EIMCO®
PROCESS EQUIPMENT
A Baker Hughes company

VOLUME 1

APPROVAL

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

HIGH DENSITY SLUDGE FACILITY

Serial No. 76738-01 thru 19

For

IRON MOUNTAIN MINE
REDDING, CA.

CH2M HILL
REDDING, CA.

Subcontract No. 118

EIMCO Order No. 76738-01 thru 19

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Iron Mountain Mine Manual—Draft Copy

1.0 General Information

1.1 FOREWORD

This Operation and Maintenance manual has been prepared to assist the operations and maintenance personnel in the understanding of the procedures, techniques and references necessary to operate and maintain the Iron Mountain Mine (IMM), acid mine drainage (AMD) facilities. To ensure proper operation, maintenance and warranty coverage of the equipment, those personnel must read and familiarize themselves with the contents of this manual.

The manual is divided into 13 sections: Sections 2 through 6, cover a facility overview, the process description, the control systems, startup, normal operation, shutdown, process monitoring, and the electrical including the monitoring and control system. Sections 7 and 8 are for operator training and safety, while Section 9 is for equipment maintenance, primarily for the EIMCO Sludge Thickener. Section 10 is miscellaneous and Section 11 contains the Parts Lists, including a complete Sludge Thickener parts list. Section 12 contains all the process and equipment drawings and Section 13 includes the accessory equipment furnished but not manufactured by EIMCO.

Copies of this manual and any supplemental copies should be accessible to personnel as a reference for day-to-day operation and routine maintenance, adjustments, and repairs of the equipment Portions of this manual may be provided in separate binders depending on the size of the final copies.

1.2 Maintenance and Start-up Services

Experienced EIMCO engineers and service personnel are available to assist in the start-up and maintenance of your EIMCO equipment. They offer you the benefits of their technical know-how and firsthand knowledge of the equipment, plus the backing of EIMCO's entire engineering and research facilities.

They can instruct on proper operating and maintenance procedures, advise on trouble shooting and, if necessary, supervise the entire start-up, depending on your requirements.

If you should want such assistance, arrangements should be made at the earliest possible date, outlining the services required, giving the approximate duration of such services. If there are any charges for the services, they can be arranged at that time.

Contact your EIMCO Representative; or refer to the "Offices" page for the nearest EIMCO representative.

1.3 Safety: Maintenance and Operation Warnings

PERSONNEL  **SAFETY WARNINGS**

WARNING: Use extreme care when working around rotating or other moving parts, to prevent injuries to yourself or others. Also, anyone entering the area of this equipment must be wearing adequate safety equipment such as safety glasses, safety shoes, hard hat, etc.

WARNING: Keep foreign objects, hands, etc. away from moving parts (belts, sheaves). Do not operate equipment if guards have been removed.

WARNING: Lock out power from electrical equipment using a manual breaker or disconnect switch before starting any work or maintenance on the equipment. Lock and tag disconnect switch so it cannot be closed.

WARNING: If any maintenance is to be performed on an EIMCO thickener drive unit, before doing any maintenance or adjustments on the drive, refer to the "Drive Maintenance Warning".

WARNING: Experience with or understanding of the equipment is essential for safe disassembly, repair and adjustments. Therefore, in case of any question on how to safely proceed, contact EIMCO immediately.

WARNING: The fumes given off during welding and cutting can be injurious to the operators health. Some fumes, such as those produced when working with Zinc, Cadmium and painted surfaces can be toxic.

Before operation, maintenance or repair of this equipment: Read and understand the instructions in this manual. Refer to Section "8.0 Safety."

Contact: **EIMCO Engineering, Salt Lake City, Ut. or call Area 801/526-2000.**

2.0 Facility Overview

2.1 The Treatment Plant

The High Density Sludge (**hds**) plant, located at Minnesota Flats near Redding, California, will use the same site and facilities used for the existing aerated simple mix (ASM) treatment system. The "**hds**" process converts this plant to a higher sludge density mix treatment operation by adding new equipment and technology.

The new equipment includes the EIMCO Model CXT Sludge Thickener, using center column pumping, an EIMCO Reactor A Sludge Conditioning Tank, waste sludge pumps, a Modicon PLC with interface computer for control of the process, and other associated piping and components.

When the plant modifications are completed, the original Aerated Simple Mix operation will remain as a part of the AMD treatment system or as a backup to the system. The **"hds"** process will be the primary treatment process for the acid mine drainage (AMD).

2.1.1 New Equipment Added to ASM Plant

Major Components and Equipment being Added to the Aerated Simple Mix Plant			
Component/ Equipment	**Qty.**	**Purpose**	**Description**
Sludge Thickener (TK-11)	1	Provide separation of solids and liquids and thicken sludge from the neutralization and oxidation reactors (TK-1 and TK-2, also known as Reactor B1 and B2), provide a source of solids for recirculation to Reactor A, produce a clarified effluent for discharge	Eimco model CXT, 280' in diameter, 12' sidewall depth, 24" rake lift, concrete floor, steel sidewalls, center column sludge pumping using two submersible pumps
Thickener Sludge Pumps (P-11A and P-11B)	2	Pump thickened sludge from the thickener to Reactor A, also capable of pumping thickened sludge to the sludge drying beds	Gallagher model 6SU submersible, 75 Hp, centrifugal
Sludge Waste Pumps (P-12A and P-12B)	2	Pump thickened sludge from the return sludge line to the sludge drying beds. These pumps can be bypassed and the thickener sludge pumps in conjunction with valve HCV-93 can be used to pump sludge to the drying beds.	Ash model SRH, ?? HP
Waste Sludge Pipelines	2	Convey thickened sludge to the waste sludge distribution header	4" HDPE, buried with cleanouts and flush water connections
Waste Sludge Distribution Header	1	Provide selection of sludge distribution to either Sludge Bed 1, 2, or 4	Carbon steel above ground header, valves, flush water connections
Waste Sludge Distribution Pipelines	3	Conveys sludge to Sludge Bed 1, 2, or 4	4" HDPE, buried, moveable discharge hoses with splash/erosion mats, flush water
Thickener Overflow (Effluent) Sampler	1	Collects a composite effluent	???add description, provide valves sizes, make, model,

(AIS-98)		sample for testing	type
Effluent Discharge Piping	1	Conveys thickener overflow (effluent) to filtrate pump station via manhole down gradient from Sludge Drying Bed Number 1.	16" pipeline, carbon steel above ground and HDPE below ground. Connects with the manhole in the filtrate drain pipeline down gradient of Sludge Bed 1
Reactor A Lime Feed Valves	4	Adds lime slurry to Reactor A	???add description, provide valves sizes, make, model, type
Reactor A (TK-13) (Sludge Conditioning Reactor)	1	Provide mixing of lime slurry and thickened sludge, which coats the sludge particles with lime so that when the lime coated sludge particles are contacted with AMD in TK-1 and TK-2 that precipitation occurs onto the surface of the lime coated sludge particle	8 feet diameter, 8 feet tall, 7'-3" sidewater depth, carbon steel, mixed with a Lightning mixer (2 Hp, pitched blade)
Reactors B1 and B2 (TK-1 and TK-2)	2	Provides neutralization of the AMD by contact with the lime coated sludge from Reactor A, provides precipitation of dissolved metals and sulfate from the AMD onto the surface of the lime coated sludge particles from Reactor A, provides oxidation of ferrous iron to ferric iron due to the introduction of air.	Reactor B1: 28' diameter, 20' tall, ??' sidewater depth, stainless steel Reactor B2: 28' diameter, 20" tall, ??' sidewater depth, stainless steel Mixers: Chemineer, 200 Hp and 1800 RPM motors, 445TS frame, CD-6 stainless steel impeller
Aeration Blowers (BL-1 and BL-2)	2	Provides air into the reactors for oxidation of ferrous iron to ferric iron. Ferric hydroxide produces a sludge with better dewatering characteristics than a ferrous hydroxide sludge.	Roots-Dresser model 824 RCS rotary lobe blowers, 250 HP motors
Portable Ultrasonic Flowmeter (FI-79)	1	Provides flow rate for the recycle sludge line from the thickener to Reactor A. This information is used to calculate the solids recycle ratio in conjunction with	???add description, provide valves sizes, make, model, type

		a percent solids analysis of the recycle sludge.	

2.1.2 "hds" Process and Plant-Goals and Methods

The **"hds"** plant method of treating the AMD, which is an acid water containing heavy metals and other dissolved constituents, is to treat the water with a lime slurry mixed with recirculated sludge formed in the process of the lime treatment.

The lime neutralizes the acidity of the water and at the same time a portion of the sludge formed in the process is recycled and mixed with the lime slurry for reuse in the treatment process. As the incoming AMD to the plant is treated with the mix of lime slurry and recycled sludge, the metallic solids (mainly ferrous iron) and other dissolved constituents are oxidated and precipitated.

The lime and recycled sludge are mixed together in the new Sludge Conditioning Reactor (Reactor A) and fed to the first of two existing Neutralization and Oxidation Reactors where the AMD enters. (Only one neutralization and oxidation reactor may be in operation during certain times of the year. If only one reactor is operating, then the lime and recycled sludge are introduced into that reactor. The lime and recycled sludge are introduced into whichever neutralization and oxidation tank is receiving the AMD.)

So, neutralization of the AMD and sludge formation occur in one or both of these existing neutralization and oxidation reactors (Reactors B1 and B2). The mixture then flows to the Thickener where the precipitated solids settle out, forming the sludge.

The sludge is recycled back to the Sludge Conditioning Reactor A to mix with the lime, except for a portion that is wasted to the sludge drying beds. The solids recirculation ratio is at least 20:1, and higher up to the high capacity design condition. The solids recirculation ratio is defined as the dry mass of solids per unit time recycled from the thickener to Reactor A, compared to the dry mass of solids created from neutralization and oxidation of the AMD per some unit time.

The effluent from the thickener goes to the filtrate pump station, along with the discharge from the sludge drying beds. The filtrate pump station pumps the combined water to lower spring creek.

2.2 Treatment Plant Design Basis

The design objective of the AMD Treatment Plant is to remove sufficient heavy metals and other solids that the effluent limitation of the Federal Regulation (CFR) will meet the Clean Water Act Effluent Guidelines and Standards for Ore Mining and Dressing (see below).

2.2.1 Influent AMD Flows and Characteristics

The AMD influent to the treatment plant consists of flows from the Richmond and Lawson portals and the Old/No. 8 seep. The flows and loads the treatment plant will receive during a year will vary significantly due to seasonal precipitation and processes occurring within the mines.

The design capacity of the treatment plant is 1,400 gallons per minute (gpm), although normal flows are less and significantly less during some periods, such as summer. A material balance for the treatment plant is provided in the IMM Process Flow Diagram, Material Balance drawing (in the drawing section 12.0), which gives the peak, average, low and design flow parameters [annual averages]. It also shows the flows through the system with stream numbers and solids loads.

2.2.2 Effluent Limits

The effluent from the high density sludge plant will consist of thickener overflow and filtrate from the high density sludge placed in the sludge drying beds. Both of these flows will be combined at the filtrate pump station and pumped to lower Spring Creek below the diversion.

In both ROD2 and ROD3 (Record of Decision), the EPA addressed the Applicable or Relevant And Appropriate Requirements (ARARS) for the treatment plant effluent. These ARARs specify that the AMD neutralization facility shall be designed and operated to meet the Clean Water Act Effluent Guidelines and Standards for Ore Mining and Dressing at 40 CFR 440.102(a) and .103(a). The Clean Water Act's system of technology-based effluent controls requires discharges to achieve Best Practicable control Technology (BPT) and Best Available Technology (BAT) economically achievable. Refer to the "Effluent Limitations" table below.

ROD2 and ROD3 specify that if the effluent is discharged into Boulder Creek or Slickrock Creek (both of which flow into lower Spring Creek), the discharge will need to comply with the effluent limitation above, except for pH and total suspended solids (TSS) levels. As stated in the RODs, the EPA has determined that for discharges to these two creeks, it will not be necessary to

adjust the effluent pH (approximately 8.5) because of the acidic nature and buffering capacity in these creeks. Treatment to TSS levels prescribed in the Clean Water Act would not be currently necessary because of the high levels of TSS already in the creeks.

However, if the discharge from the treatment plant is to Flat Creek, which is not as acidic and does not have high levels of TSS, the pH and TSS standards would have to be met.

ROD Effluent Limitations*#

	30-Day Average (mg/L)	Maximum Daily (mg/L)
Cadmium	0.05	0.10
Copper	0.15	0.30
Lead	0.30	0.60
Mercury	0.001	0.002
Zinc	0.75	1.50
pH**	6.0 to 9.0	
TSS**	20	30

Notes:

*Per ROD2, pages 72-73; 40 CFR, 440.102(a) and 440.103(a).

**pH and TSS requirements are only pertinenet for discharge to Flat Creek.

#From Weston manual Table 1-2, pg. 1-5.

2.3 AMD Treatment

The untreated acid mine drainage (AMD) is conveyed by gravity from the Richmond and Lawson portals and from the Old/No. 8 seep to the treatment plant. The design capacity of the high density sludge (**"hds"**) plant, including the lime feed and sludge recycle to meet peak demand, is 1,400 gallons per minute (gpm). That represents the observed combined peak AMD flow plus 35%.

The entire AMD flow enters the system at existing Reactor B1 or B2, as shown in the Process Flow Diagram, Material Balance drawing (EIMCO 76738D1101). The drawing also shows all major equipment in AMD treatment. (AMD diversion, if necessary, to the Cementation Plant is not shown.)

2.3.1 Reactors B1 and B2

The Reactors B1 and B2 (tanks TK-1 and TK-2) have been modified for the **"hds"** process by modifying and increasing the size of the piping, modifying the discharge wells, and replacing the blowers and mixers.

Each Reactor tank is 78,000 gallon capacity at 28'-0 Dia.x 20'- High; however, Tank TK-1 is 17'-side water depth (SWD) and 3' freeboard (FB), and tank TK-2 is 16' SWD and 4' FB. At 78,000 gallons, sludge detention time is about 60 minutes at peak AMD flow of 1,400 gpm with a conditioned sludge flow of 2,619 gpm.

The tanks are provided with submerged turbine mixers (MX-1 and MX-2), each consisting of a 200-horsepower (hp) single-speed mixer and an air sparger ring, placed above the mixer blades. Air is supplied by two air blowers (BL-1 and BL-2), one for each Reactor. The air blowers are rated at 2,671 scfm.

AMD normally flows by gravity from the influent box (TK-9) to Reactor B1; however, a three-way valve at the AMD influent allows the flow to be directed to either Reactor. The lime conditioned recycled sludge from Reactor A can likewise be added to either Reactor B1 or B2, where it is mixed with the AMD and air in the Reactor tank by the submerged turbine mixer.

Reactor B2 receives the entire flow of Reactor B1 in the normal **"hds"** process. Conditioned sludge from Reactor A can also be directed to Reactor B2, if required for pH control, or if B1 will be bypassed. But in either case, the amount and frequency of the addition from Reactor A will vary as the need occurs, to maintain pH at about 8.5 to 9.0 (actual operating pH to be determined by plant operators).

The conditioned slurry overflows from either Reactor B1 or Reactor B2 into a gravity trough that carries it to the Thickener.

2.3.1.1 ASM Process Option

This **"hds"** process still keeps the original aerated simple mix (ASM) operation as an option for the operators. In that case, the thickener and sludge conditioning Reactor A would be bypassed, the lime would go directly to Reactor B1 or B2, and the effluent would go to the sludge beds.

2.3.2 Sludge Conditioning Reactor A

In the **"hds"** process, recycled sludge from the Thickener is mixed with lime slurry in the new Sludge Conditioning Reactor (Reactor A). The Reactor tank is 8'0 Dia.x 8'-0 (7'-3 side water depth); tank flow rate is from a minimum of about 1,112 gpm up to a high of about 2,619 gpm, with detention time ranging from a minimum of .97 minutes up to a high of 2.3 minutes. (Note: Actual operational flow rates and corresponding detention times to be determined based on operational requirements.) The mixer is a Lightnin Series 10 with constant speed, 2 HP motor and chemical duty construction.

The retention of lime slurry and recycled sludge in Reactor A is just long enough to obtain a uniform mix of lime and sludge. The lime addition is controlled automatically, depending on the flow rate and pH of the AMD stream. That and the lime handling and feed facilities, will be covered later.

Reactor A is located on a separate structure elevated above Reactor B2, where it can discharge from a top overflow trough by gravity into either Reactor B1 or B2 below. Retention time can be adjusted with a weir at the overflow outlet.

2.3.2.1 "hds" Mode of Operation

In the normal sludge densification mode, a steady stream of recycled sludge from the Thickener is received by Reactor A, where it is mixed with about 10% by weight lime slurry from the lime handling and feed facilities.

The lime slurry is added only to Reactor A in this mode, and not the other Reactors. The amount of lime is controlled by a pH controller, which modulates pairs of pinch valves in either a 4" line (loop 1) or an 8" line (loop 2) from the lime slurry facility. The pH probe, which is located in either Reactor B1 or B2, depending on which receives the AMP, responds to changes in the pH. The pH control will be covered in more detail later.

2.3.2.2 ASM Alternate Mode of Operation

If plant operation is switched over to the aerated simple mix (ASM) mode, the lime is added directly to Reactors B1 and B2 and it is controlled by a pH controller in each Reactor, similar to the original method.

Only in the aerated simple mix (ASM) mode is Reactor A bypassed, which includes the bypass of the Thickener and associated pumps. This mode of operation would generally occur during a period of exceptionally low flow or during a shut down of the Thickener or Reactor A.

2.3.3 Thickener

The treated sludge from Reactor B2 overflows into a gravity fed influent trough that carries the sludge to the Thickener.

The treated sludge enters the 280'-0 Dia.x 12'0 SWD (side wall depth) Thickener tank at the 24' Dia. feedwell. The feedwell separates the incoming feed from the outer ascending and quiescent overflow water, as it directs the feed solids downward.

As the sludge solids settle to the bottom of the tank, the raking mechanism collects and pushes them to the center column, where the sludge is pumped vertically from the Thickener into the sludge recycle line by two Submersible Sludge Pumps. As the sludge is recycled to Reactor A, about $1/20^{th}$ of it will be wasted to the sludge drying beds (when operating at a steady state 20:1 solids recirculation ratio). Sludge wasting generally depends on the sludge interface level in the Thickener tank, which is signaled to the operator by a submersible level transmitter.

The thickener overflow goes to the filtrate pump station and ultimately to lower Spring Creek.

2.3.3.1 Rake Drive and Automatic Lift

The raking mechanism Center Drive Unit is an EIMCO C120B2 high torque drive with automatic 24" lifting device. The fully automatic rake lift mechanism is controlled by a drive torque control on the Center Drive Unit, which regulates the raising and lowering of the rakes based on torque load on the drive.

The Rake Drive operates with up to 2,000,000 ft.lbs. torque [duty-rated torque of 100% on the drive control]. It consists of a 120" main gear with precision bearing assembly, driven by two secondary gear and pinion assemblies, each of which is driven by a worm and gear assembly from a 10 HP constant speed motor and torque arm drive reducer.

The rake drive turns the rake arms by way of a cage assembly that connects the arms to the drive main gear. As the drive moves up

and down on the telescoping column, the rake arms move up and down.

The Lifting Device, which allows sludge storage capacity by lifting the rake arms, consists of cables and a series of sheaves that lift the telescoping column by the winding and unwinding of cables on a cable drum. The lift distance is 24 inches.

When the rake lift is operating in automatic mode, the lifting device is controlled by the drive control. Continual torque and rake lift position signals to the PMCS provide a running summary of Thickener performance and warn at high levels of torque. Torque and the lift device rake position are displayed at both the local panel and the main operator control center. The control of the drive and lifting device will be covered later under "4.2 Thickener Control Systems."

2.3.3.2 Center Column Pumps

The Two Gallagher 6SU Submersible Sludge Pumps, located in the bottom of the center column, pump the underflow sludge to the recycle line. These pumps are rated 1,109 gpm with a discharge pressure of 55.1 psig. Normally one pump is adequate for most flows, but during periods of high and peak flow conditions both pumps will be used. (Note: Operators will determine whether to use one or both pumps depending on influent solids formed and requirement to maintain at least a 20:1 solids recirculation ratio.)

The pumps are interlocked with moisture probes inside the pump housings. When a probe detects water in the housing, it will disable the pump from running and send an alarm to the PMCS. Hard sludge pipe lines connect the pumps to the sludge recycle lines, but disconnecting the pipes for removal is not difficult. If a pump is taken out of service, the 2 ton overhead hoist on the superstructure is furnished.

The sludge pump is manually started by the operator by push-button either at the main control panel or from the local drive control panel. Moisture and high temperature warning lights are provided in the local panel.

2.3.3.3 Sludge Level and the Underflow Waste Pumps

The level of sludge is monitored as a means to controlling the sludge density and overflow clarity. The concentration of solids

forms a sludge interface that is monitored by a Royce sludge level indicator and control system. The sludge level indicator, mounted to the thickener walkway, signals the depth of sludge interface to the operator and alerts at various high and low level setpoints. The operator can reduce or increase the sludge interface level by the amount of sludge wasted from the recycle using the sludge waste pumps. This will be covered later under "4.0 Sludge Thickening."

2.4 Lime Handling and Feed Facilities

The same methods of lime processing and feeding as used with the ASM process are being used in the **"hds"** treatment system. EIMCO did not furnish this equipment.

2.4.1 Modified Lime Feed System

The modified lime system uses the existing 4" and 8" lime slurry headers from the ASM lime feed system. Each line, which circulated lime in a loop back to the ASM lime supply system, was extended to Reactor A. The lime capacity to Reactor A is the same as the lime feed capacity of the ASM system.

During the **hds** treatment mode, the 10% lime slurry addition from either the lime slurry loop 1 or loop 2 to Reactor A is controlled by a pH control loop (AIC-71). This instrument loop controls the pH in the range of 8.5 ± 0.15 through lime slurry addition to Reactor A by regulating the lime feed control valves (cylinder actuated diaphragm valves).The lime slurry pump (2 pumps) that is operating will signal and control the feed control valves that will be used. For more details, refer to "3.3 Control Systems , 3.3.1 Lime Addition."

2.4.2 Lime Processing and Lime Feed System

The 3 lime feed and slaking systems have been retained from the ASM system. For more information on these processing and feed systems, refer to the Weston O & M manual: Sections 3.3 Quicklime Storage; 3.4 Feed Silo , Feeders and Slakers; and 3.5 Lime Slurry Tanks.

2.5 Sludge Dewatering and Disposal Facilities

Treated sludge from the Thickener is pumped to the existing sludge drying beds by the Thickener Sludge Waste Pumps and allowed to dewater until it can be excavated, transported, and disposed.

2.5.1 Sludge Waste Pumps

Operation of the two Ash SRH Sludge Waste Pumps, rated at 300 gpm, is controlled locally.

Sludge level readings and alarms are used by the operator in controlling these pumps for the sludge wasting. The operator can start one or both sludge waste pumps to lower the sludge level in the Thickener or shut down one or both sludge waste pumps if the interface of the sludge bed is too low.

Sludge wasting can be done either continuously or intermittently. The operator can decide when and how to operate the waste pumps and manual bypass valves. Control of sludge height and density is covered in more detail under "4.4.3 Thickener Sludge Level."

2.5.2 Sludge Line Flushing

To maintain clear open lines for sludge transfer, the sludge lines should be flushed after each use. Water flush connections are provided at both the sludge waste lines and the pump suction lines. The flushing is controlled locally by the operator, although solenoid valves that control the flush cycles are controlled by PLC timers.

The pump suction valves and flush valves are located on the deck next to Reactor A, while additional flush valves are provided at the pump discharge valves.

2.5.3 Sludge Drying Beds

The recycled sludge that will be wasted is pumped by one or both of the sludge waste pumps to the four sludge drying beds for dewatering and disposal. A manifold piping system is used to direct the sludge to any one of the beds and distribute the sludge uniformly at the beds to three or four locations. The use of multiple beds allows one bed to receive sludge while

the others are being dewatered or excavated. The existing ASM sludge conveying system will be used.

Hold downs are used to prevent erratic discharge and splash shields must be used to prevent erosion of the sand base in the discharge area and to maintain a relatively level discharge surface. The pressurized flush water must be used after each wasting to clean the waste sludge piping and distribution system.

Each drying bed has a filtrate collection system that drains the excess water to a main pumping system for discharge into Spring Creek. The filtrate flow from the drying beds is monitored continuously at the effluent monitoring station, where composite samples of the filtrate are also collected daily and analyzed for the same parameters as the thickener overflow.

The volume of sludge will also be monitored and reported monthly, while samples will be collected daily and the results reported monthly. The sludge samples will be tested for metals. And, samples for the percent solids by weight will be collected from each drying bed during the excavation, and some of those samples will be tested for metals.

For more details on the drying beds, refer to the Weston O & M manual, Section 4.1, for the previous ASM treatment plant.

2.5.4 Effluent and Filtrate Monitoring and Pump Station

Effluent from the Thickener and underdrain and decant flows from the drying beds discharge into the existing filtrate pump station. For more details on the existing filtrate pump station, refer to the Weston O & M manual, Sections 4.2 through 4.5.

2.6 Description and Operation of AMD Conveyance System

For a description of the AMD collection and conveyance system, its method of control and operation, refer to the Weston Operations and Maintenance manual, Section 2.

3.0 AMD Neutralization /Oxidation Reactors

3.1 Process Description

Heavy metals are removed from the AMD by precipitation, primarily as hydroxides, while sulfate precipitates are removed as calcium sulfate. Conditioned

sludge (from Reactor A) is added to the AMD and mixed with air in the Reactors, which serves to oxidize the ferrous iron. The lime maintains the preset operating pH under normal conditions. The precipitates are concentrated in the Thickener and recycled through Reactor A until sufficient densified sludge has accumulated for discharge to the drying beds.

3.1.1 Sludge Conditioning Reactor A

In the **"hds"** Mode, the recycled sludge consists primarily of gypsum (hydrous calcium sulfate), with amorphous iron oxides and the iron hydroxides, the less soluble components of the treated sludge. The recycle averages 1,085 gpm. At low AMD flow it averages slightly more at 1,105 gpm, and at high flow it averages 2,122 gpm.

In the sludge densification mix process (**"hds"**), it is the build up of solids through the recycling of the sludge to a ratio of 20:1+ that is effectively used in AMD treatment. Sludge percent solids can average 40%wt at low and average flow and 35%wt at high flow, while at low flow about 5,000 lbs/min of solids are circulated with up to 8,000 lbs/min at high flow.

10% lime slurry additions to the sludge are controlled by two pinch valves on each of two lime slurry lines (4" and 8") in response to a pH probe in Reactor B1 or B2.

3.1.2 Reactor B1

Reactor B1 (TK-1) was the first-stage tank in the aerated simple mix system and it's still the first stage in the **"hds"** treatment system.

In Reactor B1, the untreated AMD is mixed with air [oxygen] and the conditioned sludge from the Sludge Conditioning Reactor A, which neutralizes the acidity and converts the heavy metals and other particles into solids, less soluble in water. In converting most ferrous iron, the primary metallic component in the AMD, to the less soluble ferric iron, the air blower and sparge system provide the oxygen necessary for the conversion.

While the conditioned sludge from Reactor A contains the less soluble ferric ions of previously oxidized ferrous iron, the hydroxide ions from the lime slurry also react with other AMD trace elements of heavy metals to form insoluble metal hydroxides. At the same time, the calcium ions from the lime react with the sulfates in the AMD to form insoluble calcium sulfate.

The conditioned sludge added from Reactor A to Reactor B1 should maintain a pH in the range of 7.5 to 9.0 to precipitate the insoluble metal

hydroxides and sulfates (operating pH to be determined based on effluent requirements). In the **"hds"** mode, the control of pH is only with Reactor A, based on pH measured in Reactor B1 or B2. The pH probe in the inlet tank is for information only, not for process control.

3.1.3 Reactor B2

The conditioned slurry flows by gravity from B1 to B2 by way of a -top-connecting pipe between the two tanks.

Reactor B2 is identical to B1 (except for operating depth) and its function is almost the same in the **"hds"** Mode, but in the ASM Mode, the lime additions will be controlled by a pH controller for each Reactor and each with 2 lime lines and 2 modulating pinch valves for each line.

3.2 Design Criteria

The design conditions for the stream flow parameters are given on the Process Flow Diagram Material Balance drawing, 76738D1101. It lists the volumetric flows in gpm, solids flow in lbs/min, percent solids in wt.%, and slurry specific gravity. It also lists these parameters by Low, Average, High (Base \Design) and Peak Expected.

The drawing, further, diagrams the process flow with stream numbers and flows between each item of equipment in the Sludge Densification Mix (**"hds"**) process. Refer to the drawing.

For design conditions for Influent AMD Flow and Characteristics, refer to Table 1-1 of the previous Weston manual and for Effluent Limitations, refer to Table 1-2 of the same manual.

3.3 Control Systems

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1301 through 1304.

3.3.1 Lime Addition

Influent AMD (from Richmond and Lawson Portals) flows from the Cementation Plant Diversion Tank (TK-7) to the **"hds"** (HDS) Diversion Tank (TK-9). The flow is measured in the line between these two tanks with a flow meter sensor and transmitter (FE/FIT-3) and the rate is recorded in the PMCS through a totalizer and recorder in the line. If the

influent AMD flow drops below a set value, an alarm (FAL-3) will be energized. Similarly, a high influent AMD flow is alarmed (FAH-3).

The AMD pH is measured at the **"hds"** (HDS) Diversion Tank by a composite sampler and transmitted (AE/AIT-1) to the PMCS, before the AMD flows to Reactors B1 (TK-1) or B2 (TK-2). The pH is also recorded (AR-1) in the PMCS, but the pH is reported for information only, not process control. While the AMD normally flows to Reactor B1, a three-way valve allows the AMD to be directed to either Reactor.

In the **"hds"** Mode, 10% lime slurry addition into Reactor A (TK-13) is controlled by the **"hds"** Mode select switch and the AIC 71 mode pH control loop. The input signal is compared to a predetermined setpoint at the controller. Based on this differential, an output signal from the controller goes to either of two sets of lime feed flow control pinch valves to vary the lime addition to Reactor A, as described below under "3.3.1.1 Lime Addition, **"hds"** Mode." The pairs of valves cover a wide range of lime requirements.

3.3.1.1 Lime Addition, "hds" Mode

Refer to P&ID drawings 76738-D-1301, "Aerated Simple Mix System." and 1303 "Sludge Conditioning."

A. LIME SLURRY RECIRCULATING LOOP 1

During **"hds"** mode, 10% lime slurry addition from lime slurry loop 1 to Reactor A (TK-13) is controlled by pH control loop AIC-71. This instrument loop:

- compares the pH in either Reactor B1 or B2 with the controller setpoint value. HS-71B is used to select which pH probe is the feedback to AIC-71.
- controls pH in the target operating range through lime slurry addition in Reactor A (TK-13) by regulating lime feed control valves ACV-71C or ACV-71D; and
- activates high- and low-pH alarms.

An operation switch (OS-11) is provided to monitor operation of the lime circulation system and the related operating pump(s). The switch signals the pH controllers as to which set of valves (high or low flow) is to be used. For example, if pump P-2A or P-2B is running, switch OS-11 output signals the pH controllers to use the low-capacity lime feed control valves (ACV-71C and ACV-71D)

If lime slurry recirculation loop 2 and either pump P-3A or P-3B are operating, switch OS-11 signals the controllers to use the high-capacity lime feed control valves (ACV-71A and ACV-71B)

A pressure switch senses the pressure in lime slurry loop 1 upstream of the backpressure valve (PCV-14) and activates the high- or low-pressure alarm (PSHL-12 and PAHL-12) on the PMCS if the pressure goes above or below a set value.

Auto and OFF selection and run status (run and stop) for the lime slurry pumps (P-2A and P-2B) are indicated on the main console. If the pump (P-2A or P-2B) is called for to run and is not running, an alarm (OA-42A or OA-42B) will activate and the condition will be indicated on the PMCS. The operator should then check the pump(s).

B. LIME SLURRY RECIRCULATING LOOP 2

10% lime slurry addition from lime slurry loop 2 to Reactor A, TK-13 is controlled by pH controller AIC-71. The instrument loop:

- compares the pH in either Reactor B1 or B2 with the controller setpoint value. HS-71B is used to select which pH probe is the feedback to AIC-71.
- controls pH in the target operating range through lime slurry addition in tank TK-13 by regulating lime feed control valves ACV-71A or ACV-71B; and
- activates high- and low-pH alarms.

An operation switch (OS-11) is provided to monitor the operation of the lime circulating system and the related operating pumps(s). The switch signals the pH controllers as to which set of valves (high or low flow) is to be used. For example, if lime slurry loop 2 and pump P-3A or P-3B are operating, switch OS-11 signals the controllers to use the high-capacity lime feed control valves (ACV-71A and ACV-71B)

A pressure switch senses the pressure in lime slurry loop 2 upstream of the backpressure valve (PCV-15) and activates the high- or low-pressure alarm (PSHL-13 and PAHL-13) on the PMCS if the pressure goes above or below a set value.

AUTO and OFF selection and run status (run and stop) for lime slurry pumps P-3A and P-3B are indicated on the main console. If pump P-

3A or P-3B is called for to run and is not running, alarm OA-41A or OA-41B will activate.

3.3.1.2 ASM Mode (Original Startup Mode)

Refer to P&ID drawing 76738-D-1301, "Aerated Simple Mix System."

The Aerated Simple Mix (ASM) system tanks, Tanks TK-1 (Reactor B1) and TK-2 (Reactor B2) are described above under "2.3.1 Reactors B1 and B2" under "2.3 AMD Treatment."

The ASM (Aerated Simple Mix) mode is the same mode of operation used prior to the addition of the **"hds"** mode. For access to the ASM mode, or the "hds" mode, a security access password is required.

To select the ASM mode, the operator will make the selection at the PMCS, and as soon as the selection is made, the control system will enable or disable cetain control functions for the conversion.

The lime slurry feed control will change by closing the feed valves to Reactor A and opening the lime feed valves to Reactors B1 or B2. The **"hds"** equipment can continue to operate in the manual and auto start modes, but of course the recycle from the thickener tank to Reactor A will be stopped.

In the ASM mode, AMD flows from the Diversion Tank (TK-9) to first-stage Reactor B1. The three-way plug valve at the influent AMD line allows the AMD to flow either to Reactor B1 or B2. The [The Thickener, Reactor A and the waste pumps are not used in this Mode.]

Influent AMD pH is measured at the Diversion Tank, as covered above under "3.3.1 Lime Addition."

A 10% lime solution calcium hydroxide or $Ca(OH)_2$ and air are added and mixed with the AMD in the first stage B1 tank by a submerged turbine mixer and lime addition is controlled by the lime slurry loops 1 and 2 to maintain a pH in the target operating range, which precipitates metals as hydroxides and sulfate as calcium sulfate.

Refer to the Weston O & M manual Section 3, specifically Sections 3.1 Aerated Simple Mix Tank (First Stage) and 3.2 Aerated Simple Mix Tank (Second Stage). Also refer to EIMCO P&ID drawing 76738-D-1301, "Aerated Simple Mix System."

3.3.1.3 Quicklime Storage Silos

Refer to the Weston O & M manual Section 3.3 Quicklime Storage Silos, including the (P&ID) drawings. A summary of equipment components for silos is presented in Table 3-3 of the manual.

3.3.1.4 Feed Silo, Feeders and Slakers

Refer to the Weston O & M manual, Section 3.4 Feed Silo, Feeders, and Slakers and the (P&ID) drawing. A summary of equipment components is presented in Table 3-4 of the manual.

3.3.1.5 Lime Slurry Tanks

Refer to the Weston O & M manual, Section 3.5 Lime Slurry Tanks, including drawings and tables. A summary of the major equipment components for the lime feed and slaking system is presented in Table 3-6 of the manual.

The requirements for the lime slurry and dilution water are a function of AMD flow as well as its acid strength at any given time. These requirements also apply to the **"hds"** mode, as well as the ASM mode, and the amounts below from the Weston O & M manual are estimated as follows to cover the possible AMD operating range.

*[From Weston O & M manual, Section 3.5, pages 3-54 and 3-55.]

AMD	95%	25% $Ca(OH)_2$	Dilution 10% $Ca(OH)_2$	
Flow	CaO	Slurry[a]	Water[b]	Slurry
(gpm)	(lb/hr)	(gpm)	(gpm)	(gpm)
Normal AMD Strength:				
50	956	8	15	23
100	1,912	16	29	45
200	3,824	32	58	90
300	5,375	49	86	135
1,400	26,765	229	403	632

AMD Flow (gpm)	95% CaO (lb/hr)	25% CA(OH Slurry[a] (gpm)	Dilution Water[b] (gpm)	10%Ca(OH)2-Slurry (gpm)

Peak AMD Strength:

50	1,816	15	28	43
100	3,632	31	55	86
200	7,265	62	109	171
300	10,897	93	164	257
1,400	50,854	434	766	1,200

Notes:

[a]25% lime slurry from slaker.
[b]Dilution water needed to dilute 25% lime slurry to 10%.

3.3.2 Sludge Return from Thickener

Refer to P&ID drawing 76738-D-1302, "Sludge."

The two submersible pumps, P-11A and P-11B, recycle sludge back to Reactor A; one of which will maintain at least a minimum 1108 gpm recycle rate. The 10-inch sludge recycle line has a manual pinch valve HCV-93 and a clamp-on type ultrasonic flowmeter FI-79, which together automatically adjust the recyle flow rate to Reactor A.

Each of the pumps is provided with local and remote controls. Local hand switches (ON-OFF-AUTO) are provided on the thickener local control panel and (ON-OFF) indicators are provided at the MCC motor starters. Remotely at the PMCS, ON-OFF hand switches and AUTO, PUMP FAIL and ON indicators are also provided.

Normally one pump is always operating, but during periods of HIGH and PEAK FLOW conditions, both pumps will be called into service automatically by the PLC or by the operator at the PMCS, using STOP and START buttons.

These submersible pumps are interlocked with moisture probes inside the motor housings. When the probe detects moisture in the motor housing, it will disable the pump from running and send a MOISTURE DETECTED alarm to the PMCS.

On the 10-inch sludge recycle line are branched out two 4-inch sludge waste lines with two Sludge Waste Pumps, P-12A and P-12B. The Sludge Waste Pumps transfer sludge waste to the sludge drying beds, and they are operated locally only. Conditions to alert operators to use these pumps are based on the thickener level readings. (See Thickener section).

For P-12A and P-12B, local ON-OFF hand switches are located at the pumps. ON-OFF indicators are provided at the MCC motor starters and PUMP RUNNING status is also provided at the PMCS. There are no remote controls for these pumps.

3.4 Process and Equipment Start-up

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1301 through 1304.

3.4.1 Reactors A, B1, and B2

For Reactors B1 and B2, startup and activation of a control loop generally involves setting the setpoint, as appropriate, and placing it on AUTO at the PMCS as follows (Note: this start-up procedure assumes that both Reactors B1 and B2 are to be used):

1. Check the three-way valve on the 12-inch SS inlet AMD pipe so that it is "open" to Reactors B1 and "close" to Reactor B2.

2. Operate slide gates on the upper gravity trough carrying the conditioned sludge so that one is "open" to Reactor B1 and the other "closed" to reactor B2.

3. Ensure Reactors, B1/B2, drain valves and the bottom outlet manual valves (for effluent pumps suction) are closed.

4. Ensure that Reactor B1, outlet manual valve on the top interconnecting line with Reactor B2 is open.

5. Ensure that 20" outlet valve from Reactor B1 to the bottom gravity trough is closed and that 24" outlet valve from B2 is open.

6. Check Mixer MX-1 to ensure that it is properly lubricated as described in vendor's manual. Make sure that Reactor B1 is filled with water. Turn the mixer on at the local starter panel and listen for any unusual noises that may indicate irregularities in operation.

7. Activate level control/alarm loop 6 and 8 (Reactors B1, B2 respectively) and mixer monitoring loop 16 and 17 (Reactors B1, B2 respectively).

8. Activate influent AMD pH and flow loops 1 and 3.

9. Ensure that Reactors B1 and B2 are ready to receive the AMD in series and that its associated control loops are activated.

10. Activate air blower operation monitoring loop OA-5 and low-pressure alarm loop 4.

11. Start up the AMD conveyance system.

For Reactor A, startup is as follows (in the following instructions, activation of a control loop generally involves setting the setpoint, as appropriate, and placing it on AUTO at the PMCS):

1. Check the manual valve on the 10-inch SS sludge recycle pipe from thickener TK-11 so that it is "open" and the two 4-inch sludge waste lines are closed.

2. Verify slide gates on the upper gravity trough carrying the conditioned sludge so that one is "open" to Reactor B1 and the other "closed" to reactor B2.

3. Ensure Reactor A drain valve at the bottom of the tank is closed.

4. Check Mixer MX-13 to ensure that it is properly lubricated as described in vendor's manual. Make sure that Reactor A is filled with water (using the connection in the sludge recycle line). Turn the mixer on at the local starter panel and listen for any unusual noises that may indicate irregularities in operation.

5. Check the lime storage /slaking /slurry preparation system for adequate supply and proper operation.

6. Start up the low capacity lime circulation system (lime slurry loop 1) per the procedures described in Weston Subsection 3.6.3, open the lime shutoff valves.

7. Activate pH control loop 71 for Reactor A, and select Reactor B1 pH probe. Ensure that the pH probe is calibrated per manufacturer's procedure.

3.4.2 Lime Slurry Loops 1 and 2

For startup of the lime slurry recirculation loops 1 and 2, refer to the Weston O & M manual Sections 3.6 and 3.7, specifically Sections 3.6.3 Startup and 3.7.3 Startup. (Activation of a control loop generally involves setting the appropriate setpoint and placing it on "Auto" at the PMCS):

3.5 Normal Operations

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1301 through 1304.

3.5.1 Reactors A, B1, and B2 Operation

Under normal operating conditions, the influent AMD flows by gravity via the AMD conveyance system to the inlet splitter box (Diversion Tank) located above the reactors. AMD from the splitter box flows by gravity to Reactor B1, and in series to Reactor B2. Air is supplied by aeration blower BL-1 or BL-2 to Reactors B1 and B2. The effluent from B1 and B2 flows by gravity to the thickener through the bottom gravity trough.

The mixers at B1 and B2 reactors are normally operated from the PMCS with the local selector switches set to "AUTO" positions. The mixers can be operated locally with the selector switches set to "Test" momentary.

Sludge recycle from thickener TK-11 goes to Reactor A where 10% lime slurry is added via the lime recirculation loops. The conditioned sludge will flow into Reactors B1 or B2 by the upper gravity trough. Lime slurry loop 1 (low-capacity) will be normally operating with lime loop 2 when flow rate is above 200 gpm.

The mixer in Reactor A is normally operated from the PMCS with a 3-position selector switch set to "AUTO" position. It can be operated locally with the selector switches set to "ON".

During normal operation, lime slurry is continuously pumped from the lime slurry tank (TK-5 or TK-6) through lime slurry loop 1 to Reactor A, and back to the originating lime slurry tank.

For the operation of the lime slurry loops, refer to the Weston O & M manual Sections 3.6 4 and 3.7.4, Normal Operation.

3.6 Process and Equipment Shut Down

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1301 through 1304.

3.6.1 Reactors A, B1 and B2

When either B1 or B2 is taken out of service for summer low influent flows, inspection, repairs or preventive maintenance, the other reactor is operated in a single-stage mode of operation.

Shutdown (isolation) of **Reactor B1 or B2** is as follows:

1. Operate the conditioned sludge slide gate valves so they are in the closed position to the affected reactor and open position to the remaining reactor.

2. Operate the influent AMD three-way valve so that it is in the closed position to the affected reactor and open position to remaining reactor.

3. Close the affected reactor outlet valve on the top interconnecting line between the two reactors. Open the knife gate valve from the affected reactor to the trench.

4. Shut down the blower and then close the aeration blower damper to the affected reactor.

5. Open the affected reactor bottom outlet valve that connects to the effluent pumps P-4A/B suction lines.

6. Turn off the mixer of the affected reactor before the sludge reaches the impeller.

7. Operate the effluent pump discharging the contents of the affected reactor to the sludge drying beds. Set the level controller at the PMCS to automatically shut down the pump when the level in the affected reactor drops to a "safe" level, approximately 1 foot over suction.

8. Empty the affected reactor by opening the drain valve at the bottom of the reactor to trenches.

9. Hose down the vessel and trenches with water.

10. Inspect the effluent pumps and pipes to determine if they require washout to prevent them from becoming plugged by dried sludge.

Shutdown (isolation) of **Reactor A** is as follows:

1. Close the recycle manual valve HCV-93.
2. Let the contents drain to about 1 foot from the bottom of the Reactor A.
3. Turn off mixer MX-13 of the Reactor A.
4. Empty Reactor A by opening the drain valve at the bottom of the reactor.
5. Hose down the vessel and trenches with water.
6. Inspect the pipes to determine if they require washout to prevent them from becoming plugged by dried sludge.

3.6.2 Lime Slurry Loops Shutdown

Shutdown of a loop may be required for inspection, preventive maintenance, repairs of low flow. For more information, refer to the Weston O & M manual Sections 3.6 5 and 3.7.5, Shutdown.

3.7 Alternative or Emergency Operation

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1301 through 1304.

3.7.1 Reactors A, B1 and B2

Potential operating problemsthat can develop in Reactors A, B1 and B2 along with the causes and solutions to the problems are listed below:

	Problems	Cause/Solution
1.	pH element malfunctions.	a Clean off any material that may have fouled the probe. Replace electrode, if necessary. b. Check the accuracy of the probe by comparing the probe output with the reading

on a calibrated pH meter.

2.	Malfunction of the lime circulating system.	a. Check for plugged lines and closed valves. Clear the pluggage, if any, by opening the flushing water connection valve. b. Use a mechanical cleaning device called "pigs" (a plastic-rubber product with abrasives spirally embedded in it) to periodically descale the loop 1 and 2 pipe.
3.	Reactors B1 or B2 Low-level alarm does not come on.	a. Faulty low-level alarm switch. b. Flush the clogged LIT element with water to clean it.
4.	Level in either Reactor B1, B2 or Reactor A builds up and continues to rise beyond a very high level mark.	a. Check for plugged lines and closed valves. b. Open the flushing water connection valves to the top interconnecting lines between the tanks. In addition, flush the tank or TK-1, TK-2 top outlet pipes and the liquid sludge c, header from the tanks to the thickener. Check for solids buildup in tanks by sampling at the bottom. Rod out stillwells.

In the event of Reactor B1/MX-1 failure, or if Reactor B1/MX-1 is to be shut down for maintenance, operation will continue by isolating Reactor B1 and using Reactor B2 in a single stage mode. All of the conditioned sludge from Reactor A required to treat AMD will be added to Reactor B2. One of the two aeration blowers will supply air to Reactor B2. In a similar manner, if Reactor B2 is taken out of service, Reactor B1 will operate in a single-stage mode of operation.

In the event of Reactor A/MX-13 failure, or if Reactor A/MX-13 is to be shut down for maintenance, sludge recycle from thickener TK-11 will be terminated. For an extended Reactor A/MX-13 shutdown, plant operation shall consider switching back to ASM mode by isolating Reactor A (TK-13) and the Thickener (TK-11) all together.

3.7.2 Lime Slurry Loops

For potential operating problems that can develop in the lime slurry recirculation pumps (loops 1 and 2), along with the causes and solutions to

the problems, refer to the Weston O & M manual Sections 3.6.6 and 3.7.6 Potential Operating Problems.

4.0 Sludge Thickening and Wasting

4.1 Process Description

The discharge from Reactors B1 and B2 flows to the Thickener where the precipitated solids settle out, forming the sludge that will be recycled back to the Sludge Conditioning Reactor A, or wasted to the sludge drying beds.

The Thickener tank is 280'-0 Dia.x 12'-6 High (12'-0 side wall depth), sized to handle a maximum 5,000 gpm influent (feed) and a maximum 15,000 gpm effluent (overflow). The average design flow of treated sludge influent to the thickener is 1,285 gpm; the high design flow is 2,777 gpm; and peak flow is 4,020 gpm. The average design flow of effluent is 176 gpm; high flow is 559 gpm; and peak is 1420 gpm.

Process Flow Diagram Material Balance drawing, 76738D1101 also lists the solids flow in lbs/min, the percent solids in wt.%, and the slurry specific gravity according to Low, Average, High (Base \Design) and Peak Expected parameters.

The treated slurry entering the Thickener distributes radially and uniformly in the tank and as the insoluble sludge solids settle out into a sludge bed, a solids interface with upper clarified water is formed. In sludge densification (**"hds"**), the load of insoluble sludge is built up through the recycling until a sludge ratio of 20:1+ is achieved. (About 20 lbs. of sludge solids are required in **"hds"** for each pound of solids precipitated. from the AMD.) Sludge can average 40%wt solids.

Average design flow of sludge recycle is 1085 gpm; high flow is 2112 gpm; peak flow is 2006; while sludge wasting averages 24 gpm, high at 106 gpm, and 600 gpm at peak flow.

4.2 Control Systems

4.2.1 Thickener Sludge Level

A submersible level transmitter signals the sludge interface levels to the operator at the PMCS through loop 78.

There are 4 level alarm settings to alert the operator for sludge wasting and the amount of solids carried in the tank. Since sludge wasting is not

automated, the 4 level alarms alert the operator to the level of sludge so a decision can be made when and how much sludge should be wasted. This is covered in detail under "4.4.3 Thickener Sludge Level" to follow.

The excess sludge, depending on the sludge level in the tank, is wasted to the drying beds.

4.2.2 Thickener Center Column Pumps

The two submersible pumps (P-11A and B) recycle sludge back to the Sludge Conditioning Reactor A.

At minimum AMD flow, a 1108 gpm recycle rate is maintained and at average AMD flow the recycle is about 1085 gpm, while high flow is around 2112 gpm. These and the flows in the Material Balance drawing are just mass balance targets, not operational requirements, and so they will vary considerably from some of the values.

During Low and Average flows, one pump normally operates, but during periods of High and Peak Flow conditions, both pumps usually operate.

Each sludge pump is controlled locally or remotely through loop 93. Local ON-OFF-AUTO selector switches are provided on the thickener local control panel. At the remote PMCS, ON-OFF hand switches and light indicators for AUTO, PUMP FAIL and ON are provided.

The local panel ON-OFF modes will override the PMCS to start or stop the sludge pumps. The remote PMCS switches are only active when the local control panel selector switches are in AUTO. If a pump is selected to run from the PMCS and it does not respond within a 5 second time delay, a PUMP FAILED alarm will appear at the PMCS. To show whether a pump is running or stopped, ON-OFF indicators are also provided at the MCC motor starters.

In any mode of operation, moisture switches (MSH-93A and B) inside the pump motor housings will lock out a pump from starting or stop the pump on the detection of moisture, which indicates a pump seal failure. If water is detected in the housing, the pump will be disabled from running and a MOISTURE DETECTED alarm will be sent to the PMCS.

In the sludge line from the pumps to Reactor A, a portable ultrasonic, strap-on flowmeter is used to monitor the flow of sludge through loop 79 and a manual pinch valve HVC-93 is used to adjust the recycle flow rate with the flowmeter. At the discharge side of the pumps, local pressure gauges are also provided.

4.2.3 Thickener Rake Drive Controls

The rake drive, which is controlled through loop 81, has both local and remote controls. At the local thickener control panel, the ON-OFF-AUTO selector switch controls the operation of the drive unit. In the ON mode, the drive responds to the local START and STOP push buttons. But in AUTO mode, the drive responds only to the PMCS.

At the PMCS, the ON-OFF switches will operate the thickener drive (local panel in AUTO mode). However, if the rake drive does not start or fails to stop within 5 seconds after a selected ON or OFF, a RAKE DRIVE FAILED will alarm at the PMCS.

Drive ON and OFF indicator lights are provided at the PMCS, at the local thickener control panel, and at the drive motor starters.

The rake drive consists of two motors, each driving a torque arm reducer that drives a worm gear assembly, which ultimately end up driving the rake arms. The motors are connected by a common starter, which connects to the drive control through the local control panel.

4.2.3.1 Drive Control

One of the worm gear assemblies has the torque metering device, called the Drive Control, contained in a cylindrical housing. This Drive Control controls the operation of the drive and lifting device and continuously signals the PMCS.

This Drive Control consists of four torque actuated cam switches with two for the Drive and two for the Lifting Device. If the load on the rake arms increases the load on the drive, that will register as a percentage increase in torque above "0" on the drive control and show in percentage at the PMCS.

If the load reaches the HIGH torque switch (40% of drive rated torque), warning of an impending torque load, it will alarm at the local thickener control panel and the MCC building. Two outdoor horns will sound and HIGH TORQUE ALARM indicator lights will show at each location to alert the operator the rake lift is about to rise. HORN SILENCE buttons are located at the MCC building and at the thickener control panel. The horn will automatically silence when torque drops below 40%.

The HIGH HIGH torque switch, at 90% drive rated torque, will shut off the power to the motor drives with a latching relay and shut down the drive unit. Once tripped, normal operation of the

rake drive can only be resumed by the operator pushing the RESET button on the thickener local control panel and if torque has dropped back to less than 90%.

(**Warning**: In a high torque shutdown situation, under no circumstances should an attempt be made to restart the drive or move the rake arms without first referring to the Drive Maintenance Warning in the Maintenance Procedures section of this manual.)

4.2.3.2 Secondary Torque Controls

Mounted to the end of each worm gear assembly is a secondary limit switch (NSHH-81A and B) that will shut down the drive at 100% torque, in the event the Drive Control does not stop the drive at 90% torque. These are redundant HIGH-HIGH torque safety switches meant to backup the Drive Control. Either switch will stop the drive.

4.2.4 Thickener Automatic Rake Lift Controls

The thickener rake lift mechanism (MX-12) raises and lowers the rake arms by lifting and lowering the drive unit. The mechanism is fully automatic with 24 inches maximum lift and with only local control. The PMCS has no control of the lift device, only ON, AUTO and LIFT POSITION indication (Loop 82).

ON-OFF-AUTO selector switches and RAISE- LOWER push buttons are located on the local thickener control panel. Operation of RAISE and LOWER is handled by one reversing lift motor.

In AUTO mode, the Drive Control controls the operation of the lift device. The cam switches in the Drive Control raise and lower the Lift. When the torque reaches 50%, the lift is given a command signal to rise. The lift will then keep on rising until the torque decreases to a predetermined deadband below 50% or until the rake lift reaches the upper travel limit switch. The rake arms keep rotating throughout.

The rake arms will not lower until the drive torque drops to 30%, sending a command signal to the lifting device to lower and energizing a timer. When the timer reaches 33 minutes, which is about the time for the rake arms to complete one revolution, the rake lift will lower for 15 seconds. If the rake drive torque reading is still below 30%, the timer cycle will start again and the rakes will lower another 15 seconds. This will continue until the torque will not drop to 30% or below (outside a predetermined

deadband) or the lower travel limit switch is tripped. The lift device will not lower if the rake drive motors are not running.

To protect the lift from over traveling beyond its mechanical limits in either direction, the upper and lower travel limit switches on the rake lift (ZSH-82 and ZSL-82) are provided.

A continuous reading of the Rake Lift Position (0-100% of travel from a rake position transmitter), will be indicated at the PMCS. In addition, AUTO will indicate at the PMCS when the lift is in automatic mode.

For manual control of the lift device, RAISE and LOWER push buttons are provided at the local control panel, but they function only when the panel ON-OFF-AUTO selector switch is set at ON. The RAISE and LOWER buttons override the time sequencing for lowering, described above. When RAISE is depressed, the rake lift will rise until the button is released or until the rake lift reaches the upper travel limit switch. When LOWER is pressed, the rake lift lowers until the button is released or until the rake lift reaches the lower travel limit switch.

Be aware that rake lowering in the Manual Mode can be risky, since the 30% cutout switch and timer are bypassed, allowing the rake arms to be lowered as long as the DOWN button is pressed. The rakes must be rotating in order to lower the rake drive.

4.2.5 Sludge Waste Pumps and Flushing Controls

The Sludge Waste Pumps (P-12A and B) transfer waste sludge from the recycle line to the sludge drying beds. They are controlled locally with ON-OFF switches, on loop 92. There is no remote control from the PMCS, but pump status is indicated at the PMCS.

Control of the sludge waste pumps depends solely on the operator, who operates the pumps (one, both or no pumps) according to the indicated sludge level readings (interface level) in the thickener. Refer to the thickener level readings. under "4.4.3 Thickener Sludge Level."

The ON-OFF hand switches are located next to the pumps, while ON-OFF indication is provided at the MCC motor starters, along with PUMP RUNNING status at the PMCS. Bypass lines and valves HCV-92A1/B1 are available for gravity flow.

At the discharge sides of the pumps, local pressure gauges, manual pinch valves HCV-92A/B and air relief/vacuum valves XSV-92A/B are provided. The air relief /vacuum valves are also furnished with backwash solenoids HV-92A/B.

The sludge waste lines are flushed with solenoid activated flush water valves controlled by ON-OFF push buttons, through loop 94, located near the pumps. The operator initiates the flush, but the PLC timer controls the duration of the flush. It is activated by the ON button to energize the flush solenoid for a preset time interval. At the PMCS, ON-OFF selector switches similarly control the flushing cycle, which is indicated by a FLUSHING message. OFF interrupts the timer cycle to stop the flushing.

The pump suction and flush valves are located on the deck next to Reactor A, plus the set of solenoid flush valves located on the pump discharge air/vacuum valves.

4.2.6 Effluent Flow, pH and Turbidity Monitoring

The overflow effluent from the thickener discharges into the PS-1 Collection Basin, along with underdrain and decant flows from the drying beds. The total effluent flow is measured with an insert flowmeter sensor and transmitter and recorded and totalized in the PMCS, through loop 21, before the water is released into Spring Creek.

The effluent turbidity is measured with a turbidity sensor at the effluent monitoring station, through loop 24; while the pH is measured with a pH sensor through loop 23. The results are transmitted to and recorded in the PMCS, where HIGH turbidity and HIGH and LOW pH are also alarmed. For more details on the collection basin and station, refer to "2.5.4 Effluent and Filtrate Monitoring and Pump Station."

4.3 Thickener and Process Start-up

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1302 and 1303, the General Arrangement drawings 76738D201 and 202, the Thickener Local Control Panel drawing 76738D1426 and the Instrument System Architectural drawing 76738D1336.

4.3.1 Pre-Start-up Preparation

The start-up procedure will include the inspection of the Thickener tank for leakage.

1. Make sure the rake arms are free to move, the tank is clear of blocking, shoring, tools, and debris, and the rakes can be rotated safely.

Make sure the sludge level indicator and level alarms are properly set. Also make any corrections to the pH settings and pH probe selection, as covered above.

2. Start with the tank empty.

3. At this point in the start-up, Reactors B1 and B2 will be operating in the ASM Mode. (Refer to "3.4.1 For Reactors B1 and B2.") It is assumed that the operator has an understanding of the operation and control of the ASM system. (Also refer to "6.0 Process Monitor and Control System" and "6.3 Start-up" for the operation and control of the system.)

4. Until the **"hds"** mode is selected, the PLC will direct lime feed to Reactors B1 and B2 and the system will be operated in the original ASM mode. All motors, pumps and valves in the new **"hds"** system will be functional in the manual mode from the local panels until the system is switched over to the **"hds"** mode.

5. Start the conditioned sludge feed from Reactor B2 into the Thickener, opening the valve to the gravity trough and closing the effluent valves to the drying beds. The system will not be switched over to the **"hds"** mode until there is sufficient sludge in the tank to recycle.

6. Start the thickener rake drive at the PMCS in the AUTO mode. Only the rake drive can be operated from the PMCS, not the lifting device.

   Start the lifting device at the local Thickener control panel. It must be in AUTO mode in order to be operated automatically by the drive control [cam switches]. A torque signal is displayed on the PMCS screen, but only the drive control operates the lifting device automatically.

7. Once the liquid level has reached a depth that pumping can be commenced, start <u>one</u> of the center column pumps with the ON switch at the local Thickener Control Panel. Each pump is provided with an ON-OFF-AUTO switch on the control panel. Or, remotely at the PMCS, the ON-OFF button can be used by clicking on the pump symbol. (If any moisture is detected in a motor housing, the pump will not start or will immediately stop.)

   Set all other controls to the AUTO position.

8. When sludge starts discharging into Reactor A, switch to the **"hds"** mode (requires password entry at the PMCS). This will start the Sludge Conditioning Reactor A, reroute the lime slurry feed from Reactors B1 and B2 to Reactor A, and actuate all the control functions for automatic operation of the system. Adjust the pH control setting for the desired pH level. Refer to the previous "3.4.1 Reactor A.." instructions.

9. As the Thickener tank fills, the solids will settle to the bottom of the tank and an upper clear water level will develop. This clear water will first contact the tank above the sludge as the level rises.

   In the event of tank leakage, the filling should be stopped and the tank drained down to a point where repairs can be made. Then filling can resume.

10. As sludge starts to build up in the tank, the sludge level indicator will alert the operator to the various sludge levels for control of the sludge wasting. The Thickener should now be operating in the normal **"hds"** mode.

4.4 Normal Operation

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1302 through 1304.

Normal **"hds"** operation is for a minimum of one submersible sludge pump to continuously recycle the underflow sludge to Reactor A, while the sludge level in the Thickener tank is controlled by the operator with sludge wasting to the drying beds. The clear water overflow is directed to the filtrate pump station via buried pipeline.

4.4.1 Sludge Recycle

One pump, constantly pumping, has the capacity to maintain about 1,100 gpm recycle, while both pumps can recycle a combined flow of about 2,200 gpm. The idle pump is deenergized by the PLC.

1. Switch to AUTO at the local Thickener Control Panel (ON-OFF-AUTO) hand switch for pump P11-A or B. In the AUTO mode, the sludge pump can be controlled from the PMCS with the console START, STOP buttons. When the

pump is running, the ON indicator at the MCC motor starter will illuminate and at the PMCS, the ON-AUTO indicators will be on.

Refer to "3.5 Normal Operations" "3.5.1 Reactor A" covering the sludge recycle to the Reactor.

2. The rate at which the solids move downward and settle into a concentrated sludge depends on the rate of removal (recycle) of the underflow sludge from the thickener tank, the feed rate of solids entering the tank from the Reactors, and the depth of the sludge bed, which consists of a concentration of insoluble solids.

4.4.2 Drive and Lifting Device

1. To protect the rake drive and lift device against overload and damage during normal system operation, the thickener rake lift must be operated in the AUTO mode.

   In AUTO mode, the lift device is controlled exclusively by the Drive Control, responding to torque load on the drive unit. While the lifting device allows the rakes to adjust to sludge level, or adjust for sludge storage, the thickener should be operated in a torque range under 30% and not routinely under an alarm condition (40% alarm, 50% lift). Constant torque over 30% should be avoided by controlled sludge wasting.

2. The PMCS receives continual, running torque load and rake lift positions, plus warnings, but control is at the thickener control panel. Refer to "4.2 Thickener Control Systems."

4.4.3 Thickener Sludge Level

Between the sludge bed and the effluent outlet, the clarified water level has few solids to hinder the constant, gravity settling feed solids. As the concentration of solids increases rapidly at the top of the sludge bed, the settling rate of the solids decreases, as they become more concentrated and as the clear water is forced out and upward. The depth of the layer of solids is measured (interface between clarified water and settled sludge), which is the top of the sludge bed.

1. Since the solids concentration and depth of sludge in the tank affect the overflow water clarity and sludge density, control of the sludge level in a range between the HIGH and LOW warning levels is normal operating procedure. The operator, who has sole control of the waste pumps, as these are not automated, can decide whether continuous or intermittent wasting is used.

2. At HIGH 73.3% sludge level (16'-8" sludge level set point), effluent clarity may be affected. So the alarm alerts the operator to increase or start the sludge wasting, by opening one Sludge Waste line and starting one Wast Pump.

   At HIGH-HIGH 82% sludge level (18'-8" sludge level set point), the effluent clarity will be drastically affected and measures must be taken immediately to reduce the sludge level by using both sludge lines and pumps.

3. At LOW 49.1% sludge level (11'-2" sludge level set point), sludge density will be affected. Below the sludge interface, a compression zone develops within time where the weight of the upper solids compresses the lower solids, forcing more water out and increasing the density. A LOW sludge level alarm alerts the operator to close one or both sludge wasting lines.

   At LOW-LOW 31.5% sludge level (7'-2" sludge level set point), the settled solids will not dewater as well since there is less weight of sludge to compress out the water. Wasting of more sludge from the thickener (in terms of dry sludge mass) in excess of the amount of entering solids can drop the sludge level over time and adversely affect the sludge density and water clarity. Both sludge lines must be closed.

4. Normally, the sludge waste pumps are not operating.

5. Following any sludge wasting, the sludge lines must be flushed to ensure they remain clear. The operator will initiate the flush, but the time of the flush is programmed into the PMCS timers.

4.5 Process and Equipment Shut Down

Refer to the P &I D (Piping and Instrument Diagram) drawings 76738D-1302 and 1303, the General Arrangement drawings 76738D201 and 202.

In the **"hds"** mode, the Thickener, Reactor A and one or both sludge recycle pumps are in constant service. If any one of them must be shut down for inspection, preventive maintenance or repairs, operation can continue for a period of time, as follows, until full operation is resumed.

4.5.1 Thickener Shutdown for Maintenance

1. If the duration of a shutdown is several hours to several days and if the tank won't need to be drained or the water level reduced, raise the rakes enough to clear any anticipated sludge build-up. Continue with the normal **"hds"** mode of operation if the shutdown is a matter of hours. If the shutdown goes beyond a few hours, switch to sludge recycling to the thickener trough to keep the sludge fluid and moving around the bottom of the column.

Be aware that the sludge will continue to compact and settle in around the sludge pumps, since the rake arms are not moving the sludge, and if the over-thickening is allowed to continue may affect the operation of the pumps with serious shutdown consequences. Consider switching to the ASM mode and recycling back to the thickener trough, after a day or two, to prevent the over-thickening of the sludge. Refer below to 4.5.1.

2. **CAUTION:** Do not shut down the drive under high torque (40%+ torque) or heavy sludge (HIGH+ sludge level) conditions, unless it is an emergency. Raise the rakes until there is basically no load on the drive. Then the electrical power to the drive and lift can be shut off if that is required.

   WARNING: If the drive must be shut down, set the selector switch to OFF at the local thickener control panel, and lock out the power when serious maintenance is performed on any of the drive or lift equipment. Be aware that in local AUTO mode, the drive can be started remotely at the PMCS, endangering maintenance personnel.

3. Continue pumping underflow to Reactor A and, if the sludge level is near the HIGH level, commence wasting sludge as long as density and the sludge level permit

4. If the shutdown will be longer than several days, sludge movement in the tank and recycling can be problems, despite sludge wasting; so, if such a shutdown is anticipated, switch from the **"hds"** mode to the ASM mode. If it is necessary to drain the tank, refer to "Emergency Operation" below."

4.5.2 Center Column Sludge Pump Shutdown

1. If a pump fails, or fails to start, due to water leakage in the pump housing, switch over to the other sludge pump and close the plug valve. (Refer to "4.6 Alternative or Emergency Operation" below) This requires immediate action so the system can continue operating. The overhead crane will be used to hoist the pump. Refer to "9.0 Maintenance Procedures" for pump removal.

2. If a condition exists that neither underflow pump is operational, switch over to the ASM mode. Flush the 10" sludge return line using the hose connections on the line.

4.5.3 Options in Case of Reactor A Shut Down

1. When underflow sludge cannot be recycled to Reactor A for several hours up to a day, due to down time for service or repairs, the thickener can be used temporarily for sludge storage. But, some sludge should be recycled back to the thickener trough and some should be wasted in order to keep the sludge

pumpable and prevent clogging around the base of the column. To do this, switch over to the ASM system for lime feeding and mixing the AMD, but continue to discharge the sludge from Reactor B2 into the thickener. Refer above to "3.3.1.2 ASM Mode."

2. In case of heavy sludge flows, longer downtime for the Reactor, or existing High sludge level, the thickener can be bypassed temporarily by operating in the original ASM mode. Refer above.

4.6 Alternative or Emergency Operation

Emergency procedures may be required as a result of a mechanical or electrical failure of equipment or a process problem. In most cases the system can remain fully functional with only a partial shut down, an adjustment, or a switch to the alternative ASM mode of operation.

4.6.1 Center Column Sludge Pump Failure

Any time moisture is detected in a pump housing, the pump will immediately stop or be unable to start until the moisture detect signal clears. Start the other pump, if it is not operating.

4.6.1.1 Pump Fails to Start in 5 Seconds

1. After the 5 seconds, the alarm will sound.

   At the PMCS, the pump symbol will turn yellow as an alarm pop up message flashes, the affected pump PUMP FAILED will appear on the Wonderware screen, and the alarm printer will identify the pump that has failed.

2. To silence the audible alarm, push the ACKNOWLEDGE alarm button. That will also clear the pop up alarm.
3. Seal failure is the cause of leakage and so the malfunction must be corrected in order to operate the pump. Remove the pump, correct the problem referring to the manufacturer's instructions, and then return it to service.
4. When the alarm clears, the operator can start the pump at the PMCS (if the local selector switch is in AUTO) or locally.

4.6.1.2 Pump Fails During Operation

1. On detection of moisture, the pump will stop.

   At the PMCS, the pump symbol will turn yellow as an alarm pop up message flashes, the "affected pump PUMP FAILED" will appear on the Wonderware screen, and the alarm printer will identify the pump that has failed.

2. To silence the audible alarm, push the ACKNOWLEDGE alarm button. That will also clear the pop up alarm.
3. Since seal failure is the cause of leakage, the malfunction must be corrected in order to operate the pump. Remove the pump, correct the problem referring to the manufacturer's instructions, and then return it to service.
4. When the alarm clears, the operator can start the pump at the PMCS (if the local selector switch is in AUTO) or locally.

4.6.2 Power Failure

WARNING: To prevent a sudden start-up of a piece of equipment that someone may be near or servicing, turn all local selector switches to OFF. Failure to do this could result in serious injury, if power is suddenly restored. Note that the center column pumps will start automatically in the automatic restart sequence of the PMCS controlled load, if the local switch is turned to AUTO.

With a power failure and a return to power, all PMCS outputs go to the OFF mode, except the drive and lift device. Refer to "6.8.2 Functional Descriptions, XX. Loop: Restart." When power is restored, the system will restart automatically as described. At startup, check the sludge level in the tank and the drive torque. Return the system to AUTO as soon as possible in the **"hds"** mode.

4.6.3 High Drive Torque

4.6.3.1 Process Problems

1. Often a process problem will be first noticed as an increase in the drive control torque, due to an increase in the sludge load that may be immediate or long term. In the short run, rake lift and sludge wasting can mitigate the problem. In the long run, constant high torque loads can be detrimental to good operation and cause a mechanism overload and serious wear to the drive.

2. **Sludge islands** - A high sludge bed can lead to island formations of sludge at the outer periphery of the tank, which rotate with the rake arms rather than move to the center of the tank. (This may allow dilute feed to short circuit to the underflow, affecting the process.) If it occurs, which will be noted by an increasing torque on the drive, manually raise the rake arms to break through the rotating islands (torque may drop suddenly as the arms rise and the sludge settles).

4.6.3.2 Torque Overload

1. If the lifting device is at its maximum UP position (24" lift) and the drive torque reaches HIGH-HIGH (90%) torque [or 100% secondary backup switches], the drive will stop (drive control cuts the electrical power to the drive).

2. If that happens, immediately stop the feed to the thickener by closing the 20" SST/13 valve and switching to the ASM system. Continue to pump underflow sludge to Reactor A, and waste as much sludge to the drying beds as possible, using both sludge pumps. Also operate both thickener sludge pumps.

3. Keep pumping and wasting the underflow sludge. If the sludge bed cannot be reduced adequately to free up the rake arms, it may be necessary to drain the tank down to a level where the rakes will turn freely. Last resort is to remove the sludge from the tank by sluicing or digging. Refer to the Drive Maintenance Warning.

   Do not attempt to "jumper" the drive control or tamper with the overload alarm switch adjustment. Do not jog the drive and do not start-up with a load of sludge in the tank.

4. The lift device must remain in the AUTO mode so that it will not be forced to operate beyond the torque setpoint limits. Thickener drive must be RESET to restart.

5. When the HIGH (40%) torque alarm horn sounds, that is a warning the torque is increasing and the rakes are about to lift (50%). The horn can be silenced with the SILENCE button located on the thickener control pane or at the MCC building.

6. The torque signal from the drive control to the PLC will be displayed and activate a flashing indicator on the PMCS screen at the same time it gives off the alarm.

4.6.4 High Sludge Bed

1. A sludge bed allowed to rise too high can drastically affect the overflow clarity by allowing excessive amounts of solids to overflow with the effluent, particularly if the bed reaches the HIGH-HIGH sludge level. This must be watched when the AMD water flow rates are not relatively constant or the volumetric flow is high.
2. In a high sludge bed situation, both waste sludge pumps should operating. If sludge wasting is not keeping up with the sludge in flow to the thickener, check the pumps for operation and the sludge lines to be sure they are open. Flushing may be required.

   Water flushing is vital to keeping the transfer lines, valves and equipment clean and in good working order. The time of the flushing may need to be increased with the PLC timer at the PMCS. And always flush after a transfer of sludge.
3. If the sludge pumps are not operating and/or the lines are not clear, bypass lines for gravity discharge can be used by opening valves HVC-92A1/B1.

4.6.5 Low Sludge Bed

1. Wasting of sludge to the drying beds in excess of the influent solids entering the thickener can drop the sludge bed over time to the LOW-LOW level. That will not only reduce the solids concentration in the underflow but may also adversely affect the overall densification for the **"hds"** process.The wasting must be discontinued.
2. At LOW-LOW level, thickening will occur, but the underflow recycle will remain low density and little concentration of solids will take place in the compression zone of the sludge bed. During this time, the sludge bed will probably not adversely affect overflow clarity nor contribute much to underflow density, but the sludge bed can be sensitive to large changes in the feed solids rate, up or down. Avoid excessive wasting of sludge as the level approaches LOW level and discontinue wasting under LOW level.

4.6.6 Alternative to Absolute Equipment Shutdown

1. Pay attention to equipment alarm warnings, such as, flow and load indicators, level alarms, operating limits, failure alarms, etc. Watch for abnormal behavior of equipment that would indicate possible problems, as unusual sounds, excessive heat, vibrations, abnormal leakage, erratic operation, stoppage, etc.

2. Indications of problems should be immediately investigated. Supervisors should be made aware. Don't take chances with equipment that may just need an adjustment, cleaning, etc.

3. Equipment that is shut down for a problem should not be restarted until the problem is resolved. For example, an overload shutdown of the thickener drive may not only cause serious damage, but it may also be a danger to personnel.

   Restarting a shut down **"hds"** system can take time.

5.0 Electrical System

Reference drawings: Refer to the Weston "AMD Treatment Facility Single Line Diagram" drawings, Figures 6-1, 6-2, 6-3, and 6-4 in the drawing section of this manual or in the original Weston O&M manual. Also, refer to EIMCO "IMM **"hds"** Treatment Facility Electrical Single Line Diagram" drawing 76738 D 1423

5.1 GENERAL

Electrical procedures described in the Weston O & M manual and in this manual should be performed only by experienced personnel trained and qualified to work on electrical distribution and utilization equipment and in close proximity to the various voltages available.

5.2 POWER SOURCE

Refer to the Weston O & M manual, Section 11 Electrical System, and specifically Section 11.2 Power Source.

5.3 POWER DISTRIBUTION SYSTEM

Refer to the Weston O & M manual, Section 11.3 Power Distribution System.

5.4 AUTOMATIC TRANSFER SWITCHES

Refer to the Weston O & M manual, Section 11.4 Automatic Transfer Switches.

5.5 ELECTRICAL EOUIPMENT MAINTENANCE

Refer to the Weston O & M manual, Section 11.5 Electrical Equipment Maintenance.

6.0 Process Monitor and Control System

Refer to the EIMCO "Instrument System Architectural Diagram" drawing 76738 D 1336 in the drawing section of the manual.

6.1 Unit Description

The Process Monitor and Control System (PMCS) is shown schematically in the reference drawing 76738D-1336. The PMCS consists of three Programmable Logic Controllers (PLC) , one with two remote Input/Output (I/O) units, two Man Machine Interfaces (MMI)), Uninterruptable Power Supplies (UPS), and a portable work station.

Each of the pump stations (filtrate and creek water) has small PLCs to control their functions independent of the main PLC. The individual PLCs are linked to the main PLC to allow the operator to monitor and supervise the pump station. Each of the PLCs has its own I/O (identified as I/O D for the filtrate pump station and I/O E for the creek water system).

The main PLC, located in the Motor Control Center Building, monitors and controls the simple mix operation/sludge densification mix operation, and the lime and utilities systems. The main panel I/O (A) is directly connected to the PLC. Two satellite I/Os, one in the lime feed area (B) and one in the lime unloading area ©, interface with the equipment in their respective areas.

The MMI is an industrial-grade personal computer (PC) with floppy drives for uploading and downloading programs and data, and a hard drive for temporarily storing data and operating programs. The primary MMI is located in the Administration Building and interfaces with the PLCs. The secondary MMI can perform the same functions from a remote location. The MMI presents, in graphic displays, the facilities and process from which the operator can monitor and control the facility. The MMI displays and prints the alarms that occur. The computer alarm descriptions and setpoints and operator responses are summarized in Subsection 6.9.

The MMI displays and provides interface to the PLC to maintain and configure the PLC. This function can also be monitored and controlled with the use of the portable unit.

6.2 Methods of Control

Conventional digital PLC control is used to control the logic functions of motor control and sequential control. This control is done in standard "ladder logic." Information is accepted from the I/O inputs and action is transmitted to the I/O outputs for operation of the appropriate devices. The PLC also contains software to perform standard process control algorithms. Faceplate graphics provide access to and operate the controllers. The graphic screens are interactive to provide operator control. The basic graphic screens as provided by the vendor will be included in the Final O&M Manual.

To monitor the facilities, the operator can scroll through the graphics to the page depicting the function(s) to be monitored. The graphics are active, depicting the status of the equipment and the current value of process variables. The data are continuously updated.

The operator can, through the proper graphic and with the proper key strokes, start and stop motors, start and stop lime operations, control pH and level setpoints, etc.

6.3 Startup

Once the system is configured and the power is turned on, the system will automatically "boot up;" therefore, no operator action is required to "start up" the system. The systems include UPS ( ) on the PLCs and the MMI, and therefore should ride out a short-term power loss of less than 20 minutes. Power should be restored from the standby generators to the main PLC, the MMI, and the creek water pump station before the UPS backup is depleted. The PLC at the filtrate pump station does not have a standby generator, but will reboot itself when power is restored.

When the system comes on-line, all of the outputs are automatically set to off. The operator will start the equipment, as required.

6.4 Normal Operation

Normally, the facilities run as programmed into the PLC. The operator can monitor and control the facilities from the MMI. The graphic displays on the MMI show the status of equipment and the process values. The operator can select the equipment to be run from the MMI.

The control functions executed by the PLC are described in the individual process descriptions included in Sections 3 and 4 and in the functional descriptions in Subsection 6.8. If the operator has selected a function and that function is not activated, an alarm will sound.

The operation of the individual PMCS hardware components in the system is described in the vendor's O&M manuals.

6.5 Shutdown

The PMCS will not normally be shut down. Normally, it will remain active and maintenance will be performed on the run. If shutdown is required, after the process has been shut down, the power can be shut off without further action. An internal battery in the PLC will retain the basic program.

6.6 Potential Operating Problems

Once the system is configured and has been operating, malfunctions will most commonly be a result of field device or wiring faults. If a main PLC malfunctions, the redundant PLC will automatically take over and an alarm will warn of the malfunction. The vendor's O&M manuals should be consulted to determine the problem and the corrective action.

Because of the exposure length (the link between the main PLC and the satellite PLCs), the link may fail. This failure will be alarmed. Unless the alarm is a result of the remote PLC failure and not just a link failure, the remote PLCs will function normally.

System malfunctions, e.g., I/O card failure, will be indicated on the system graphic. Changing of the defective card should be performed by a qualified technician based on the vendor's instructions.

The vendor's O&M manual lists the malfunctions or problems and the corrective action that should be taken.

6.7 Alternative Operating/ Emergency Operation

Emergency operation will require the service of a qualified electrician to disable the automatic control with "jumpers" so that the operator can operate the equipment from the local Auto-Off-Test switches for motors. This operation bypasses interlocks and controls, and therefore requires continuous operator supervision of the process.

6.8 Instrument Functional Description

6.8.1 General

This section contains the basic functional description of each instrument loop. The individual components in a loop are identified on P&IDs with the function letter designation and loop number identification in accordance with I.S.A. Standard S-5.1.

The calibrations listed are initial settings and may require some field adjustment during startup. For convenience, the "ACTIVATE" is listed as the turnon value and

the "RESET' is the turnoff value. A summary of these setpoints is shown in Table 6-1.

Table 6-1

Set Point Listing*

Tag	Activate @ (On)	Reset (Off)
FAL-3	20 gpm Decreasing	25
FAH-3	1400 gpm Increasing	1,200
FAR-3 (Rate of Change)	500 gpm/min	100 gpm/min
PAL-4	2 psig Decreasing	2.5
PAH-4	12 psig Increasing	10
PAL-5	2 psig Decreasing	2.5
PAH-5	12 psig Increasing	10
LAH-6	17 ft Increasing	16.5
LCS-6A (Pumps)	14 ft Increasing	12.5
LCS-6B (Mixer)	8 ft Increasing	4
LAL-6	11.5 ft Decreasing	12
AAH-7	8.5 pH Increasing	8.2
AAL-7	6.5 pH Decreasing	6.8
AIC-7	7.5 pH	
LAH-8	17 ft Increasing	16.5
LCS-8A (Pumps)	14 ft Increasing	12.5
LCS-8B (Mixer)	8 ft Increasing	4
LAL-8	11.5 ft Decreasing	12
AAH-9	9.1 pH Increasing	9.0
AAL-9	8.3 pH Decreasing	8.5
AIC-9	8.5 pH	
PAH-12	25 psig Increasing	20
PAL-12	5 psig Decreasing	10
PAH-13	25 psig Increasing	20
PAL-13	5 psig Decreasing	10

Tag	Activate @ (On)	Reset (Off)
PCV-14	20 psig	
PCV-15	20 psig	
AAH-23	9.0 pH Increasing	8.8
AAL-23	6.8 pH Decreasing	7.0
AAH-24	100 NTU Increasing	90
LAH-26	8.6 ft Increasing	8.5
LCS-26A (Feed)	6.5 ft Decreasing	8.5
LCS-26 (Pumps)	3 ft Increasing	1
LCS-26B (Mixer)	5 ft Increasing	3
LAL-26	2 ft Decreasing	3
LAH-27	8.6 ft Increasing	8.5
LCS-27A (Feed)	6.5 ft Decreasing	8.5
LCS-27 (Pumps)	3 ft Increasing	1
LCS-27B (Mixer)	5 ft Increasing	3
LAL-27	2 ft Decreasing	3
LAH-31	29 ft Increasing	
LCS-31A (Lead Pump)	26.5 ft Decreasing	28
LCS-31B (Lag Pump)	25 ft Decreasing	26.5
LAL-31	23 ft Decreasing	24
PAL-32	85 psig Decreasing	
LAH-33	10.5 ft Increasing	10
LCS-33A (Lead Pump)	6.5 ft Increasing	4.2
LCS-33B (Lag Pump)	7.5 ft Increasing	5.2
LAL-33	4 ft Decreasing	4.2
FAL-36	3 gpm Decreasing	3.5
FCS-37	100 gpm Increasing	90
AIC-71	**8.5 pH**	

Tag	Activate @ (On)	Reset (Off)
LAHH-78	**18 ft 8 in.**	
LAH-78	**16 ft 8 in.**	
LAL-78	**11 ft 2 in.**	
LALL-78	**7 ft 2 in.**	
NSHH-81A	**100 % Torque**	
NSHH-81B	**100 % Torque**	
NSHH-81	**90% Torque**	
NSH-81	**40% Torque**	
NSL-81	**30% Torque**	
NSH-81A	**50% Torque**	
MSH-93A	**Moisture Detected**	
MSH-93B	**Moisture Detected**	

* See Weston O & M manual, pages 12-7 through 12-9 for original setpoint listing. New additions to Listing are in bold face type.

6.8.2 Functional Descriptions

A. Loop: 1 (AE, AIT, and AR)
Function: Influent pH
Equipment: Pipe Line 18-AMD-PL-11

The pH shall be measured at the inlet splitter box to the simple mix system with a pH sensor. The pH shall be indicated locally at the transmitter and the transmitter shall provide an output.

The pH shall be recorded in the PMCS.

Calibration

AIT-1 0-14 pH

B. Loop: 2 Not Used

C. Loop: 3 (FE, FIT, FFIC, FEt, and FQI)
Function: Influent Flow and Lime Addition
Equipment: T-7, P-2, and P-3

Flow shall be measured with an insert flowmeter sensor and transmitter. The flow rate shall be indicated.

The flow signal from the transmitter provides the input to two electronic indicating controllers located on the central control panel.

The signal provides a signal to adjust the lime feed via the pH controllers of the simple mix tank to adjust for changes in the rate of the flow.

High, low, and rate of change of flow rate shall be alarmed.

Rate of change in excess of a set amount shall be alarmed.

The flow rate shall be recorded and totalized in the PMCS.

Calibration

Tag	Activate @ (On)	Reset (Off)
FIT-3 0-1,500 gpm		
FAL-3	20 gpm Decreasing	25
FAH-3	1,400 gpm Increasing	1,200
FAR-3 (Rate of Change)	500 gpm/min	100

D. Loop:4 (PSL and PAL)
Function: Aeration Pressure Alarm
Equipment: TK-l and BL-1

Pressure is sensed in the air sparger line.

If the pressure drops below or above a set value, an alarm activates on the main control panel.

Calibration

Tag	Activate @ (On)	Reset (Off)
PAL-4	2 psig Decreasing	2.5
PAH-4	12 psig Increasing	10

E. Loop:5 (PSL and PAL)
Function: Aeration Pressure Alarm
Equipment: TK-2 and BL-2

Pressure is sensed in the air sparger line.

If the pressure drops below or above a set value, an alarm activates on the main control panel.

Calibration

Tag	Activate @ (On)	Reset (Off)
PAL-5	2 psig Decreasing	2.5
PAH-5	12 psig Increasing	10

F. Loop:6 and 8 (LE, LIT, LIC, LSH, and LSL)
Function: Level Control
Equipment: TK-1 and TK-2; and P-4A and P-4B

Level is sensed in both tanks. The signals are transmitted to the main control.

The operator will manually select the flow path and pump speed (high or low). The choices are: both tanks in use; TK-2 only in use; or TK-1 only in use and either pump P-4A or P-4B. If used, the effluent pumps shall be on/off controlled based on the route and speed selected.

Selection of pump speed or pump versus gravity operation shall be based on the ability of the piping to the drying beds to handle the flow.

The operator will manually set the valves for the operation selected.

The effluent pumps shall becapable of operating as follows:

Both Tanks in use:

Low flow: No control or pumps active.
Medium flow: LCS-T2 and P-4A or P-4B low speed active.
High flow: LCS-T2 and P-4A or P-4B high speed active.

TK-1 only tank in use:

Low flow: No control or pumps active.
Medium flow: LCS-T1 and P-4A or P-4B low speed active.
High flow: LCS-T1 and P-4A or P-4B high speed active.

TK-2 only tank in use:

Low flow: No control or pumps active.
Medium flow: LCS-T2 and P4A or P-4B low speed active.
High flow: LCS-T2 and P-4A or P-4B high speed active.

If the effluent pump in use fails, an alarm shall activate and the backup or standby pump, if it is in AUTO, it shall start. If the standby pump fails, an alarm shall activate, and one attempt to restart the primary pump shall be made.

The fail over sequence shall be resetable from the console. The operating pump or the last operating pump shall become the primary pump.

High level shall be alarmed. Low level (1 ft below pump stop) shall be alarmed.

Calibration

Tag	Activate @ (On)	Reset (Off)
LIT-6 0-20 ft		
LAH-6	17 ft Increasing	16.5
LCS-6A (Pumps)	14 ft Increasing	12.5
LCS-6B (Mixer)	8 ft Increasing	4
LAL-6	11.5 ft Decreasing	12

G. Loop: 7 (AE, AIT, AtC, and AR)
Function: pH Control and Recording
Equipment: TK-1; P-2A and P-2B; and P-3A and P-3B

The pH shall be measured at the discharge of the mix tank with a pH sensor. The pH shall be indicated locally at the transmitter and the transmitter shall provide an output.

During ASM Mode, the pH signal from the transmitter provides the input to an electronic indicating controller located in the PLC. The controller output signal goes to either of two sets of valves to vary the lime addition.

In **"hds"** Mode, the pH signal of Loop 7 and 9 will be selected to provide input to AIC-71. All outputs of AIC-7 and 9 will be forced to zero output. See Loop 71 for **"hds"** mode operation. Each set of valves, one large and one small per set, shall be used to cover the wide range of lime requirements. There shall be four 4-20 mA outputs from the controller, one going to each of the valves.

The output of the controller shall be switched to the high-capacity valves when either high-capacity circulating pump is in service.

The operator shall manually select the P-2 or P-3 lime pump based on the lime required to treat the process.

On low flow (low lime use), the control shall be capable of on/off operation.

On a flow change of the influent flow (loop 3), the controller primary output shall increase or decrease proportional to the flow change to avoid pH upset due to the change in lime demand.

The pH signal shall be recorded and logged in the PMCS.

High and low pH and high and low controller output of the controller in use are alarmed.

Calibration

Tag	Activate @ (On)	Reset (Off)
AIT-7 0-14 pH		
AAH-7	8.5 pH Increasing	8.2
AAL-7	6.5 pH Decreasing	6.8
AIC-7	7.5 pH	

H. Loop: 8 (See Loop 6)

Calibration

Tag	Activate @ (On)	Reset (Off)
LIT-8 0-20 ft		
LAH-8	17 ft Increasing	16.5
LCS-8A (Pumps)	14 ft Increasing	12.5
LCS-8B (Mixer)	8 ft Increasing	4
LAL-8	11.5 ft Decreasing	12

I. Loop: 9 (AE, AIT, AIC, and AR)
Function: pH Control and Recording
Equipment: TK-2; P-2A and P-2B; P-3A and P-3B

The pH shall be measured at the discharge of the mix tank with a pH sensor. The pH shall be indicated locally at the transmitter and the transmitter shall provide an output.

During ASM Mode, the pH signal from the transmitter provides the input to an electronic indicating controller located in the PLC. The controller output signal goes to either of two sets of valves to vary the lime addition.

In **"hds"** Mode, the pH signal of Loop 7 and 9 will be selected to provide input to AIC-71. All outputs of AIC-7 and 9 will be forced to zero output. See Loop 71 for **"hds"** mode operation. Each set of valves, one large and one small per set, shall be used to cover the wide range of lime requirements. There shall be four 4-20 mA outputs from the controller, one going to each of the valves.

The output of the controller shall be switched to the high-capacity valves when either high-capacity circulating pump is in service.

The operator shall manually select the P-2 or P-3 lime pump based on the lime required to treat the process.

On a flow change of the influent flow (loop 3), the controller output shall increase or decrease proportional to the flow change to avoid pH upset due to the change in lime demand.

The pH signal shall be recorded and logged in the PMCS.

High and low pH are alarmed.

On low flow (low lime use), the control shall be capable of on/off operation.

Calibration

Tag	Activate @ (On)	Reset (Off)
AIT-9 0-14 pH		
AAH-9	9.1 pH Increasing	9.0
AAL-9	8.3 pH Decreasing	8.5
AIC-9	8.5 pH	

J. Loop: 10 (FE, FIT, FR, and FQI)

Function: Cementation Flow
Equipment: Line 18-AM9-PL-11

Existing instrumentation will be used for this function.

Flow shall be measured at the discharge to the plant.

The flow rate shall be recorded and totalized on a local chart recorder.

K. Loop: 11 (OS)
Function: Valve Selection and P-4
Equipment: P-1A and P-1B; P-4A and P-4B; AIC-7 and AIC-9; and FFIC-3

Operation of the circulating system is monitored with respect to the pump(s) that are operating. The switch signals the controllers as to which set of valves is to be used (high or low flow).

L. Loop: 12 (PI, PAS, and PCV)
Function: Not Functional

M. Loop: 13 (PI and PAS)
Function: Not Functional

N. Loop: 14 (PCV)
Function: Not Functional

O. Loop: 15 (PCV)
Function: Not Functional

P. Loop: 16-19, 41, and 42 (OA, IO)
Function: Equipment Monitoring
Equipment: P-4A and P-4B; MX-1 and MX-2

AUTO and OFF selection and run status (fast, slow, and stop) are indicated on the main console.

If the equipment is called for to run and is not running, an alarm shall activate.

Q. Loop: 21 (FE, FIT, FR, and FQI)
Function: Effluent Flow
Equipment: Effluent Monitoring Station

Flow shall be measured with an insert flowmeter sensor and transmitter. The flow rate shall be indicated.

The flow rate shall be recorded and totalized in the PMCS.

Calibration

Tag		Activate @ (On)	Reset (Off)
FIT-21	0-3,000 gpm		

R. Loop: 22 Not Used

S. Loop: 23 (AE, AIT, and AR)
Function: Effluent pH
Equipment: Effluent Monitoring Station

The pH shall be measured with a pH sensor. The pH shall be indicated locally at the transmitter and will provide an output.

The pH shall be recorded in the PMCS.

High and low pH shall be alarmed.

Calibration

Tag	Activate @ (On)	Reset (Off)
AIT-23 0-14 pH		
AAH-23	9.0 pH Increasing	8.8
AAL-23	6.8 pH Decreasing	7.0

T. Loop: 24 (AE, AIT, and AR)
Function: Effluent Turbidity
Equipment: Effluent Monitoring Station

The turbidity shall be measured with a turbidity sensor. The turbidity shall be indicated locally at the transmitter and will provide an output.

The turbidity shall be recorded in the PMCS.

High turbidity shall be alarmed.

Calibration

Tag	Activate @ (On)	Reset (Off)
AIT-24 0-1,000 NTU		
AAH-24	100 NTU Increasing	90

U. Loop: 25 Not Used

V. Loop: 26 (LIT and LCS)
Function: Level Control
Equipment: TK-5

Level is sensed in TK-5. The signals are transmitted to the main control.

The level signal from the transmitter provides the input of switches located in the PLC.

One switch output signal goes to the slaker system (ME-1 or ME-2, as selected) to supply lime to the slurry tank.

A second output energizes the dilution valve to the slurry tank.

A third output shall stop the selected circulating pumps on low level.

All switches shall have adjustable differential.

High level and low level shall be alarmed.

Calibration

Tag	Activate @ (On)	Reset (Off)
LIT-26 0-12 ft		
LAH-26	8.6 ft Increasing	8.5
LCS-26A (Feed)	6.5 ft Decreasing	8.5
LCS-26 (Pumps)	3 ft Increasing	1
LCS-26B (Mixer)	5 ft Increasing	3
LAL-26	2 ft Decreasing	3

W. Loop: 27 (LIT and LCS)
Function: Level Control
Equipment: TK-6

Level is sensed in TK-6. The signals are transmitted to the main control.

The level signal from the transmitter provides the input of switches located in the PLC.

One switch output signal goes to the slaker system (ME-2 or ME-3, as selected) to supply lime to the slurry tank.

A second output energizes the dilution valve to the slurry tank.

A third output shall stop the selected circulating pumps on low level.

All switches shall have adjustable differential.

High level and low level shall be alarmed.

Calibration

Tag	Activate @ (On)	Reset (Off)
LIT-27 0- 12 ft		
LAH-27	8.6 ft Increasing	8.5
LCS-27A (Feed)	6.5 ft Decreasing	8.5
LCS-27 (Pumps)	3 ft Increasing	1

LCS-27B (Mixer)	5 ft Increasing	3
LAL-27	2 ft Decreasing	3

X. Loop: 28 (FCV, OC, Transfer Switch and Generator)
Function: Monitors and Controls Incoming Power to the Treatment Plant
Equipment: Transfer Switch and Generator

Upon loss of power, the transfer switch will start the generator. When the generator is up to speed and voltage, the transfer switch will close to re-establish power to the facility.

When the transfer switch senses that normal power has been restored, it will permit the operator via the PMCS to transfer to normal power.

When the generator runs, solenoids in the fuel line between the storage tank and the generator day tank will open the day tank. Day tank level is controlled by a float operated valve in the day tank.

See electrical drawings for wiring.

Y. Loop: 29 (FCV, OC, Transfer Switch, and Generator)
Function: Monitors and Controls the Utility Water Pump Station
Equipment: Transfer Switch and Generator

Upon loss of power, the transfer switch will start the generator. When the generator is up to speed and voltage, the transfer switch will close to re-establish power to the facility.

When the transfer switch senses that normal power has been restored, it will transfer to normal power.

When the generator runs, solenoids in the fuel line between the storage tank and the generator day tank will open to permit filling of the day tank. The day tank level is controlled by a float-operated valve in the day tank.

See electrical drawings for wiring.

Z. Loop: 30 Not Used

AA. Loop: 31 (LIT, LIC, and LAS)
Function: Utility Water
Equipment: P-5A, P-5B, and P-5C; and TK-8

Level is measured in the utility water storage tank.

When the level goes below a set value, the lead supply pump shall start. If the level goes below a second lower set value, the lag pump shall start. When the level goes above a set value, the pumps shall stop.

The lead/lag pump shall be selected by the operator.

If either the lead or lag pump fails to start, the backup pump shall start within 0 to 30 seconds and a failure alarm will activate.

A level switch in the pump suction sump shall shut down the operating pumps on low level. The pumps shall stop with an approximate 15-second delay between pumps.

A level switch in the storage tank sump shall shut down the operating pumps on high level. The pumps shall stop with a 10-minute delay before restarting with an approximate 10-second delay between pumps.

An alarm shall activate on low level.

Calibration

Tag	Activate @ (On)	Reset (Off)
LIT-31 0-32 ft		
LAH-31	29 ft Increasing	
LCS-31A (Lead Pump)	26.5 ft Decreasing	28
LCS-31B (Lag Pump)	25 ft Decreasing	26.5
LAL-31	23 ft Decreasing	24

AB. **Loop: 32 (PIT)**
Function: Pressure Alarm
Equipment: Instrument Air System

Pressure is measured at a remote location in the unloading area.

Pressure is indicated and alarmed if low (<80 psig) on the PMCS.

Calibration

Tag	Activate @ (On)	Reset (Off)
PAL-32	85 psig Decreasing	90

AC. Loop: 33 (LE, LIT, and LCS)
Function: Level Control
Equipment: Filtrate Effluent Sump

Level is sensed in the sump. The signals are transmitted via the local PLC to the main control.

The level signal from the transmitter provides the input of switches located in the local PLC.

The output shall run the selected discharge pumps on an alternating lead/lag sequence. Pump and sequence selection shall be downloaded from the main console or locally with the portable terminal.

High and low level and pump malfunction shall be alarmed at the main console. Malfunction is when a pump is called for and does not operate within 5 seconds.

Calibration

Tag		Activate @ (On)	Reset (Off)
LIT-33	0-15 ft		
LAH-33		10.5 ft Increasing	10
LCS-33A (Lead Pump)		6.5 ft Increasing	4.2
LCS-33B (Lag Pump)		7.5 ft Increasing	5.2
LAL-33		4 ft Decreasing	4.2

AD. Loop: 34 (FC and FCV)
Function: Lime Dilution Flow Control
Equipment: ME-1 or ME-2; and TK-5

On a run signal from ME-1B (or ME-2B if feeding TK-5), FCV shall open to feed dilution water to the slurry tank.

The rate of flow of FC shall be set manually from the PLC.

AE. Loop: 35 (FC and FCV)
Function: Lime Dilution Flow Control
Equipment: ME-2 or ME-3; and TK-6

On a run signal from ME-3B (or ME-2B if feeding TK-6), FCV shall open to feed dilution water to the slurry tank.

The rate of flow of FC shall be set manually from the PLC.

AF. Loop: 36 (FAS and FCV)
Function: Effluent Monitoring Sample Flow
Equipment: Effluent Monitoring Station

Flow is sensed in the sample line from the discharge of the effluent pumps.

If any pump is running and no flow is sensed within an adjustable (0 to 30 seconds) time, an alarm shall activate.

If the no flow is not corrected within a set time (adjustable 0 to 30 rninutes), the effluent pumps shall shut down and an alarm will activate.

Calibration

Tag	Activate @ (On)	Reset (Off)
FAL-36	3 gpm Decreasing	3.5

AG. Loop: 37 (FCS)
Function: Utility Booster Pump Control
Equipment: P-7

The pump is started manually from various locations (two on the simple mix platform, one at the lime circulation pumps, and one at the filtrate pump station) or from the main control.

Flow is sensed in the suction line of the booster pump.

If the flow goes above 100 gpm within an adjustable time (flow switch closing), the booster pump shall run.

If the flow goes or stays below 100 gpm (flow switch opens) for an adjustable (3 to 30 minutes) time, the pump shall stop. The initial timer is set at 5 minutes.

Calibration

Tag	Activate @ (On)	Reset (Off)
FCS-37	100 gpm Increasing	90

AH. Loop: 41 (OC)
Function: Monitor and Select the Lime Circulating Pumps
Equipment: P-2A and P-2B

The operator shall select the pump to be operated and the tank in use.

If the tank level goes below a set level, the pump shall stop and an alarm will activate.

AI. Loop: 42
Function: Monitor and Select the Lime Circulating Pumps
Equipment: P-3A and P-3B

The operator shall select the pump to be operated and the tank in use.

If the tank level goes below a set level, the pump shall stop and an alarm will activate.

AJ. Loop: 71 HS, AIC
Function: "hds" or ASM Mode Select
Equipment: "hds" or ASM equipment

A two-position selector switch HS-71A is provided in the PMCS for selecting "Sludge Densification Mix (**"hds"**) Mode" or "Aerated Simple Mix (ASM) Mode". When **"hds"** mode is selected , a pH controller AIC-71 in the PMCS for Reactor A will be active while pH controllers AIC-7 and AIC-9 for

Reactors B1 and B2 respectively will be disabled. In this mode, another two-postion selector HS-71A, "pH Sensor Select" is provided in the PMCS to select the pH probe from either Reactor B1 or Reactor B2 for input signals to AIC-71. There are four lime slurry valves responding to the AIC-71 controller outputs with ACV-71A, B operating on the 8-inch lime slurry loop 2 and ACV-71C, D operating on the 4-inch lime slurry loop 1. Valves will only be active when their respective lime loop feed pump P-2A or B, P-3A or B is running.

When ASM mode is selected, AIC-71 outputs will be disabled while AIC-7 and 9 will be active. Individual pH tank controller of AIC-7 and 9 for Reactor B1 and B2 will resume to its original configuration. See Loops 7 and 9 for ASM mode operation.

Calibration Tag		Activate @ (On)	Reset (Off)
AIT-7	0-14 pH		
AIT-9	0-14 pH		
AIC-71		8.5	

AK. Loop: 72 NOT USED.

AL. Loop: 73 NOT USED

AM. Loop: 74 NOT USED.

AN. Loop: 75 NOT USED.

AO. Loop: 76 NOT USED.

AP. Loop: 77 HS
Function: Reactor A Mixer Control
Equipment: MX-13 Reactor A Mixer

A 3-positon "ON-OFF-AUTO" selector HS-77 is provide locally to operate the Reactor A tank mixer. In the ON mode, the mixer will run continuously, and in the AUTO mode, the mixer will run in response to the PMCS.

An ON-OFF two-positon selector HS-77A is provided in the PMCS for remote controls. This control switch will only be active when the local selector switch is selected for AUTO. In the ON mode, the mixer will run continuously. If the mixer

is called to run or stop from the PMCS and does not respond within a 5-second time delay, then an alarm QA-77 of MIXER FAIL will trip at the PMCS.

MIXER ON and MIXER OFF indication for the sludge conditioning tank mixer are provided at the mixer starter. MIXER ON (QL-77A) and AUTO (QL-77B) indication of the sludge conditioning tank mixer are provided at the PMCS.

AQ. Loop: 78 LT, LSHH, LSH, LSL, LSLL
Function: Thickener Sludge Interface Level
Equipment: TK-11, Thickener

Sludge blanket level of thickener TK-11 is measured and monitored in the PMCS. with HIGH, HIGH-HIGH, LOW and LOW-LOW sludge levels alarmed at the PMCS.

Calibration

Tag		Activate @ (On)	Reset (Off)
LT-78	0-22.75 ft		
LSHH-78	18'-8" (82.0%)	18'-8"	18'-0"
LSH-78	16'-8" (73.3%)	16'-8"	16'-0"
LSL-78	11'-2"(49.1%)	11'-2"	11'-10"
LSLL-78	7'-2"(31.5%)	7'-2"	7'-10"

AR. Loop: 79 FI
Function: Recycle Sludge to Reactor A
Equipment: Recycle Line

A portable ultrasonic, strap-on flowmeter is used to monitor the thickener recycle flow to Reactor A.

Calibration

Tag		Activate @ (On)	Reset (Off)
FI-79	0-3000 gpm		

AS. Loop: 80 NOT USED.

AT. Loop: 81 HS, NIT, NSH, NSL
Function: Rake Drive Controls
Equipment: MX-11A&B Rake Drive Motor

A local ON-OFF-AUTO selector switch, HS-81, is provided for operation of the thickener drive unit. In the ON mode, the drive unit shall respond to signals from local pushbuttons HS-81A (START) and HS-81B (STOP). In AUTO mode, the drive unit shall run in response to the PMCS.

A remote ON-OFF selector switch, HS-81D, is provided in the PMCS for the thickener rake drive unit. This switch will only be active when the local selector HS-81 is set in AUTO mode. In the ON mode, the rake drive will run continuously. If the rake drive is called to run or stop from the PMCS and does not repond within a 5-second time delay, it will alarm "RAKE DRIVE FAILED" (QA-81) at the PMCS.

Indicator lights of "DRIVE ON" and "DRIVE OFF" are provided at the drive motor starter. Indication of ON (QL-81A) and AUTO (QL-81B) are provided at the PMCS. An indicator light of "RAKE DRIVE ON" (QL-81) is also provided on the thickener local control panel.

In any mode of operation, a HIGH-HIGH torque switch, NSHH-81 (rated at 90% torque) is provided to lock out the drive on a HIGH-HIGH torque conditon. In addition, redundent HIGH-HIGH torque switches NSHH-81A, and B (both rated at 100% torque) are provided to lock out the rake drive. A RESET pushbutton, HS-81C, at the thickener local control panel will enable the drive for restarting after any HIGH-HIGH torque condition is cleared.

A local drive torque indication, NIT-81, and a local HIGH torque switch, NSH-81, (rated at 40% torque) are provided. When this HIGH torque switch trips, it will alarm two outdoor horns "NAH-81", located at the MCC building, and at the local thickener panel. In addition, "HIGH TORQUE ALARM" indicator lights will also be lit at these locations. The operator can silence these horns by pushing the "HORN SILENCE" buttons, HS-81E or HS-81F, at any one of those locations. This HIGH torque alarm will also trip at the PMCS, NAH-81. Continuous readings of the drive torque will be indicated at the PMCS, NI-81.

AU. Loop: 82 HS, ZT, ZI, ZSH, ZSL
Function: Thickener Rake Lift Controls
Equipment: MX-12 Rake Lift, Rake Lift Position

A local ON-OFF-AUTO selector switch, HS-82, located on the thickener local control panel is provided for operation of the thickener automatic rake lift. In the ON mode, the rake lift is controlled locally, with local push buttons of "RAISE", and "LOWER". In AUTO mode, the rake lift will run in response to the rake torque readings or the "Drive Control" cam switches.

There are no controls from the PMCS, only ON and AUTO indication for the rake lift running.

To safeguard the rake lift from overtravelling in either directions, the UP LIMIT and DOWN LIMIT switches, ZSH-82 and ZSL-82, are provided. In addition a lift position transmitter will indicate the lift position at the PMCS.

AV. Loop: 92 HS, HCV, PI, XSV
Function: Sludge Waste Pumps
Equipment: P-12A/B, Manual Control Valves, Air Relief/Vacuum Valves

Local ON-OFF selector switches HS-92A/B, located next to the Sludge Waste pumps (P-12A and B) are used to start and stop the pumps.

No remote controls are provided for these pumps. A pump status will be indicated in the PMCS.

At the discharge sides of the pumps, local pressure gauges PI-92A/B, manual pinch valves HCV-92A/B and air relief/vacuum valves, XSV-92A/B are provided. Air relief/vacuum valves are also equipped with backwash solenoids HV-92A/B. (See Loop 94)

There are pump bypass line and valves HCV-92A1/B1 for gravity flow operation.

AW. Loop: 93 HCV, HS, MSH, MAH, PI
Function: Center Column Pumps
Equipment: P-11A/B

Local ON-OFF-AUTO selector switches HS-93A/B, located on the thickener local control panel, are provided for operation of thickener center column pumps.The ON and OFF modes will override the PMCS and start or stop the pumps.

Remote ON-OFF selector switches HS-93A1/B1, are provided in the PMCS for pump control. These switches will only be active when the local selector switch is selected for AUTO. In the ON positon, the pump will run continuously. If the pumps are selected to run or stop from the PMCS and do not respond within a 5-second time delay, then an alarm PUMP FAILED (QA-93A or QA-93B), at the PMCS, will be activated.

In any mode of operation, a moisture switch, MSH-93A or B, located inside the submersible motor housing, is provided to lock out the pump from starting on detecting water moisture which indicates the pump seal has failed. In addition it will alarm MOISTURE DETECTED (QA-93A or B) at the PMCS. The affected pump will not restart until the condition is cleared.

Indicator lights of "PUMP ON" and "PUMP OFF" are provided at the pump motor starter. Indication of ON (QL-93A1 or B1) and AUTO (QL-93A2 or B2) are provided at the PMCS.

Local pressure gauges are provided at pump discharge sides as PI-93A and PI-93B.

On the line going back to Reactor A, a manual pinch valve HCV-93 is provided to adjust the recycle flow rate with the clamp-on ultrasonic flowmeter, FI-79.

AX. Loop: 94 HS, KS
Function: Sludge Waste Line Flush System
Equipment: Sludge Waste Line A/B and Air Relief Valve Backwash

Local ON-OFF pushbutton switches HS-94A/B located near Sludge Waste Pumps P-12A/B are provided for flushing the sludge waste lines. In the ON mode, the PLC timer will be activated and the flush water solenoid valve energizes for a preset time interval. The timer cycle may be cancelled by the pressing the OFF switch.

Remote ON-OFF selector switches HS-94A1/B1 are provided in the PMCS for the flush water solenoid control. These control switches duplicate the local ON-OFF selectors. In the ON position, the PLC timer will be activated and the flush water solenoid valve energized for a preset time interval. In the OFF position, the timer cycle will be interrupted. When the timer cycle is activated, a message "FLUSHING" will be indicated on the screen in the PMCS.

When the flushing is on, the PLC timer will also activate the backwash solenoid valve for the Sludge Waste Pump discharge air relief/vacuum valves.

AY. Loop: 95 NOT USED

AZ. Loop: 96 NOT USED

BA. Loop: 97 NOT USED

BB. Loop: 98 AIS
Function: Automatic Sampler
Equipment: Thickener Overflow Pipe Line 1TOF-1"-MTS/07

Thickener overflow samples are taken periodically into 2½-gallon sample collection jars. The automatic composite sampler is locally powered and there is no connection back to the PLC/PMCS.

BC. Loop: 99 FS, FA
Function: Indicate Usage at the Eyewash /Safety Shower Station
Equipment: Thickner Area Eye Wash/Safety Shower

Flow is sensed by a flow switch on water pipe at the eye wash/safety shower in the thickener area.

If the flow rate rises above a set value, it will light up the indicator light which comes with the eye wash/safety shower, indicating someone has activated the eye wash/safety shower.

The eye wash and safety shower is used locally and there is no connection back to the PMCS.

Calibration

Tag	Activate @ (On)	Reset (Off)
FA-99	Manufacture Std	Manufacture Std

BD. Loop: 101 (LS)
Function: Indicates the Level in the Storage Silo
Equipment: ME-4 Storage Silo

Level is sensed with a switch at high, middle, and low levels.

The high level will be indicated on the unloading panel located in the scale house and the transfer panel located on the lime slaking platform (via the PMCS). It will alarm directly on the unloading panel.

The high level shall activate an alarm on the PMCS.

The unloading system shall be capable of being started if the level is not high, the dust filter is operating, and the unloading hose is connected. The dust filter shall be activated when the unloading sequence is activated.

The middle level will be indicated on the unloading panel and the transfer panel.

The middle level shall be indicated on the PMCS. The middle level indicates the capacity for more lime in the storage silo.

The low level will be indicated on the unloading panel~and the transfer panel.

The low level shall activate an alarm on the PMCS.

BC. Loop: 102 (LS)
Function: Indicates the Level in the Storage Silo
Equipment: ME-5 Storage Silo

Level is sensed with a switch at high, middle, and low levels.

The high level will be indicated on the unloading panel and the transfer panel (via the PMCS). It will alarm directly on the unloading panel.

The high level shall activate an alarm on the PMCS.

The unloading system shall be capable of being started if the level is not high, the dust filter is operating, and the unloading hose is connected. The dust filter shall be activated when the unloading sequence is activated.

The middle level will be indicated on the unloading panel and the transfer panel.

The middle level shall be indicated on the PMCS. The middle level indicates the capacity for more lime in the storage silo.

The low level will be indicated on the unloading panel and the transfer panel.

The low level shall activate an alarm on the PMCS.

BD. Loop: 103 (LS)
Function: Indicates the Level in the Feed Silo
Equipment: ME-1 Feed Silo

Level is sensed with a switch at high, middle, and low levels.

The high level will be indicated on the unloading panel and the transfer panel.

The high level shall activate an alarm on the PMCS and will shut down the transfer sequence.

See loops 106 and 107 for sequence description.

The middle level will be indicated on the unloading panel and the transfer panel.

The middle level shall activate an alarm on the PMCS if transfer operation is not started within 10 minutes (adjustable).

The middle level indicates the need for more lime in the feed silo.

The low level will be indicated on the unloading panel and the transfer panel.

Low level shall stop the slaking after a preset run time (0 to 10 minutes) if the low level has not cleared.

The low level shall activate an alarm on the PMCS.

BE. Loop:104 (LS)
Function: Indicates the Level in the Feed Silo
Equipment: ME-2 Feed Silo

Level is sensed with a switch at high, middle, and low levels.

The high level will be indicated on the unloading panel and the transfer panel.

The high level shall activate an alarm on the PMCS and will shut down the transfer sequence.

See loops 106 and 107 for sequence description.

The middle level will be indicated on the unloading panel and the transfer panel.

The middle level shall activate an alarm on the PMCS.

The middle level indicates the need for more lime in the feed silo.

The low level will be indicated on the unloading panel and the transfer panel.

Low level shall stop the slaking after a preset run time (0 to 10 minutes) if the low level has not cleared.

The low level shall activate an alarm on the PMCS.

BF. Loop: 105 (LS)
Function: Indicates the Level in the Feed Silo
Equipment: ME-3 Feed Silo

Level is sensed with a switch at high, middle, and low levels.

The high level will be indicated on the unloading panel and the transfer panel.

The high level shall activate an alarm on the PMCS and will shut down the transfer sequence.

See loops 106 and 107 for sequence description.

The middle level will be indicated on the unloading panel and the transfer panel.

The middle level shall activate an alarm on the PMCS.

The middle level indicates the need for more lime in the feed silo.

The low level will be indicated on the unloading panel and the transfer panel.

Low level shall stop the slaking after a preset run time (0 to 10 minutes) if the low level has not cleared.

The low level shall activate an alarm on the PMCS.

BG. Loop: 106 (FCV, ZS, and PS)
Function: Transfers Lime From the Storage to the Feed Silos
Equipment: BL-3; ME-4B and ME-4C; and Dust Filters on the Feed Silos

The transfer route from MEXA to the feed silos is selected.

Manual or auto transfer is selected.

In the manual mode, the transfer is initiated by operator action. In the auto mode, the transfer is initiated when one of the active feed silo's contents goes below the middle-level switches.

When the transfer sequence is initiated, the feed silo diverter valves (FCV 111-114) are energized to position the valve to the silo to be used. The position is verified (ZS) and indicated on the transfer panel and the PMCS.

As soon as the route is verified, the outlet valve is opened. When the valve is proven open, the blower starts.

When the outlet valve is proven open and the blower has run for a period of time (0 to 15 minutes), the rotary air lock energizes and the bin activator operates on a preset time cycle.

If the pressure increases above the set value, the rotar,v air lock stops for a period of time until the pressure decreases, indicating a clear line. The air lock then restarts.

When high level in the selected feed silo is reached, the rotary air lock and bin activator stop and the blower purges the line. After the line is purged, the blower stops and its discharge valve closes.

BH. Loop: 107 (FCV, ZS, and PS)
Function: Transfers Lime From the Storage to the Feed Silos
Equipment: BL-4; ME-5B and ME-5C; and Dust Filters on the Feed Silos

The transfer route from ME-5A to the feed silos is selected.

Manual or auto transfer is selected.

In the manual mode, the transfer is initiated by operator action. In the auto mode, the transfer is initiated when one of the active feed silo's contents goes below the middle-level switches.

When the transfer sequence is initiated, the feed silo diverter valves (FCV 111-114) are energized to position the valve to the silo to be used. The position is verified (ZS) and indicated on the transfer panel and the PMCS.

As soon as the route is verified, the blower is energized.

When the blower is up to maximum pressure, its outlet valve opens.

When the outlet valve is proven open, the rotary air lock energizes and the bin activator operates on a preset time cycle.

If the pressure increases above the set value, the rotary air lock stops for a period of time until the pressure decreases, indicating a clear line. The air lock then restarts.

When high level in the selected feed silo is reached, the rotary air lock and bin activator stop and the blower purges the line. After the line is purged, the blower stops and its discharge valve closes.

BI. Loop: 200 Series
Function: Lime Slaking
Equipment: ME-1, ME-2, and ME-3

The operator shall select the slaker(s) to be used.

ME-1 and ME-2 can be used with TK-5, and ME-3 and ME-2 can be used with TK6. ME-2 can be use with either TK-5 or TK-6, but not simultaneously.

On a low signal from the tank level transmitter, the feeder, the grit screw (ME-1 and ME-3 only), and the grit screen shall start. The dilution water shall turn on. The bin activator timer shall activate to run the activator at a preset (adjustable on and off) time sequence.

The dilution water valve opens (see loops 34 and 35).

On high level in the slurry tank, the above equipment shall stop.

On low level in the feed silo, the system will be signaled to shut down and will do so after the feed run that is in progress. It shall not restart unless the level has been re-established by going above the center level switch.

The slaker motor runs continuously when the slaker is in service or selected. If the unit stops or is on initial startup, the slaker shall run for an adjustable time before the feed system is permitted to operate.

On high temperature in the slaker dilution water is added via a local control.

BJ. Loop: Restart
Function: Restarts Equipment After a Power Loss
Equipment: PMCS Controlled

On a power failure and a switchback to PG&E power, all PMCS outputs shall go to the off mode. Process equipment operating at the time of the power failure shall restart automatically in the sequence listed below if the outage is less than an adjustable (0 to 1 hour) time period.

The lime unloading and transfer systems shall go to the off state and require manual (operator initiated) operation or reset to automatic operation.

The switch from generator to purchased power (PG&E) shall be manually initiated by the operator to avoid unnecessary unexpected shutdowns and restarts. All operating motors shall shut down and restart in the order listed below.

There shall be an adjustable delay (0 to 30 seconds) after starting each load (initially set for 10 seconds). If a load was not in use at the time of the power loss or the equipment is started as part of a group that can be started simultaneously, the delay time will be set to 0. The following is the automatic restart sequence of the PMCS controlled loads:

MX-13	Reactor A Mixer
P-11A or P11-B	Thickener Center Column Pumps
MX-1	TK-1 Mixer
MX-2	TK-2 Mixer
P-2A or P-2B	Loop 1 Lime Circulating Pump
P-3A or P-3B	Loop 2 Lime Circulating Pump
P-4A or P-4B	Effluent Pump
MX-4	TK-5 Mixer
MX-5	TK-6 Mixer
BL-1	Aeration Blower
BL-2	Aeration Blower
ME-1	Lime Feed Silo
ME-2	Lime Feed Silo

ME-3 Lime Feed Silo

At the end of the restart sequence, the PMCS shall permit the lime transfer system and MX-11 Thickener Rake Drive to operate or be set to automatic.

If power failure lasts more than 10 minutes, the above auto-sequence shall be disabled and all equipment shall require manual restart.

6.9 Computer Alarm System Summary

A summary of the computer alarm functions and setpoints, the instrument/electrical control actions that occur on"Auto" operation, and the appropriate operator responses is presented in Table 6-2.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
FAL-3	Low influent AMD flow			20 gpm		None	Ensure that the aboveground and underground AMD pipelines are not leaking by visual/leak detection ports inspection (especially during wet-weather periods).
FAH-3	High influent AMD flow	1,400 gpm				None	Initiate lime slurry loop 2 operation if AMD lime demand exceeds the loop 1 supply capacity. Adjust (increase) lime feeder controller setting and the flow rate of water to the slaker according to the AMD lime demand (see Subsections 3.4 and 3.5). Initiate second slaker operation, if necessary.
PAL-4	Low air pressure to tank TK-1			2 psig		None	Ensure that the blower (BL-1 or BL-2) is running and the appropriate discharge valves are open. Refer to the troubleshooting guides for the blower in the vendor's O&M manual. Call maintenance service, if necessary.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
PAH-4	High air pressure to tank TK-1	12 psig				None	Monitor the blower discharge flow rate; if significantly lower than 1,400 scfm and the pressure is high (>12 psig), the sparger in tank TK-1 may be clogged. If so, make arrangements for cleaning the sparger. In addition, refer to the blower vendor's O&M manual for troubleshooting guide.
LAL-6	First-stage simple mix tank TK-1 low level			11.5 ft		Shut down the effluent pump (if running, during TK-1 only in use) before tank TK-1 level drops to the low-level alarm setpoint. See Table 7-1 for a listing of setpoints.	TK-1 Only Operation Ensure that the effluent pump (P-4A or P-4B) is shut down. Close discharge valves to prevent draining tank. Check to see if drain valve is open. TK-1 and TK-2 Operation Check for tank or piping leak or open drain valve.
LAH-6	First-stage simple mix tank TK-1 high level	17 ft				Start the effluent pump (if selected, during TK-1 only use) before tank TK-1 level reaches the high- level alarm setpoint.	Ensure that the effluent pump (P-4A or P-4B), if selected, is running. Check for plugged lines and closed valves. If the level continues to rise, make arrangements for flushing the pipelines and rod out stillwalls (see Subsection 3.1.7).

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
OA-4	Blower BL-1 operation				X	None	Check the electrical and instrumentation control systems for BL-1; call maintenance service, if necessary.
OA-5	Blower BL-2 operation				X	None	Check the electrical and instrumentation control systems for BL-2; call maintenance service, if necessary.
OA-16	First-stage simple mix tank TK-1 mixer; MX-1 operation				X	None	Check the electrical and instrumentation control systems associated with mixer MX-1; call maintenance service, if necessary.
AAL-7	Low pH in tank TK-1			6.5		None	Check operation of the lime circulation system, including the lime feed flow control valves. Initiate lime slurry loop 2 operation, if necessary.
AAH-7	High pH in tank TK-1	8.5				None	Check the instrument loop (control loop 7), the lime circulation system, and the lime feed flow control valves for proper operation. Call maintenance service, if necessary.
PAL-5	Low air pressure to tank TK-2			2 psig		None	Check for piping leaks. The blower (BL-2) may be malfunctioning. Refer to the vendor's O&M manual. Call maintenance service, if necessary.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
PAH-5	High air pressure to tank TK-2	12 psig				None	The sparger in tank TK-2 may be clogged if the air flow is significantly lower than 1,400 scfm and the pressure is high (>12 psig). Make arrangements for cleaning the sparger
LAL-8	Second-stage simple mix tank TK-2 low level			11.5 ft		Shut down the effluent pump (if running) before tank TK-2 level drops to the low-level alarm setpoint. See Table 7-1 for a listing of setpoints.	Ensure that the effluent pump (P-4A or P-4B) is shut down. Close discharge valves to prevent draining the tank. Check to see if drain valve is open.
LAH-8	Second-stage simple mix tank TK-2 high level	17 ft				Starts the effluent pump before TK-2 level reaches the high-level alarm setpoint	Ensure that the effluent pump (P-4A or P-4B), if selected, is running. Check for plugged lines and closed valves. If the level continues to rise, make arrangements for flushing the pipelines and rod out stillwalls (see Subsection 3.2.6).
OA-18	Effluent pump P-4A operation				X	None	Check the electrical and instrumentation control systems associated with effluent pump P-4A; call maintenance service, if necessary.
OA-19	Effluent pump P-4B operation				X	None	Check the electrical and instrumentation control systems associated with effluent pump P-4B; call maintenance service, if necessary.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
AAL-9	Low pH in tank TK-2			8.3		None	Check operation of the lime circulation system and the lime feed flow control valves. Initiate lime slurry loop 2 operation, if necessary.
AAH-9	High pH in tank TK-2	9.1				None	Check the instrument loop (control loop 8), the lime circulation system, and the lime feed flow control valves for proper operation. Call maintenance service, if necessary.
LAL-26	Lime slurry tank TK-5 low level			2 ft		Shut down the operating lime slurry pump when the level drops to 1 ft.	Ensure that the lime feed and slaking systems are properly functioning. Ensure that the feeder controller setting and the slaking water flow rate are set at appropriate levels (see Subsections 3.4 and 3.5). Check for circulating line leak or malfunction. Ensure that the other tank (TK-6) and the other loop with the corresponding lime slurry pump are ready for operation.
LAH-26	Lime slurry tank TK-5 high level	8.6 ft				Stop the lime feed from the slaker system to tank TK-5. Deactivate the dilution valve to tank TK-5.	Ensure that the slaker discharge and the dilution water supply to tank TK-5 are shut down. Ensure that the lime slurry pump is running.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
LAL 27	Lime slurry tank TK-6 low level			2 ft		Shut down the operating lime slurry pump when the level drops to 1 ft.	Ensure that the lime feed and slaking systems are functioning properly. Ensure that the feeder controller setting and the slaking water flow rate are set at appropriate levels (see Subsections 3.4 and 3.5). Ensure that the other tank (TK-5) and the other loop with the corresponding lime slurry pump are ready for operation.
LAH-27	Lime slurry tank TK-6 high level	8.6 ft				Stop the lime feed from the slaker system to tank TK-6. Deactivate the dilution water supply valve to tank TK-6.	Ensure that the slaker discharge and the dilution water supply to tank TK-6 are shut down. Ensure that the lime slurry pump is running.
PAL-12	Lime slurry loop 1 low pressure			5 psig		None	Pressure control valve PCV-14 may be malfunctioning. Check instrument control loops 12 and 14 and adjust the desired pressure setting (20 psi ±) for PCV-14. Call instrumentation service, if necessary. Inspect plugged line between the pump and the lime feed valves. Arrange for flushing the line with high-pressure water.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
PAH-12	Lime slurry loop 1 high pressure	25 psig				None	Pressure control valve PCV-14 may be malfunctioning and/or loop 1 may be clogged. Check control loops 12 and 14 and adjust the desired pressure setting (20 psi ±) for PCV-14. If necessary, initiate loop 2 operation and shut down loop 1 for maintenance and cleanout.
OA-42A	Lime slurry pump P-2A operation				X	None	Check the electrical and instrumentation control systems associated with lime slurry pump P-2A. Call operation maintenance service, if necessary.
OA-42B	Lime slurry pump P-2B operation				X	None	Check the electrical and instrumentation control systems associated with lime slurry pump P-2B. Call maintenance service, if necessary.
OA-41A	Lime slurry pump P-3A operation				X	None	Check the electrical and instrumentation control systems associated with lime slurry pump P-3A. Call maintenance service, if necessary.
OA-41B	Lime slurry pump P-3B operation				X	None	Check the electrical and instrumentation control systems associated with lime slurry pump P-3B. Call maintenance service, if necessary.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
PAL-13	Lime slurry loop 2 low pressure			5 psig		None	Pressure control valve PCV-15 may be malfunctioning. Check control loops 13 and 15 and adjust the desired pressure setting (20 psi ±) for PCV-15. Call instrumentation service, if necessary.
PAH-13	Lime slurry loop 2 high pressure	25 psig				None	Pressure control valve PCV-15 may be malfunctioning and/or loop 2 may be clogged. Check control loops 13 and 15 and adjust the desired pressure setting (20 psi ±) for PCV-15. If necessary, initiate loop 1 operation and shut down loop 2 for maintenance and cleanout.
LAL-31	Utility water holding tank TK-8 low level			23 ft		Start the utility water pump before TK-8 level drops to the low-level alarm setpoint. See Table 7-1 for a listing of setpoints.	Ensure that the utility water pump (P-5A, P-5B, or P-5C) is running.
LAH-31	Utility water holding tank TK-8 high level	29 ft				Shut down the utility water pump before TK-8 level reaches the high-level alarm setpoint.	Ensure that the utility water pump is shut down.
OA-37	Utility water booster pump P-7 operation				X	None	Check the electrical and instrumentation control systems for P-7. Call maintenance service, if necessary.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
FAL-36	Low filtrate sample flow to the effluent monitoring station			3 gpm		Shut down the filtrate pumps if there is no flow in the sample line within a set time (adjustable from 0 to 30 minutes at the PMCS).	Ensure that the inlet valve on the sample line and the pumps' discharge valves are fully open. Refer to troubleshooting guides for the filtrate pumps provided in Section 4 and in the vendor's O&M manual.
AAL-23	Low filtrate pH			6.8		None	Check the calibration of the pH monitoring system. Clean the pH sensor. If the filtrate pH remains low even after checking or rectifying the pH instrumentation system, check operation of the treatment system, including lime feed flow and pH controls at the simple mix tanks. Initiate lime slurry loop 2 operation, if necessary (due to increased AMD lime demand).
AAH-23	High filtrate pH	9.0				None	Check the calibration of the pH monitoring system 2 Clean the pH sensor. If the filtrate pH remains high even after checking or rectifying the pH instrumentation system, check operation of the AMD treatment system, including lime feed flow and pH controls at the simple mix tanks.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
AAH-24	High filtrate turbidity	100 NTU				None	Check the calibration of the turbidity monitoring system. Clean the turbidity sensor. If the filtrate turbidity still remains high, the filtrate collection system to the drying bed may have failed. Make arrangements for inspection of the filtrate collection system.
LAHH-78	Thickener Sludge Blanket Level High-High Alarm	18'-8"				None	Use both sludge waste lines to drain to drying beds. If the flow velocity is not adequate, operate sludge waste pumps.
LAH-78	Thickener Sludge Blanket Level High Alarm	16'-8"				None	Use one sludge waste line to drain to drying beds. If the flow velocity is not adequate, operate one sludge waste pump.
LAL-78	Thickener Sludge Blanket Level Low Alarm	11'-2"				None	Reduce to use one sludge waste line. Consider shutting sludge waste pumps if running.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
LALL-78	Thickener Sludge Blanket Level Low-Low Alarm	7'-2"				None	Close both sludge waste lines and shut down sludge waste pumps..
MAH-93A	Center Column Pump Moisture Detected	PumpMFR. STD.				Shut down Center Column Pump and alert operators in the PMCS..	Check and replace submersible motor housing seal or pump mechanical seal. Replace moisture switch if sensor is bad. Arrange to use the other pump.
MAH-93B	Center Column Pump Moisture Detected	PumpMFR. STD.				Shut down Center Column Pump and alert operators in the PMCS.	Check and replace submersible motor housing seal or pump mechanical seal. Replace moisture switch if sensor is bad. Arrange to use the other pump.
QA-81	Thickener Rake Drive Failed.				X	None	Check the electrical and instrumentation control systems for MX-11, Rake Drive. Call maintenance service, if necessary.
QA-93A	Center Column Pump A Failed.				X	None	Check the electrical and instrumentation control systems for P-12A Center Column Pump A. Call maintenance service, if necessary.
QA-93B	Center Column Pump B Failed.				X	None	Check the electrical and instrumentation control systems for P-12B Center Column Pump B. Call maintenance service, if necessary.

Table 6-2
Computer Alarm Summary

Tag	Alarm Description	Alarm Setpoint				Instrument/ Electrical Control Action	Operator Response
		High	Middle	Low	Off		
QA-77	Reactor A Mixer Failed.				X	None	Check the electrical and instrumentation control systems for MX-13, Reactor A Mixer. Call maintenance service, if necessary.

7.0 Operator Training

7.1 Instructional Objectives

The objectives of these courses are to familiarize personnel with the High Density Sludge (**"hds"**) system, and its differences with the original ASM system, with the operation and control of the Thickener, with sludge production and wasting, with recycling and neutralization, and with the instrumentation and control of the system.

7.2 Sludge Treatment Process

Session: December 2
Location: Classroom and facility

7.2.1 Facility and Treatment Process Overview

Classroom or facility:

Time: ½ hour

EIMCO Representative: Craig Mc Donald

1. Basic change in the AMD treatment process from the Aerated Simple Mix System [ASM] to High Density Sludge Treatment [**"hds"**].

2. The EIMCO equipment that made the change possible.

3. EIMCO selected on basis of quality, dependability and technical experience.

7.1.2 The Treatment Processes

Time: 2 ½ hours

EIMCO Instructor: Vaughn Weston

Classroom:

1. Acid Mine Drainage [AMD]--its sources and lime treatment to neutralize, oxidate and precipitate.

2. Aerated Simple Mix System [ASM]--previous method of treatment and sludge wasting.

3. High Density Sludge [**"hds"**]--densification and recycling of sludge in Thickener; lime treatment in Reactor A; and sludge wasting.

4. Differences in the two systems ASM and **"hds"** and ASM as option; basic densification requirements in sludge recycling.

5. Critical factors affecting the performance of the **"hds"** process.

6. Effluent limits and EPA requirements.

Facility walk around:

1. Physical facilities and major equipment.

2. Flow through the treatment plant from the AMD to the drying beds and effluent.

7.2 Thickener Operation and Control

Session: December 2
Location: Classroom and facility

7.2.1 Thickener Components

Time: 1 hour
EIMCO Instructor: George Foster

1. Mechanism components

   a. Thickener basic components, size and configuration, a general orientation
   b. Stationary column w/sludge discharge ports
   c. Drive unit, cage and rake arms
   d. Lifting device telescoping column, cables and sheaves, cable drum, and drive platform
   e. Superstructure, supports and monorail with hoist

f. Submersible sludge pumps with moisture protection and sludge lines to recycle and waste
g. Influent launder, feedwell and effluent launder
h. Sludge level control and indicator

2. EIMCO C120B2P drive components

a. Duty rated torque and size
b. Main gear assembly with precision bearing
c. Secondary drives and pinions
d. Worm drives with shaft mounted gear reducers and motors
e. Primary drive control:
   - worm shaft, sliding seat, compression spring and bearings
   - drive control cams action and limit switches for warning, lift device control and drive cut-out; enclosure and arrow
f. Secondary drive cut-out switches

3. CLD Rake Lifting Device

a. Cable, cable drum and sheaves
b. Telescoping column and guides
c. Lift limit switches

7.2.2 Thickener Operation

Time: 4 hours
EIMCO Instructors: Vaughn Weston and George Foster

1. Operation

a. Purpose of the gravity Thickener in sludge densification; thicken to 20:1+ sludge ratio by sedimentation and recycling.
b. Sludge level control with level transmitter and sludge wasting; rake lifting and sludge level; solids inventory.
c. Center column pumps recycle sludge back to Reactor A or sludge wasting; one pump normal and 2 pumps for high flows.
d. Drive control and automatic rake lifting:
   - Torque levels and alarm (40%), and automatic rake arm lifting (50%)
   - Torque and automatic rake arm lowering (30%) at 15 sec intervals
   - Control from local panel

2. Thickener Start-up

   a. Filling the tank with treated AMD.
   b. Using the treated AMD clarified water to do hydro-static test.
   c. Sludge recycling and **"hds"** start-up.

3. Operating difficulties and adjustments

   a. Higher than normal torque, overload alarm sounds, lift position at highest level.
   b. Loss of electrical power; normal start-up sequence.
   c. Poor settling sludge; no clear interface of solids; solids in effluent.
   d. Operating with lifting device at maximum lift.

4. Shutdown

   a. Thickener shutdown while ASM process continues
   b. Emergency shut down of Thickener; maintenance warning in case of high torque shut down
   c. Long term shut down
   d. Restart after power failure

5. Trouble shooting

   Mechanical problems:

   a. High torque alarm
   b. Rake drive torque build up - lift device at maximum lift
   c. Rake drives stop or won't start
   d. Lift device does not operate, lift or lower
   e. Center column pump(s) does not start after 5 seconds or stops
   f. Sludge recycle and/or waste line(s) is not flushed
   g. Line flushing time is too short

   Process problems:

   a. Sludge level too high
   b. Sludge level too low
   c. Solids in overflow effluent
   d. Low solids content in sludge
   e. Sludge not discharging to thickener from Reactor(s)

7.3 Thickener and Accessories Lubrication and Maintenance

Session: December 3
Location: Plant site

Time: 4 hours
EIMCO Instructor: George Foster

7.3.1 Thickener Review and Safety Warnings

1. Thickener mechanism components - review and orientation
2. Maintenance WARNINGS -
   a. Moving parts and electrical power
   b. Lock out power before maintenance
   c. Knowledge of equipment necessary

3. Thickener rake drive maintenance WARNING
   a. Check for stored high torque energy - 2 steps to recognize stored energy
   b. How to relieve stored energy
   c. Dangerous methods

7.3.2 Thickener Lubrication

1. Drive unit
   a. Check oil levels weekly (worm, secondaries and main)
   b. How to add oil to the drive
   c. How to remove condensate and clean sight glass vents
   d. Replace oil once a year, or use synthetic oil, alternative
   e. Recommended lubricants and lube equivalents-
   f. Magnetic probe to check drive for wear

2. Lifting device
   a. Importance and method of lubricating the wire rope
   b. Special wire rope lubricant
   c. Sheaves and drum lubrication
   d. Lubrication intervals

3. Gear reducers and motor drives
   a. Manufacturer's recommendations for interval checks and methods
   b. See manufacturers for recommended lubricants

7.3.3 Thickener preventive maintenance

1. Maintenance summary and frequency - in manual
2. Drive control and secondary control checks; and drive general inspection including belts tension
3. Lifting device
   a. 6 month inspection of wire rope for wear, damage and fatigue
   b. 6 month inspection of drum and sheaves for wear and damage

7.3.4 Drive and lift device repairs

1. Rake drive, drive control demonstration of limit switch actuation
2. Locations of drive and lift device disassembly and reassembly instructions in the manual
   - Inspection of gears, worms, bearings, seals and their replacements
3. Parts and repair orders
4. Reducers and motors - manufacturer's instructions

7.4 Process Monitor and Control System - Wonderware

Session: December 3 and 4
Time: 6 hours
Location: Classroom and control room

CDC Instructor: _____

7.4.1 Unit description

1. System overview and equipment descriptions
   [PLCs] Programmable logic controllers (3)
   [I/O] Remote I/O units
   [MMI] Man machine interfaces
   [UPS] Uninteruptive power supplies
   portable work station
2. Start-up and "boot up of system" and normal operation
3. New and modified screens
4. Demonstration of MMI graphics display, proper keystrokes, controls, setpoints, functions and alarms
5. Digital control with conventional PLCs alarms
6. Potential operating problems

System malfunction, emergency operation and alternative operation

7. Hands on operation at the control console

7.5 PICS Process Control

Session: December 4
Time: 4 hours
Location: Plant site

CDC Instructor: _____

7.5.1 Control Philosophy

1. Control concept
2. Control of operating system with loops

7.5.2 Details of loops

1. Functions
2. Equipment
3. Location on P&ID drawings and relationships to the equipment
4. The loops from 31 through XX

7.6 Instrumentation and Monitoring Equipment

Session: December 4
Time: 2 hours
Location: Classroom and facility

CDC Instructor: _____

7.6.1 pH controls

1. pH meters and transmitters
2. Locations and loop controls
3. The calibration and adjustment

7.6.2 Flow meters

1. The flow meters
2. Locations and controls

3. Calibration and adjustment

7.6.3 Sludge level detector

1. The level detector
2. Adjustment for setpoint levels
3. Maintenance

7.7 Reactor A Mixer, Center Column Pumps And Waste Pumps

7.7.1 Center column pumps

Session: December 5
Time: 4 hours
Location: Classroom and Plant Site

Envirotech Pump Instruction: Brad Walton

a. Use of hoist for removal from column
b. General pump description and information
c. Pump parts locations
d. General pump maintenance
e. Trouble shooting
f. Hands on visual inspection and questions and answers

7.7.2 Waste pumps -

a. General pump description and information
b. Pump parts locations
c. General pump maintenance
d. Trouble shooting
f. Hands on visual inspection and questions and answers
g. Flush valves and their locations

Davidson Sales & Engineering Instructor: _____

7.7.3 Reactor A, Lightnin Mixer

Session: December 5
Time: 2 hours
Location: Classroom and facility

Lightnin Instructor: Jeff Caulfield (Milton S. Frank Co.)

a. Lightnin mixer description and overview
b. Safety features
c Start-up and operation
d. Maintenance of mixer
e. Questions and answers

EIMCO Instructor: _____

f. Lime slurry valves - manufacturer's manuals

7.8 Process Monitoring, Documentation and Sampling

7.8.1 Composite Sampler

Session: December 5
Time: 3 hours
Location: Class room and job site

Waterford Systems Instructor: Jeff Wiest

a. General sampler description
b. Programming the sampler controller
c. Trouble shooting techniques
d. Sampling procedure
e. Performance of an operating test
f. Hands on visual inspection and questions and answers

7.8.2 Samples and the Analytical Requirements

Session: December 6
Time: 1 hour.
Location: Class room

Instructor:,_____

a. Sample analysis
b. Alalytical requirements
c. Use of samples in making decisions

7.8.3 Review Data Forms

a. The data forms

b. Interpretations of data

7.9 Health and Safety

Session: December 6
Time: 2 hours
Location: Class room

EIMCO Instructor: _____

7.9.1 Process Health and Safety

7.9.2 Health and Safety Review

7.8 Questions and Follow-up

8.0 Safety

8.1 General

Treatment plant personnel are potentially subject to physical and bodily injury as are workers in all industries. To reduce the probability of such incidents, all treatment plant personnel should be familiar with the safety practices discussed within this section. Where indicated, the following safety recommendations are required by the Occupational Safety and Health Administration (OSHA). A more thorough discussion of the OSHA standards may be found in 29 CFR 1910, OSHA Safely and Health Standards, U.S. Department of Labor, OSHA.

The procedures and practices established here represent those that will be most commonly encountered and used in the operation of the treatment plant. However, such procedures and practices are not intended to serve as a substitute for common sense, or for safety practices and procedures recommended by equipment and material vendors and suppliers. Specific emergency response procedures have been presented in Section 8.

8.2 Electrical Hazards

Since most of the mechanical equipment in the treatment plant is powered by electricity, the following rules should be adhered to:

- Do not ground yourself in water, on pipes, or on drains. Avoid them when working near any electricity.
- Allow only authorized personnel to work on electrical equipment and to perform repairs or maintenance.
- Keep all electrical controls accessible and well-marked.
- Keep rubber mats on the floor in front of electrical panels; keep edges trimmed so that they do not become a tripping hazard.
- Keep wires from becoming a tripping hazard.
- Place "Man on Line" signs and lock the switches when working on electrical equipment that another person can turn on (e.g., implement a lockout/tagout program).
- Never use metal ladders around electrical equipment.
- Handle breaker wires as though they were live wires.
- When there is a question about any electrical hazard, ask before you expose yourself to it.

Do not use any part of your body to test a circuit.

Ground all electrical tools.

When working around electrical equipment, as with any other hazardous work, keep your mind on the hazard at all times.

8.3 Mechanical Equipment Hazards

The following "General Safety Regulations" outline most of the safety precautions applicable when working around mechanical equipment:

- No one will be allowed at the treatment plant while under the influence **of** alcohol or narcotics.

- No one will be allowed to work while his/her abilities are impaired **by** fatigue, illness, or other causes that might increase the risk of an accident or injury.

- Horseplay of any sort will not be tolerated.

- Employees shall not work in or around any mechanical equipment lacking mechanical belt guards or other protective devices (approved guards are to be installed on all applicable moving equipment).

- Ensure that highly visible hazard warning signs (e.g., moving parts, thermal hazards, vehicular traffic, construction hazards, electrical hazards, etc.) are posted in appropriate areas.

- Personnel shall perform no maintenance beyond the scope of their duties unless first receiving specific instructions from their supervisor.

- No employee shall enter any confined spaced unless the appropriate safety procedures (OSHA confined space standards can be found in 29 CFR 1910) are followed.

All personnel shall thoroughly cleanse that portion of their body that inadvertently comes in contact with AMD, treated sludge, or other chemical substance.

- Personnel shall familiarize themselves with the location and operation of all fire extinguishers and safety equipment.

- Hard hats shall be worn at all times where danger of falling objects exists.

- Where appropriate, safety glasses or goggles must be worn in areas with potential eye hazards (treatment plant area, on-site laboratory, etc.).

- Loose clothing shall not be worn around any moving mechanical equipment.

- No mechanical equipment shall be repaired or adjusted while in operation.

- Gasoline or other highly flammable liquids shall not be used for cleaning purposes.

- All injuries or accidents shall be immediately reported to the plant supervisor and an incident report filed. Injured personnel requiring a physician's care may not return to work without that physician's release.

- All areas within the treatment facility shall be kept clean and free from potential safety hazards.

8.4 Explosion and Fire Hazards

All plant personnel will be trained in the proper use of fire extinguishers and in the emergency response procedures for fires. The location of each fire extinguisher should be marked by highly visible signs.

In addition, observe the following fire prevention regulations:

All work areas shall be kept clean and free from accumulations of trash and debris.

Rags containing grease and oil shall be deposited only **in** a vented metal container.

Smoking is forbidden at the treatment plant except at specifically designated locations.

- All potential fire hazards shall be reported immediately to a supervisor.
- Extreme care shall be exhibited whenever handling flammable liquids.

8.5 Laboratory Hazards

To provide personnel with additional information on the hazards of laboratory chemicals, Material Safety Data Sheets (MSDSS) should be obtained and made available in the laboratory. In addition, the following safe laboratory practices will aid in the development of an effective accident prevention program in the laboratory:

<u>General Laboratory Conduct</u>

Follow instructions explicitly.

Perform only authorized analyses.

Protect eyes, face, hands, and body.

Practice good housekeeping.

Know where to get help fast.

Know the locations of fire extinguishers, first-aid kits, and other safety equipment.

Report at once all accidents and unusual occurrences.

Do not smoke in the laboratory.

Do not "horse around."

Handling Glassware

Inserting glass-tubing in a stopper:

·Protect hands with gloves or cloths.

Match diameters of stopper holes and tubing. Fire polish too] ends of tubing.

Moisten or lubricate tubing and hole. Hold tubing in hands close to hole. Do not force too vigorously.

Pouring AMD, Reagents, or Other Liquids

Read labels carefully.

Hold bottle well away from face.

Use funnel in small bottles.

Pour down a stirring rod or the wall of a vessel. Clean up spills immediately.

Hold beakers or bottles with both hands. Return bottles to safe-storage area.

Pour acid into water, NEVER water into acid.

Help

· Protect eyes.

· Keep noxious and toxic chemicals under hood.

· Do not use an open flame to heat flammable liquids.

Carrying Glass Bottles of AMD, Acids, bases, and other Corrosive and Flammable Liquids

Use a container of sufficient capacity to hold liquid if the bottle should break.

In addition, ensure that the laboratory layout is safe by taking the following measures:

Ensure exits, aisles, stairways, doors, etc., are clear at all times. Maintain exhaust hoods.

Maintain ventilators

Maintain adequate lighting.

Do not clutter laboratory with unneeded or unused furniture. Maintain adequate storage facilities.

8.6 Chemical Handling Minimum Safety Requirements

Presented below are the minimum safety requirements to be followed when handling chemicals. Plant personnel are encouraged to supplement this list as required to maintain safe working conditions:

When unloading chemicals from a tank truck (e.g., calcium oxide), ensure that the handbrake is set and all wheels are locked.

- NEVER leave the tank truck or hose unguarded during unloading operations.
- Be cautious in areas of high vehicular traffic (e.g., when receiving lime truck deliveries, when hauling sludge to BFP, etc.).
- All personnel at the treatment plant should be aware of the proper spill response procedures as specified in the MSDS.
- Whenever working around chemicals, all personnel must wear the proper safety equipment as specified in the applicable MSDS (MSDSs are to be made available to all plant personnel).

- All personnel must learn the location and use of safety showers, eyewash fountains, and first-aid kits prior to working in an area.

- All operating personnel at the treatment plant should -be familiar with the appropriate first-aid procedures in case of accidental chemical exposure. These procedures should be obtained from the MSDS or directly from the chemical manufacturer.

Chemical-specific hazards are listed below. For any chemical brought on-site, vendor MSDSs should be obtained and reviewed.

AMD

AMD is acidic; therefore, skin or mucous membrane contact might result in irritation. Prolonged skin contact or inhalation of aerosols or mists of the AMD should be avoided. Workers with a potential for exposure to AMD should be protected by the use of a disposable dust mask, impervious gloves, and splash-proof safety glasses or goggles. Although traces of zinc, copper, and cadmium are present in the AMD, their concentrations are below the OSHA cutoff of 1,7o for hazardous constituents of a mixture and the 0.1% requirement for describing mixture components that have a carcinogenic potential.

Following eye or skin exposure to AMD, flush the affected area with copious amounts of water. If ingested (and the victim is conscious), dilute with large amounts of water, but do not to induce vomiting. Seek medical assistance following any exposure.

Calcium Oxide (CaO)

Calcium oxide is a caustic and irritating material. Untreated contact and irritation can cause dermatitis and chemical burns. Impervious gloves and clothing and safety glasses should be worn when the potential for contact exists. Calcium oxide dust is considered a significant industrial hazard. The treatment plant will minimize employee exposure to calcium oxide dust (the entire lime storage and preparation system will be outdoors). A National Institute for Occupational Safety and Health (OSHA)-approved respirator (not to be used in oxygen-deficient enviromnents) should be used when responding to baghouse pluggages, leaks, and/or spills.

Following eye or skin exposure to calcium oxide or calcium hydroxide, flush the affected area with copious amounts of water (do not use soap). If ingested (and the victim is conscious), dilute with large amounts of water, but do not induce vomiting. If calcium

oxide has been inhaled, immediately move the exposed person to fresh air. Seek medical assistance following any exposure.

Calcium Hydroxide ($Ca(OH)_2$)

Calcium hydroxide is formed by hydrating calcium oxide. Lime slurry used to neutralize AMD is a suspension of calcium hydroxide. Calcium hydroxide is considered a skin, mucous membrane, and respiratory system irritant. As with calcium oxide, impervious gloves and clothing and safety glasses should be worn when the potential for contact exists.

Emergency first-aid procedures are the same as for calcium oxide.

Sodium Hypochlorite (NaOCl)

A 15% sodium hypochlorite solution is used to disinfect the treatment plant utility water supply. Sodium hypochlorite is a corrosive material, an oxidizer, and an eye irritant. It should be noted that sodium hypochlorite produces highly toxic chlorine gas when strongly heated (during a fire).

Emergency first-aid procedures for exposure to sodium hypochlorite solution should be reviewed from the vendor MSDS once received.

8.7 Safety Equipment

In order to keep all safety equipment in ready order, the following must be adhered to:

Periodically inspect safety showers and eye-baths.

Periodically inspect fire extinguishers.

Provide adequate personal protective equipment (PPE), safety glasses, face masks, gloves, aprons, respiratory equipment, etc.

In addition, emergency facility information should be accessible, as follows:

- Keep first-aid kits and post first-aid procedures for poisoning, burns, bleeding, etc.
- Post telephone numbers of physicians, ambulance, and fire department (such a list is provided in Subsection 8.2).

9.0 Maintenance Procedures

9.1 Thickener Drive Lubrication

The drive is a combination of EIMCO manufactured drive components and gear motors purchased from others. These instructions apply only to the Eimco manufactured components. **Note:** EIMCO drives are shipped without oil.

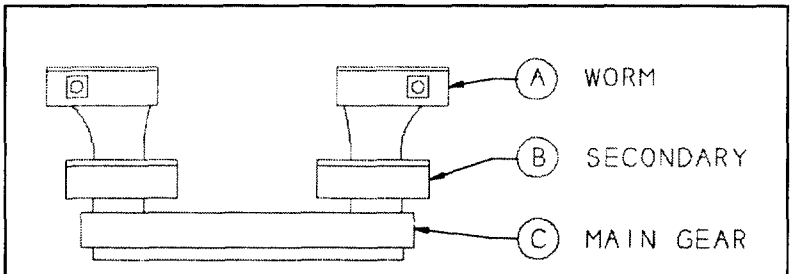

Fig. a

PART	METHOD	MINERAL LUBRICANT*	AGMA NO.	SYNTHETIC LUBRICANT**
Worm Gear (A)	Oil Bath	Mobilgear 632 oil	6EP	Mobil SHC 630
Secondary Gear (B)	Oil Bath	Mobilgear 632 oil	6EP	Mobil SHC 630
Main Gear (C)	Oil Bath	Mobilgear 632 oil	6EP	Mobil SHC 630

* Although Mobil products are specified, any equivalent product can be used. Refer to the Lubricant Equivalent List in this manual.

** Synthetic oil is recommended for year round use, or when ambient temperatures are below 20° F., and for all worm drives.

9.1.1 Check Oil Levels Weekly

A general oil level check can be made while the drive is operating, but to be more accurate, stop the drive a few minutes to allow the oil to settle. Excess oil will overflow.

9.1.2 Drain Condensate Once a Month

This will keep the oil free of water. Refill to operating level.

9.1.3 Clean the Sight Glass Vents

If the vent opening in the top screw plug is clogged or dirty, a sight glass will not show the correct oil level and it may not show an oil level at all. Check monthly.

9.1.4 Check the Magnetic Magnetic Probes

Clean at least every 2 months. Refer to "Magnetic Probes" instructions that follow below.

9.1.5 Replace the Oil Once a Year

Note: Synthetic oil has a much longer operating life than mineral oil and so there is no time limit for replacement, but a yearly oil analysis is required to evaluate contamination. Also, synthetic oil is recommended specifically for the worm gear drives due to its excellent lubricating qualities.

Oil replacement: Mineral oil should be replaced each year, but that can be extended a year or two provided a yearly analysis is made to check lubrication qualities and contamination. Drain the housing and refill with fresh oil, as specified on the preceding page.

Oil fill procedure: At first until the oil settles, a sight glass will not show an accurate oil level, due to settling time, trapped air and other factors. Allow the drive to sit at least 15-20 minutes after filling to check the oil level, and then recheck the level while operating [Item 1]. Be aware that too much oil will overflow.

9.1.6 Lubrication of the Drives, Pumps, and Other Equipment

Equipment supplied but not built by Eimco, refer to the manufacturer's instructions.

Drive chain If chain driven, lube with Mobilgear 632 oil, monthly.

9.1.7 Sight Glass Replacement -

If an oil level glass is replaced, it must be notched to show the oil level, as shown on the Drive Assembly drawing. Do likewise for drives shipped without the oil level notched.

DRIVE OIL QUANTITIES IN U.S. GALLONS

MODEL	WORM GEAR	SECONDARY GEAR	MAIN GEAR
C-120B2P	7½ (each)	55 (each)	100

9.1.8 Magnetic Probes

The purpose of the probes is to check for metal particles in the drive lubricant. The probes are located in the main gear housings.

The probes should be checked at 2 month intervals, when condensate is drained. Remove only the probes. Do not remove the pipe plugs.

From the first day a drive unit is operated, the lube oil can be expected to show evidence of metal particles. Normal wear in gears will generate particles 0.005 inch in size or less, which should not be a cause for alarm so long as the quantity of these small particles is not very high (3 particles or less per drop of lube oil is considered normal wear).

Metal particles of a larger size or an accelerated accumulation of smaller particles can be a concern and may represent severe wear of either gears or bearings. Weekly inspection of the particles separated from the oil on the Magnetic Probe will reveal whether the wear condition has stabilized, or is continuing to worsen.

Parts inspection and preventive maintenance should be scheduled if evaluation of the metal particles indicates abnormal wear. The use of synthetic oil in place of the mineral oil should be considered and/or a higher viscosity oil if the drive loading appears to be a cause of the wear.

9.2 CLD Rake Lifting Device Lubrication

ITEM	TYPE OF LUBRICANT	METHOD	INTERVAL
Cable Sheaves	Mobilith SHC 220	Gun	6 months
Drive Chain	Mobilgear 632 Oil	Wipe clean and apply with brush	Monthly
Gearmotor	Refer to the manufacturer's instruction		
Wire Rope	Mobilrama 798 (see below)		6 months
Drum Bearings	Mobilith SHC 220	Gun	Monthly

Wire Rope

Lubrication is important for proper operation and long life of the wire rope. And, frequent applications of lubricant are better than infrequent, heavy applications. The entire cable especially the portion on the drum must be lubricated.

Before lubricating, the rope should be cleaned to remove dirt or other abrasive material.

Lubricant:

Mobil Mobilarma 798 wire rope lubricant.

Any equivalent lubricant must have the following characteristics:

1. Be free of acids and alkalis.
2. Have sufficient adhesive strength to stay on rope.
3. Have viscosity capable of penetrating between the wires.
4. Have a high film strength
5. Must resist oxidation

Note:

It is recommended that the lifting device be operated through several complete lift and lower cycles periodically to distribute and maintain a protective film of lubricant on the working parts. Local conditions will dictate frequency of this operation. Also, before a prolonged shut down, the keys and guides must be cleaned and a heavy coat of grease applied.

Check drive chain tension periodically to make sure the chain is not slipping the sprocket.

9.3 Center Column Sludge Pump Removal

Refer to the Center Column Pump Removal Instructions drawing 76738D1490.

In the event a seal should leak or fail on a center column pump, a moisture detector will immediately disable the pump, and send an alarm. To repair the pump, it will be necessary to remove it from the column

Lifting cables are attached to each of the pumps with the lifting ends located at the intermediate lifting point at the lower grating inside the column.

9.3.1 Removal of a pump:

1. Shutoff and lock out the electrical power to the pump.

2. Remove the platform grating for access and removal of the pump. The platform removable grating is in two sections.

3. Disconnect the fast disconnects from the 8" pipe spool (11'- 0 length) to the pump being removed. Use the second hoist for lifting the pipe. Set the pipe and subsequant pipes in the space vacated by the spool.

4. From the overhead monorail, connect the cable to the lifting end of the pump cable inside the column at the lower grating This lower pump cable extends down to and connects to the pump. Pull the pump high enough to disconnet the next pipe spool.

5. Continue pulling the pump from the column and disconnecting the piping until the pump is in position on the platform to move it to a safe place for the seal repair, or other maintenance. Take care to prevent damage to the piping and connections during this procedure and storage on the platform.

6. Refer to the pump manufacturer's instructions.

9.3.2 Pump reinstallation:

1. As the pump is lowere into place in the column, connect the sections of piping in the order of the last pipes removed.

2. When the pump touches bottom, first connect the pump liifting cable end and connect it to the holding device in the column. Make sure all piping has been connected and s secure. Then disconnect the monorail cable and rewind.

3. Check pump operation. Replace the grating.

9.4 Lifting Device Wire Rope Maintenance and Replacement

While certain regulatory agencies have many requirements pertaining to wire rope and its applications, few requirements apply to this lifting device. But whether or not they apply, the wire rope should be inspected according to the list of critical inspections to follow. This list is to be used as a guideline in the inspection, but it is not intended as a substitute for the judgement of an experienced inspector.

9.4.1 Wire Rope Inspection

The wire rope should be inspected every 6 months for any of the conditions listed below that would indicate the rope should be replaced.

These inspections should be made both visually and by running a soft cloth (preferably cotton) over the entire length of the wire rope. Any area of the rope that picks up threads of the cloth should be reexamined.

Keep a record of all inspections.

Check for abrasion wear:

This is indicated by a reduction in rope diameter, including broken wires, or wear on the sheaves.

Rope diameter is checked by using calipers, as shown in Fig. a, when the wire rope is under load. Compare the dimension with the diameter recorded during installation.

NOTE: A reduction in the rope diameter is normal as load is applied to the rope.

Check for broken wires:

If the rope has 3 or more broken wires in any one lay (see Fig. a), it should be replaced.

NOTE: After start-up of a new rope a single wire may break. However, if no other wires break at that time, there is no need for concern.

Check for corrosion:

This is usually caused by a lack of lubrication, and it appears as both pitting of the wires and severe rusting. Increase lubrication, but if any wires are broken, refer to "Check for broken wires", above.

Check for protruding core:

If the rope core protrudes anywhere between the strands, or lays, the rope should be replaced. See Fig. a.

Check for scrubbing:

Scrubbing refers to the displacement of wires and strands as a result of rubbing around or against an object. This causes wear and displacement of wires and strands along one side of the rope. Replace the rope in case of protruding core or broken wires, referring above. Correct the cause of the scrubbing, if possible.

Check for fatigue failure:

This appears as wires that break with square ends, while showing little surface wear. These failures can occur on the crown of the wires or in the valleys of the rope. If the rope has more than 3 broken wires in any one lay the rope should be replaced.

Check for kinks (short tight twists or curls):

Ropes with kinks must be replaced.

A reduction in the rope diameter can be caused by:

a. Excessive external abrasion
b. Internal or external corrosion
c. Inner wire breakage
d. Rope stretch (refer to note above

9.4.2 Sheaves and Drum Inspection

The sheaves and the drum should be inspected every 6 months for wear or broken parts. Since worn or broken sheaves can damage the wire rope, this inspection should be made carefully.

Check the sheaves for broken or cracked flanges. Replace any that are damaged.

Check the sheaves grooves using a groove gauge. The gauge should fit into 150° of the arc of the groove as shown in Fig. b. Fig. c shows a groove that is too tight and Fig. d shows a groove that is too loose. Replace as necessary.

Check the sheaves and drum for smooth surfaces. Those that have burrs or other defects that could damage the rope should be replaced, if the defects cannot be removed.

Check the bearings on the drum. The bearing mounting bolts must be secure, the drum must be parallel with the column, and the drum must rotate freely.

9.4.3 Wire Rope Handling

Wire rope is shipped either in coils or on reels. Care must be taken when the rope is removed from the coil or reel, as the rope can be permanently damaged by improper unreeling. Looping the rope over the head of the reel or pulling the rope off a coil while it is lying on the ground will create loops in the rope. These loops when pulled tight will cause kinks in the rope. Once a rope is kinked the damage to the rope is permanent and cannot be repaired.

1. Unwinding wire rope from a reel:

Three methods can be used to remove the wire rope from a reel as shown below:

a. The reel can be mounted on supports, as shown in Fig. e, with the reel free to turn. The rope is removed from the reel by holding the end and walking away from the reel.

9.5 Drive Maintenance and Repair

10.0 Miscellaneous

11.0 Eimco Parts Lists

12.0 Eimco Drawings

13.0 Accessory Equipment