>
<td>Vertical turbine, 2-stage enclosed impeller, non-reversing ratchet motor</td>
</tr>
<tr>
<td>Manufacturer/Model</td>
<td>Floway Pumps/8JKH-2 Stg.</td>
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<tr>
<td>Capacity, gpm @ ft TDH</td>
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<tr>
<td>Number of Stages</td>
<td>2</td>
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<tr>
<td>Motor Manufacturer</td>
<td>US</td>
</tr>
<tr>
<td>Hp/rpm</td>
<td>50/3,500</td>
</tr>
<tr>
<td>Electrical service, v/ph/Hz</td>
<td>460/3/60</td>
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</tbody>
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#### Hydropneumatic Tanks

<table>
<thead>
<tr>
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<tr>
<td>Number</td>
<td>2</td>
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<tr>
<td>Manufacturer/Model</td>
<td>Canalis/FXA-700T</td>
</tr>
</tbody>
</table>

**CDM** Camp, Dresser & McKee
33.3 Equipment Controls

The following controls and their functions are associated with the equipment described above. Controls are listed from the device and/or its control panel (LOCAL), through the motor control center (MCC), to the local control panel (LCP) and the remote computer processing unit (CPU). Devices controlled by the CPU are accessed from either the Central Operator's Console (COC) or the Distributed Operator's Console (DOC).

**Plant Water Pumps**

**LOCAL:** H-O-A selector switches; status lights (white-POWER ON, red-RUN, green-OFF); alarms annunciators (LOW SYSTEM PRESSURE, HIGH SYSTEM PRESSURE, LOW PUMP SUCTION); Alarm Silence/Reset and Motor Overload Reset pushbuttons; pump alternation selector switches (2-3-4) (3-4-2) (4-2-3); ON/OFF disconnect switches (NORMAL POWER & NORMAL/STANDBY).

**LCP-4:** Status lights (red-RUN, green-OFF); common trouble alarm and low pressure alarm.

**COC:** Status lights (red-RUN, green-OFF); common trouble alarm and low pressure alarm.

**MCC:** ON/OFF disconnect switches.

**Plant Water Flow**

**LOCAL:** Flow Indication

**LCP-4** Flow Indication. A flow pacing signal is generated to drive the NaOCL Pump No. 4.

**COC:** Flow Indication and flow totalizer. A flow pacing signal is generated to drive the NaOCL Pump No. 4.

**Automatic Backwash Strainer**

**LOCAL:** HAND-OFF-AUTO selector switch; status lights (yellow-POWER ON, red-BACKWASH IN PROGRESS, green-BACKWASH ON, white-HIGH DP AUTO, yellow-HIGH DP MAN); Overload Reset pushbuttons; ON/OFF disconnect switch.

**MCC:** ON/OFF disconnect switch.

CDM Camp, Dresser & McKee
33.4 Process Control

The plant water pump skid is a fully automated system requiring minimal operator attention. Therefore, the operator exercises little control over the normal operation of the plant water pumping system.

However, there may be occurrences of foul odors or bio-solids regrowth in the plant distribution system, particularly at the remote use points or during periods of infrequent usage. A hypochlorite chemical feed pump (located in the Effluent Pump Station) has been dedicated to the plant water system to facilitate dosing of the line for these reasons. The hypochlorite pump may either be flow paced by the plant water skid magnetic flow meter or manually operated by adjusting the pump speed and stroke rate. Operator experience with the application of hypochlorite to the plant water distribution system will enable proper adjustment and setting of the desired chlorine residual in the system. A good starting point may be to establish a 0.5 mg/l residual at the point of discharge/use that demonstrates a need for chlorination. The residual may be adjusted up or down with operator experience. Refer to Chapter 24 for additional information relative of the hypochlorite feed system.

The plant water source from the hypochlorite cell contact tanks may contain solids on occasion. These solids may affect the performance of the plant water pumps or possibly cause damage to the pumps. To protect the pumps a duplex strainer system is provided. The strainers are provided with local differential pressure monitors to alert the operator of strainer fouling. Routinely, the strainers must be manually operated and the strainer flushed to clean debris from the strainer.

NOTE: It is recommended that the strainers be checked every shift or more frequently during a process upset, equipment or tank change, following power outage, rain event or any other unusual event.

To remove fine solids and prevent their entry into the plant water distribution system, an automatic simplex backwash strainer is provided. The strainer will protect equipment dependent on the plant water for cooling and seals from solids accumulations. The strainer is controlled by either a timer or pressure differential sensor. The strainer controls are local to the strainer and are not announced or controlled from the LCP or COC. When cycled to clean the strainer, the automatic drive motor will be energized and the blow-off/drain valve will open and flush backwash to drain. After completing the cycle, the strainer motor will stop and the blow-off/drain valve will close. The system will wait for the next timed cycle internally adjusted from 10 minutes to 10 hours to begin the process again unless over-ridden by the differential pressure sensor. Backwash is carried through the 2-inch copper backwash line to the secondary scum wet well for conveyance with skimmings to the sludge processing building.

CDM Camp, Dresser & McKee
33.5 Normal Operation

The operation of the plant water system is designed to be automatic. The operator will place the pump selector switches and the lag pump selector switches in automatic mode.

Under normal flow conditions, the smaller of the pumps, will always be the lead pump. This 25 horsepower, vertical turbine pump, operates at a constant speed and has a capacity of 400 gallons per minute (gpm).

Because all the pumps are operated at a constant speed, pump over-temperature protection has been provided. Each pump is fitted with an electrical temperature probe and purge valve. The temperature probe signals the purge valve to open when water in the pump becomes too hot due to lack of flow. The hot water is purged to a drain which allows cool water to enter the pump. Once the pump has cooled, the temperature probe signals the purge valve to close.

Two hydropneumatic tanks have been supplied with this system. Each tank holds 170 gallons of water. These are connected to the discharge manifold and supply the system with water and pressure during a very low or no flow period when the lead pump is not running.

Two switches are interconnected at these tanks, and must be satisfied, or "made", before the lead pump shuts down. The first is a pressure switch. This switch is made when maximum storage and pressurization have taken place in the tanks. The second switch is the "maxi-store" flow switch. This switch is made when a true no-flow condition occurs.

Once these conditions have been satisfied, the lead pump will shut down. The tanks will provide regulated system pressure until they have reached the preset pressure set-point. At this point, the pressure switch will open, just before system pressure design, and restart the lead pump.

If low flow conditions still exist, the cycle will be repeated. If the pressure and maxi-store switch are made before the lead pump minimum run time has expired, the pump will continue to run. Shut down will occur at the end of the pumps minimum run time.

**NOTE:** Each pump’s run signal is governed by a five minute run period. The minimum run period serves a dual purpose. First it protects the electric motors from excessive starts per hour. The second purpose is that it helps provide smooth system pressure regulation by eliminating excessive start/stop operations.

During higher flow conditions, the lead pump will provide flows up to its rated capacity. When this capacity is reached, the first leg pump flow switch will start the designated
first lag pump. Both pumps will continue to operate up to their combined capacity. Should flows continue to increase, the second flow switch will activate the next designated lag pump. If the three pumps are not able to satisfy the demand, the third lag pump will be energized by the third flow switch. All four pumps will then operate to their combined rated capacity.

As flow demand decreases, destaging of pumps will occur in reverse order of that noted above.

Periodic cleaning of the system strainer is required. Once a week, the strainer screens should be manually rotated; the backwash matter being discharged through a 4-inch line to the drainage trench, located in the Final Settling Tank Gallery.
33.6  Alternate and Emergency Operations

33.6.1  Alternate Operation

The lag pump selector is a three way switch containing 2-3-4, 3-4-2, 4-2-3 functions. The normal mode of operation requires that this switch be rotated as required to facilitate equipment rotation of the principal lead pump. This is easily accomplished by placing the selector switch in the preferred sequence position. After this selection is made, the lag pump sequence will be the same, regardless of operating time, until the switch is changed. Flow controls and pressure controls will still remain in effect for individual pump.

All four pumps have been supplied with H-O-A control selectors at the panel. When the OFF mode is selected, the pump will not operate under any conditions.

When the selector is placed in the HAND mode, the pump will operate continuously. The flow and pressure switches will not affect the pump in this mode. The temperature probe and purge valve will continue to operate.

The operator will have to monitor the system and control pump operation manually. Caution should be exercised in the operation of a pump in this mode as abnormalities in operation may not be apparent until damage has resulted.
33.6.2 Emergency Operations

There are two types of emergency situations which the operator is likely to encounter during operation of the wastewater treatment plant: loss of power or mechanical failure of one or more components of the systems.

Loss of Power

If the normal source of power is interrupted, the emergency generator will start automatically and supply standby power to equipment necessary to maintain the plant in a state of readiness for restart following restoration of normal power.

During this interim period, plant water demand should be at a minimum; pump seal water taking precedence. Therefore, the base pump is supplied with alternative power for uninterrupted plant water supply and pressure during the loss of normal power. Upon restoration of the normal source of power, the remaining lag pumps will automatically start as required to satisfy any demand on restart.

Time delays have been placed in the P.C. to prevent multiple pump startup on restoration of normal power.

2. Base Pump Enabled - 15 second delay, first lag pump starts (as required).
3. First Lag Pump Enabled - 15 second delay, second and third lag pumps start (as required).

Mechanical Failure

Mechanical failure of a component of the plant water supply system should be repaired without delay. The plant water system flow capacity is designed to provide continuous supply of plant water under several conditions of demand. Without a third or fourth pump, or other element of the system operational insufficient water pressure or supply may result when critically required.

Alarm Conditions

An alarm system has been designed for the plant water system. A horn, silence/reset push-button and status lights have been provided locally. Run and pump trouble status lights for each pump have been provided locally at the panel. Additionally, a system loss of pressure condition is announced locally at LCP-4 and at the Central Operator's Console (COC).

The local alarm status lights are red and are for the following conditions:

1. Low system pressure
2. High system pressure
3. Low pump suction

Any of the above abnormal conditions will activate the alarm system. A status light will illuminate and the alarm horn sounded locally. An alarm at the COC will also be activated simultaneously.

By depressing the alarm silence/push-button once, the horn will be extinguished. Five seconds must elapse before the push-button can be depressed again to reset the system.

CAUTION: Before resetting the system, the operator should investigate the cause of the alarm. Failure to do so may result in damage to the pumps and/or associated equipment. The electric drive motors have been outfitted with external thermal protection. An internal thermostat will open a relay in the panel circuitry, causing the overheated motor to shut down.

The alarm system also has a feature known as a first alarm indication. If two or more alarms cause a shutdown, the status light to the first alarm condition will flash.

If the system will not reset, the reset push-button can be pushed in and held. The status lights to those systems which are not within normal limits will be displayed. When the button is released, the lights will return to their original state, with the first alarm condition in effect.
33.7 Shutdown Considerations

Plant Water Pumping System

Normally, the plant water system is always available for operation. However, if an extend system shutdown is anticipated the following guidelines should be considered:

1. De-energize the system at the local control panel and the MCC. Tag the disconnect switches.
2. Close all suction and discharge valves.
3. Isolate the system with valving.
4. Drain the suction and discharge manifolds. Drain the pumps and flush any solid matter with clean water.
5. Perform preventive maintenance and lubrication task on the pumps and motors per the manufacturers’ service manual recommendations.

Plant Water Pump

Normally, all plant water pumps should always be available for operation. However, if a pump must be removed for service, the following guidelines should be considered:

1. De-energize the pump at the local control panel and tag the disconnect switches.
2. Position the local control panel pump sequence selector switch to take the out-of-service pump out of the pumping sequence.
3. Close all suction and discharge valves.
4. Drain the pump and flush any solid matter with clean water.
5. Perform preventive maintenance and lubrication task on the pump and motors per the manufacturers’ service manual recommendations.

Strainers

Normally, both the duplex and simplex strainers should always be in service. However, if a strainer must be removed for service, the following guidelines should be considered:

1. Divert flow around the strainer by opening the by-pass line.
2. Close the inlet and outlet valve of the strainer and drain the strainer.

3. The simplex strainer control panel selector switch must be placed in the OFF position.

4. Perform maintenance tasks as required of the manufacturer's service manuals.
33.9 Startup Considerations

Normal operation of the plant water system is automatic and has no special startup requirements. The following is a checklist for general startup, or startup following an extended shutdown:

1. Remove any tools or debris from the pumps and motors.
2. Perform any required lubrication.
3. Internally inspect, clean/repair the pressure reducing valve (P.R.V.) and strainer (refer to specific manufacturer’s recommendations).
4. Inspect all controls, switches and wiring for proper position and connection.
5. Close and/or plug all drains.
6. Open all system isolation valves.
7. Open suction and discharge valving.
8. Purge any air from pumps.
9. Inspect all piping for leaks.
10. Energize the local control panel and each pump.
11. Place the pump sequence selector switches in the proper position, place the pumps in the AUTO mode.
12. Monitor system closely for leakage, operation, vibration and overheating.

Strainers

To re-start an out-of-service strainer, reverse the above shutdown procedures.
### 33.9 Safety Considerations

Chapter 8 describes in detail the safety considerations and requirements with which the plant operating staff should be familiar. The operator should reference the appropriate Safety sections for information on the hazards related to the plant water pumping system:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical</td>
<td>8.4.5</td>
</tr>
<tr>
<td>Electrically Powered Equipment</td>
<td>8.4.6</td>
</tr>
<tr>
<td>Non-Atmospheric Pressures</td>
<td>8.4.12</td>
</tr>
</tbody>
</table>
# Chapter 34

**Electrical Systems**

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.1</td>
<td>General Information</td>
<td>34-2</td>
</tr>
<tr>
<td>34.2</td>
<td>Power Distribution</td>
<td>34-3</td>
</tr>
<tr>
<td>34.3</td>
<td>Safety Precautions</td>
<td>34-6</td>
</tr>
<tr>
<td>34.4</td>
<td>Controls</td>
<td>34-7</td>
</tr>
<tr>
<td>34.5</td>
<td>Lighting System</td>
<td>34-13</td>
</tr>
<tr>
<td>34.6</td>
<td>Emergency Troubleshooting</td>
<td>34-15</td>
</tr>
<tr>
<td>34.7</td>
<td>Special Safety Precautions</td>
<td>31-16</td>
</tr>
<tr>
<td>34.8</td>
<td>Other References to Electrical Equipment</td>
<td>34-17</td>
</tr>
</tbody>
</table>
34.1 General Information

The electrical system has been designed and installed in strict compliance with all federal, state, and local codes having jurisdiction over this type of installation. In as such, any and all maintenance of electrical equipment should be performed by qualified personnel following applicable codes. Additionally, access to electrical equipment: Switchgear, Transformer, MCC'S, Power Panels, Transfer switches, Control panels, etc. should be strictly limited to qualified personnel.

The New Bedford WPCF is fed from either of two separate electrical feeds. Incoming power is distributed over both high and low voltage electrical systems within the plant. In the event of loss of both normal electrical service feed, two natural gas fired emergency generators will provide an alternative power source.
34.2 Power Distribution

Electrical power for the plant is provided by the Commonwealth Electric Company at 13.2 kilovolts (KV). Electrical service, rated for 13.2 KV, 3 phase, 60 Hertz, is brought to the treatment facility through either of two separate incoming lines, both within the same conduit duct bank. The power company power lines are brought underground to the Administration Building's electrical room and tied into the 13.2 KV switchgear (refer to Figure 34-1A).

The 13.2 KV switchgear contains the electrically operated circuit consisting of two main breakers, four plant feeder breakers, one generator breaker and one time breaker in addition to electricity revenue meters for both incoming lines, electricity monitoring meters (voltmeters, ammeters, and wattmeters), protective relays, transformers and plant service feeders. The emergency generator power is fed to the 13.2 KV switchgear, when on-line through the generator circuit breaker (refer to Figure 34-2). Control functions within the switchgear permits the automatic switching from normal electrical service to the alternative electrical power in the event of normal power supply failure.

From the 13.2 KV switchgear, power is fed underground from the 13.2 KV switchgear's four feeder breakers to the ten remote pad mounted transformers. At the transformers, the 13.2 KV electrical service is stepped down to usable voltage and distributed to four 480 volt switchgears and the 4160 volt motor control center serving the aeration blowers (refer to Figure 34-2). Two properly sized pad mounted transformers are provided for each of the four 480 volt switchgears and a single 4160 volt MCC. The following table identifies the switchgears and their electrical characteristics:

Table 34-1 Switchgear Schedule

<table>
<thead>
<tr>
<th>Area Served</th>
<th>Switchgear</th>
<th>Voltage</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration Building</td>
<td>SWGR-AM</td>
<td>480 V</td>
<td>750 KVA</td>
</tr>
<tr>
<td>Effluent Station &amp; FST</td>
<td>SWGR-EP</td>
<td>480 V</td>
<td>1500 KVA</td>
</tr>
<tr>
<td>Influent Station, PST &amp; PAH</td>
<td>SWGR-HW</td>
<td>480 V</td>
<td>1500 KVA</td>
</tr>
<tr>
<td>Sludge Processing &amp; GT</td>
<td>SWGR-SP</td>
<td>480 V</td>
<td>3000 KVA</td>
</tr>
<tr>
<td>Blowers &amp; Aeration Basin</td>
<td>MCC-AB</td>
<td>4160 V</td>
<td>2000 KVA</td>
</tr>
</tbody>
</table>

Each of the four 480 volt switchgears are fed by two incoming electrical service lines through both of the two pad mounted transformers. From the transformers, power is fed through a main breaker within the 480 volt switchgear. There are two main breakers (A & B), one on either end of the switchgear bus and a "Tie Breaker" situated in the middle of the bus. During normal use both breakers will be in the closed position providing power to the respective motor control centers while the tie breaker is in the open position. In the event that one of the incoming power lines is lost, its main breaker will open and the tie breaker will close automatically and permit power to be fed to equipment (MCCs) on the lost side of the buss.

Power for the Aeration Basin blowers is fed through the two pad mounted transformers to the 4160 volt MCC-AB through main disconnects, and two
disconnects. However, MCC-AB is not provided with an automatic switching tie breaker but a key interlock system that requires manual switching of the power to the entire buss in the event that an incoming power line is lost.

Each of the four switchgear provides 480 volt power to the respective Motor Control Centers (MCCs). Each of the MCCs will provide protected power to the various equipment served from the MCC through circuit breakers and combination motor starter units.

In the event that both normal electrical services supplied by the power company are temporarily interrupted, alternative power is provided by the 2 emergency generators. Each generator/engine set is rated to deliver 1000 kilowatts (Kw) at 1428 kilovolt ampe (Kva) for a total of 2,000 Kw at 2,856 Kva. They are capable of supplying sufficient electrical power throughout the plant for emergency equipment operation. The purpose of alternative power is to sustain the treatment plant's current operating status in the interim period until normal electrical service is continued. Therefore, it is not necessary or prudent to operate all equipment on alternative power.

Certain equipment are provided with automatic re-start once emergency generator power is available. Refer to the table below for a listing of equipment that with automatically re-start through computer control and as a function of the electrical interlocks. The listed equipment is in addition to plant auxiliary equipment (HVAC, lighting, etc.) that will also be energized with emergency power.
Table 34-2  Equipment Restart Sequence

The re-starting sequence shall be as follows (All other process equipment must be manually restarted):

<table>
<thead>
<tr>
<th>Start Status</th>
<th>Sequence</th>
<th>Process Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>1.</td>
<td>Start plant water system including plant water strainer.</td>
</tr>
<tr>
<td>A.</td>
<td>2.</td>
<td>Start influent sluice gate power pack.</td>
</tr>
<tr>
<td>B.</td>
<td>3.</td>
<td>Start effluent pumps. These pumps will not start unless the effluent wastewater level in the wet well will require them to run.</td>
</tr>
<tr>
<td>A.</td>
<td>4.</td>
<td>Start effluent sluice gate hydraulic power pack.</td>
</tr>
<tr>
<td>A.</td>
<td>5.</td>
<td>Start Chlorination and dechlorination system. This system includes:</td>
</tr>
<tr>
<td>C.</td>
<td>a.</td>
<td>Sodium hypochlorite feed pumps.</td>
</tr>
<tr>
<td>C.</td>
<td>b.</td>
<td>Sodium hypochlorite mixers.</td>
</tr>
<tr>
<td>C.</td>
<td>c.</td>
<td>Sodium bisulfite feed pumps.</td>
</tr>
<tr>
<td>C.</td>
<td>d.</td>
<td>Sodium bisulfite mixers.</td>
</tr>
<tr>
<td>A.</td>
<td>7.</td>
<td>Start effluent sampler.</td>
</tr>
<tr>
<td>A.</td>
<td>8.</td>
<td>Start residual sampling pumps.</td>
</tr>
<tr>
<td>B.</td>
<td>10.</td>
<td>Start sulfite residual monitor.</td>
</tr>
<tr>
<td>A.</td>
<td>12.</td>
<td>Start primary-air handling system, including:</td>
</tr>
<tr>
<td>C.</td>
<td>a.</td>
<td>H₂S scrubber exhaust fans.</td>
</tr>
<tr>
<td>C.</td>
<td>b.</td>
<td>Scrubber recirculation pumps.</td>
</tr>
<tr>
<td>C.</td>
<td>c.</td>
<td>Sodium hypochlorite feed pumps.</td>
</tr>
<tr>
<td>C.</td>
<td>d.</td>
<td>Sodium hydroxide feed pumps.</td>
</tr>
<tr>
<td>C.</td>
<td>e.</td>
<td>Ferrous chloride feed pumps.</td>
</tr>
<tr>
<td>A.</td>
<td>15.</td>
<td>Start grit and screenings belt conveyor.</td>
</tr>
<tr>
<td>A.</td>
<td>17.</td>
<td>Start grit tank blowers.</td>
</tr>
<tr>
<td>B.</td>
<td>22.</td>
<td>Start primary sludge cross collectors.</td>
</tr>
<tr>
<td>B.</td>
<td>23.</td>
<td>Start primary sludge pumps.</td>
</tr>
<tr>
<td>A.</td>
<td>26.</td>
<td>Start recycle sampling pump.</td>
</tr>
<tr>
<td>A.</td>
<td>27.</td>
<td>Start recycle sampler.</td>
</tr>
</tbody>
</table>

Legend:  
A............. Automatic Self-Starting  
B............. Automatic Computer  
C............. Manual Restart
34.3 Safety Precautions

The distribution system operates with a solid ground neutral, which offers the greatest protection possible against excessive shock. However, electrical shock to personnel can occur if safety rules are not observed. Most major equipment operates at 480 volts between phases. A grounded neutral system limits the voltage rise about ground for fault conditions. It also offers a system where the circuit breaker will trip if one phase becomes grounded. Only qualified personnel should perform any testing or repairing of this equipment.
13.2 KV Switchgear Control Description

During normal operations, the switchgear will be characterized by the following normal conditions:

1. Both main breakers are closed.
2. The tie breaker is open.
3. The generator transformer breaker is open.
4. There are loads on all four feeder breakers (they are in the closed position).
5. The Switchgear AUTO/MANUAL selector switch is locked in the AUTO position.

During the loss of incoming voltage (normal service) on Line No. 1:

1. The negative sequence voltage relay and the undervoltage relay monitor the incoming line voltage on the load side of each main breaker.
2. If the incoming line voltage amplitude falls below the undervoltage relay dropout setting or the negative sequence voltage exceeds the negative sequence voltage relay setting, then after an adjustable time delay (1.5 - 15 seconds to avoid nuisance tripping), the affected main breaker will be tripped.
3. If the voltage on the remaining bus is satisfactory and the affected main breaker trip is verified, then the tie breaker will be closed after an adjustable time delay (1.5 - 15 seconds).

The automatic transfer sequence on loss of Line No. 2 incoming voltage is similar.

In the event that both Line Nos. 1 & 2 incoming voltages are lost:

1. The negative sequence voltage relay and the undervoltage relay monitor the incoming line voltage on the load side of each main breaker.
2. If the incoming line voltage amplitude falls below the undervoltage relay dropout setting or the negative sequence voltage exceeds the negative sequence voltage relay setting, then after an adjustable time delay (1.5-15 seconds) the affected main breaker will be tripped.
3. If the voltage on the remaining bus is not satisfactory, then the remaining main breaker will be tripped.
4. If both main breakers have been tripped, then after an adjustable time delay (1.5 - 15 seconds) from a fail-safe off-delay relay, normally closed contact closures will trip the tie breaker (if it has been closed), and will trip the FEEDER C breaker. The Standby Generators' start sequence will then be initiated.

If the voltage from the generator transformer is at 90% of the rated voltage and the frequency is within 95% of 60 hertz, for an adjustable time delay (1.5 - 15 seconds), then the voltage and frequency relays will seal-in and the generator
breaker will be closed.

5. After an adjustable (1.5 - 15 seconds) time delay after the generator transformer breaker has been closed, the FEEDER C breaker will be closed.

Once normal service is available, re-transfer to the Normal Source is as follows:

1. Restoration of power following loss of incoming line voltage will be performed by the power company, using the main and tie breaker control switches, and the AUTO/MANUAL key selector switch (if necessary).

The 13.2 KV switchgear is provided with control interlocks:

1. Only one power supply may be connected to a bus. An exception is described in the next section (Manual By-pass) below.

2. The standby generator will not be paralleled with either of the power company's incoming lines. As described above, the generator transformer breaker may not be closed in the automatic transfer mode unless the tie breaker and main breaker No. 2 are open.

3. The generator transformer breaker will not be able to be manually closed unless either the tie and main No. 2 breakers are open or both main breakers are open. A backup power supply will not be automatically connected to a bus (including a feeder bus) which has tripped on overcurrent or has been manually tripped.

The 13.2 KV switchgear is provided with a Manual By-pass:

1. An alternate mode of operation (Manual By-pass) will be provided which permits the power company to close the tie breaker while both main breakers are closed, using the key operated AUTO/MANUAL selector switch on the control panel. This will permit taking an incoming line out of service without cutting off power to the plant (closed transition transfer).

2. If the AUTO/MANUAL key selector switch is placed in the MANUAL position, the tie breaker interlocks which prevent closing the tie breaker will be disabled and the synch-check relay interlock will be enabled. Then it will be possible to close the tie breaker, using the tie breaker control switch, if the incoming lines have the same phase rotation and are in phase. Synchronous phase monitoring provided through the synch-check relay.

480 Volt Generator Switchgear Control Description

During normal operations, the switchgear will be controlled in the following manner:

1. The generator switchgear will provide for complete automatic or manual paralleling control for the two engine generator sets. Automatic or manual starting and stopping of each generator is controlled from the engine control panels.
2. The generators will be brought up to speed and closed into the generator switchgear main bus through their individual generator breakers. Voltage and frequency relays will be provided for each generator to lock the generator from the main bus until correct voltage and frequency are reached.

3. Each generator will be capable of being first to assume the bus load, depending upon which first reaches correct voltage and frequency. The other incoming generator will automatically synchronize and parallel with the first unit.

4. Each engine generator will be capable of starting and assuming load within seven seconds after the start circuit is energized, and the other generator will be synchronized, paralleled, and divide the load within ten seconds after the starting circuit is energized.

5. All engine on/off and timing functions will be controlled by the engine control panels.

The following describes the required interlocking between the engine control panel, the automatic transfer system and the generator synchronizing switchgear:

1. An OFF position is provided to allow a normal shutdown with a time delay to allow the engine to cool after operating under load. Whenever the engine selector switch is placed in the OFF position while the engine is operating, the generator circuit breaker will trip, but the engine will continue to operate until the expiration of the time delay setting of the idle relay.

2. When the engine selector switch is placed in the AUTO/REMOTE position, the engine generator will be on standby and will start whenever a power failure signal is given from the automatic transfer system. When the commercial power returns (refer to Re-transfer of normal source above) and the transfer system signals the engine generator to shut down, the circuit breaker will be tripped, and the engine will continue to operate for the idle time delay period before shutting down in readiness for the next power failure.

3. When the engine selector switch is placed in the RUN position, the engine will start and come up to speed. It will continue to run until the selector switch is returned to the OFF position or one of the EMERGENCY STOP pushbuttons is operated. This position is to be used for testing or for manual operation.

4. A system test switch is included in the engine control panel to initiate a complete automatic system operation by simulating the closure of the remote engine start signal. This switch is mounted inside the master section to limit access to authorized personnel only.

5. When the switch is placed in the test position, the generators will automatically start and all automatic synchronizing functions will complete, except that the feeder breakers will remain open unless preferred power source should fail during the test procedure. The generators will be automatically synchronized and paralleled on the main bus at no load.
6. Returning the test switch to the normal position will trip the generator breakers and restore all equipment to normal operation.

**480 V Switchgear Automatic/Manual Synchronizing Switch**

In the AUTOMATIC position, all-functions will perform in the sequence as specified hereinafter.

**NOTE:** In the MANUAL position, all automatic functions will be locked out and the opening and closing of breakers and synchronizing and paralleling procedures will be manually performed.

1. The differential voltage detector will compare the voltage of the oncoming generator to the paralleling bus. If the voltage is not within the factory set difference of plus or minus 5% (adjustable from 0 to plus or minus 10%), the voltage detector will lockout the circuit breaker closing relay and simultaneously initiate adjustment of the voltage through the raise/lower output relays. When the oncoming generator voltage is within the preset acceptable limit, the lockout will be removed.

2. The differential frequency detector will compare the frequency of the oncoming engine generator set to the paralleling bus. If the frequency is not within the preset acceptable difference of plus or minus 0.5 Hz (adjustable from 0 to plus or minus 0.5 Hz), the frequency detector will lockout the circuit breaker closing relay and simultaneously generate a DC voltage proportional to the frequency difference to cause the engine governor to bring the frequency within the preset acceptable limit. When the oncoming engine generator frequency is within the acceptable limit, the lockout will be removed.

3. When the voltage and frequency limits are satisfied, and the relative phase angle between the oncoming unit, and the bus reduces to 5 degrees approaching zero degrees, the synchronizer will hold (phase lock) the generator output in synchronism with the bus, the circuit breaker closing relay will close to initiate breaker closing and paralleling. DC control of the governor and voltage control will be terminated simultaneously with breaker closure. The complete system will function in such a manner as to insure that the maximum relative phase angle at the instant of paralleling does not exceed 5 electrical degrees.

4. A fail-to-synchronize time delay relay is provided to terminate the operation of the synchronizer and sound the master alarm horn in the event the generators are unable to be synchronized within an adjustable period of time, approximately 0-3 minutes. After failing to synchronize automatically, the operator, at his discretion, will be able to connect either one or both of the generators to the emergency bus by turning the master control switch to the manual position and by operating the manual synchroscope system and the circuit breaker control switches.

5. Over/under frequency and over/under voltage sensors are provided to detect an abnormal condition on the emergency bus. An over/under voltage and an over frequency failure will cause an alarm horn to sound and a red fail lamp to light. An under frequency condition will initiate load shedding as well as sounding the master alarm horn and lighting a red fail lamp.

CDM Camp Dresser & McKee 34-10
Load shedding control is provided to protect against overload. The controls function as follows:

1. Allow predetermined loads only to be connected to the emergency system until the second generator is connected in parallel to the emergency switchboard bus.

2. Reduce the load on the emergency bus in case of failure of either engine generator. Upon restoration of the failed engine generator, the load will be automatically re-added to the bus.

**Motor Control Centers (MCC)**

All power is distributed through Motor Control Centers as well as lighting panels. Each MCC is fitted with a main service disconnect switch. This switch "opens" and "closes" the electrical supply to and from the MCC. In addition, each circuit that is serviced is protected from overloads and short circuits by a fused switch and/or an air circuit breaker. The circuit breaker also serves as main manual disconnect for its circuit. The fuse or fused units are used for the smaller motor circuits. The fuse or circuit breaker will open if a rapid overload or short circuit occurs. An opened fuse must be replaced in order to resume power supply. A control selector switch is located on the faceplate of each circuit breaker which has four operation positions: ON, TRIP, OFF and RESET. The ON position indicates that the circuit breaker has been manually closed.

The TRIP position indicates that the breaker has been automatically opened because of an overload or short circuit. If the breaker has been automatically set to the TRIP position, closing the breaker should not be attempted until the cause of opening has been determined. The breaker must be set to RESET before it will close the circuit; then set in the ON position. The control lever on the breaker is arranged in such a manner that the breaker must be set to the OFF position before the access door may be opened to perform work inside the unit.

If a fuse or breaker has been automatically opened, as indicated by the position of the control lever, the circuit should be tested for short circuits before replacing the fuse or attempting to close the breaker. To determine if the line is short circuited, open the fuse switch or turn the breaker to OFF, open the access door, and make a resistance test across all phases (and all phases to ground) on the load side of the breaker with an ohmmeter. A reading of infinity, or close to it, should be read between all phases (and all phases to ground) if the circuit is open. A low reading indicates a short circuit in the cable or in the equipment. This situation must be corrected before the circuit may be used.

The circuit breakers and switches are equipped with lockouts. These lockouts may be fitted with a padlock, if desired, to prevent personnel from starting units or to prevent tampering. Cards similar to those displayed in Figure 6-3 (refer to Volume I Chapter 6, Safety) should be hung on the circuit breaker when it is locked out. Control for the various motors actuate the magnetic starters.
described above which supply power to the motors. The following controls are used throughout the plant in various combinations:

**START/STOP Switch or Pushbuttons**

These have two operating positions: START and STOP. When this control station is set on START, the motor will start if the other controls for the same motor are set for start. When this control station is set for STOP, the motor will stop and will not start regardless of the settings of the other controls until this station is set for START. These stations are "maintained contact" because, if the power supply to the motor is cut off, the station will remain switched on and as soon as power is restored, the motor will restart. These stations are installed on the essential equipment in the plant which must be started again as soon as possible after a power failure has ended. These units may be locked in either the START or STOP position by a padlock. If locked on START, the unit may be stopped by either removing the lock or switching the main circuit breaker at the motor control center to OFF. If locked on STOP, the lock must be removed before the unit will start.

**Pushbutton Station**

This has two operating positions: START and STOP. When the control station is set on START, the motor will start if the other controls for the same motor are set for START. When this control is set for STOP, the motor will stop; however, the motor may be restored by another pushbutton station. These stations are "momentary contact" because, if the power supply to the motor is cut off, the station will switch off and the motor will not restart when power is restored until the START button is pressed.

**Pushbutton Station with Lockout**

These pushbutton stations are similar to the pushbutton stations described above, except that these stations have a locking device in the STOP position so that when the lock is in place, the motor will not start, regardless of other controls. These pushbutton stations are located beside the motor that they control, and should be used for shutting off and locking off the motor.

**HAND/OFF/AUTOMATIC (H-O-A) Switch**

This type of switch is used on motors which may be controlled by both an automatic control and a manual control. When the switch is set to OFF, the motor will not start, regardless of the settings of the other controls. When the switch is set to AUTOMATIC, the motor will start if the START/STOP switches controlling the motor are set for START and the automatic controller switch is switched to ON. The motor will continue to operate until the automatic controller switches to OFF or the motor is manually shut off. When the switch is set for HAND, the motor will start if any START/STOP switches controlling motor are set for START. Hand operation bypasses the automatic controller. The motor will continue to operate until it is manually shut off. For some equipment, when the selector switch is put in either the HAND or AUTO position, they will immediately start operating.
HAND/OFF/REMOTE (H-O-R) Switch

This type of switch is used on motors which may be controlled by both a remote control and a manual control. When the switch is set to OFF, the motor will not start, regardless of the settings of the other controls. When the switch is set to REMOTE, the motor will start if the START/STOP switches controlling the motor are set for START and the REMOTE controller switch is switched to ON. The motor will continue to operate until the REMOTE controller switches to OFF or the motor is manually shut off. When the switch is set for HAND, the motor will start if any START/STOP switches controlling motor are set for START. Hand operation bypasses the REMOTE controller. The motor will continue to operate until it is manually shut off. For some equipment, when the selector switch is put in either the HAND or REMOTE position, they will immediately start operating.

Status Indicating Lights

Indicating lights are provided at various locations to indicate whether a motor is running or not. At the motor control centers and process control center, a red light indicates the motor is running and a green light indicates the motor is not running.

34.5 Lighting System

Three types of lighting fixtures are installed at this facility. They are incandescent, fluorescent, and high pressure sodium.

Fluorescent fixtures are furnished with Class P, high power factor, rapid start ballasts. Class P ballasts have internal thermal protection. If it is tripped by the thermal protector, it will automatically reset when cooled to within its safe limits.

High pressure sodium fixtures are furnished with constant wattage auto-transformer (CWA) type ballasts. This type of ballast has the characteristics of high power factor, low starting current, low running current and low line extinguishing voltage.

Light output of lamps decrease as the lamps age and as dirt accumulates on the lamp and luminaire surfaces. This can be reduced by a planned relamping program and by periodically cleaning the luminaries.

Fluorescent lamps are silicone coated to ensure that accumulated moisture is converted into droplets so that there is not continuous path between the droplets across the lamp surface.

In order for the lamp to operate properly, a charge is created upon the glass of the lamp and excites the electrons. If the glass is wet or dirty, this charge tends to drain away. Therefore, the lamps must be kept clean. The most effective time to initiate an annual cleaning program is in the Spring when the high humidity season is first approaching. A sponge or cloth dampened in plain water is the best method to use for cleaning. If detergent is used and not
completely removed, a film will be left on the lamps and defeat the purpose of the silicone coating.
Emergency Troubleshooting

Emergencies in the electrical system are usually the result of excess electrical current flowing in a circuit or circuits. Circuit breakers throughout the system serve to isolate such emergency conditions by automatically removing such circuits from the electrical system. In addition, there is redundant protection inherent in the electrical system.

Only qualified personnel are to work on electrical equipment. If a fuse or circuit breaker has automatically opened, as indicated by the position of the control lever, the circuit should be tested for short circuits before replacing the fuse or attempting to close the breaker. To determine if the line is short circuited, open the fuse switch or turn the breaker to OFF, open the access door, and make a resistance test with an ohmmeter across all phases (and all phases to ground) on the load side of the breaker. A reading of infinity, or close to it, should be read between all phases to ground if the circuit is open. A low reading indicates a short circuit in the cable or in the equipment. This situation must be corrected before the circuit may be used.
34.7 Special Safety Precautions

When inspecting, repairing, and performing maintenance on metal-clad switchgear, the fact that dangerous voltages may exist must be kept in mind and precautions taken to ensure that no personnel come in contact with a "live" high voltage part. Common general precautions for high voltage work are:

1. All connections should be considered "live" until the crew expecting to work on them is assured that the circuits are "dead", and until every possible precaution has been taken to see that there is no chance of a circuit being energized while the crew is working.

2. Switches which have been opened to de-energize a circuit to permit work on equipment should be locked or blocked open and a suitable visible warning device placed thereon.

3. Do not work on parts normally carrying current at high voltage until their parts have been disconnected from the system and connected to the ground bus. Provisions should, therefore, be made for connecting adequate flexible ground leads so as to reach every part of the switching equipment.

4. A good and reliable ground connection is necessary for every switchgear installation. It should be of sufficient capacity to take care of any abnormal condition that might occur on the system and should be independent of the grounds used for any other apparatus.
34.8 Other References to Electrical Equipment

Discussion on special subjects relative to electrical equipment is also included in:

Chapter 8  Safety
Chapter 7  Emergency Operation and Response Program
Chapter 6  Maintenance Management System
Chapter 6/ Table 6-5  Maintenance Troubleshooting Guide

It is good practice to disconnect and thoroughly test all electrical equipment before commencing repair work to ensure that all parts have been de-energized.

Manufacturer's control diagrams and instruction manuals should be kept in a readily accessible location for reference.
Chapter 35
Plumbing Systems

35.1 Introduction.................................................................35-2
35.2 Plumbing Systems.............................................................35-2
35.3 Plumbing Appurtenances......................................................35-2
35.4 Sump Pumps................................................................35-4
35.5 Gasoline and Oil Trap Manholes.........................................35-5
35.6 Potable Water Supply.........................................................35-5
35.1 Introduction

The information provided within this section lists the various plumbing systems provided at the treatment plant. Contract drawings GD-P-1 through FP-3 should be referred to as a guide in determining locations, size, as well as fluids conveyed in exposed, concealed and buried piping.

35.2 Plumbing Systems

The various building plumbing systems are as listed below.

- Sanitary plumbing waste and vent
- Acid resisting waste and vent
- Rainwater leader
- Potable cold water
- Potable hot water
- Protected cold water
- Protected hot water
- Plant Water

Information on the wet-type fire lines, CO₂ fire system and compressed air systems may also be found in the Contract drawings. For additional information on these systems, refer to the respective chapters.

35.3 Plumbing Appurtenances

The following is a list of component items and equipment that are incorporated within the plumbing system. Reference should be made to manufacturer's service manuals for technical information on the units and to the contract drawings for exact locations of various equipment.

These various pieces of equipment do require periodic preventative maintenance. Consideration should be given to these items by plant personnel. Inclusion of these items, to a plant-wide general maintenance program will insure trouble-free operations.

Table 35-1 Plumbing Appurtenances Suggested P/M

<table>
<thead>
<tr>
<th>Item or Equipment</th>
<th>Suggested Procedure</th>
</tr>
</thead>
</table>
Floor Drains (F.D.)
Check seals of all traps.
Replace broken or removed grates. Remove any debris.

Flush Floor Cleanouts (FCO)
Ensure accessibility to FCO at all times.
Ensure ease of removal of access plates and covers.

Thermometers and Gauges
Perform periodic calibration tests.

Reduced Pressure Backflow Preventers (RPBP)
furnished and according to manufacturer’s suggested procedures and local regulations.

Emergency Shower and Eye Wash Units (E.S.) (E.W.U.)
Institute periodic flushing and alarm check.

Flush Valves (water closets and urinals)
Check diaphragms for wear.

Toilet Room Accessories
Check periodically for rigidity and wax ring condition, replace as necessary.

Portable Fire Extinguisher
Check for proper weight and pressure.

Possible Cross-Connections
Constant check of possibility required (most important).

Wall Hydrants
Check for illegal use.

Potable Hot Water Heater and Generator
Periodic drawdown for sediment removal.
Check for leaks.

Line Strainers
Periodic removal and cleaning.
35.4 Sump Pumps

Sump pumps are provided for the conveyance of various waste flows from the building's low point to the treatment plant influent. The following pump listing provides information on the pumps and their location. New sump pumps have been provided in the existing buildings where indicated.

Table 35-2 Sump Pump Schedule

<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity (GPM)</th>
<th>Head (TDH)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Influent Pump Station</td>
<td>70</td>
<td>30</td>
<td>Duplex</td>
</tr>
<tr>
<td>Aerated Grit Tank Gallery</td>
<td>80</td>
<td>32</td>
<td>Duplex</td>
</tr>
<tr>
<td>Primary Sludge Pump Gallery (North)</td>
<td>75</td>
<td>24</td>
<td>Duplex</td>
</tr>
<tr>
<td>Primary Sludge Pump Gallery (South)</td>
<td>75</td>
<td>24</td>
<td>Duplex</td>
</tr>
<tr>
<td>Primary Gallery (West)</td>
<td>75</td>
<td>24</td>
<td>Duplex</td>
</tr>
<tr>
<td>Primary Gallery (East)</td>
<td>75</td>
<td>24</td>
<td>Duplex</td>
</tr>
<tr>
<td>Aeration Gallery (West)</td>
<td>65</td>
<td>31</td>
<td>Duplex</td>
</tr>
<tr>
<td>Aeration Gallery (East)</td>
<td>65</td>
<td>25</td>
<td>Duplex</td>
</tr>
<tr>
<td>Final Settling Gallery (West)</td>
<td>60</td>
<td>26</td>
<td>Duplex</td>
</tr>
<tr>
<td>Final Settling Gallery (East)</td>
<td>68</td>
<td>25</td>
<td>Duplex</td>
</tr>
<tr>
<td>Gravity Thickener Pump Station</td>
<td>68</td>
<td>25</td>
<td>Duplex</td>
</tr>
<tr>
<td>Sludge Processing Building</td>
<td>68</td>
<td>25</td>
<td>Duplex</td>
</tr>
<tr>
<td>Sludge Processing Building</td>
<td>75</td>
<td>24</td>
<td>Duplex</td>
</tr>
<tr>
<td>Sludge Processing Building</td>
<td>84</td>
<td>23</td>
<td>Duplex</td>
</tr>
<tr>
<td>Primary Air Handling Building</td>
<td>75</td>
<td>15</td>
<td>Duplex</td>
</tr>
<tr>
<td>Effluent Pump Station</td>
<td>55</td>
<td>17</td>
<td>Simplex</td>
</tr>
<tr>
<td>Effluent Pump Station</td>
<td>55</td>
<td>17</td>
<td>Simplex</td>
</tr>
<tr>
<td>Effluent Pump Station (In Pump Vault)</td>
<td>70</td>
<td>25</td>
<td>Simplex</td>
</tr>
<tr>
<td>Barscreen Channel Dewatering Pump</td>
<td>150</td>
<td>15</td>
<td>Portable</td>
</tr>
<tr>
<td>Portable Tank Drainage Sump Pump</td>
<td>200</td>
<td>25</td>
<td>Portable</td>
</tr>
<tr>
<td>Chemical Containment Area Sump Pump</td>
<td>100</td>
<td>15</td>
<td>Portable (2)</td>
</tr>
</tbody>
</table>

The corrosion resistant and portable sump pumps are not a part of the plumbing system but warrant listing. Their operation is strictly manual and the pumps' discharge must be positioned to either be returned to the chemical tank or an awaiting waste hauler type container truck.

The sump pumps were installed for moisture/flood control (excluding the chemical pumps, see above paragraph). Reference should be made to the manufacturer's service manual for proper maintenance procedures.
35.5 Gasoline and Oil Trap Manholes

Gasoline and oil trap manholes are located on the West side of the Sludge Processing Building and the South side of the Administration/Maintenance Building. These units service the truck garage floor drains for each Building.

Both gasoline manholes drain to the Recycle Sewer (refer to Figure 31-2, Recycle Sewer System Flow Schematic). The recycle sewer will carry gasoline free washwater back to the head of the treatment plant. It is imperative that a routine program of inspection and cleaning of the gasoline trap manholes be implemented.

35.6 Potable Water Supply

Potable water is supplied from the 12-inch Brock Avenue water main. A 12-inch potable cold water line is tapped off of the 12-inch main supplying water to the treatment facility’s Administration Building from a loop system.

Water enters the treatment facility grounds from the Brock Avenue water main, loops by the Administration Building, and rejoins the 8 inch city water main at the northeast corner of Rodney French Boulevard. A constant fresh water supply is provided in this manner.

From the 12-inch facility water line loop two services are provided: A full-service fire hydrant at the Administration Building north lawn and a 12-inch potable water feed line to the facility.

The 12 inch potable water line is split into two separate lines and reduced prior to entering the water service room located on the northwest corner of the Administration Building. An 8-inch line feeds the fire pump, a single 10-inch protected potable water (P) line supplies water to the plant buildings and a 10-inch line feeds the Booster Water System for the building services. All three lines are protected from backflow by a system of reduced pressure backflow preventers and are metered separately prior to distribution throughout the facility.

Water entering the Administration Building is measured as it passes through a compound water meter. The meter is called a compound unit because it is a single unit made up of several meters. This unit is designed to measure minimum to maximum water flows with a minimum amount of flow restriction. The meter contains a register that records the gallons passing through the meter while it is activated.
Reduced Pressure Backflow Preventers (R.P.B.P.) have been installed in series with the water flow meter. After being metered, the water passes through the R.P.B.P.s. The fire protection system is excluded from flow measurement; however, it is provided with its own point of entry into the building and with its own R.P.B.P.

Each of the R.P.B.P. units are designed with two spring loaded check valves. Should the pressure on the discharge side of the units become greater than the pressure on the supply side, the check valves will close, preventing a reverse flow of water. In addition, a hydraulically operated “dump” valve will sense the pressure differential between the two ends. The valve will open and dump the water between the two check valves, causing an air gap separation of the supply and discharge ends.

**CAUTION:** A constant drip, trickle or stream of water being “dumped” from the vent is a sign of a malfunction. The operations supervisor should be notified immediately and the R.P.B.P. removed from service if instructed to do so. Provisions should be made to have the device repaired as soon as possible. The intent of the unit is to protect the potable drinking water supplies from cross contamination. If left out of service, or in a state of disrepair it can no longer afford the level of protection of the public that it was designed to provide.
<table>
<thead>
<tr>
<th>36.1</th>
<th>Introduction</th>
<th>36-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>36.1.1</td>
<td>Heating</td>
<td>36-2</td>
</tr>
<tr>
<td>36.1.2</td>
<td>Air Conditioning</td>
<td>36-4</td>
</tr>
<tr>
<td>36.1.3</td>
<td>Ventilation</td>
<td>36-5</td>
</tr>
<tr>
<td>36.2</td>
<td>Equipment Schedule</td>
<td>36-6</td>
</tr>
<tr>
<td>36.3</td>
<td>Normal Operations</td>
<td>36-8</td>
</tr>
<tr>
<td>36.4</td>
<td>Maintenance Recommendations</td>
<td>3-46</td>
</tr>
</tbody>
</table>
36.1 Introduction

The following subsections explain the equipment components, maintenance requirements and operating procedures for the heating, ventilating and air conditioning equipment and their subsystems. Reference should be made to the contract drawings, shop drawings, and the equipment manufacturer's specific operating and maintenance instructions furnished by the heating, ventilating, and air conditioning equipment suppliers.

The equipment described in this chapter has been installed in the various buildings within the treatment plant. Specifically these buildings are:

<table>
<thead>
<tr>
<th>Plant Buildings</th>
<th>Building Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration/Maintenance Building</td>
<td>AM</td>
</tr>
<tr>
<td>Headworks Building</td>
<td>HW</td>
</tr>
<tr>
<td>Primary Settling Tanks</td>
<td>PT</td>
</tr>
<tr>
<td>Aeration Basin Blower Building</td>
<td>AB</td>
</tr>
<tr>
<td>Final Settling Tanks</td>
<td>FT</td>
</tr>
<tr>
<td>Effluent Pump Station</td>
<td>EP</td>
</tr>
<tr>
<td>Sludge Processing Building</td>
<td>SP</td>
</tr>
<tr>
<td>Gravity Thickener Pump Station</td>
<td>GT</td>
</tr>
<tr>
<td>Primary Air Handling Building</td>
<td>AH</td>
</tr>
</tbody>
</table>

The various HVAC systems contained within the buildings of the New Bedford Water Pollution Control Facility are complex. However, even with the complexity of these systems, basic principles of heating, ventilation and air conditioning still apply. An understanding of these principals will be of assistance in the efficient operation of these systems, as well as an aid in troubleshooting any problems arising in their operation. The following will discuss these basic principles.

36.1.1 Heating

Heat is supplied to the entire treatment facility by two natural gas fired hot water boilers.

Natural gas is piped to the burner assembly of each boiler. The burner assembly contains gas pressure regulators and gas valves to ensure a steady gas flow to the burner when it is ignited. The heat from the flame heats the boiler vessel and the water it contains.

Both boilers are connected to a closed loop heating system containing supply and return piping. The hot water boilers create heated water/glycol at approximately 200 degrees F for distribution through the closed loop. The heated water/glycol is pumped by either of three constant duty centrifugal glycol pumps at approximately 750 gpm.
As heat is demanded by the system controls (thermostats, sensors, etc.), hot water is permitted to enter the heating element, as system controls require, by activation of the pneumatically operated hot water supply valves. Heat is liberated from the hot water within the heating element and the lower temperature hot water flows into the hot water return line. The hot water loop consist of a supply line carrying hot water (glycol) out to the heating elements and a return line carrying the cooled hot water (glycol) back to the hot water boiler for reheat.

The heating elements are designed to transfer the heat contained in the hot water lines into the air. Metals that are good heat conductors are used for this purpose. In most cases the heating elements use copper pipe to contain the steam. Thin pieces of aluminum are connected to the copper pipe to enhance heat transfer, and are called fins. In some cases the copper is attached to a honey comb configuration.

Air may be supplied to heating elements by a fan or blower. In this instance the heat transfer is considered conduction. In situations where the air is allowed to circulate (by design) around the heating element, the heat transfer is considered convection. As an example normal baseboard heaters allow the cold air to enter the bottom of the heater, while heated air escapes and rises.

Feed (make-up) water is supplied to the boiler by two centrifugal pumps. The pumps are attached to a manifold mounted on the boiler feed tank. A float controller mounted on the boiler monitors the water level in the vessel. This float controller starts and stops the boiler feed pumps. If the water level recedes to a predetermined level a pump is started. If the water level continues to recede, a second pump will be started. As the water level rises the pumps are shut off.

A second method of heating is used in areas that may require the exclusion of water; electrical rooms. Electricity is used as a heat source for these cabinet heaters. The heat transfer process is much the same as with steam (conductive and convection). The only difference is the method used for heat generation. High voltage electricity is passed through an element that is resistant to electrical current (amperage). This resistance causes the element to become hot. The heat is transferred to the coil which has fins as described earlier.
36.1.2 Air Conditioning

Air conditioning equipment has been supplied to various areas for environmental temperature control. These systems have been designed to provide operator comfort and to protect equipment from excessive temperatures.

All air conditioning units (ACU) contain several basic items. These items are a refrigerant (Freon), a refrigerant gas compressor, a condenser, a thermal expansion valve (TXV), and evaporator coils.

Freon is supplied to the evaporator coil as a liquid. The evaporator coil is designed much like a steam heater. Refrigerant (Freon) is contained within the copper piping. Heat transfer is conducted through the conductive metal fins and piping as described earlier (see Heating).

Just prior to entering the evaporator coil, liquid Freon (under pressure), passes through a thermal expansion valve (TXV). The TXV is an orifice type device that performs two basic functions. First, the TXV meters the amount of Freon entering the evaporator while maintaining a back pressure on the liquid remaining on the supply side of the valve. Second, because the TXV is an orifice, the velocity of the Freon passing through, causes atomization (expansion) of the Freon. The atomized Freon absorbs any available heat and converts from a liquid to a gas.

The gas is then piped to the compressor. The compressor pressurizes the gas and, in so doing, further elevates the temperature. The increased temperature is desirable because it makes the gas easier to condense to a pressurized liquid. This is the function of the condenser.

The condenser receives the hot (Freon) gas under pressure. The hot gas is passed through coils that are configured like the coils in the evaporator. In order to provide a larger surface area, the length or number of coils in a condenser is greater than an evaporator. A larger volume of air is forced (by a fan), over the coils. The heat is rapidly removed from the Freon gas causing it to cool and condense into a liquid. The cooled liquid is then directed back to the TXV and evaporator.

In some systems a receiver is placed between the condenser and the TXV. This is usually done on larger systems. The purpose of the receiver is to collect and store liquid Freon from the condenser. In this manner the receiver may supply various demands made by multiple evaporators while minimizing the amount of equipment needed for satisfactory performance.
36.1.3 Ventilation

Proper ventilation of any building is of primary importance to the HVAC system. Air is recirculated and mixed proportionately with fresh air taken from outside of the building. The mixing process ensures that the air in the building does not become stagnant or stale. To further improve circulation of air, exhaust systems allow a certain (proportionate) amount of air to be exhausted to the atmosphere. When combined the two systems ensure heat equalization, minimize odorous environmental conditions, and prevent the air from becoming stagnated and stale.

Air is supplied to the buildings through stationary or motorized louvers. The louvers may be indirectly or directly interconnected to other equipment such as supply fans or Air Handling units (AHU). Often AHUs are used for multiple environmental air treatments, such as filtering, heating, and air conditioning. Air is drawn from the building (recirculated), as is air from outside the building. The two sources of air are introduced and mix at preset proportions. The air is then pumped back into the building by means of a blower assembly. Return air may be blown directly into the space from the AHU and/or distribution duct work. Diffusers may direct the path of circulation.

In other situations air is directly supplied by in-line fans. In these cases, outside air is supplied at a preset rate by a fan placed within the duct work. In most cases these supply fans are manually controlled and interconnected to some type of exhaust fan. In-line fans are equipped with access panels for ease of maintenance and inspection.

Exhaust fans may be of the in-line type or the roof type. The in-line fans are arranged like the in-line supply fans, except that air is withdrawn from the building space and exhausted outside. Roof fans are mounted on the roof of a building. The fan is mounted in such a fashion that the air moves vertically through the unit. A dome shaped cap or shroud is placed on top of the unit in such a way that the air is easily vented, but rain and snow are not allowed to enter the system. Both types of exhaust fans may be interconnected, by duct work, to several different spaces.

Fixed or motorized louvers are also used to enhance air circulation internally. These louvers are placed in internal walls to allow air from one space to enter into another space. This type of inner circulation is usually aided by an exhaust fan withdrawing air from the smaller isolated space.

Odor control units are provided to assist in controlling odorous air discharge from process areas. Air is removed and treated by the odor scrubbers from occupied spaces: Headworks and Sludge Processing Building. For additional information relative to the Odor Control System, refer to Chapter 23.
36.2 Equipment Schedule

Mechanical components necessary for the proper maintenance of the plant buildings' environment are listed in the following Tables.

- Table 36-1 re-familiarizes the operator with the plant structures (buildings) and their appropriate abbreviations.
- Table 36-2 identifies the standard HVAC equipment abbreviations.
- Table 36-3 identifies the major HVAC process function and the various HVAC equipment components that are necessary to make the process function work.

These three tables (Table 36.3 will be found in the next section), when cross-referenced with the Automatic Temperature Control (ATC) manufacturer’s service manual, the HVAC ladder logic diagrams and the equipment plans and schedules, will provide the operator with a more thorough understanding of the respective HVAC system.

Table 36-1 Plant Structure Abbreviations

<table>
<thead>
<tr>
<th>Plant Structure/Building</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration/Maintenance Building</td>
<td>AM</td>
</tr>
<tr>
<td>Headworks Building</td>
<td>HW</td>
</tr>
<tr>
<td>Primary Settling Tanks</td>
<td>PT</td>
</tr>
<tr>
<td>Aeration Basin Blower Building</td>
<td>AB</td>
</tr>
<tr>
<td>Final Settling Tanks</td>
<td>FT</td>
</tr>
<tr>
<td>Effluent Pump Station</td>
<td>EP</td>
</tr>
<tr>
<td>Sludge Processing Building</td>
<td>SP</td>
</tr>
<tr>
<td>Gravity Thickener Pump Station</td>
<td>GT</td>
</tr>
<tr>
<td>Primary Air Handling Building</td>
<td>AH</td>
</tr>
</tbody>
</table>

Table 36-2 Standard HVAC Equipment Abbreviations

<table>
<thead>
<tr>
<th>HVAC Equipment</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning Unit</td>
<td>ACU</td>
</tr>
<tr>
<td>Air Handling Unit</td>
<td>AHU</td>
</tr>
<tr>
<td>Heat Exchanger</td>
<td>HX</td>
</tr>
<tr>
<td>Electrical Unit Heater</td>
<td>EUH</td>
</tr>
<tr>
<td>Cabinet Unit Heater</td>
<td>CUH</td>
</tr>
<tr>
<td>Unit Heater</td>
<td>UH</td>
</tr>
<tr>
<td>Base Board Heater</td>
<td>BBH (BB)</td>
</tr>
<tr>
<td>Exhaust Fan</td>
<td>EF</td>
</tr>
<tr>
<td>Supply Fan</td>
<td>SF</td>
</tr>
<tr>
<td>Transfer Fan</td>
<td>TF</td>
</tr>
<tr>
<td>Roof Fan</td>
<td>RF</td>
</tr>
<tr>
<td>Make-up Fan</td>
<td>MF</td>
</tr>
<tr>
<td>Plant Water Duct Coil</td>
<td>FWDC</td>
</tr>
<tr>
<td>Equipment</td>
<td>Abbreviation</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Hot Water Unit Heater</td>
<td>HWUH</td>
</tr>
<tr>
<td>Convection Heater (Hot Water)</td>
<td>CONV</td>
</tr>
<tr>
<td>Duct Heater (Hot Water)</td>
<td>DH</td>
</tr>
<tr>
<td>Water Cooled Liquid Chiller</td>
<td>CH</td>
</tr>
<tr>
<td>Air Condition</td>
<td>AC</td>
</tr>
<tr>
<td>Condenser (Air Conditioner)</td>
<td>CU</td>
</tr>
<tr>
<td>Variable Acting Valve</td>
<td>VAV</td>
</tr>
</tbody>
</table>
36.3 Normal Operations

The following Table 36.3 contain excerpts from the HVAC suppliers service manual. The operating controls and the equipment that are operated by each may be referenced by the reader from the supplier’s contract plans and vendor manuals provided to the plant following system check-out and startup.

The preceding tables in subchapter 36-2 should be consulted while examining the HVAC equipment controls (Table 36.3). The first column of the table references the individual HVAC process description while the second column contains the respective equipment or system that is associated with that HVAC description. Each description has an associated control narrative that describes the individual HVAC equipment and how it is controlled to produce the desired results. The entire system has a logical manner by which it is expected to behave. This system manufacturer followed a ladder logic in designing the system, this logic is provided in the below listed Figures:

- Figure 36-1 Automatic Temperature Controls Diagram I
- Figure 36-2 Automatic Temperature Controls Diagram II
- Figure 36-3 Automatic Temperature Controls Diagram III
- Figure 36-4 Automatic Temperature Controls Diagram IV
- Figure 36-5 Automatic Temperature Controls Diagram V
- Figure 36-6 Automatic Temperature Controls Diagram VI
- Figure 36-6 Automatic Temperature Controls Diagram VII

When examining the table, some knowledge of HVAC component nomenclature must be maintained. For instance:

HW-AHU-4 refers to:  
| HW-AHU-4 | Structure or Building Location (Headworks) |
| 4        | Type of HVAC equipment (Air Handling Unit) |

It can be determined by the HVAC equipment nomenclature where the unit is installed and its function. Major HVAC components will be marked for easy identification in the field. However, the operator still should consult the record drawings and manufacturer’s drawings for installation details.

Table 36.3 HVAC Process Equipment Controls

<table>
<thead>
<tr>
<th>HVAC Process Description</th>
<th>Associated Equipment/System</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% Outside Air Make Up Unit With Exhaust Fan</td>
<td>HW-AHU-7 WITH HW-EF-2</td>
</tr>
<tr>
<td></td>
<td>GT-AHU-1 WITH GT-EF-1</td>
</tr>
<tr>
<td></td>
<td>AH-AHU-1 WITH AH-EF-1</td>
</tr>
<tr>
<td></td>
<td>AH-AHU-2 WITH AH-EF-2</td>
</tr>
<tr>
<td>Summer Ventilation Fans</td>
<td>HW-AHU-6 WITH HW-EF-1</td>
</tr>
</tbody>
</table>

CDM Camp, Dresser & McKee 36-8
Ventilation With Minimum Outdoor Air And Heating
100% Outside Air Makeup Unit With Exhaust Fan
100% Outside Air Makeup Unit With Exhaust Fan
Ventilation With Minimum Outdoor Air And Heating
Generator Room Ventilation
100% Outdoor Air Make Up Units
100% Outside Air Make Up Units
Air Conditioning With Return Fan
Duct Mounted Coils
Transfer And Process Exhaust Fans With Dampers:
Transfer And Process Exhaust Fans Without Dampers:
General Ventilation Units:
Air Conditioning In Electrical Equipment And Control Rooms
Air Conditioning In Electrical Equipment And Control Rooms Below 2000 cfm Supply Air
Chilled, Condenser, Hot Water Pumps Variable Volume Boxes, Manual Exhaust Fans: P-1 THRU P-7, AM-VAV-1 THRU AM-VAV-12
Static Pressure Controlled Manual Exhaust (2-Speed)
Heat Recovery
Summer And Emergency Ventilation (2-Speed)

HW-AHU-5, AB-AHU-1, AB-AHU-2
HW-AHU-3, AB-AHU-3
EP-AHU-1, SP-AHU-3,4,5
PT-AHU-1 WITH AB-EF-3
PT-AHU-2 WITH AB-EF-4
AM-AHU-8 WITH AM-EF-17
AM-AHU-12 WITH AM-EF-25
AM-AHU-15
AM-SF-1, AM-SF-2
HW-AHU-1, HW-AHU-2
SP-AHU-1, SP-AHU-2
AM-AHU-9 WITH AM-EF-18
SP-RHC-1, AM-DH-3,4,5,6
SP-TF-2, SP-EF-7, SP-EF-8
SP-TF-4, SP-EF-1
SP-TF-3M SP-EF-6
FT-EF-1, FT-EF-2
HW-TF-3, PT-TF-2,
SP-EF-5, EP-EF-1, 3,
AM-EF-11, 20, 26
HW-AHU-4, SP-SF-2,
AM-AHU-7, EP-AHU
HW-AC-1, SP-AC-5,
EP-AC-1,2 AM-AHU-14,
AB-AC-1, FT-AC-2
SP-AC-2,3,4, FT-AC-3
AM-AHU-13, SP-AC-6
AH-EF-4, EP-EF-4, AM-EF-9, 24,
28, AB-EF-1, 2, AB-RF-1
AM-EF-10
SP-SF-1, SP-TF-1, SP-EF-2,3,4
AH-EF-3 AH-EF-4
<table>
<thead>
<tr>
<th>Exhaust Fans</th>
<th>All Baseboard Heaters (BB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finned Tube Radiation Unit And Cabinet Unit Heaters/Glycol Differential Pressure Control</td>
<td>AM-AHU-10</td>
</tr>
<tr>
<td>Summer And Emergency Ventilation (2-Speed Exhaust Fans)</td>
<td>AM-EF-2 AH-EF-5</td>
</tr>
<tr>
<td>Air Conditioning Without Return Fan</td>
<td>AM-EF-4 W/AM-AHU-3</td>
</tr>
<tr>
<td>Laboratory Hood Exhaust With Ducted Make Up Air</td>
<td>AM-EF-5 W/AM-AHU-2</td>
</tr>
<tr>
<td></td>
<td>AM-EF-6 W/AM-AHU-5</td>
</tr>
<tr>
<td></td>
<td>AM-EF-7 W/AM-AHU-4</td>
</tr>
<tr>
<td>Locker Room 100% Outside Air</td>
<td>W/AH-11, W/AM-EF-21, 22, 23</td>
</tr>
<tr>
<td></td>
<td>AND DH-1, 2</td>
</tr>
<tr>
<td>Boiler Combustion Air Unit</td>
<td>AM-AHU-16</td>
</tr>
<tr>
<td>Summer Ventilation Exhaust Fans</td>
<td>AM-EF-12, AM-EF-16, AM-EF-15</td>
</tr>
<tr>
<td>Laboratory Hood Exhaust W/O Ducted Makeup Air Transfer Exhaust Fans</td>
<td>AM-EF-1, 2, 3 and 8, FT-TF-1, PT-TF-1, HW-TF-1 and 2</td>
</tr>
<tr>
<td>Air Conditioning with Variable Volume</td>
<td>AM-AHU-6</td>
</tr>
</tbody>
</table>
100% OUTSIDE AIR MAKE UP UNIT WITH EXHAUST FAN

HW-AHU-7 WITH HW-EF-2
GT-AHU-1 WITH GT-EF-1
AH-AHU-1 WITH AH-EF-1
AH-AHU-2 WITH AH-EF-2

SEQUENCE OF OPERATION

Under a normal condition the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply and exhaust fans will be off, the outside air damper will be closed, the glycol heating control valve will be closed and the exhaust air damper will be closed. If the switch is in the AUTO position the unit will be able to run.

If the supply air smoke detector is in a smoke mode the fans will be off, the dampers will be closed and the heating coil valve will be closed.

If the space smoke detector is in a smoke mode the fans will be off, the dampers will be closed and the heating coil valve will be closed.

If the low limit thermostat (manual reset), is in a low temperature condition, the fans will stop, the dampers will close, the heating coil valve will close and an alarm light will indicate a freeze condition. If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode the supply fan will start. The return fan will start through an interlock with the supply fan. The outside air and exhaust air dampers will open and the glycol heating valve will be controlled by the supply air temperature transmitter through the panel mounted receiver controller. On a rise in space temperature the heating coil valve will modulate closed to maintain set point. On a drop in temperature the reverse will occur.

The duct mounted air flow sensor will light an alarm on the panel face and send a signal to the central panel if the air flow is below set point.

If the fireman's switch is in the OFF position, the fans will be off and the dampers and heating valve will be closed.

If the fireman's switch is in the VENTILATION position, the fans will run regardless of the ATC panel selector switch and smoke and freeze safeties. The supply and exhaust dampers will open and the heating valve will be under control.
SUMMER VENTILATION FANS
HW-AHU-6 WITH HW-EF-1

SEQUENCE OF OPERATION.

Under normal conditions the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position. The unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply and exhaust fans will be off, the outside air damper will be closed, the glycol heating control valve will be closed and the exhaust air damper will be closed. If the switch is in the AUTO position the unit will be able to run.

If the space smoke detector is in a smoke mode, the fans will be off and the dampers will be closed.

If the space smoke detector is in the normal mode the unit will be under control of the space thermostat. If the space temperature is below 80°F, the supply and return fans will be off and the intake and exhaust dampers will be closed. If the space temperature rises above 80°F, the intake and exhaust dampers will open. When each damper opens an end switch will allow the associated fan to run.

If the fireman's switch is in the OFF position, the supply and exhaust fans will be off and the dampers will be closed.

If the fireman's switch is in the VENTILATION position, the intake and exhaust dampers will run regardless of the smoke detector. When the end switches prove the dampers to be open, the fans will run.
VENTILATION WITH MINIMUM OUTDOOR AIR AND HEATING

HW-AHU-5,
AB-AHU-1,
AB-AHU-2

SEQUENCE OF OPERATION

Under a normal condition the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position, the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the bypass, position and the multi-zone damper will be open to the hot deck. If the switch is in the AUTO position the unit will be able to run.

A panel mounted time clock will determine occupied/unoccupied mode. When in the unoccupied mode, the supply fan will be off, the outside, air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck.

If the supply air smoke detector is in a smoke mode, the fan will be off, the outside air damper will air damper will be closed, the heating coil valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside air damper will close, the heating coil valve will close, the cooling coil valve will be in the BYPASS position, and Multi-zone dampers will be open to the hot deck and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode, the supply fan will start. The outside air damper will open and the hot and cold deck will be under control.

When the outside air temperature, is below 55°F, the cooling coil valve will be in the BYPASS position and the heating coil will be in the BYPASS position and the heating coil will be under control of the hot deck discharge air temperature transmitter through a panel mounted receiver controller to maintain hot deck supply temperature, a 120°F set point.

When the outside air temperature is between 55°F and 65°F, the cooling coil will be under control of the cold deck temperature transmitter through a panel mounted receiver controller to maintain a cold deck supply temperature of 55°F and the heating coil valve will be under control of the hot deck discharge air temperature.
transmitter through a panel mounted receiver controller to maintain hot deck supply temperature, a 120°F setpoint.

When the outside air temperature is above 45°F, the heating coil valve will be in the CLOSED position and the cooling coil will be under control of the cold deck discharge air temperature transmitter through a panel mounted receiver controller to maintain cold deck supply temperature, a 55°F setpoint.

For the 3 individual zones on a drop in space temperature, the space thermostat will modulate the zone dampers open to the hot deck. On a rise in space temperature, the thermostat will modulate the zone damper open to the cold deck.

If the fireman's switch is in the OFF position, the fan will be off and the outside air damper and heating valve will be closed. The cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck. If the switch is in the AUTO position the unit will be able to run.

If the fireman's switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch and smoke and freeze safeties. The outside air damper will open and the heating and cooling valves and multi-zone dampers will be under control.

Whenever the outside air temperature is below 55°F, the preheat coil temperature transmitter will through a panel mounted receiver controller modulate the N.O. preheat Coil valve to maintain 50°F. When the outside air temperature is above 55°F, the preheat coil valve will be closed.
100% OUTSIDE AIR MAKEUP UNIT WITH EXHAUST FAN

HW-AHU-3,
AB-AHU-3
EP-AHU-1,
SP-AHU-3,4,5

SEQUENCE OF OPERATION

Under a normal condition, the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply and exhaust fans will be off. The outside air damper will be closed, the glycol heating control valve will be closed and the exhaust air damper will be closed. If the switch is in the AUTO position, the unit will be able to run.

If the supply air smoke detector is in a smoke mode, the fans will be off, the dampers will be closed and the heating coil valve will be closed.

If the space smoke detector is in a smoke mode, the fans will be off, the dampers will be closed and the heating coil valve will be closed.

If the low limit thermostat (manual reset) is in a low temperature condition, the fans will stop, the dampers will close, the heating coil valve will close and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode the supply fan will start. The return fan will start through an interlock with the supply fan. The outside air and exhaust air dampers will open and the glycol heating valve will be controlled by the supply air temperature transmitter through the panel mounted receiver controller. On a rise in space temperature, the heating coil valve will modulate closed to maintain set point. On a drop in temperature, the reverse will occur.

The duct mounted air flow sensor will light an alarm light on the panel face and send a signal to the central panel, if the air flow is below set point.

If the fireman's switch is in the OFF position, the fans will be off and the dampers and heating valve will be closed.

If the fireman's switch is in the VENTILATION position, the fans will run regardless of the ATC panel selector switch and smoke and freeze safeties. The supply and exhaust dampers will open and the heating valve will be under control.
100% OUTSIDE AIR MAKEUP UNIT WITH EXHAUST FAN

PT-AHU-1 WITH AB-EF-3
PT-AHU-2 WITH AB-EF-4
AM-AHU-8 WITH AM-EF-17
AM-AHU-12 WITH AM-EF-25

SEQUENCE OF OPERATION

Under a normal condition, the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply and exhaust fans will be off. The outside air damper will be closed, the glycol heating control valve will be closed and the exhaust air damper will be closed. If the switch is in the AUTO position, the unit will be able to run.

If the supply air smoke detector is in a smoke mode, the fans will be off, the dampers will be closed and the heating coil valve will be closed.

If the space smoke detector is in a smoke mode, the fans will be off, the dampers will be closed and the heating coil valve will be closed.

If the low limit thermostat (manual reset) is in a low temperature condition, the fans will stop, the dampers will close, the heating coil valve will close and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode the supply fan will start. The return fan will start through an interlock with the supply fan. The outside air and exhaust air dampers will open and the glycol heating valve will be controlled by the supply air temperature transmitter through the panel mounted receiver controller. On a rise in space temperature, the heating coil valve will modulate closed to maintain set point. On a drop in temperature, the reverse will occur.

The duct mounted air flow sensor will light an alarm light on the panel face and send a signal to the central panel, if the air flow is below set point.

If the fireman's switch is in the OFF position, the fans will be off and the dampers and heating valve will be closed.

If the fireman's switch is in the VENTILATION position, the fans will run regardless of the ATC panel selector switch and smoke and freeze safeties. The supply and exhaust dampers will open and the heating valve will be under control.
VENTILATION WITH MINIMUM OUTDOOR AIR AND HEATING

AM-AHU-15

SEQUENCE OF OPERATION

Under a normal condition the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position, the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone damper will be open to the hot deck. If the switch is in the AUTO position the unit will be able to run.

A panel mounted time clock will determine occupied/unoccupied mode. When in the occupied mode, the unit will be able to run. If the time clock is in the unoccupied mode, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck.

If the supply air smoke detector is in a smoke mode, the fan will be off, the outside air damper will air damper will be closed, the heating coil valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside air damper will close, the heating coil valve will close, the cooling coil valve will be in the BYPASS position and Multi-zone dampers will be open to the hot deck and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode, the supply fan will start. The outside air damper will open and the hot and cold deck will be under control

When the outside air temperature, is below 55°F, the cooling coil valve will be in the BYPASS position and the heating coil will be in the BYPASS position and the heating coil will be under control of the hot deck discharge air temperature transmitter through a panel mounted receiver controller to maintain hot deck supply temperature, a 120°F set point.

When the outside air temperature is between 55°F and 65°F, the cooling coil will be under control of the cold deck temperature transmitter through a panel mounted receiver controller to maintain cold deck supply temperature of 55°F and the heating coil valve will be under control of the hot deck discharge air temperature transmitter through a panel mounted receiver controller to maintain hot deck supply temperature, a 120°F setpoint.
When the outside air temperature is above 45°F, the heating coil valve will be in the CLOSED position and the cooling coil will be under control of the cold deck discharge air temperature transmitter through a panel mounted receiver controller to maintain cold deck supply temperature, a 55°F set point.

For the 3 individual zones on a drop in space temperature, the space thermostat will modulate the zone dampers open to the hot deck. On a rise in space temperature, the thermostat will modulate the zone damper open to the cold deck.

If the fireman’s switch is in the OFF position, the fan will be off and the outside air damper and heating valve will be closed. The cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck. If the switch is in the AUTO position the unit will be able to run.

If the fireman’s switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch and smoke and freeze safeties. The outside air damper will open and the heating and cooling valves and multi-zone dampers will be under control.

Whenever the outside air temperature is below 55°F, the preheat coil temperature transmitter will through a panel mounted receiver controller modulate the N.O. preheat Coil valve to maintain 50°F. When the outside air temperature is above 55°F, the preheat coil valve will be closed.
GENERATOR ROOM VENTILATION

AM-SF-1, AM-SF-2

SEQUENCE OF OPERATION

Under normal condition, the TEST/OFF/AUTO switch on the Motor Control Center will be left in the REMOTE position.

The unit will be started and stopped by a panel mounted selector switch. If the switch is in the OFF position, the supply fan will be off and the plant water control valve will be closed. If the switch is in the AUTO position the unit will be able to run.

If the space temperature is below the low set point of the receiver controller, the supply fan will be off and the plant water control valve will be closed.

If the space temperature is above the high set point of the receiver controller, the supply fan will be started and the plant water control valve will be open.

If the fireman’s switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch and smoke and freeze safeties. The supply and exhaust dampers will be open and the heating valve will be under control.
100% OUTDOOR AIR MAKE UP UNITS

HW-AHU-1
HW-AHU-2

SEQUENCE OF OPERATION

Under a normal condition, the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position, the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed and the exhaust air damper will be closed. If the switch is in the AUTO position the unit will able to run.

If the supply air smoke detector is in a smoke mode, the fan will be off, the dampers will be closed and the heating coil valve will be closed.

If the exhaust duct smoke detector is in a smoke mode, the fan will be off, the dampers will be closed and the heating coil valve will be closed.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the dampers will close, the heating coil valve will close and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in normal mode, the supply fan will start. The outside air and exhaust

Air dampers will open and the glycol heating valve will be controlled by the supply air temperature transmitter through the panel mounted receiver controller. On a rise in space temperature the heating coil valve will modulate closed to maintain set point. On a drop in temperature the reverse will occur.

The duct mounted air flow sensor will light an alarm light on the panel face and send a signal to the central panel if the air flow is below set point.

If the fireman's switch is in the OFF position, the fan will be off and the dampers and heating valve will be closed.

If the fireman's switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch and smoke and freeze safeties. The supply and exhaust dampers will open and the heating valve will be under control

these units in "explosion proof" areas. Control panels located in non-explosion area.

C. D. M. Camp, Dresser & McKee
100% OUTSIDE AIR MAKE UP UNITS

SP-AHU-1,
SP-AHU-2

SEQUENCE OF OPERATION

Under a normal condition, the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position, the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed and the exhaust air damper will be closed. If the switch is in the AUTO position the unit will be able to run.

If the supply air smoke detector is in a smoke mode, the fan will be off, the dampers will be closed and the heating coil valve will be closed.

If the exhaust duct smoke detector is in a smoke mode, the fan will be off, the dampers will be closed and the heating coil valve will be closed.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the dampers will close, and the heating coil valve will close and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode, the supply fan will start. The outside air and exhaust air dampers will open and the glycol heating valve will be controlled by the supply air temperature transmitter through the panel mounted receiver controller. On a rise in space temperature, the heating coil valve will modulate closed to maintain set point. On a drop in temperature the reverse will occur.

The duct mounted air flow sensor will light an alarm light on the panel face and send a signal to the central panel if the air flow is below set point.

If the fireman's switch is in the OFF position, the fan will be off and the dampers and heating valve will be closed.

If the fireman's switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch and smoke and freeze safeties. The supply and exhaust dampers will open and the heating valve will be under control.
AIR CONDITIONING WITH RETURN FAN
AM-AHU-9 WITH AM-EF-18

SEQUENCE OF OPERATION

Under a normal condition the HAND/OFF/AUTO switch on the Motor Control Center will be in the AUTO position.

If the fireman's switch is in the NORMAL position, the unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone damper will be open to the hot deck. If the switch is in the AUTO position the unit will be able to run.

A panel mounted time clock will determine occupied/unoccupied mode. When in the occupied mode, the unit will be able to run. If the time clock is in the unoccupied mode, the supply fan will be off, the outside, air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck.

If the supply air smoke detector is in a smoke mode, the fan will be off, the outside air damper will air damper will be closed, the heating coil valve will be closed, the cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside air damper will close, the heating coil valve will close, the cooling coil valve will be in the BYPASS position, and Multi-zone dampers will be open to the hot deck and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode, the supply fan will start. The outside air damper will open and the hot and cold deck will be under control.

When the outside air temperature, is below 55°F, the cooling coil valve will be in the BYPASS position and the heating coil will be under control of the hot deck discharge air temperature transmitter through a panel mounted receiver controller to maintain hot deck supply temperature, a 120°F set point.

When the outside air temperature is between 55°F and 65°F, the cooling coil will be under control of the cold deck temperature transmitter through a panel mounted receiver controller to maintain a cold deck supply temperature of 55°F and the heating coil valve will be under control of the hot deck discharge air temperature transmitter through a panel mounted receiver controller to maintain hot deck supply temperature, a 120°F setpoint.
When the outside air temperature is above 45°F, the heating coil valve will be in the CLOSED position and the cooling coil will be under control of the cold deck discharge air temperature transmitter through a panel mounted receiver controller to maintain cold deck supply temperature, a 55°F set point.

For the 3 individual zones on a drop in space temperature, the space thermostat will modulate the zone dampers open to the hot deck. On a rise in space temperature, the thermostat will modulate the zone damper open to the cold deck.

If the fireman’s switch is in the OFF position, the fan will be off and the outside air damper and heating valve will be closed. The cooling coil valve will be in the BYPASS position and the multi-zone dampers will be open to the hot deck. If the switch is in the AUTO position the unit will be able to run.

If the fireman’s switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch and smoke and freeze safeties. The outside air damper will open and the heating and cooling valves and multi-zone dampers will be under control.

Whenever the outside air temperature is below 55°F, the preheat coil temperature transmitter will through a panel mounted receiver controller modulate the N.O. preheat Coil valve to maintain 50°F. When the outside air temperature is above 55°F, the preheat coil valve will be closed.
DUCT MOUNTED COILS

SP-RHC-1,
AM-DH-3,4,5,6

SEQUENCE OF OPERATION

A panel mounted selector switch will determine if the heating coil valve can be operated.

If the switch is in the off mode, the heating coil valve will be closed. If the switch is in the AUTO position, the space temperature transmitter will modulate the heating coil valve to maintain temperature.
TRANSFER AND PROCESS EXHAUST FANS WITH DAMPERS:

SP-TF-2,
SP-TF-3,
SP-TF-4,
SP-EF-1
SP-EF-6
SP-EF-7,
SP-EF-8

SEQUENCE OF OPERATION

Under a normal condition, the TEST/OFF/AUTO switch on the Control Panel will be left in the ON position.

If the Motor Control Center switch is in the ON position, a solenoid valve will be energized and open the exhaust damper. Only after the exhaust damper is proved open with a damper end switch will the fan actually start.

A duct mounted air flow sensor will light an alarm light and panel face and send a signal to the central panel if the air flow is below set point.

Interlock Schedule

SP-TF-2 INTERLOCKED WITH SP-EF-7 AND SP-EF-8
SP-TF-4 INTERLOCKED WITH SP-EF-1
SP-TF-3 INTERLOCKED WITH SP-EF-6
TRANSFER AND PROCESS EXHAUST FANS WITHOUT DAMPERS:

FT-EF-1,
FT-EF-2
HW-TF-3,
PT-TF-2,
SP-EF-5,
EP-EF-1, 3,
AM-EF-11, 20

SEQUENCE OF OPERATION

Under a normal condition, the TEST/OFF/AUTO switch on the Motor Control Center will be left in the ON position.

If the Motor Control Center switch is in the ON position, the fan will run.

A duct mounted air flow sensor will light an alarm light and panel face and send a signal to the central panel if the air flow is below set point.
GENERAL VENTILATION UNITS:

HW-AHU-4,
SP-SF-2,
AM-AHU-7,
EP-AHU-2

SEQUENCE OF OPERATION

Under a normal condition the HAND/OFF/REMOTE switch on the Motor Control Center will be left in the REMOTE position.

If the fireman’s switch is in the NORMAL position the unit will be started and stopped by a pane mounted 3 position selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air and exhaust dampers will be closed and the return damper will be open. If the switch is in the AUTO/ON/HAND position the unit will be able to run.

If the supply air smoke detector is in a smoke mode, the fan will be off, the outside air and exhaust air dampers will be closed and the return air damper will be open.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside and exhaust dampers will close, the return air damper will be open and an alarm will be generated at the control panel (pilot light).

If the panel mounted switch is in the AUTO position, all of the above safety conditions are in a normal mode and the space temperature is below 70° F, the supply fan will be off, the outside and exhaust dampers will be closed and the return damper will be open.

If the panel mounted switch is in the AUTO position, all of the above safety conditions are in a normal mode and the space temperature is above 70° F, or the panel mounted switch is in the HAND position, the supply fan will start and the outside air and exhaust air dampers will modulate open a rise in temperature to maintain 78° F. The return air damper will modulate closed accordingly.

If the fireman’s switch is in the OFF position, the fan will be off, the outside air and exhaust dampers will close and the return damper will open.

If the fireman’s switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch and smoke and freeze safeties. The outside air and exhaust dampers will open and the return dampers will close.
AIR CONDITIONING IN ELECTRICAL EQUIPMENT AND CONTROL ROOMS

HW-AC-1,
SP-AC-5,
EP-AC-1, 2
AM-AHU-14,
AB-AC-1,
FT-AC-2

SEQUENCE OF OPERATION

Under normal condition, the OFF/REMOTE switch on the Motor Control Center will be left in the REMOTE position.

The unit will be started and stopped by a panel mounted selector switch. If the switch is in the OFF position, the supply fan will be off, the outside air damper will be closed and the cooling coil will be deactivated. If the switch is in the AUTO position, the fan will be able to run.

If the supply air smoke detector is in a smoke mode, the fan will be off, the outside air damper will be closed. The cooling coil will be deactivated.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside air damper will close, the cooling coil will be deactivated and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode, the space temperature transmitter will, on a rise in temperature above 85°F, start the supply fan, open the outside air damper and activate the cooling coil via controls provided by unit manufacturer. On a drop in space temperature, the reverse will occur.
AIR CONDITIONING IN ELECTRICAL EQUIPMENT AND CONTROL ROOMS
BELOW 2000 CFM SUPPLY AIR

SP-AC-2,3,4,
FT-AC-3
AM-AHU-13
SP-AC-6

SEQUENCE OF OPERATION

Under normal condition, the OFF/REMOTE switch on the Motor Control Center will be left in the REMOTE position.

The unit will be started and stopped by a panel mounted selector switch. If the switch is in the OFF position, the supply fan will be off, the outside air damper will be closed and the cooling coil will be deactivated. If the switch is in the AUTO position, the fan will be able to run.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside air damper will close, the cooling coil will be deactivated and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and the above safety condition is in a normal mode, the space temperature transmitter will, on a rise in temperature above 85°F, start the supply fan, open the outside air damper and activate the cooling coil via controls provided by unit manufacturer. On a drop in space temperature, the reverse will occur.
Chilled, Condenser, Hot Water Pumps Variable Volume Boxes, Manual Exhaust Fan. P-1 Thru P-7, AM-VAV-1 Thru AM-VAV-12

AH-EF-4,
EP-EF-4,
AM-EF-9, 24, 26,
AB-EF-1, 2,
AB-RF-1

Chilled, Condenser And Glycol Heating Water Pumps:

**SEQUENCE OF OPERATION**

Under a normal condition, the OFF/ON switch on the Motor Control Center will be left in the ON position.

When in the ON position, the pumps will run. When the pump is started, a time delay relay will be energize. After an adjustable time delay, if flow is not sensed by the flow sensor, a panel mounted alarm light will light. The light will stay lit until manually reset even if flow is returned.

**Variable Volume Box Control -- Vav Only;**

**SEQUENCE OF OPERATION**

On a rise in space temperature, the thermostat will modulate the VAV box open to maintain set point. On a drop in temperature, the VAV box will close toward its MINIMUM position.

Vav With Baseboard Radiation/Reheat:

**SEQUENCE OF OPERATION**

A deadband thermostat will modulate the VAV box as follows: on a rise in temperature, the box will be at a minimum and the heating valves will modulate closed to maintain the heating set point. On a further rise between the heating and cooling set point no action will occur. On a rise above the cooling set point, the VAV box will modulate open to maintain cooling set point. On a drop in temperature, the reverse will occur.

Set: heating at 68°F
Set: cooling at 78°F

Manual Exhaust Fans

**SEQUENCE OF OPERATION**

CDM Camp, Dresser & McKe
Under normal conditions the OFF/ON switch on the Motor Control Center will be left in the ON position.

For unit AM-EF-28 only, if the CO₂ interface contact is activated the fan will stop and the exhaust damper will close.

When the fan is in the on mode, a solenoid valve will energize opening the outside air exhaust air dampers.

When the exhaust damper is proved open by the damper end switch, the exhaust fan will start.
STATIC PRESSURE CONTROLLED MANUAL EXHAUST (2-SPEED)

AM-EF-10  (AM building maintenance static pressure. Control of relief vent dampers.)

Static Pressure Controlled Manual Exhaust (2-Speed)

SEQUENCE OF OPERATION

AM-EF-10 ASSOCIATED WITH AM-AHU-1

Under a normal condition the ON/OFF switch on the Motor Control Center will be left in the ON position.

Provided the associated AHU unit is in the AUTO position, the exhaust fan controls will be activated. The panel mount photohelic pressure sensor will perform the following functions:

Below -.10" W.C., the exhaust fan will be off and the exhaust fan damper will be closed.

Between -.10" and -.05" W.C., the exhaust damper will open. After an end switch proves the damper to be open, the fan will start on low speed.

Above -.05" W.C., the exhaust damper will open. After an end switch proves the damper to be open, the fan will start on high speed.

If the associated AHU is in the OFF or HAND position, the exhaust fan will be off and the exhaust damper will be closed.

Maintenance shop/oil storage static pressure control

SEQUENCE OF OPERATION

A static pressure transmitter (DPT-1) thru a receiver controller will modulate the relief damper to maintain a negative static pressure in the shop storage area relative to the corridor.

Static pressure transmitter (DPT-2) will, thru a receiver controller, modulate the relief damper in the oil storage room to maintain a negative static pressure relative to the shop storage room.
HEAT RECOVERY

SP-SF-1,
SP-TF-1,
SP-EF-2,3,4

SEQUENCE OF OPERATION

Under a normal condition, the HAND/OFF/AUTO switch on the Motor Control Center will be left in the AUTO position for supply fan SP-SF-1 and transfer fan SP-TF-1.

If the fireman's switches for SP-SF-1 and SP-TF-1 are in the NORMAL position.

If the supply air smoke detector in the discharge of SP-SF-1 is in a smoke mode, the supply fan will be off and the exhaust air and heat recovery dampers will be closed.

If the exhaust air smoke detector in the suction of SP-TF-1 is in a smoke mode, the transfer fan will be off and the exhaust air and heat recovery dampers will be closed.

If the fireman's switches and the smoke detectors are in a normal mode, the system will be controlled based on outside air temperature.

If the outside air temperature is above 55°F, the supply and transfer fans will run, the heat recovery damper will be closed and the exhaust air and supply fan inlet and discharge dampers will be open.

If the fireman's switch for SP-SF-1 is in the OFF position, the supply fan will be off and the outside air and discharge air dampers will be closed.

If the fireman's switch for SP-TF-1 is in the OFF position. The transfer fan will be off and the exhaust air and heat recovery dampers will be closed.

If the fireman's switch for SP-SF-1 is in the VENTILATION position. The supply fan will run, the outside air and discharge air dampers will be open, the heat recovery damper closed and the exhaust dampers will open. When open, the exhaust fans SP-EF-2, SP-EF-4 will be called to run.

Provided the OFF/ON switch in the Motor Control Center is in the ON position, a solenoid valve will energize open an exhaust damper. After an end switch proves each exhaust fan damper to be open, the exhaust fan will start.

If the fireman's switch for SP-TF-1 is in the VENTILATION position, the transfer fan will run, the exhaust air damper will open and the heat recovery damper will be closed.
The duct mounted air flow sensor will light an alarm light on the panel face and send a signal to the central panel if the air flow is below set point for SP-TF-1, SP-EF-2, SP-EF-3 and SP-EF-4.
SUMMER AND EMERGENCY VENTILATION (2-SPEED EXHAUST FANS)

AH-EF-3
AH-EF-4

SEQUENCE OF OPERATION

Under a normal condition the OFF/ON switch on the Motor Control Center will be left in the ON position.

If the fireman's switch is in the NORMAL position

If the exhaust air smoke detector is in a smoke mode, the fan will be off, the outside air and exhaust air dampers will be closed.

If the panel mounted emergency ventilation switch is in the OFF position, the unit will be started and stopped by a panel mounted OFF/TEST/AUTO selector switch.

If the OFF/TEST/AUTO switch is in the OFF position, the exhaust fan will be off and the outside air and exhaust air dampers will be closed. If the switch is in the TEST position, the exhaust damper will open. After an end switch proves the damper open, the exhaust fan will start on low speed. If the switch is in the AUTO position, the unit will be under control of the space temperature transmitter.

If the space temperature is below 80°F, the exhaust fan will be off and both the outside air and exhaust air damper will be closed. If the space temperature is above 80°F, the outside air and exhaust air dampers will open. After an end switch proves the exhaust damper open, the exhaust fan will start on low speed.

If the emergency ventilation switch is in the ON position, outside air and exhaust dampers will open. After an end switch proves the exhaust damper open, the exhaust fan will start on high speed.

If the fireman's switch is in the OFF position, the fan will be off, the outside air and exhaust air dampers will be closed.

If the fireman's switch is in the VENTILATION position, the outside air and exhaust dampers will open. After an end switch proves the exhaust damper open, the exhaust fan will start on high speed.
FINNED TUBE RADIATION UNIT AND CABINET UNIT HEATERS/ GLYCOL DIFFERENTIAL PRESSURE CONTROL

All baseboard (BB) Heaters

Finned tube radiation and natural convection heaters:

SEQUENCE OF OPERATION

A reverse acting room thermostat will, on a rise in space temperature, modulate the glycol heating control valve closed to maintain set point.

Baseboard radiation for the am-building in rooms with VAV boxes will sequence with the VAV box via a direct acting room thermostat and a reversing relay. On a call for heat, only after the VAV box is at its MINIMUM position, will the valve modulate open.

Unit heaters and cabinet unit heaters:

SEQUENCE OF OPERATION

A LINE/LOW voltage space thermostat will cycle the heater fan ON/OFF to maintain set point.

Glycol constant differential pressure: control - building heating system:

SEQUENCE OF OPERATION

The system differential pressure transmitter will, through a panel mounted receiver controller, modulate the differential pressure control valve to maintain a predetermined set point.

Limit switches on the control valve will activate two alarm lights on the ATC panel. If the valve reaches 10% open to indicate the need to turn on an additional boiler or 90% open to indicate the need to turn off one boiler.
SUMMER AND EMERGENCY VENTILATION (2-SPEED EXHAUST FANS)

AH-EF-2
AH-EF-5

SEQUENCE OF OPERATION

Under a normal condition the OFF/ON switch on the Motor Control Center will be left in the ON position.

If the fireman’s switch is in the NORMAL position

If the exhaust air smoke detector is in a smoke mode, the fan will be off, the outside air and exhaust air dampers will be closed.

If the panel mounted emergency ventilation switch is in the OFF position, the unit will be started and stopped by a panel mounted OFF/TEST/AUTO selector switch.

If the OFF/TEST/AUTO switch is in the OFF position, the exhaust fan will be off and the outside air and exhaust air dampers will be closed. If the switch is in the TEST position, the exhaust damper will open. After an end switch proves the damper open, the exhaust fan will start on low speed. If the switch is in the AUTO position, the unit will be under control of the space temperature transmitter.

If the space temperature is below 80°F, the exhaust fan will be off and both the outside air and exhaust air damper will be closed. If the space temperature is above 80°F, the outside air and exhaust air dampers will open. After an end switch proves the exhaust damper open, the exhaust fan will start on low speed.

If the emergency ventilation switch is in the ON position, outside air and exhaust dampers will open. After an end switch proves the exhaust damper open, the exhaust fan will start on high speed.

If the fireman's switch is in the OFF position, the fan will be off, the outside air and exhaust air dampers will be closed.

If the fireman's switch is in the VENTILATION position, the outside air and exhaust dampers will open. After an end switch proves the exhaust damper open, the exhaust fan will start on high speed.
AIR CONDITIONING WITHOUT RETURN FAN:

AM-AHU-10

SEQUENCE OF OPERATION

Under a normal condition, the OFF/REMOTE switch on the Motor Control Center will be left in the REMOTE position.

The unit will be started and stopped by a panel mounted selector switch. If the switch is in the OFF position, the supply fan will be off, the outside air damper will be closed. The glycol heating control valve will be closed and the cooling coil valve will be in the BYPASS position. If the switch is in the AUTO position, the unit will be able to run.

A panel mounted time clock will determine occupied/unoccupied mode. When in the occupied mode, the unit will be able to run. If the time clock is in the unoccupied mode, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed and the cooling coil valve will be in the BYPASS position.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside air damper will close, the heating coil valve will close, the cooling coil valve will be in the BYPASS position and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position, the time clock is in the occupied mode and all of the above safety conditions are in a normal mode, the supply fan will start and the outside air damper will open to its MINIMUM position, via MINIMUM position switch.

The space temperature transmitter will then, on a rise in temperature, through a panel mounted receiver controller, modulate in sequence the heating coil valve closed open to the coil to maintain set point. On a drop in temperature, the reverse will occur. The valve pilot positioners will be set so that below 70°F the heating valve will modulate, above 78°F. The cooling coil valve will modulate and, between 70 and 78°F, the heating coil valve will be closed and the cooling coil valve will be in the BYPASS position.
LABORATORY HOOD EXHAUST WITH DUCTED MAKE UP AIR

AM-EF-4 With AM-AHU-3
AM-EF-5 With AM-AHU-2
AM-EF-6 With AM-AHU-5
AM-EF-7 With AM-AHU-4

SEQUENCE OF OPERATION

Under a normal condition, the OFF/REMOTE switch or the Motor Control Center will be left in the REMOTE position.

The exhaust fan will be started and stopped by an ON/OFF switch at the lab hood provided by the electrical contractor. Whenever the exhaust fan is started, the supply fan will start.

If the hood switch is in the OFF position, the supply fan and exhaust fan will be off and the outside and exhaust dampers will be closed. The heating coil valve will also be closed. If the hood switch is in the ON position, the fans will be able to run.

If the low limit thermostat (manual reset) is in a low temperature condition, the exhaust fan will run, the exhaust damper will open, the supply fan will stop, the outside air damper will close, the heating coil valve will close and an alarm light will indicate a freeze condition.

Damper mounted end switches will prevent the exhaust fan and supply fan from running until their respective damper is proven open.

The supply temperature transmitter will then, on a rise in temperature through a panel mounted receiver controller, modulate the heating coil valve closed to maintain set point. On a drop in temperature the reverse will occur.
LOCKER ROOM 100% OUTSIDE AIR
AM-AHU-11 with AM-EF-21,22, 23 and DH-1,2

SEQUENCE OF OPERATION

Under a normal condition, the OFF/REMOTE switch on the Motor Control Center will be left in the AUTO position.

If the fireman's switch is in the NORMAL position, the unit will be started and stopped by a panel mounted selector switch. If the switch is in the OFF position, the supply and exhaust fans will be off, the outside air dampers will be closed, the glycol heating control valves will be closed and the exhaust air dampers will be closed. If the switch is in the AUTO position, the unit will be able to run.

A panel mounted time clock will determine occupied/unoccupied mode. When in the occupied mode, the unit will be able to run. If the time clock is in the unoccupied mode, the supply, and exhaust fans will be off, the outside air and exhaust air dampers will be closed, and the glycol heating control valve will be closed.

If the supply air smoke detector is in a smoke mode, the fans will be off, the dampers will be closed, and the heating coil valves will be closed.

If the low limit thermostat (manual reset) is in a low temperature condition, the fans will stop, the dampers will close, the heating coil valves will close and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode, the supply fan will start. The return fans will start through an interlock with the supply fan. The outside air and exhaust air dampers will open and the glycol heating valve will be controlled by the supply air temperature transmitter through the panel mounted receiver controller. On a rise in supply air temperature, the heating coil valve will modulate closed to maintain set point. On a drop in temperature, the reverse will occur.

On a rise in space temperature, the reheat coil valves will modulate closed to maintain set point. On a drop in temperature, the reverse will occur, (typical for AM-DH-1 and AM-DH-2). If the supply fan is off, reheat coil valves will be closed.

If the fireman's switch is in the VENTILATION position, the fans will run regardless of the ATC panel selector switch and smoke and freeze safeties. The supply and exhaust dampers will open and the heating valve will be under control.
BOILER COMBUSTION AIR UNIT

AM-AHU-16

SEQUENCE OF OPERATION

Under a normal condition, the HAND/OFF/REMOTE switch on the Motor Control Center will be in the REMOTE position.

If the fireman's switch is in the NORMAL position. The unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air and exhaust dampers will be closed and the glycol heating control valve will be closed. If the switch is in the AUTO position the unit will be able to run.

If any boiler is running, a signal will be sent to the control panel and allow the unit to run.

If all boilers are off, the supply fan will be off, the outside air and exhaust dampers will be closed and the glycol heating control valve will be closed. If the switch is in the AUTO position the unit will be able to run.

If the supply air smoke detector is in a smoke mode, the fan will be off, the outside air and exhaust air dampers will be closed and the heating coil valve will be closed.

If the low unit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside air and exhaust dampers will close, the heating coil valve will close and an alarm light will indicate a freeze condition.

If the panel mounted switch is in the AUTO position and all of the above safety conditions are in a normal mode, the supply fan will start and the outside air and exhaust air dampers will open.

The supply temperature transmitter will, then, on a rise in temperature through a panel mounted receiver controller, modulate in sequence the heating coil valve closed to maintain set point. On a drop in temperature the reverse will occur.

The duct mounted air flow sensor will light an alarm light on the panel face and send a signal to the central panel, if the air flow is below set point.

If the fireman's switch is in the OFF position, the fan will be off, the outside air and exhaust dampers will close and the heating valve will be closed.

If the fireman's switch is in the VENTILATION position, the fan will run regardless of the ATC panel selector switch, boiler status and smoke and freeze safeties. The outside air and exhaust dampers will open and the heating valve will be under control.
SUMMER VENTILATION EXHAUST FANS

AM-EF-12,
AM-EF-16,
AM-EF-15

SEQUENCE OF OPERATION

Under a normal condition, the HAND/OFF/REMOTE switch on the Motor Control Center will be: left in the REMOTE position.

Exhaust fan AM-EF-15 only will be held off and its dampers closed if a CO₂ interface (by others) is activated.

If the fireman’s switch is in the NORMAL position and if the area smoke detector is in a smoke mode, The fan will be off and the exhaust and outside air dampers will be closed.

If the smoke detector is not in a smoke mode and the space temperature rises above 80°F. The intake and exhaust dampers will open. When a local end switch proves the exhaust dampers to be open, the exhaust fan will run. When the space temperature drops below 80°F, the fan will stop and the dampers will close.

If the fireman’s switch is in the OFF position. The fans will be off and the dampers will close.

If the fireman’s switch is in the VENTILATION position, the dampers will open and the exhaust fan will run after the damper is proven open.
LABORATORY HOOD EXHAUST W/O DUCTED MAKEUP AIR,
TRANSFER EXHAUST FANS

AM-EF-1, 2, 3 and 8
FT-TF-1
PT-TF-1
HW-TF-1 and 2

SEQUENCE OF OPERATION

Under a normal condition the OFF/ON switch on the Motor Control Center will be
left in the ON position.

A lab hood switch (by e.c.) will start the exhaust fan provided AM-AHU-1 is running.
When the exhaust fan is called to run, the exhaust damper will open. After a local
end switch proves the damper to be open, the fan will start.

Toilet exhaust fans

SEQUENCE OF OPERATION

Under a normal condition, the OFF/ON switch on the Motor Control Center will be
left in the ON position.

If the fireman's switch is in the NORMAL position and smoke detector is in the
NORMAL mode, the fan will run. If the smoke detector is in a SMOKE condition,
the fan will stop.

If the fireman's switch is in the OFF position, the fan will be off.
If the fireman's switch is in the VENTILATION position, the fan will run.
AIR CONDITIONING WITH VARIABLE VOLUME

AM-AHU-6

SEQUENCE OF OPERATION

Under a normal condition, the OFF/REMOTE switch on the Motor Control Center will be in the REMOTE position.

The unit will be started and stopped by a panel mounted selector switch. If the selector switch is in the OFF position, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the BYPASS position and the VAV damper will be closed. If the switch is in the AUTO position, the unit will be able to run.

A panel mounted time clock will determine occupied/unoccupied mode. If the time clock is in the unoccupied mode, the supply fan will be off, the outside air damper will be closed, the glycol heating control valve will be closed, the cooling coil valve will be in the BYPASS position and the VAV damper will be closed. When in the occupied mode, the unit will be able to run.

If the supply air smoke detector is in a smoke mode, the fan will be off, the outside air damper will be closed, the heating coil valve will be closed, the cooling coil valve will be in the BYPASS position and the VAV damper will be closed.

If the low limit thermostat (manual reset) is in a low temperature condition, the fan will stop, the outside damper will close, the heating coil valve will close, the cooling coil valve will be in the BYPASS position and the VAV damper will close and an alarm will indicate freeze condition.

If the panel mounted switch is in the AUTO position, the time clock is in the occupied mode and all of the above safety conditions are in a normal mode, the supply fan will start.

The duct mounted differential pressure transmitter will, through panel mounted receiver controller, modulate the inlet vanes to maintain a preset static pressure.

The supply air temperature transmitter will then, on a rise in temperature, through a panel mounted receiver controller, modulate in sequence the heating coil valve closed followed by modulating the cooling coil valve open to the coil to maintain set point. On a drop in temperature, the reverse will occur.

A panel mounted MINIMUM position switch will position the outside air damper to a minimum whenever the unit runs.
36.4 Maintenance Recommendations

It is essential that personnel become familiar with all instructions provided by the equipment manufacturers and the temperature control supplier. The staff is provided with manufacturers’ service manuals that detail the maintenance and lubricant requirements of individual equipment components. These instructions should be followed in order to preserve the integrity of the HVAC system. Failure of a single component due to neglect may create an uncomfortable environment in which to work or cause detriment to other equipment.

In addition to the manufacturers’ instructions regarding inspection, oiling, greasing, and cleaning, the following procedures should be considered:

1. The most important maintenance procedure is maintaining clean water. A dirty strainer will result in reduced performance of the equipment, low water flow and sluggish temperature control at the air handling units.

2. All air handling units are provided with one spare set of filters. These spares may be rotated with those in use on a regular schedule. Dirty filters must be removed and replaced. The frequency of changing filters will vary according to use and local dust loading. It is usually required every 8 to 12 weeks. Experience in operation will allow a schedule to be set up. Generally, air conditioning units (ACU) have fiberglass filters that also must be maintained.

3. V-belt drives should be checked and adjusted for proper tension. Worn or cracked belts must be properly replaced. If the drive utilizes two belts, they must be replaced with a matched pair.

4. Time switches are utilized in some units for startup and shutdown during occupied hours for both heating and cooling. After a power failure it will be necessary to adjust the dial of each time switch to indicate the correct local time so that the proper “START” and “STOP” periods are in function.

5. Inspect all heating/cooling coils for dust and/or direct. A build-up reduces the efficiency of the heat exchanger.

6. Inspect drip pans for dirt and debris. Ensure overflow tubes are clear.
Chapter 37
Communications Systems

37.1 Communications System Description ..............................................................37-2
37.1 Communication System Description

In order to maintain contact with the members of the plant staff, the facility is equipped with a paging intercom system. The system provides two channel conversation between any remote wall and desk station. The system is also equipped with a separate paging channel through which any remote station can initiate a page over the public address system.

The central power unit of the paging intercom can provide service for as many as 48 remote handset stations on five common-talking party lines. There are separate inputs for background music and individual volume controls for both paging and music.

Both the desk style and wall mounted handset stations are constructed of steel reinforced high impact resistant plastic. With these components, an employee can converse with one or more stations on either of five party lines. In addition, live announcements can be made over the paging system by utilizing the pushbutton located on the station.

To enhance the sound system, most handset stations have a loudspeaker with a volume control to regulate the sound level of the speaker. Rooms and hallways in the Maintenance Building, Headworks, PST, Aeration, FST Galleries, Effluent Pump Station and the Sludge Processing Building are provided with 8-inch speaker systems or wide angle horns to provide the most audible sound for that specific installation.

For specific information relative to the operation of the Page/Party Intercom System, the personnel should reference the manufacturer's service manuals located in the plant library.
Chapter 38
Fire Alarm Systems

38.1 Fire Suppression System Description ...........................................38-2
38.1 Fire Suppression System Description

Fire prevention is a constant concern of plant personnel and individuals living in the surrounding neighborhood. Therefore, fire detection, alarm and protection systems are provided for the entire treatment plant.

The individual rooms, passageways and galleries of the various plant buildings and structures are provided with specific wet or dry type sprinkler systems, based upon each individual application. Those areas utilizing fire protection at the New Bedford WPCF are as follows:

Table 38-1 Fire Suppression Systems by Zone

<table>
<thead>
<tr>
<th>Zone</th>
<th>Building/Room</th>
<th>Type of Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Administration Building (Office wing - East)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>2</td>
<td>Administration Building (Maintenance wing)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>3</td>
<td>Administration Building (Vehicle/Yard Storage Garage)</td>
<td>Dry Type System</td>
</tr>
<tr>
<td>4</td>
<td>Administration Building (Flammable Storage Room)</td>
<td>CO₂ Suppression System</td>
</tr>
<tr>
<td>5</td>
<td>Administration Building (Generator Room)</td>
<td>CO₂ Suppression System</td>
</tr>
<tr>
<td>6</td>
<td>Priamray Air Handling Building</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>7</td>
<td>Grit Loading Area</td>
<td>Dry Type System</td>
</tr>
<tr>
<td>8</td>
<td>Headworks (Screenings Area)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>9</td>
<td>Headworks (Screenings Basement)</td>
<td>Foam suppression piping for Fire Department use.</td>
</tr>
<tr>
<td>9</td>
<td>Headworks (Pumping Area)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>9</td>
<td>Headworks (Pump Station Basement)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>9</td>
<td>Headworks (Pump Station Sub-basement)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>10</td>
<td>Aerated Grit Tank Pump Room</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>10</td>
<td>Primary Settling Tank Gallery and Sludge Pump Gallery (North and South)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>11</td>
<td>Aeration Basin Gallery</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>12</td>
<td>Aeration Blower Building</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>13</td>
<td>Final Settling Tank Gallery</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>14</td>
<td>Effluent Pump Station</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>15</td>
<td>Sludge Processing Building (Bin Garage)</td>
<td>Dry Type System</td>
</tr>
<tr>
<td>16</td>
<td>Sludge Processing Building Basement</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>17</td>
<td>Sludge Processing Building (Control Room)</td>
<td>Dry Type System</td>
</tr>
<tr>
<td>18</td>
<td>Sludge Processing Building (First Floor)</td>
<td>Wet Sprinkler System</td>
</tr>
</tbody>
</table>
Table 38-1 Fire Suppression Systems by Zone (Continued)

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>System Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Sludge Processing Building (Mezzanine Level)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>20</td>
<td>Sludge Processing Building (Second Floor Elev 36.00)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>21</td>
<td>Sludge Processing Building (Third Floor Elev 50.00)</td>
<td>Wet Sprinkler System</td>
</tr>
<tr>
<td>22</td>
<td>Gravity Thickener Pump Station &amp; Gallery</td>
<td>Wet Sprinkler System</td>
</tr>
</tbody>
</table>

The automatic wet-type sprinkler system is hydraulically-designed to provide a density of 0.19 gallons per minute per square foot (gpm/sq ft) over the most remote 1,500 square foot of area. Sprinkler heads are rated for activation at temperatures in excess of 225°F. Fire Department pumper connections are provided at the
- Sludge Processing Building,
- Effluent Pump Station,
- Aeration Gallery Building,
- Primary Gallery,
- Headworks
- Primary Air Handling Building,
- and Administration Building.

Pumper connections are provided for additional fire fighting capabilities. The pumper connection is a standard 4-inch Y-type fire hose connection located on the front face of each building. Refer to the following Figures for additional information relative to the fire suppression system:
- Figure 38-1 Protection Diagram
- Figure 38-2 Protection Diagram
- Figure 38-3 Protection Diagram

The lubricant storage room and generator room located in the Administration/Maintenance Building is considered an extra hazardous area and is provided with separate carbon dioxide fire suppression system that provide a chemical density of 0.29 gpm/sq ft of total area. The unit is a fully automatic pneumatic system actuated by rate-of-rise temperature devices. Carbon dioxide is flooded into the room in the event of a fire by multiple jet discharge nozzles from 75 pound cylinders located in the adjacent rooms.

The main fire service supply lines in the Administration Building is provided with reduced pressure backflow prevention (R.P.B.P.) devices at the service lines' point of entry to the building. The R.P.B.P. provides protection to the potable water supply lines in the event that a Fire Department pumper truck must be hooked up to the pumper connection for additional fire fighting.
capabilities. As with all R.P.B.P. devices, they should be inspected and tested on a routine basis to show compliance with Fire and Health ordinances.

The sprinkler systems are provided with an alarm check valve, excess pressure pump kit, pressure gauge, site test pipe, alarm bell, and associated accessories and fittings. The heads of the sprinklers are designed based upon guidelines established by the National Fire Protection Association and are classified for ordinary and intermediate hazard. In the event that the sprinkler system experienced any loss in pressure, each of the systems and each branch for each floor level or area is fitted with a low pressure switch installed downstream of the alarm valve or water flow indicator.

To make personnel aware of the status of the sprinkler system, alarm devices are furnished and installed in the sprinkler supply lines. These alarm devices include sprinkler alarm valves, low pressure alarms, and loss of water flow indicator alarms. Alarms are annunciacted at the Central Operators Console (COC).