

Linear Motion (LM) Mixing of Digesters



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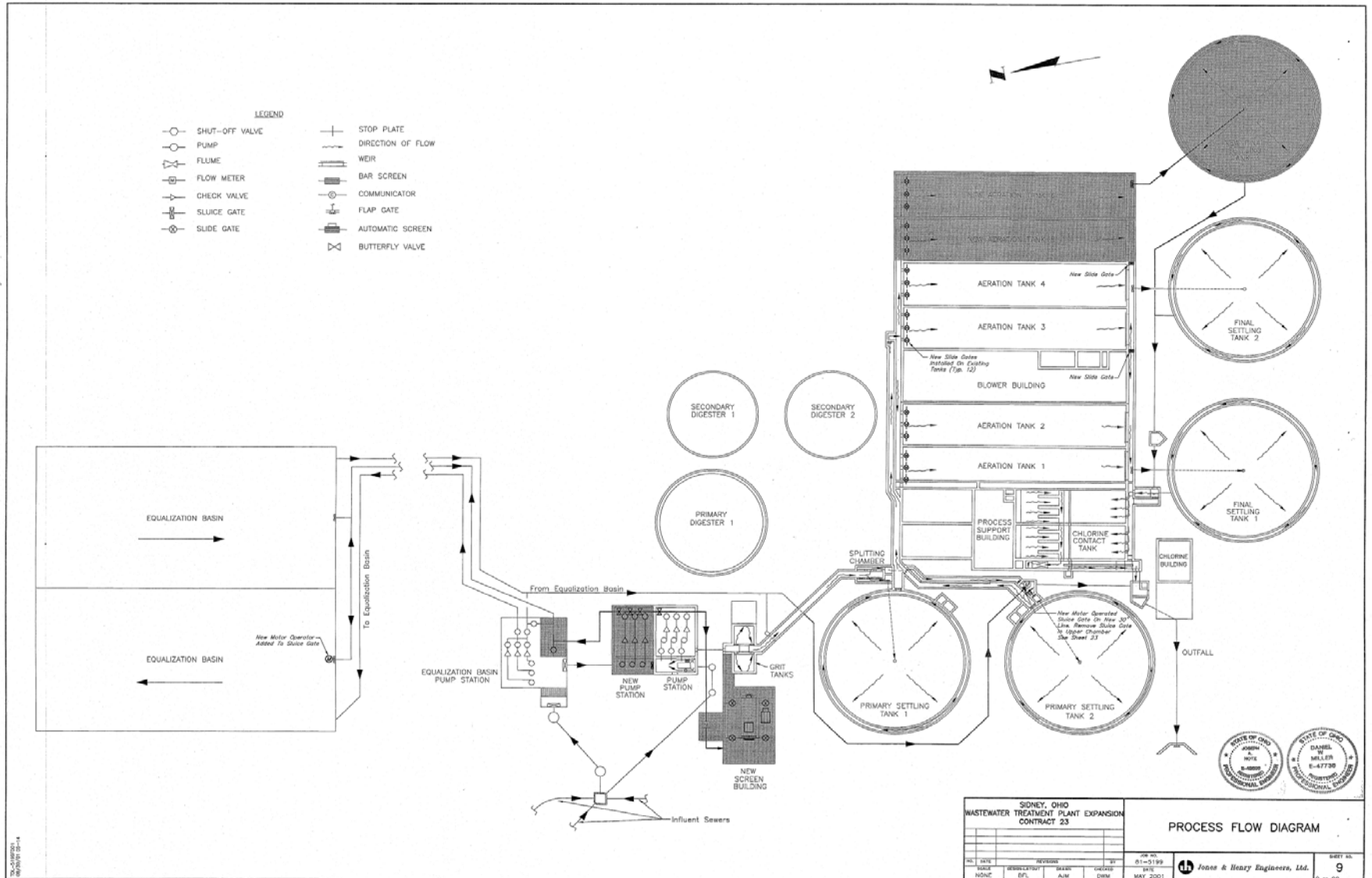


Linear Motion Mixing of a Digester

- Overview of the City of Sidney's WWTP
- Selection of the OVIVO (Eimco) LM Mixer
- Planning for the installation
- Installation
- Lessons learned
- Operational observations



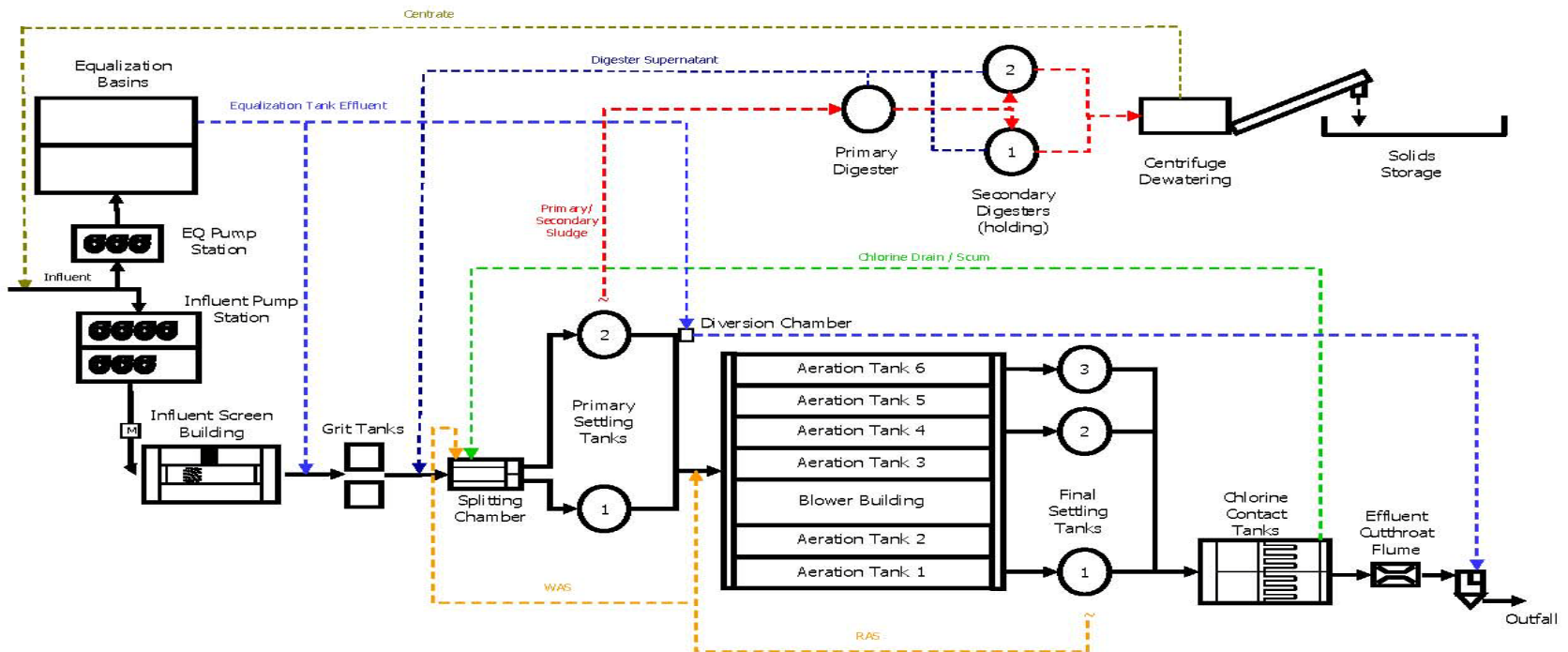
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Sidney, Ohio WWTP





Sidney WWTP

- **Staffing (8 full time staff)**
 - **Administration (2)**
 - **Operations (3) 1 Operator position vacant**
 - **Maintenance (1)**
 - **Laboratory (1)**
 - **Industrial Pre-treatment (1)**
 - **OTCO Intern (1)**
- **Storm Water Monitoring (1) – Stormwater Phase II**



Sidney WWTP

- Staffing
 - Normally staffed 7:00 am – 3:30 pm Mon-Fri
 - Weekends are staff 3-4 hrs through overtime
 - SCADA system provides continuous monitoring and call out capability
- Staff
 - Highly capable staff
 - Class IV – 1
 - Class III – 4 (Brian Clark Chief Operator 2010 recipient of the Dean Stewart award)
 - Class II - 1



Sidney WWTP

- 7.0 MGD Design ADF
 - 13.5 MGD Peak
- 20,500 people served
 - Population Equivalent of 52,000 based on flow & 35,000 based on loading
- 700 – 800 dry tons of biosolids land applied annually
 - Class B – table 3 (clean sludge)
- Significant Industrial Base
 - 45% of WWTP flow & 65% of WWTP loading from IUs
 - 16th largest IPP in Ohio
 - 16 Significant Industrial Users
 - 33 Control Documents in effect



Sidney WWTP ENERGY EFFICIENCY EFFORTS

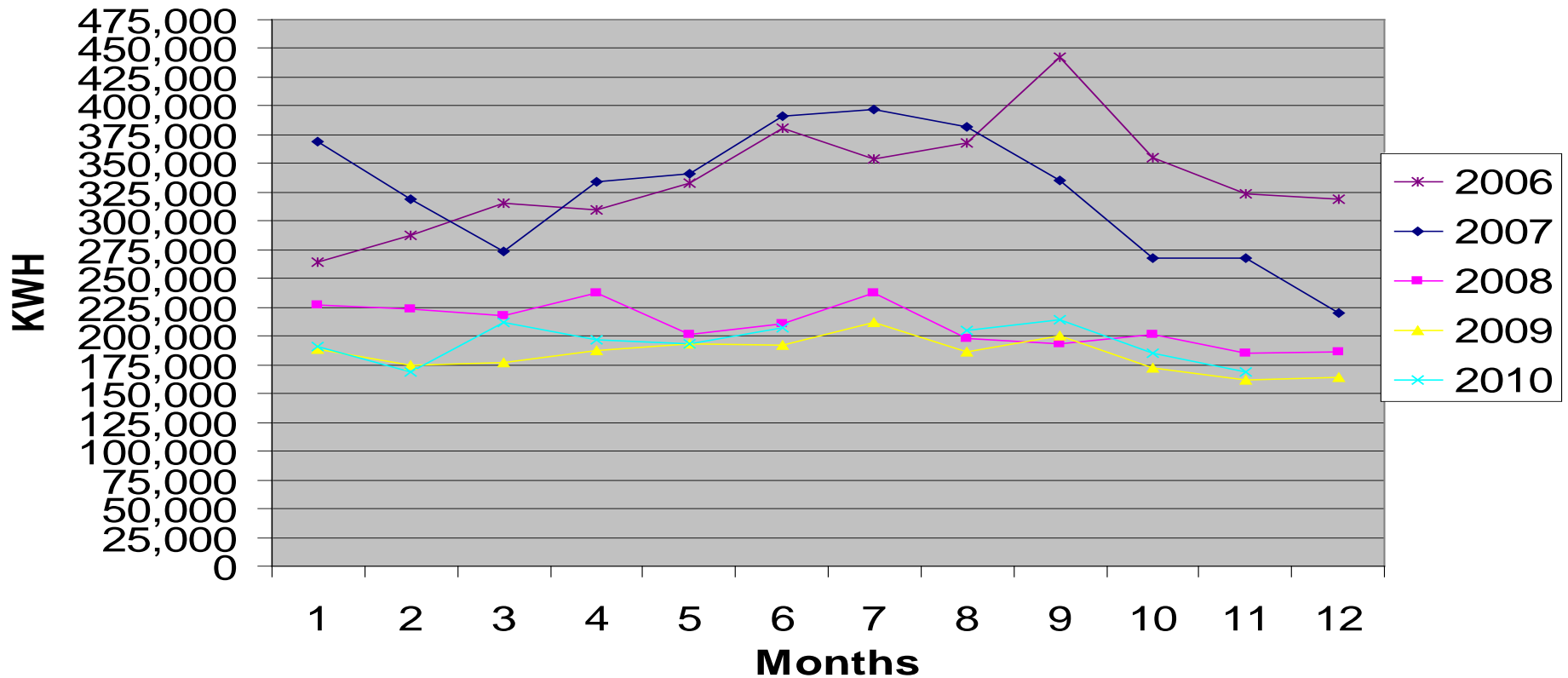
Energy Efficiency efforts Include

- Centrifuge operation moved to weekends to avoid peak demand and place centrate on plant during typically lower flow/loading periods
- Programming a “Blower Hold” function in the SCADA that prevents additional blower from coming on-line during peak demand times unless approved by the Operator
- Significantly increased use of VFD on motors <30 HP
- Aeration basin diffuser replacement
- Energy efficiency is considered when replacing equipment



Sidney WWTP ENERGY EFFICIENCY EFFORTS

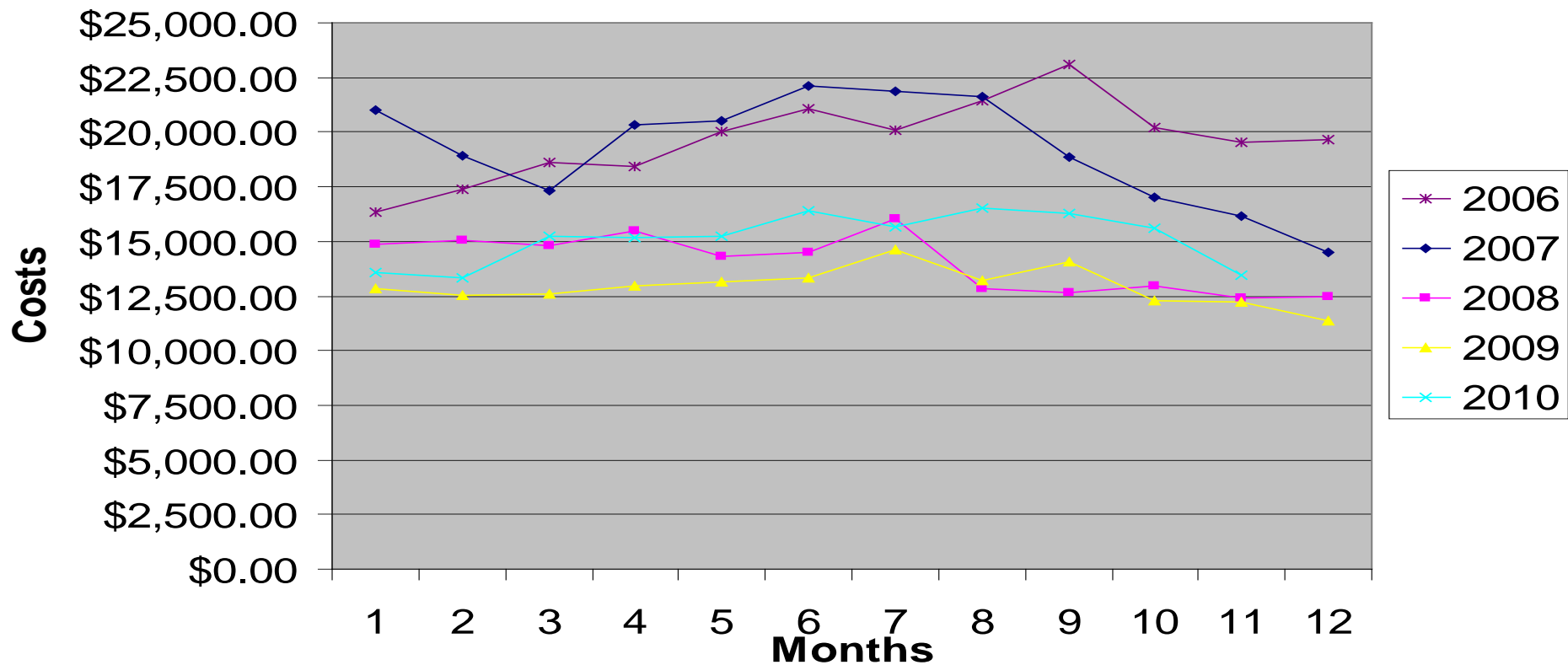
ELECTRIC USAGE





Sidney WWTP ENERGY EFFICIENCY EFFORTS

ELECTRIC COSTS





Repair/Replace existing mixers

- Existing Eimco RDT mixers were installed during 1989 expansion
- Fall 2009 - lower bearing failure caused one mixer to be removed from service
- Staff began researching options to repair or replace
 - cost estimates obtained to ship and repair existing mixers
 - quotes obtained to replace existing with similar new mixers
 - quotes obtained to replace existing with LM mixer



Repair or Replace?

- All options were evaluated based on the following
 - lead times to implement repair or replacement
 - cost to repair or purchase and removal/installation
 - estimated O&M costs
 - performance
- Vendor products considered were
 - Philadelphia Mixers (replacement mixer utilizing existing draft tubes)
 - Eimco (rebuild of existing or new Linear Motion mixer)



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Philadelphia

Pros:

- Reduced HP compared to existing
- Improved access for maintenance
- Lowest initial cost option

Cons:

- Questions regarding deflection with shaft length
- Questions regarding operation (forward/reverse)
- Higher O&M cost compared to LM mixer (less than existing)

PHILADELPHIA MIXING SOLUTIONS		DRN. ---	CHK. ---	REVIEWED BY			ORDER NO. _____	FA-BSE																					
OUTLINE INSTALLATION DRAWING		APPRD. ---	DATE ---	DEPT. ---	INIT. ---	DATE ---	SERIAL NO. _____																						
DRAWING NO. PM Q44940 Sidney, OH								QUANTITY ON THIS ORDER: _____																					
** ATTACH WARNING LABELS TO ALL COVERS **																													
								CAUTION CONSULT SERVICE MANUAL BEFORE PROCEEDING WITH THE INSTALLATION AND START-UP OF THIS EQUIPMENT	SIZE: FA-BSE B MODEL TOP ENTRY EXACT SPEED RATIO: 508 : 1 BELT S.F. 2.0 OUTPUT SPEED: 144 RPM																				
DESIGN CONDITIONS: MIX VOLUME: _____ MAX. MIX VOLUME: _____ MIN. MIXING PRODUCT: WATER SPECIFIC GRAVITY: _____ DEG F OPERATE DURING FILL OR DRAIN: <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO OTHER: _____				MOTOR: MAKE PMSL STANDARD HP: 5 RPM 1800 FRAME 215 T SERVICES: 3 PH 60 HZ 460 V ENCLOSURE: TEFC SUPPLIED BY PMSL SPECIAL: MillChem, Premium Efficient				STUFFING BOX: _____ DESIGN: PRESSURE _____ TEMP. _____ OPERATING: PRESSURE _____ TEMP. _____ TYPE: _____ MAKE: _____ INTERNAL COMPONENTS: METALLIC _____ FLEXIBLE _____ FACE MAT'L S _____ VS. _____ FLANGE FACING MATERIAL: _____ HOUSING MATERIAL: _____ LUBRICATION: REF. DWG. _____ SEALANT FLUID: _____	ADAPTOR FACE FLANGE SIZE: _____ SIZE & NO. OF BOLTS: _____ BOLT CIRCLE: _____ LOCATION: _____ MOUNTING FLANGE THICKNESS: _____ FLANGE MATERIAL: _____																				
VESSEL INFORMATION: (VESSEL SUPPLIED BY OTHERS) DIAMETER: _____ HEIGHT: 25 ft max HANDLE SP: BOLT CIRCLE: _____ SIZE & NO. OF BOLTS: _____ LOCATION: _____ PRESSURE: _____ TEMP: _____ BOTTOM TYPE: Close Bottom				NOTES: 1. SHAFT ROTATING CLOCKWISE LOOKING FROM BELT SPROCKET END. 2. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED. 3. ALL DRIVES TO BE PREPARED FOR LONG TERM STORAGE. 4. MOUNTING HARDWARE BY OTHERS.				MATERIAL REQUIREMENTS: WETTED PARTS IN TANK ARE IMPELLER 316 SS SHAFT 316SS UNLESS OTHERWISE SPECIFIED, HARDWARE MATERIAL, 316 SS SUBSTITUTION OF UPGRADED MATERIALS IS ALLOWED.	COMPONENT WEIGHT IN LBS. (APPROX.): MIXER WITH SHAFT _____ LBS. MOTOR _____ LBS. IMPELLER _____ LBS. FLANGE _____ LBS. AUTOMATIC COMPONENTS N/A LBS. TOTAL _____ LBS.																				
PAINT REQUIREMENTS: HOUSING: PMSL STANDARD PHILADELPHIA BLUE MOTOR: VENDOR STANDARD AGITATOR PARTS: NONE GUARD AND COVERS: SAFETY YELLOW W/CAUTION SIGNS				THIS DRAWING IS THE PROPERTY OF PHILADELPHIA MIXING SOLUTIONS AND IS SUBJECT TO RETURN UPON REQUEST. IT IS TO BE USED ONLY FOR THE PURPOSES FOR WHICH IT WAS EXPRESSLY FORWARDED AND IT IS NOT TO BE USED IN ANY WAY DETRIMENTAL TO THE INTERESTS OF THIS CORPORATION.				MIXER SUPPORT DESIGN LOADS: (INCLUDING SUITABLE OVERLOAD FACTOR) STATIC WEIGHT _____ LB. DYNAMIC SHEAR _____ LB. WEIGHT MOMENT _____ LB. IN. DYNAMIC MOMENT _____ LB. IN. DYNAMIC TORQUE _____ LB. IN.	CUSTOMER INFORMATION: NAME: _____ ADDRESS: _____ CITY: _____ STATE _____ ZIP: _____ SHIP TO: _____ ADDRESS: _____ STATE _____ ZIP: _____ CUSTOMER P.O. NO. _____ ITEM TAG NO. _____ REQUESTED ROUTING _____																				
PHILADELPHIA MIXERS CORP CERTIFIED DATA NAME: _____ DATE: _____				REVISIONS <table border="1"> <tr> <th>NO.</th> <th>DESCRIPTION</th> <th>NAME</th> <th>DATE</th> <th>APPROV.</th> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>				NO.	DESCRIPTION	NAME	DATE	APPROV.						REVISIONS <table border="1"> <tr> <th>NO.</th> <th>DESCRIPTION</th> <th>NAME</th> <th>DATE</th> <th>APPROV.</th> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </table>	NO.	DESCRIPTION	NAME	DATE	APPROV.						
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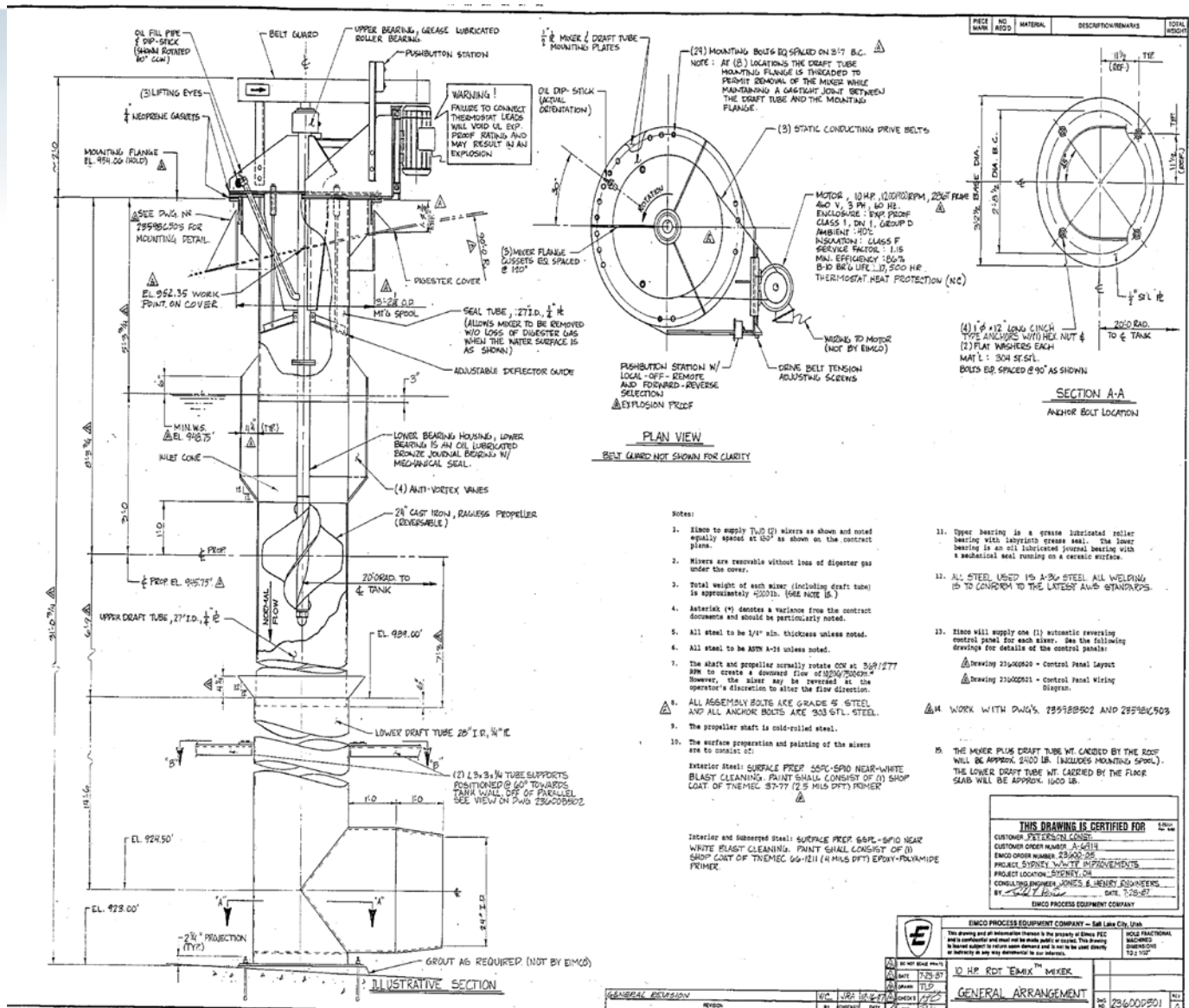
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EIMCO Rebuild Pros:

- Direct fit to our lid
- Known performance

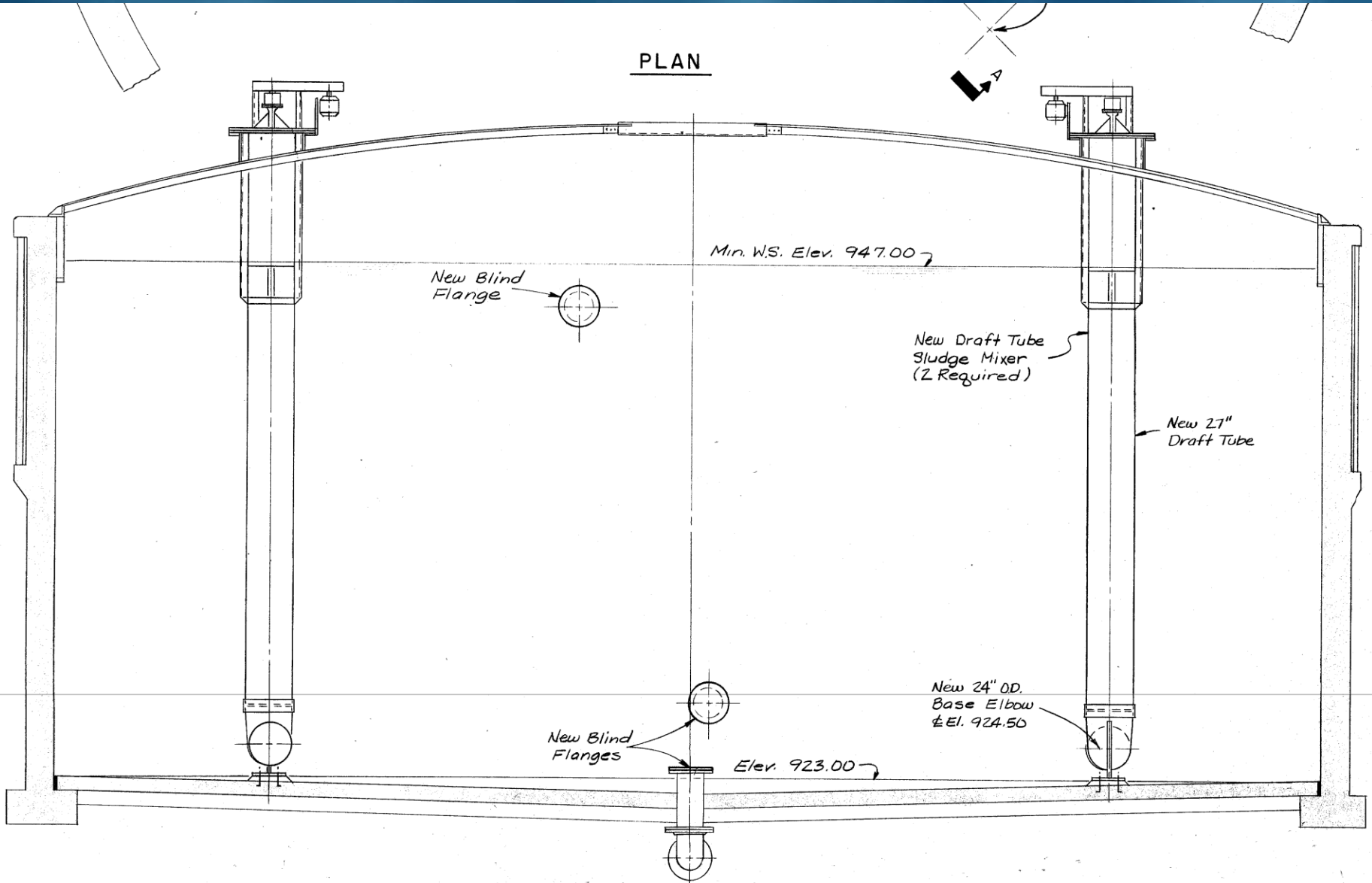
Cons:

- limited access for maintenance
- More expensive than replacement with Philadelphia mixer
- Longest lead time
- Shipping costs
- Least energy efficient





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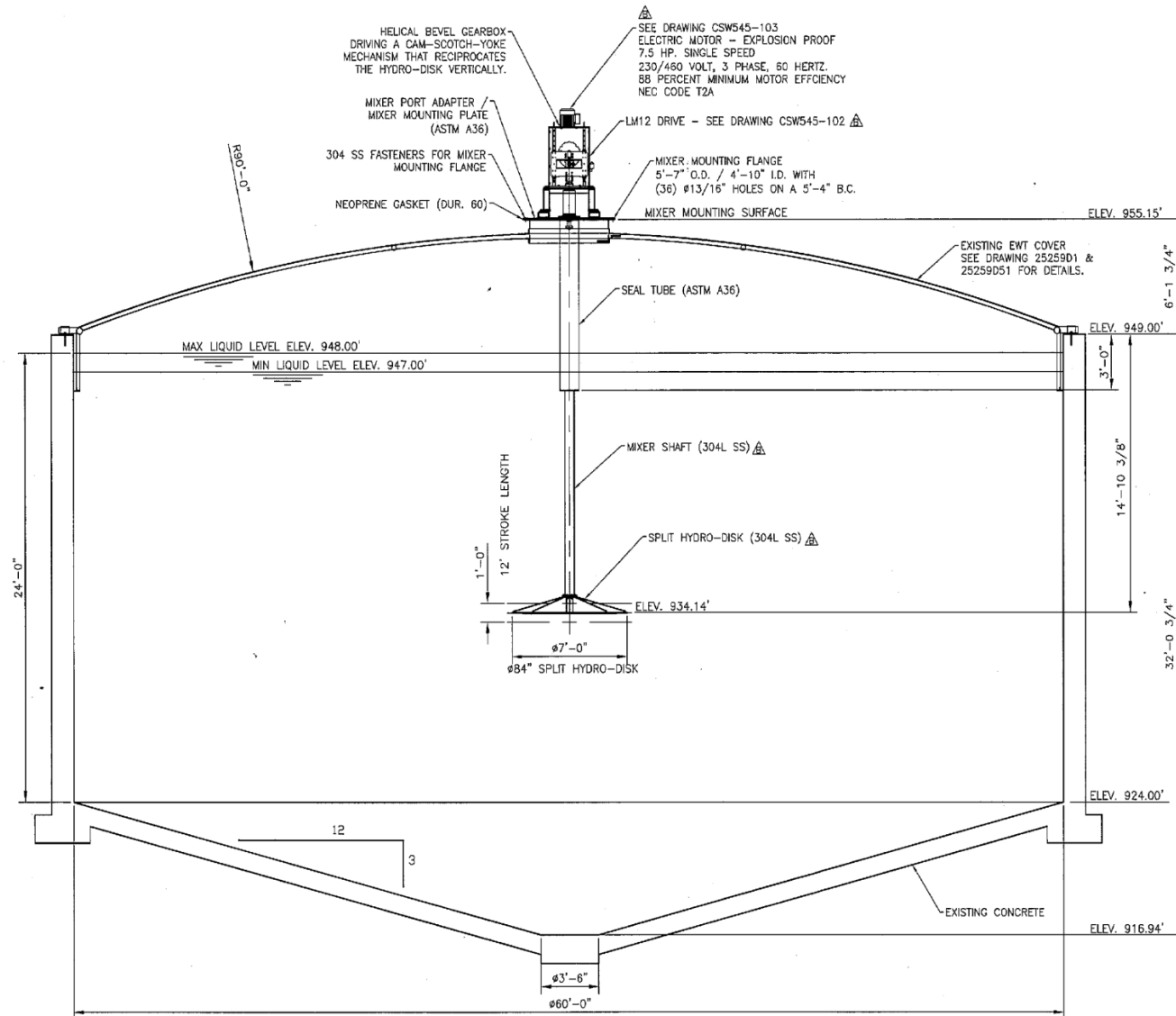
EIMCO (OVIVO) Linear Motion

Pros:

- 1 mixer needed
- 7.5 HP
- Direct fit to our lid
- Easy maintenance
- Lowest O&M costs
- CFD modeling for performance
- B&V evaluation of performance

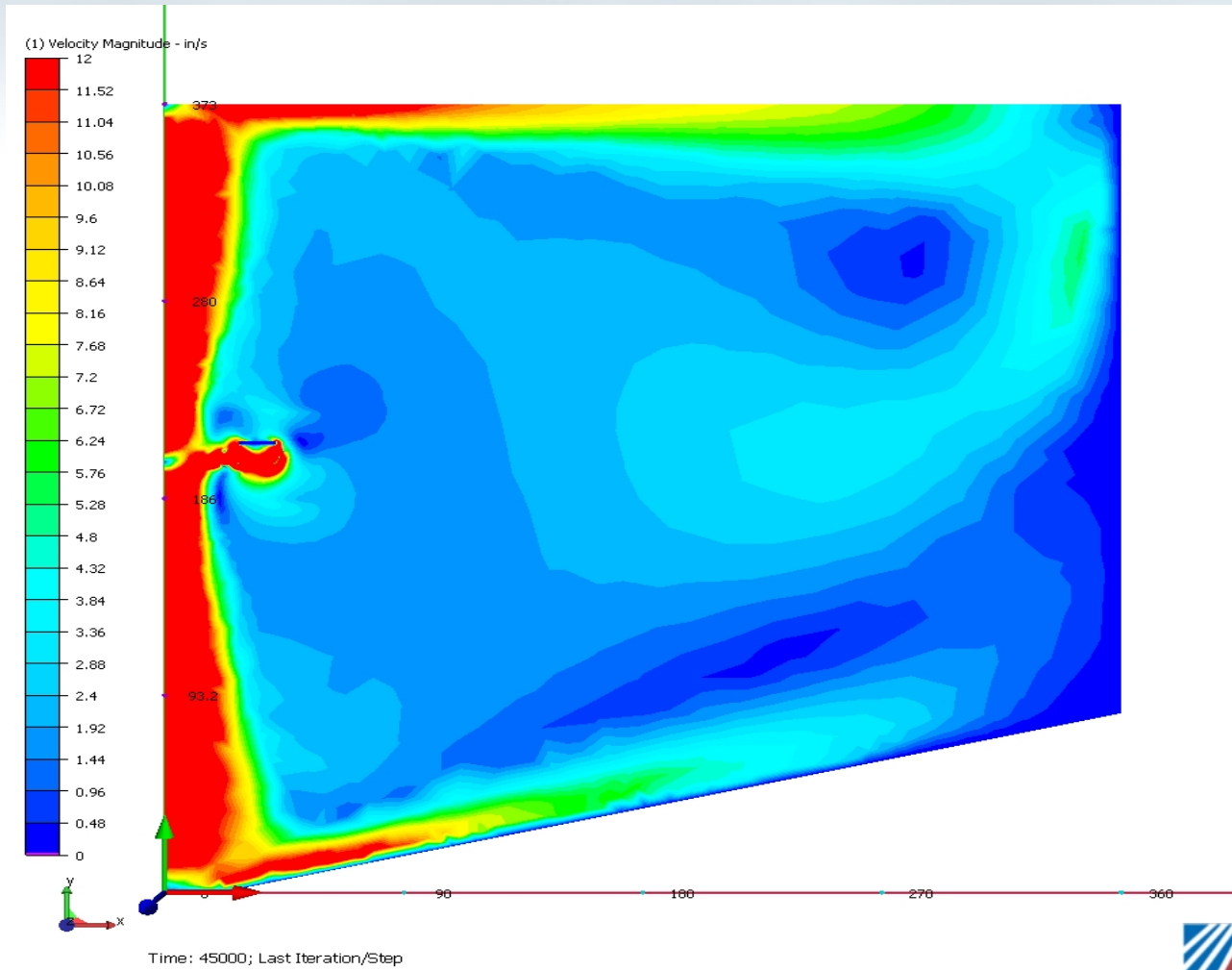
Cons:

- Limited use
- No redundancy
- Highest initial cost option



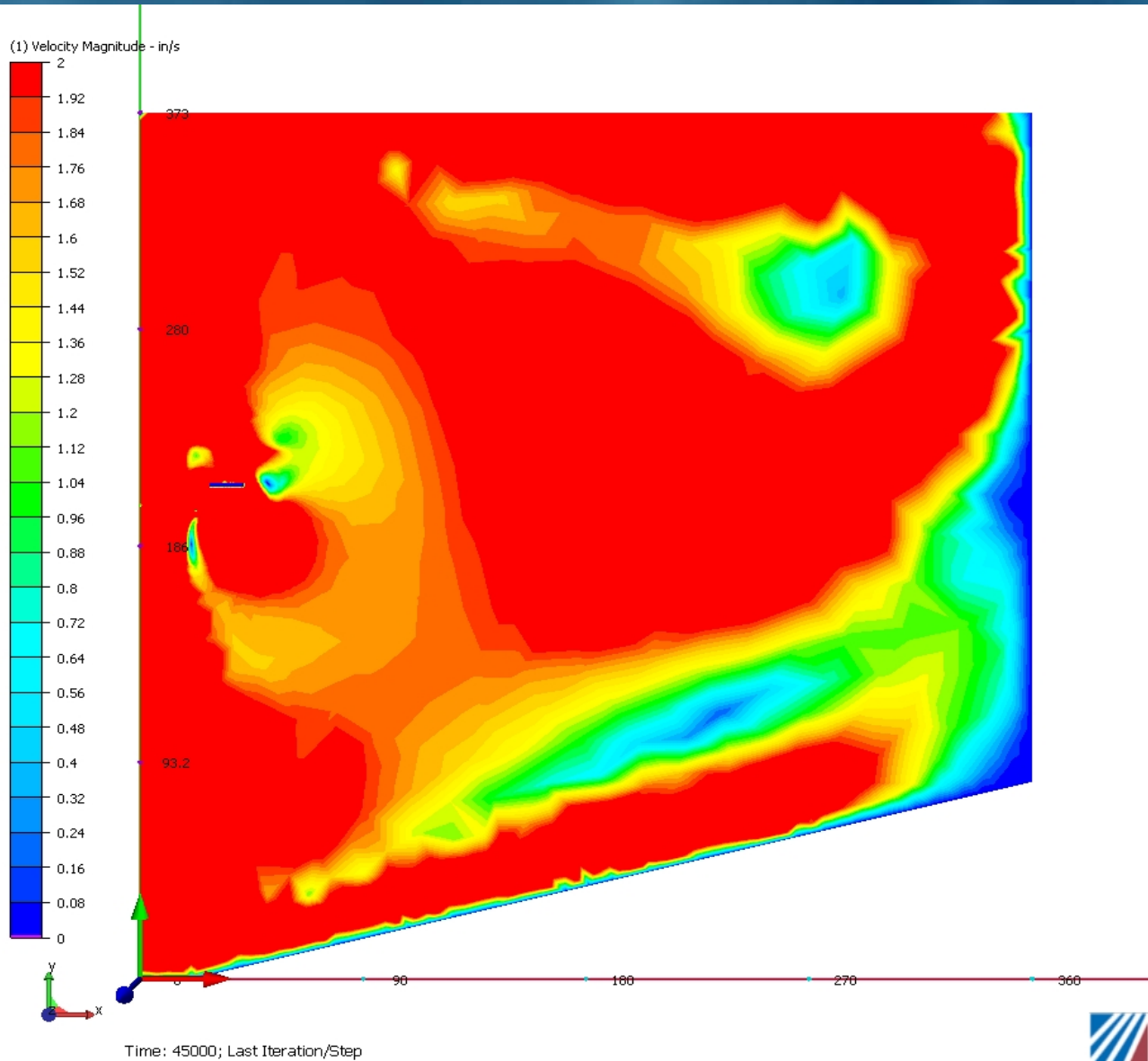


CFD Modeling performed by Eimco (OVIVO)



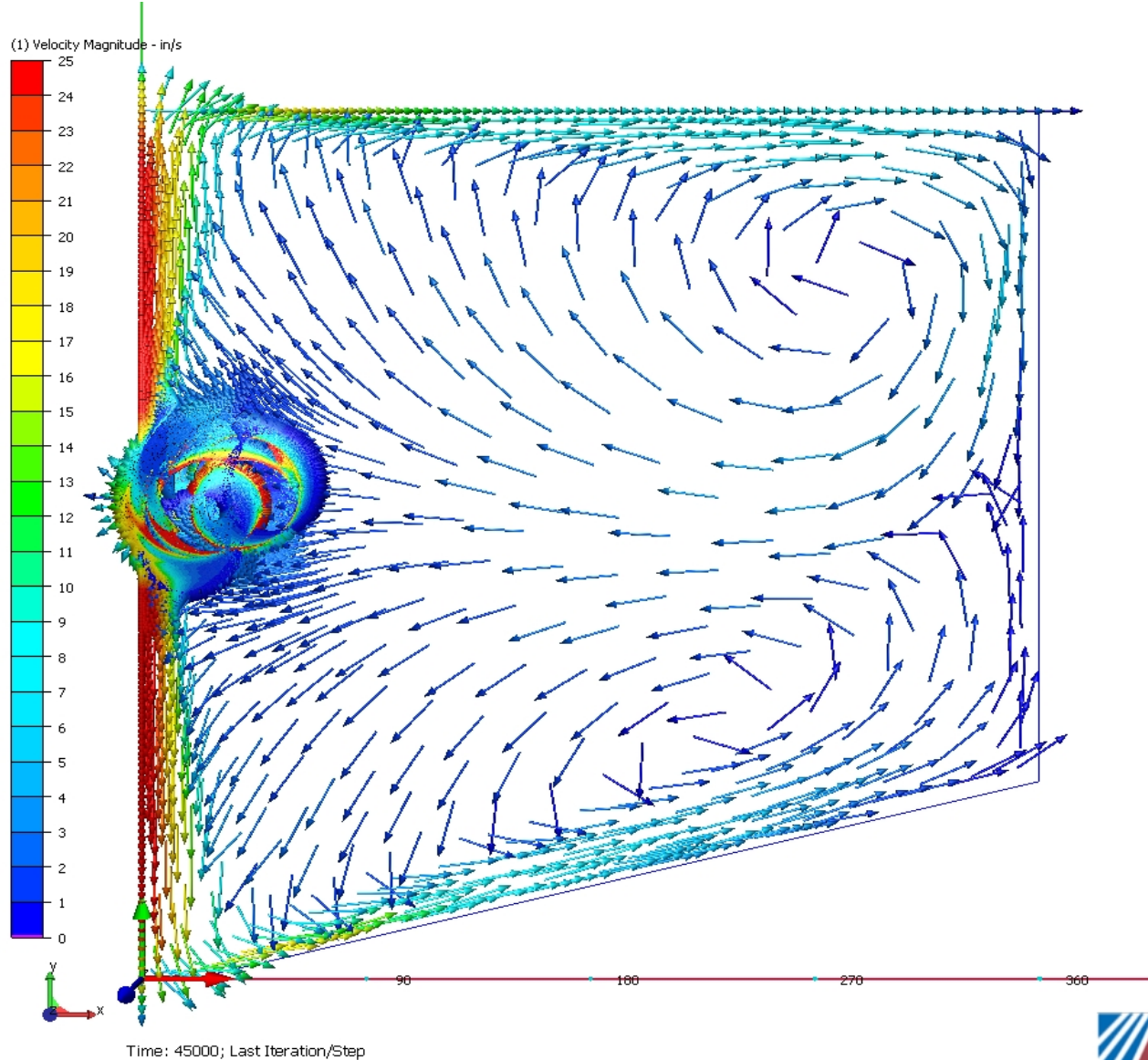


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Black & Veatch – Neil Massart

- Location – Ina Road Water Pollution Control Facility, Tucson, Arizona
- Four existing anaerobic digesters (90 foot diameter and 40 feet deep with a cone bottom)
- Existing digester mixing system includes four 20 horsepower draft tube mixers and one 10 horsepower center mixer.
- Existing mixers are ~20 years old. Mixers require significant maintenance and expensive to operate.

Lithium Test Results

		Digester 2			Digester 4 (LM Mixer Installed)		
Time (hrs)	Location	Value (mg/L)	Average (mg/L)	Difference %	Value (mg/L)	Average (mg/L)	Difference %
8	A	7.2		0.6	7.0		-0.3
8	B	7.2		0.6	7.1		1.1
8	C	7.2		0.6	7.2		-0.3
8	D	7.0		-2.2	7.2		-1.7
8	E	7.2	7.16	0.6	7.2	7.12	1.1
12	A	7.9		3.7	7.2		-0.3
12	B	7.5		-1.6	7.2		-0.3
12	C	7.8		2.4	7.2		-0.3
12	D	7.3		-4.2	7.2		-0.3
12	E	7.6	7.62	-0.3	7.3	7.22	1.1

Solids Test Results

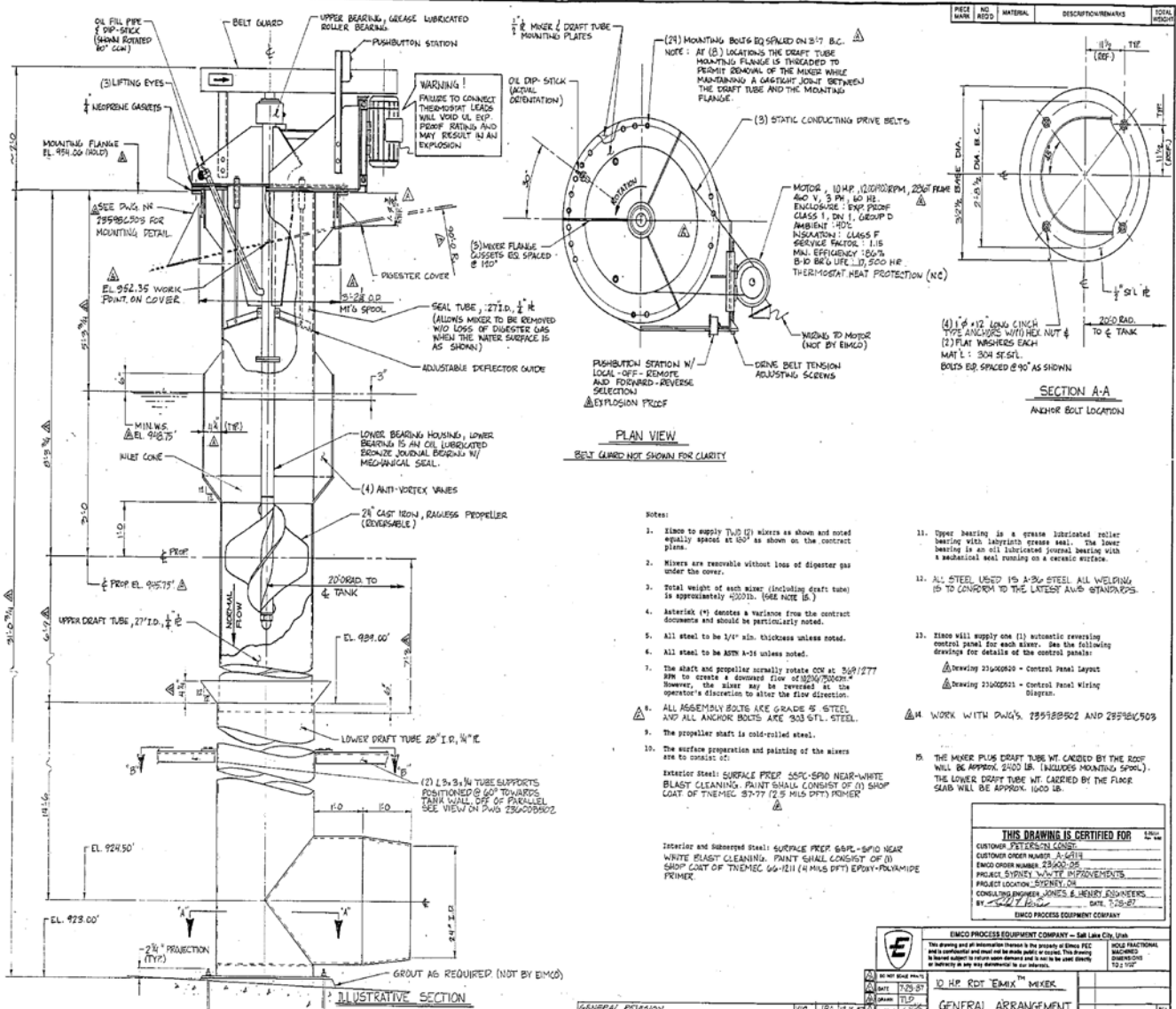
		Digester 2			Digester 4 (LM Mixer Installed)		
Time (hrs)	Location	% TS	%VS	Difference % TS versus average	% TS	% VS	Difference % TS versus average
8	A	1.64	70.4	0.37	1.81	68.5	-0.55
8	B	1.64	69.4	0.37	1.86	69.6	2.20
8	C	1.66	70.4	1.59	1.79	68.4	-1.65
8	D	1.62	70.0	-0.86	1.83	67.3	0.55
8	E	1.61	69.4	-1.47	1.81	71.0	-0.55

Black & Veatch – Neil Massart





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Cost Comparison

- LM Mixer
 - Mixer Purchase Price \$102,978
 - Estimated annual O&M cost \$4,875*
- RDT Rebuild (Eimco)
 - Rebuild estimate \$50,946 (not including shipping and motors)
 - Estimated annual O&M cost \$12,400*
- Philadelphia Mixers
 - 2 Replacement Mixers w/ motors \$46,000 (estimate)
 - Estimated annual O&M cost \$8,500*
- OTI
 - 2 Replacement Mixers w/ motors \$75,000
 - Estimated annual O&M cost \$10,100*

* Includes: estimated 20yr rebuild costs, power, lubrication & man hours for scheduled maintenance



Eimco LM Mixer selected

- CFD model of performance
- Black & Veatch's evaluation of performance
- Direct fit to our digester lid
- Most energy efficient
- Lowest overall O&M costs
- Although the most expensive option, it remained competitive and within budget constraints
- Durability?



- **PLANNING FOR THE INSTALLATION**
 - Staff received a copy of the O&M manual several months before the mixer was installed.
 - Staff met weekly for previous two months to discuss operations, installation, procuring needed items, and brain storming on how to address potential issues



- **PLANNING FOR THE INSTALLATION** Cont...
- Staff would be performing the installation
 - Major concerns were
 - Safety
 - Plant operations
 - Installation Process (schedule of work to be performed)



- **PLANNING FOR INSTALLATION**
 - **SAFETY CONCERNS**
 - **Confined Space**
 - OSHA standard (CFR 1910.146)
 - Hazardous atmosphere
 - Entrance/egress
 - Communication



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Confined Space

- Hazardous atmosphere





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Confined Space

- Entrance/Egress





Confined Space

- Communication





- PLANNING FOR INSTALLATION
 - SAFETY CONCERNS
 - Suspended Loads
 - OSHA Standard (CFR 1926.550(a)(19))





- PLANNING FOR INSTALLATION
 - SAFETY CONCERNS
 - Personal Protective Equipment



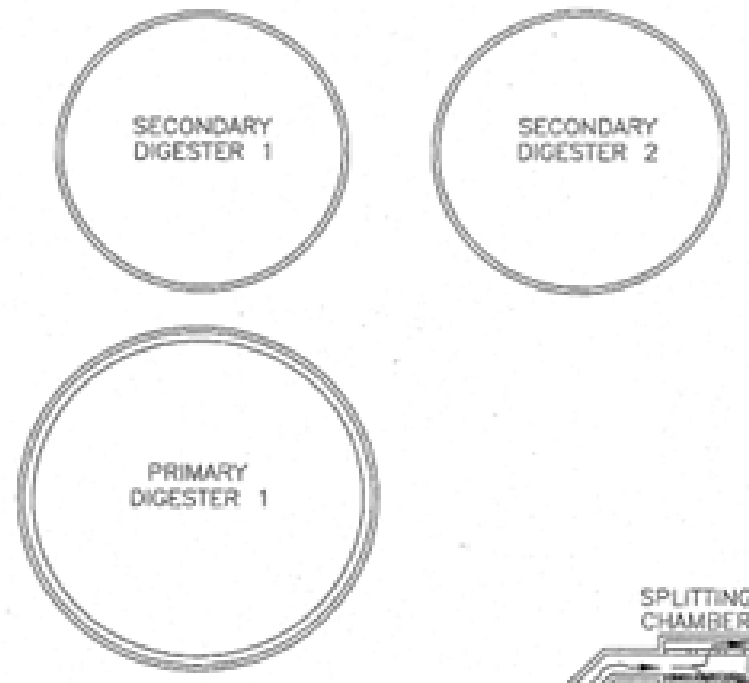


- PLANNING FOR INSTALLATION
 - SAFETY CONCERNS





- PLANT OPERATIONAL CONCERNS
 - Centrifuge Operations





- PLANT OPERATIONAL CONCERNS
 - Primary Digester Shutdown
 - Venting Digester Gas
 - Transferring Primary Digester Contents

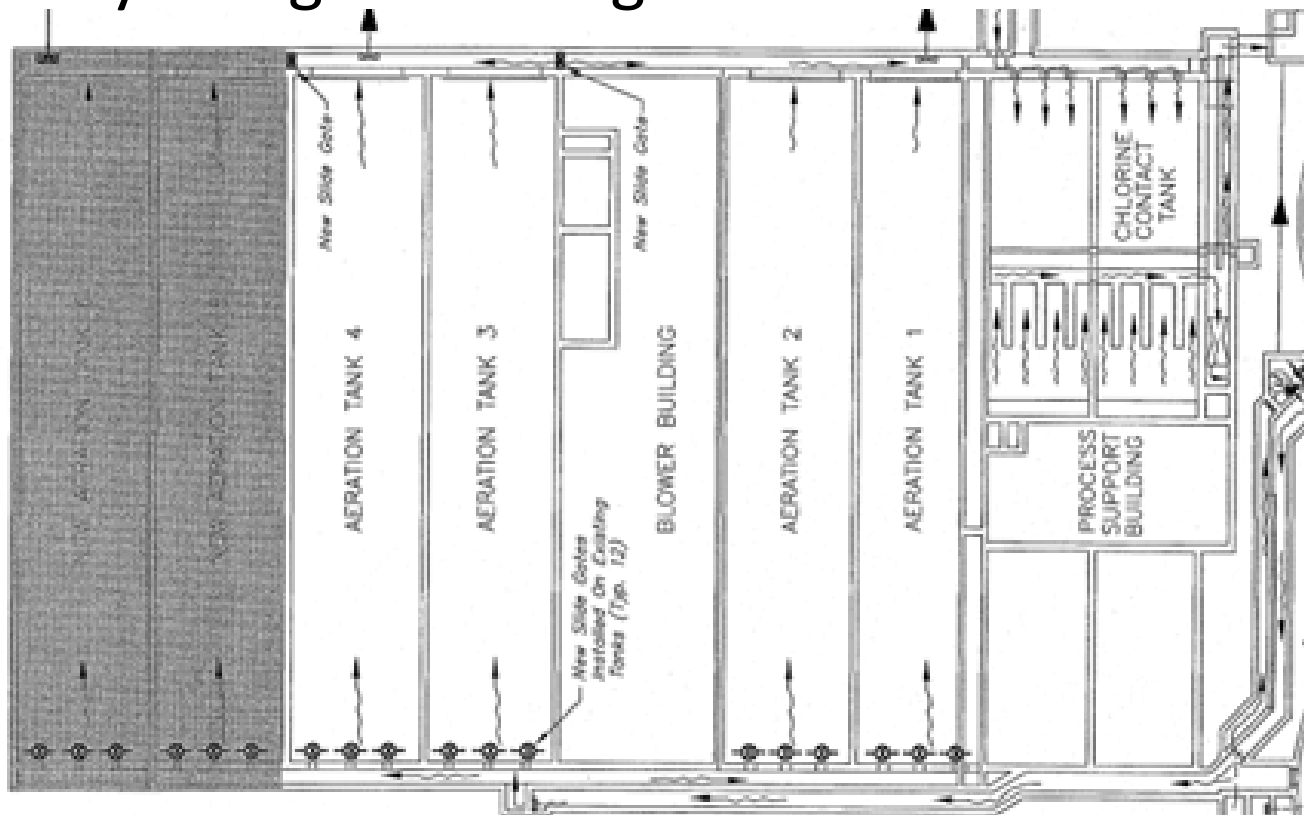


DIGESTER PIPING





- PLANT OPERATIONAL CONCERNS
 - Secondary Sludge (WAS) Handling
 - Primary Sludge Handling





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September 2010

September 2010							October 2010						
S	M	T	W	T	F	S	S	M	T	W	T	F	S
			1	2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	17	18	19	20	21	22	23
19	20	21	22	23	24	25	24	25	26	27	28	29	30
26	27	28	29	30			31						

Monday	Tuesday	Wednesday	Thursday	Friday	Sat/Sun
		September 1	2	3	4
				Run Centrifuge	
					5
					Run Centrifuge
					6
Run Centrifuge					7
					8
					9
					10
				Run Centrifuge	11
					12
					Run Centrifuge
					13
					14
		Run Centrifuge			15
					16
					17
				Transferring Primary Digester	18
				Purge Digester Gas	
				Shutdown Primary Digester	
					19
				Transferring Primary Digester	
					20
Transferring Primary Digester					21
Crane Onsite	Demo Draft Tubes	Clean Digester			22
Demo Old Mixers			Install LM Mixer		23
Weld Gussets				Transfer Contents back into Primary Digester	
					24
					25
					26
					Transfer Contents back into Prima
					27
LM Mixer Startup					28
					29
					30



- Installation
 - VFD desired for controlling mixer
 - Output signal for SCADA system
 - Ease of installation
 - Less costly than other motor control methods
 - A panel and gear sized for the motor would have been required
 - Rebate of \$300 from DP&L for VFD
 - Cost: \$1,300 - \$300 rebate = \$1,000
 - Potential to reduce speed?



- Installation Lessons Learned
 - Missing hardware not listed on prints caused installation delays.
 - Do a mock installation inspecting each piece carefully
 - Identify where each bolt goes and make sure it was provided and is the right type
 - VFD over-volt on down stroke caused VFD faults
 - VFD vendor recommended DC Buss brake to prevent over-volt condition

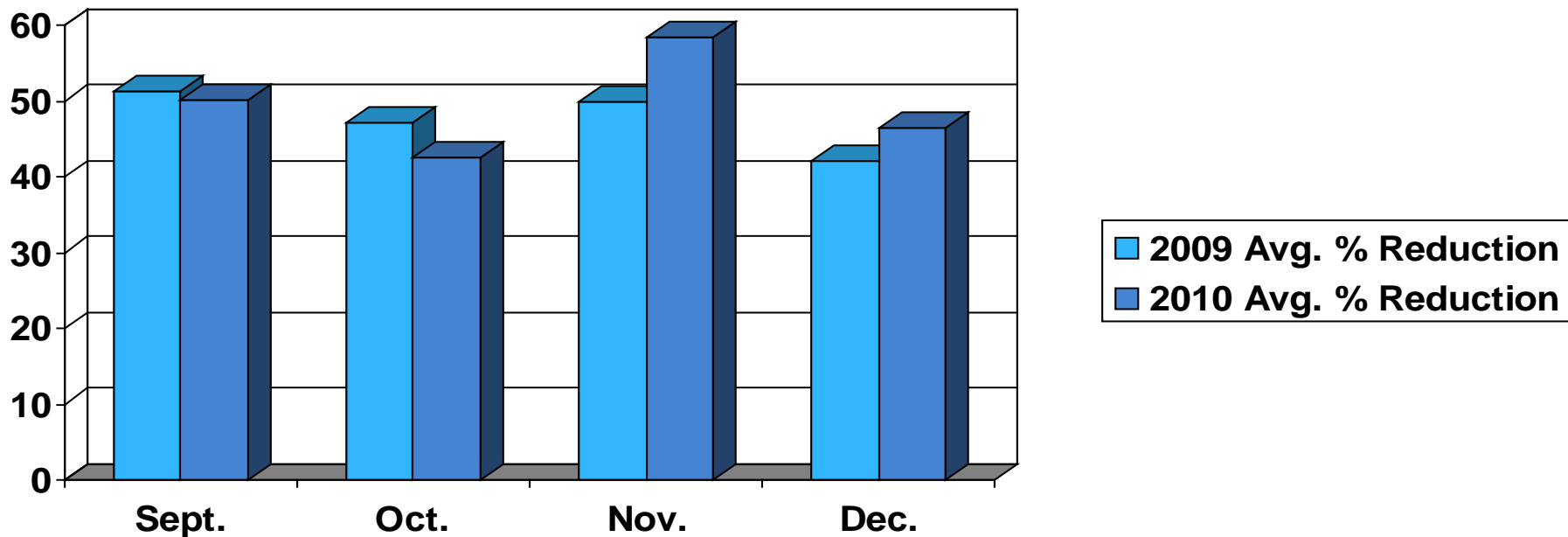


- Installation Lessons Learned
 - Verify O&M manual with manufacturer
 - Many parts of the O&M manual did not match our equipment



- OPERATIONAL OBSERVATIONS

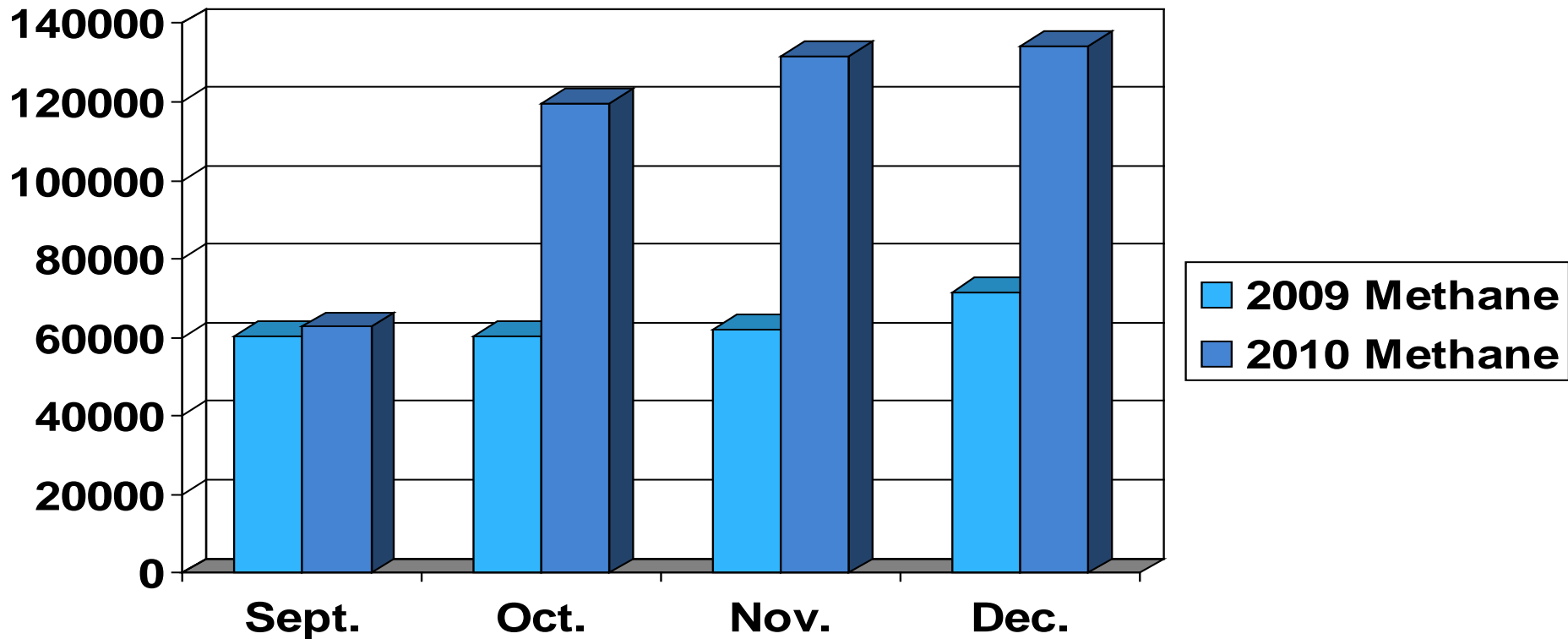
- Mixer performance is as expected
 - slight improvement with volatile solids reduction





• OPERATIONAL OBSERVATIONS

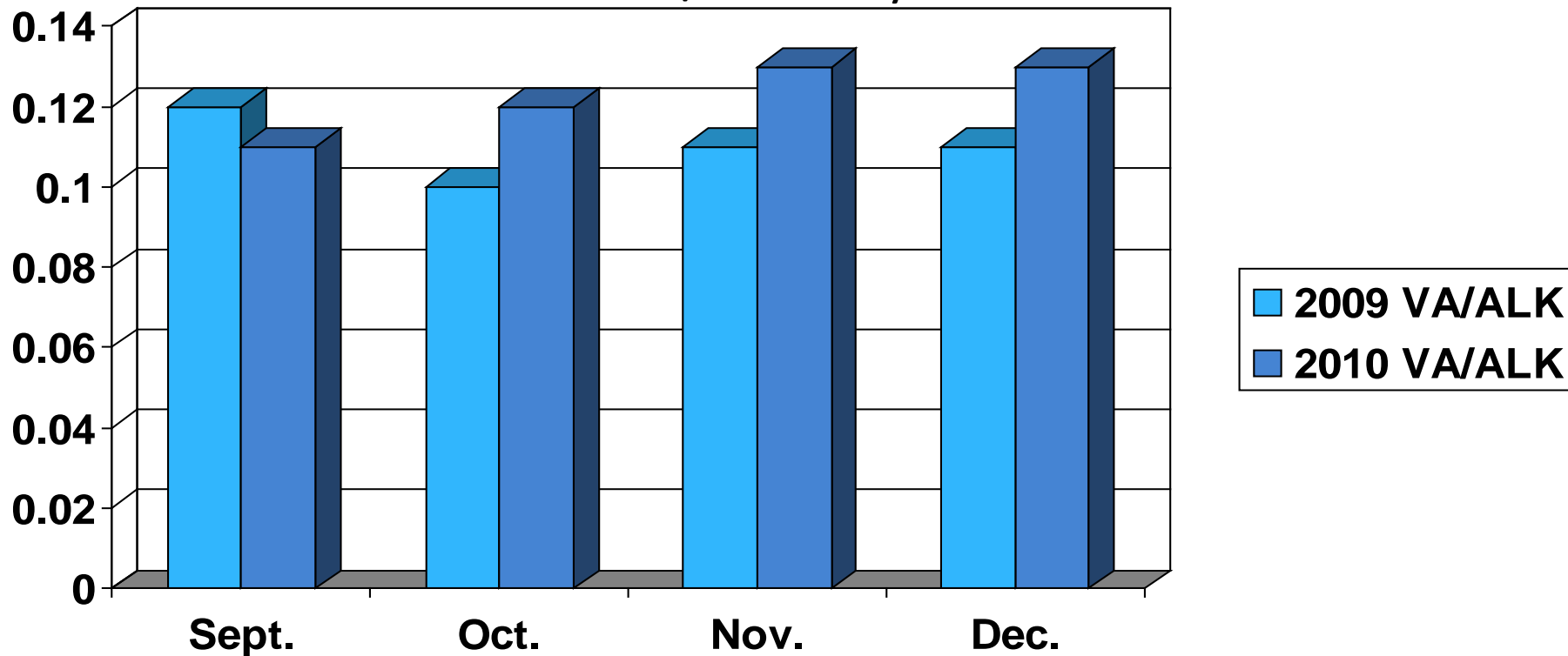
- Gas production has increased by 45%





• OPERATIONAL OBSERVATIONS

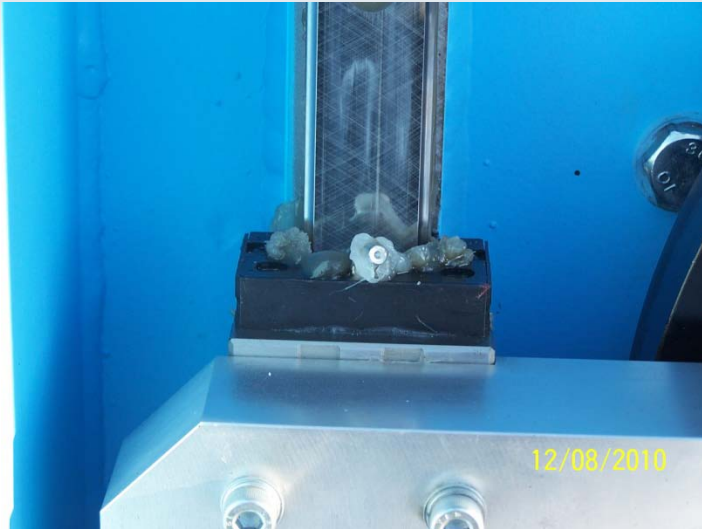
- Digester temperature is consistent indicating good mixing
- Maintain similar Volatile/Alkalinity Ratios





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MIXER WEAR ITEMS





Video of LM Mixer



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