ENGINEERING LABORATORY DESIGN INC.

MODEL B-16 HYDRAULIC DEMONSTRATION CHANNEL

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

Engineering Laboratory Design, Inc.

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B-16 HYDRAULIC DEMONSTRATION CHANNEL

Department of Civil Engineering
Texas Tech University
Lubbock, Texas

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Purchase Order No.: P0475390
Delivered: December, 2016

B-16 HYDRAULIC DEMONSTRATION CHANNEL

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

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1.0 RECEIVING AND UNPACKING

The channel is shipped in a single crate. The aluminum side rails and headtank are secured underneath the channel. All other accessory models are packed in the plastic channel. A box containing all loose hardware is included. Carefully unpack the models and compare them to the enclosed packing list and the purchase order.

Inspect the crate at the time of delivery for evidence of external damage. Note any damage on the delivery receipt. Failure to do so may result in the carrier refusing to honor a claim for damages.

Carefully remove the crate from the delivery vehicle, uncrate the skidded channel, and remove any packing material. Thoroughly examine the contents for damage as soon as possible after delivery. If damage is discovered during unpacking, notify the carrier immediately and request a damage inspection. Retain all packing materials until after the carrier's agent has inspected them.

2.0 SITE SELECTION AND ELECTRIC SERVICE

The channel should be located so that convenient access is available to both sides of the working section. Convenient access to both electrical and water service should also be a consideration.

This unit is arranged to operate from 115VAC/1ϕ/60Hz electrical service. Two (2), 20 amp circuits are required for operation. The individual motor amperage draw is denoted on the motor nameplate. The National Electrical Code, Paragraph 430.24 specifies a branch circuit capacity of 125% of the largest motor nameplate "full load amperage" plus the sum of amperages of all other system components for this application.

3.0 ASSEMBLY PROCEDURE

The channel requires some assembly prior to use. The aluminum side rails must be fixed to the top of the chanel walls. The headtank must be mounted onto the upstream end of the channel section and the electrical connections made. The manometers for the flow orifice meters must be mounted onto the upstream section of the channel. A total pressure probe sight tube must be installed into the fitting on the downstream channel section.

3.1 TOOLS/MATERIAL REQUIRED

Tin Snips
Pry Bar
Caulk Gun
Hammer
2 ft Level
Wire Nuts (Provided)
No. 2 Phillips Screwdriver
6, 10-24UNC-2A x 0.5" long (Provided)
3/4" Open End Wrench
7/16" Open End Wrench
Flat Blade Screwdriver
8, 1/4-20UNC-2A x 1.00" long HHCS (Provided)
8, 1/4" Flat Washers (Provided)
2, 1/4-20UNC-2A x 0.75" long SHCS (Provided)
44, 10-24UNC-2A x 1.0' long FHMS (Provided)
Tube Silicone RTV (Provided)

3.2 PROCEDURE

1. Uncrate the channel using a pry bar and/or a hammer. The headtank and aluminum side rails are secured underneath the channel. The remaining models are shipped inside of the plastic channel. Remove all of the packing material, being conscious that models are included within the channel. Remove the channel from the crate.

2. Move all of the components to the installation site. The channel support frame is fitted with casters for mobility.

3. To prevent damage from dissimilar coefficients of expansion during cold weather months, the aluminum side rails are removed from the channel during shipment. Each rail section is marked with a number that corresponds to a number marked on the Plexiglas channel wall where it is to be attached. Match the rails to the designated locations and secure to the channel sidewalls with the forty-four (44), 10-24UNC-2A x 1.0" long Flat Head Machine Screw (FHMS) supplied.

4. Secure the end cap angle to the downstream end of the channel with two (2) 10-24UNC-2A x 0.5" long FHMS.

5. Secure the mid-length tie bar to the side rails at the mid-length channel joint. Secure the tie bar with four (4) 10-24UNC-2A x 0.5" long FHMS.

6. Employ a 2 ft level to level the channel. Leveling pads are provided at each corner of the frame. Place the level along the channel sidewall aluminum stiffeners to check for streamwise level. To check for spanwise level, place the level across the channel. Adjust the leveling pads using a 3/4" open end wrench. Tighten the locking hex nuts once the channel is level.

7. Using the included tube of silicone caulk, place a bead on the three (3) headtank flanges. Place a bead on the corresponding surfaces on the upstream end of the channel.

8. Position the headtank on the aluminum bars at the upstream end of the channel. *When attaching the headtank please ensure that the rubber headgate seals are inserted so that they are curled toward the upstream end of the channel. When the headtank fills with water, the water pressure will press the seals against the channel walls.*

9. Secure the headtank to the channel with the eight (8), 1/4-20UNC-2A x 1.00" long Stainless Steel (SS) Hex Head Cap Screws (HHCS) and washers provided. *Do not over tighten the screws.*

10. Feed the wiring and conduit running from the headtank into the electrical enclosure and secure the conduit in place by tightening the provided conduit locknut.

11. Connect the seven (7), color-coded wires to the terminal strip as indicated on the label immediately above the strip (Fig. 2).

12. The pressure drop across the line orifice meters is monitored by two (2), three-foot long differential manometers. Secure the manometer bracket to the underside of the aluminum bar located at the top of the channel sidewall on the operator side near the upstream end using two (2) 10-24UNC-2A x 0.75" long SS Round Head Machine Screws (RHMS) and lock washers provided.

13. Insert the pressure lines to the manometers as labeled. Note: To release the pressure lines from the manometers, apply pressure to the insert ring and remove the pressure line.

14. A 0.375" diameter acrylic tube is secured to the stainless steel cover near the downstream end of the channel. These two (2) tubes are the site tubes for the total pressure probes mounted at the upstream and

downstream end of the channel floor. Insert the long tube through the bracket guide hole near the top edge of the channel and press firmly into the associated fitting.

15. Connect each power cord to a grounded receptacle. The channel draws approximately 30 Amps, therefore two (2), *separate*, 115VAC/1ϕ/20 amp circuits must be used.

16. Remove any remaining packing material from the channel.

4.0 DESCRIPTION

4.1 GENERAL

The system is a self contained, portable apparatus designed for use as a "hands on" student laboratory device and also as a demonstration teaching aid in support of classroom lectures. All flow variables are controlled by the operator. The unit consists of a transparent flume; a headtank with an adjustable, undershot gate; a movable tailgate; a reservoir; two (2) circulating pumps; integral flow meters, and flow control valves. A motorized jacking system adjusts the slope of the channel bed. The complete assembly is mounted on a caster frame for easy portability. All of the wetted parts of the equipment are made of non-corrosive materials. The only utility required for operation is electric service.

The overall dimensions of the system are: length, 16'-2.25" (4.94 m); width, 40.44" (102.71 cm); height, 91.67" (2.33 m). Net weight (dry) is 1350 lbs (612 kg).

4.2 CHANNEL

The working channel is 12.00" (30.48 cm) wide by 18.00" (45.72 cm) deep by 16'-0" (4.87 m) long and is fabricated of 0.50"(1.27 cm) thickness, clear acrylic. A double bottom, box section floor is used. All construction joints are stainless steel fastened and solvent welded. Integral acrylic flanges join the two channel modules at the center. An aluminum bar, 2.00" (5.08 cm) by 0.75" (1.91 mm), stiffens the top edge of the channel sidewalls. The bar also serves as an instrument rail.

4.3 RESERVOIR

A one piece fiberglass tank contains the approximately 200 gallons (757 L) system water supply. The reservoir also serves to support the flume and the pumps. The reservoir is fitted with a drain valve and a 6.00" (15.24 cm) diameter access port.

4.4 PUMPS AND MOTORS

Flow is supplied to the channel with two (2) high volume, low head pumps *(Price Pump Model XT200AB-525-21111-75-18C-1D6)*. The pumps are of all bronze construction, fitted with mechanical seals. The pumps are direct driven by 0.75 HP, ODP, 1800 RPM, 115 VAC/1 ϕ/60 Hz motors *(Baldor Model No. 34F181W198)*. Each pump delivers 95 GPM (360 Lpm) @ 25'-0" head (0.75 bar) for a maximum total flow of 190 GPM (720 Lpm).

4.5 PIPING

Water is conveyed to the flume via PVC piping

4.6 FLOW METERING

The first pump supply line is fitted with both a high and low range flow orifice meter. A single high range meter is furnished in the second pump supply line. The deflection of water columns in on-board U-tube manometers can be

related to the flow rate in the channel using the furnished calibration curves. A copy of the calibration curve is adhered to the operator's side of the head tank.

The flow through the orifice meters is regulated with three (3) bronze valves.

4.7 HEADTANK

A headtank, fabricated from 0.50" (1.27 cm) thick acrylic, is positioned at the upstream end of the upstream channel section. The headtank has internal dimensions of 12.00" (30.48 cm) width; 10.30" (26.16 cm) length; and 24.00" (60.96 cm) height). An undershot gate (headgate) is provided. The headgate is positioned by a 1/15 HP, 16 RPM gearmotor (*Dayton Model 1LRA2*). Over-travel is protected by limit switches. All acrylic joints are mechanically fastened with stainless steel screws and solvent welded.

4.8 TAILGATE

The tailgate is comprised of a two (2) leaf, anodized, aluminum plate mounted at the end of the channel. The tailgate serves to regulate the flow depth. The tailgate is positioned by a 1/10 HP, linear actuator (*Dayton Model 1XFX9*). Over-travel is protected by limit switches.

4.9 CONTROLS

A NEMA type 12 electrical enclosure contains the electrical controls for the pumps, headgate, tailgate, and the slope motors. The enclosure is located at the upstream end of the channel. Limit switches protect the motor driven assemblies from over travel. A spirit level device on a protractor indicates the slope of the channel bed.

The electrical enclosure is fitted with two (2) 20'-0" length SO cords. The buyer is responsible for the connecting of the electrical cord to the building electric service.

5.0 OPERATING INSTRUCTIONS

5.1 GENERAL

Before attempting to operate the channel, insure that tools and other loose objects have been removed from the test section and that the electrical branch circuit serving the channel is energized. It is recommended that new users be familiarized with the equipment prior to first operation.

5.2 FILLING/DRAINING PROCEDURE

5.2.1 TOOLS/MATERIAL REQUIRED

Garden Hose

7/16" Open End Wrench

5.2.2 PROCEDURE

1. Fill the reservoir approximately half full with clean, softened water. A sight tube is placed on the operator's side of the reservoir with a fill line indicating the desired height of the water.

2. The channel can be filled by either connecting a standard garden hose fitting to the sillcock located at the lowest point of the reservoir on the non-operator's side of the channel or by simply placing the garden hose directly in the channel.

3. Open the vent plugs on the top of each pump housing using a 7/16" wrench to vent any trapped air within the housing. Re-tighten the plugs.

4. The addition of a wetting agent (typically used in household dishwashers) is recommended to minimize the boundary layer growth along the channel floor and sidewalls.

NOTE: The channel should be drained periodically to prevent the growth of algae. If chemicals such as bleach or alkalides are used in the system, the water should be drained as soon as the tests are completed. Check with the facility administrator to determine if special disposal techniques must be used with the mixture.

5.3 SLOPE MECHANISM AND ADJUSTMENT

The operating slope of the channel is designed to be adjustable between +12% and -4%. The slope is adjusted by a 0.33HP, 39:1 reduction gearmotor assembly (*Dayton Model 4CVU1*) attached to the ACME screws of the jacking station. The jacking station is located at the upstream end of the channel support frame.

5.3.1 ADJUSTMENT

The two-position, momentary, toggle switch labeled **SLOPE** on the control console is used to control the gearmotor. The slope of the channel can be determined using the spirit level attached to the reservoir below and to the right of the control console. Inclination of the channel bed can be determined by adjusting the indicator until the bubble depicts that the needle is level. The corresponding percent slope can be read from the scale. Alternatively, a desired channel slope can be obtained by adjusting the needle to the desired percent slope, and operating the slope mechanism until the bubble depicts that the needle is level.

5.3.2 LIMITS

The slope mechanism is protected from dangerous over-travel by limit switches mounted underneath the reservoir on the support frame. These limits have been pre-set at the factory. Changing these settings is strongly discouraged, as damage may result to the system.

5.4 FLOW DEPTH ADJUSTMENT

The operating depth of the channel is controlled by adjusting the position of the tailgate mounted at the downstream end of the channel. The tailgate is a two (2) piece hinged unit that will automatically fold as it is lowered. However, the tailgate needs to be fully raised or lowered manually.

5.4.1 ADJUSTMENT

The momentary toggle switch labeled **TAILGATE** on the control console controls the direction which the tailgate moves. To increase the operating depth of the flow in the channel, raise the tailgate to obstruct the flow. To fully deploy the tailgate; reach into the channel and unfold the top leaf once the tailgate has cleared the folding buttons mounted on the channel sidewall.

NOTE: When lowering the tailgate, the buttons will fold the top leaf over, but will not completely close unless the tailgate is manually pushed down onto the lower leaf.

5.4.2 LIMITS

The tailgate is protected from dangerous over-travel by limit switches mounted in the linear actuator. These limits have been pre-set at the factory. Changing these settings is strongly discouraged, as damage may result to the system.

5.5 HEAD ADJUSTMENT

The amount of head against the channel flow can be adjusted by controlling the position of the undershot type headgate located at the upstream end of the channel.

5.5.1 ADJUSTMENT

The momentary toggle switch labeled **HEADGATE** on the control console controls the direction which the headgate moves. To increase the head applied to the channel flow lower the headgate until the channel flow is restricted.

CAUTION: When the headgate is lowered into the flow, the water volume backs up into the headtank. *At high flow rates, the headtank can fill quickly and overflow.* When lowering the headgate, constantly monitor the water level in the headtank and be prepared to decrease the volume flow rate of the channel.

5.5.2 LIMITS

The headgate is protected from dangerous over-travel by limit switches mounted in the electrical box near the gear motor. These limits have been pre-set at the factory. Changing these settings is strongly discouraged, as damage may result to the system.

5.6 FLOW MEASUREMENT

5.6.1 GENERAL

The rate of discharge can be controlled by the gate valves located at the upstream end of the channel. Flow can be completely stopped without damaging the pumps.

The rate of flow in the channel can be determined by using the orifice meters fitted in the two (2) individually valved supply pipes. These piping networks are mounted below the acrylic channel. Higher flow rates can be measured with the large orifice(s) in the 3.00" (7.62 cm) diameter pipe(s). Lower flow rates are measured using the small orifice in the 1.50" (3.81 cm) diameter pipe. To prevent errors in flow measurement, ensure that the valves connected to the orifice pressure taps not in use are fully closed.

5.6.2 FLOW MEASUREMENT ORIFICES

The differential pressure across each orifice may be observed on the manometers located near the upstream end of the channel. A calibration chart relating the manometer deflection to the flow rate is furnished with the channel. The orifice to be measured by the manometer in the pump no. 1 supply line is selected with the small brass needle valves mounted on the bottom of the manometer.

The large orifices are identical and have the following flow equation:

$$Q = K \cdot \frac{\pi d^2}{4} \cdot \sqrt{2g\Delta h}$$

where:

- Q: volume flow rate (ft^3/s) (lpm)
- K: flow coefficient calculated from calibration chart ≈ 0.8139
- D: diameter of the piping, 3.042" (0.2535ft) (0.0773m)
- d: diameter of the orifice, 2.375" (0.1979ft) (0.0603m)
- g: gravitational acceleration, $32.2 ft/s^2$ ($9.81 m/s^2$)
- Δh: measurement from a differential manometer (ft) (m)

Substituting these values into the equation and simplifying:

$$Q = 0.2009 \cdot \sqrt{\Delta h}_{(ft)} \ (ft^3/s) = 618.226 \cdot \sqrt{\Delta h}_{(m)} \ (lpm)$$

The small orifice has the following flow equation:

$$Q = K \cdot \frac{\pi d^2}{4} \cdot \sqrt{2g\Delta h}$$

where:

Q:	volume flow rate (ft^3/s)
K:	flow coefficient calculated from calibration chart ≈ 1.0000
D:	diameter of the piping, 1.592" (0.1327ft) (0.0404m)
d:	diameter of the orifice, 1.125" (0.09375ft) (0.02858m)
g:	gravitational acceleration, 32.2ft/s² (9.81m/s²)
Δh:	measurement from a differential manometer (ft) (m)

Substituting these values into the equation and simplifying:

$$Q = 0.0554.\sqrt{\Delta h}_{(ft)} (ft^3/s) = 170.496.\sqrt{\Delta h}_{(m)} (lpm)$$

5.7 CHANNEL SECTION

The channel section's interior may be accessed through the upper open surface.

The acrylic floor has sixty-one (61), brass, 10-24UNC-2B internal threaded inserts installed at 6.00" (15.24 cm) spacing for the mounting of test models. The acrylic walls of the channel sections may be drilled and tapped to facilitate mounting of models, instruments and test fixtures as required.

6.0 CAUTIONS

1. Ensure that all persons using this equipment have been familiarized with its operation.

2. Do not operate the pumps without water in the channel. The pumps are equipped with mechanical seals; damage could result from running a pump dry.

3. Verify that models and test fixtures are securely fastened in the channel floor before operation.

4. Overflow of the headtank can result when operating at a high flow rates with the headgate lowered or in the act of being lowered.

5. **DO NOT** change any of the limit settings for the slope motor, headgate or tailgate. This could result in damage to the system.

6. **DO NOT** operate the system with any of the safety guards removed.

7. **DO NOT** immerse the electronics in water. These items should be protected from water splash and spray by the use of simple shields or deflectors employed where necessary.

8. Monitor the water level within the headtank constantly when lowering the headgate to prevent overflow.

7.0 MAINTENANCE

7.1 GENERAL

Users and maintenance personnel are urged to read the manufacturer's instructions which are applicable to the system components. Adherence to the pump lubrication schedule is particularly important.

7.2 PUMP AND MOTOR ASSEMBLIES

The motors are furnished with double sealed or shielded ball bearings, pre-lubricated prior to installation. Grease fittings are not supplied and bearings are designed for an average of 100,000 hours (7 years) of operation under standard conditions (8 hours of operation per day, normal loading, relatively dust free). Consult with a Baldor Electric representative for motor maintenance.

For detailed instructions related to pump and motor maintenance and service, see respective manufacturer's documentation.

7.3 HEADGATE AND TAILGATE MOTOR ASSEMBLIES

The tailgate actuator assembly is factory pre-lubricated for life and does not require periodic maintenance.

The headgate gearmotor bearings are factory pre-lubricated and will not require relubrication. Should the gears require lubrication, use 6 oz. of Mobil Delvac Xtreme Grease #105984.

For detailed instructions related to actuator and gearmotor maintenance and service, see the appropriate manufacturer's documentation or contact a Dayton, Inc. representative.

7.4 SLOPE MOTOR ASSEMBLY

7.4.1 LUBRICATION

The slope motor assembly is furnished pre-lubricated prior to installation. For the operating conditions of this equipment, the oil in the gear reducer should only require changing when performing maintenance that requires gearbox disassembly.

For detailed instructions related to motor and gear case maintenance and service see the manufacturer's documentation or contact a Dayton, Inc. representative.

Lubricate the ACME screws every six (6) months.

7.4.1.1 Tools/Material Required

Grease Gun — Canister No. 2 Grease
Rags

7.4.1.2 Procedure

1. Apply No. 2 grease to the grease zerk located on the brass nut.

2. Raise/Lower the channel to introduce the grease.

7.4.2 CHAIN TENSION

The slope mechanism chain drive will stretch over time. Adjust the tension of the chain drive every six (6) months or when a noticeable slack response in the system occurs.

7.4.2.1 Tools/Material Required

No. 2 Phillips Screwdriver

2, 9/16" Open End Wrench

7.4.2.2 Procedure

1. Remove the chain drive guard by removing the two (2) 10-24UNC-2A x 0.38" long RPHMS, located near each end of the guard on the top surface. Lift the guard off.
2. Loosen the two (2), 3/8-16UNC-2A HHMS that secure the slope motor mounting plate to the supporting frame.
3. Pull the slope motor to increase the tension on the chain drive. The correct amount of tension is when the chain deflection is about 3/8" across the longest span.
4. Tighten the two (2) 3/8-16UNC-2A HHMS and recheck the chain tension.
5. Re-fasten the chain guard.

7.5 FIBERGLASS/SUPPORTING FRAMEWORK

7.5.1 GENERAL

Dirt and grease marks may be removed from the laminate and enamel surfaces using a detergent/water solution applied with a soft cloth and a sponge. Abrasive cleaners should not be used.

7.5.2 FIBERGLASS SCRATCH REPAIR

7.5.2.1 Tools/Material Required

Gelcoat Repair Kit (West Marine P/N: 4546123)

Rags

7.5.2.2 Procedure, Blue (Exterior)

1. Scuff selected area.
2. Fill a Dixie cup roughly 1/3 full of gel-coat.
3. Mix 3-4 drops of catalyst into the cup. (Use 50:1 gel-coat to catalyst ratio)
4. Brush the gel-coat onto scuffed or scratched areas.
5. Let the gel-coat patch harden.

7.5.2.3 Procedure, White (Models)

1. Remove any abraded or loose gel-coat and/or fiberglass strands.
2. Prepare the surface around the damaged area with medium grit sand paper (120-150 grit).
3. Mix the gel-coat as per steps in section 7.5.2.2 and fill the damaged area.
4. Cover the applied gel-coat with scotch tape to hold the gel-coat while it cures.
5. After the gel-coat is cured, carefully sand the repaired surface flush with adjacent areas using 400 grit wet/dry sand paper. Continue in successively finer grits to remove the sanding marks. The surface can be polished with an automotive type polish applied by hand.

7.6 CHANNEL SECTION

The acrylic sidewalls and floor should be washed periodically with a mild detergent and clean water using a soft cloth. Remove residual water with fresh paper toweling. Care should be exercised to avoid scratching the channel surfaces. Fine abrasions and cloudiness may be removed by fine sanding and polishing. A scratch removal kit available from

Micro-Surface Finishing Products, Inc.
1217 West Third Street
PO Box 70
Wilton, Iowa 52788

is recommended. Attempts to remove deep scratches are generally futile.

7.7 WATER

The water within the reservoir should be changed periodically. An algaecide may be required in some climates to prevent organic growth in the system.

8.0 LIMITED WARRANTY

Engineering Laboratory Design, Inc. (ELD) warrants its new products to be free of defects in material and workmanship under normal use and service for a period of one (1) year from the date of acceptance of the product by the original purchaser. Engineering Laboratory Design's obligation under this warranty shall be limited to replacing at its factory, any products, or parts thereof which are returned to **ELD** with transportation charges prepaid, and which upon **ELD**'s examination are determined to be in fact defective. In the event of warranty service, **ELD** reserves the right to substitute new or improved equipment as replacement components.

This warranty shall not apply to any product which has been repaired or altered, outside of **ELD**'s factory, in any way deemed to affect the product's stability or reliability, nor to any product having been subjected to improper installation by others, improper operation or storage, negligence, accident, abrasion, corrosion, electrolysis, improper electrical supply, careless handling, nor to any product subjected to other than normal use or service.

Engineering Laboratory Design will not grant any allowance for repairs or alterations made without written consent of authorized personnel. **ELD** shall in no way be liable or responsible for injuries or damages to persons or property, arising from or out of the use or operation of the product.

Engineering Laboratory Design reserves the right to make changes in design, or to make additions to, or improvements in, its products without imposing any obligation upon itself to install them on products previously manufactured.

Maintenance and service, at the purchaser's location, or maintenance and repair service for equipment for which the warranty has expired, can be contracted for by contacting **Engineering Laboratory Design, Inc.**, PO Box 278, 2021 South Highway 61, Lake City, MN USA 55041, (651) 345-4515. Alternatively you may contact **ELD Inc.** via fax at: (651) 345-5095, or e-mail to: eldinfo@eldinc.com or visit our website at: www.eldinc.com.

9.0 ILLUSTRATIONS

Figure 1: Channel Without Headtank

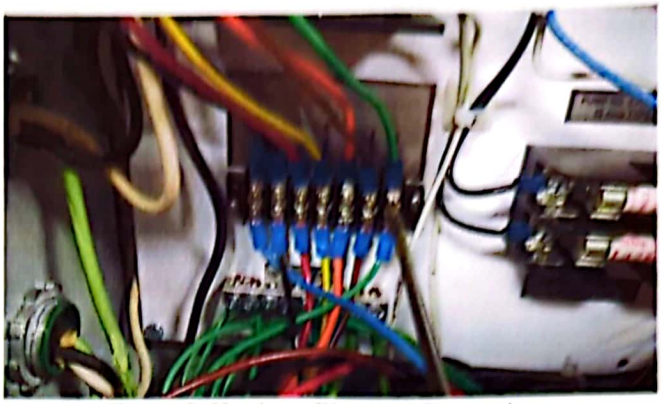

Figure 2: Headgate Electrical Connections

Figure 3: Manometer Assembly

Figure 4: Total Pressure Drop Tube Assembly

Water Channel Verification Test Data

Engineering Laboratory Design
Date: 29-Nov-16
Engineer: JP & JAL

Organization: Texas Tech University
Project: B-16 Hydraulic Channel

Channel Width (in): 12
Dye Distance (in): 44

Temp (F): 65

Model No.: 14
Serial No.: 87516
PO No.: PO475390

Pump Type: (2) Price, 5.25" Impellor, Centrifugal Pump
HP: 0.75

Check
[x] operation of head gate
[x] pitot tubes for full movement to floor
[x] hoses going to manometer for shortest length possible
[x] manometer vent valve for air leaks
[x] downstream sight gauges for overflow

Start: 1:00 PM
Finish: 3:45 PM

$Q_{Small} = 0.0554 * \Delta H^{1/2}$ (ft^3/s)
$Q_{Large} = 0.2009 * \Delta H^{1/2}$ (ft^3/s)
Q'= Determined from Visual Dye Stream Analysis

Orifice	ΔH (ft)	Q (cfs)	Q (gpm)	V (ft/s)	T1 (Amps)	T2 (Amps)	Dye Stream Depth (in)[1]	Time[2]	Q' (cfs)	Q' (gpm)	V' (ft/s)	Notes:
Small	0.020	0.008	3.516	0.262	5.1	-	0.36	8.93	0.012	5.515	0.411	Pump 1
Small	0.090	0.017	7.460	0.425	5.1	-	0.47	6.85	0.021	9.384	0.535	
Small	0.420	0.036	16.115	0.707	5.2	-	0.61	5.69	0.033	14.684	0.645	
Small	0.880	0.052	23.326	0.850	5.3	-	0.73	4.86	0.046	20.704	0.754	
Small	1.660	0.071	32.037	0.997	5.5	-	0.86	4.45	0.059	26.497	0.825	
Small	2.550	0.088	39.707	1.079	5.6	-	0.98	3.81	0.079	35.457	0.963	
Large	0.010	0.020	9.017	0.257	5.5	-	0.94	4.12	0.070	31.238	0.890	Pump 1
Large	0.280	0.106	47.714	0.972	6.1	-	1.31	2.95	0.136	60.958	1.241	
Large	1.110	0.212	95.000	1.505	6.8	-	1.69	2.80	0.184	82.678	1.310	
Large	1.170	0.217	97.534	1.391	7.3	-	1.88	2.42	0.237	106.433	1.518	
Large	1.390	0.237	106.309	1.338	7.4	-	2.13	2.34	0.278	124.649	1.568	
Large	1.530	0.248	111.534	1.325	7.6	-	2.25	2.12	0.324	145.415	1.728	Full Open
Large	1.540	0.249	111.898	1.330	7.6	-	2.25	2.23	0.309	138.497	1.646	Pump 2
Large	0.015	0.025	11.044	0.385	-	5.1	0.77	5.53	0.042	18.997	0.663	
Large	0.330	0.115	51.799	0.998	-	6.0	1.39	3.51	0.121	54.201	1.044	
Large	0.740	0.173	77.567	1.276	-	6.7	1.63	2.93	0.170	76.112	1.252	
Large	1.170	0.217	97.534	1.391	-	7.2	1.88	2.71	0.212	95.027	1.355	
Large	1.420	0.239	107.450	1.436	-	7.4	2.00	2.54	0.241	108.072	1.445	Full Open
Large	1.570	0.252	112.983	1.422	-	7.5	2.13	2.59	0.251	112.608	1.417	Both Pumps
Large	1.610	0.255	114.413	1.440	-	7.6	2.13	2.71	0.239	107.459	1.352	
Both	1.53/1.6	0.492	220.860	2.010	7.7	7.6	2.9375	1.79	0.503	225.564	2.053	Full Open

1. Indicates approximate values for data verification.
2. Dye Stream Time is the averaged value for a minimum of five (5) tests over a distance of 44"

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P.O. BOX 270
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(651) 345-5095 FAX
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Model B-16 Hydraulic Demonstration Channel

List of Components

	Component	Manufacturer	Model/Part No.	Serial No.
1.	Digital Scale	Mitutoyo	572-312-10	
2.	Chain, Jacking	Martin	No. 35 (ISO No. 06C-1)	
3.	Fuse, Headgate 2.5A	Ferraz Shawmut	TRM 2 1/2	
4.	Fuse, Slope Motor 8A	Ferraz Shawmut	ATDR 8	
5.	Fuse, Pump No.1 Motor 15A	Ferraz Shawmut	ATDR 15	
6.	Fuse, Pump No.2 Motor 15A	Ferraz Shawmut	ATDR 15	
7.	Fuse, Tailgate 2.5A	Ferraz Shawmut	TRM 2 1/2	
8.	Gearmotor, Slope 1/3 HP	Dayton	4CVU1	
9.	Linear Actuator, Tailgate	Dayton	1XFX9	
10.	Motor, Headgate 1/15HP	Dayton	1LRA2A	
11.	Motor, Pump, Operator 3/4HP	Baldor	34F181W198	F1607110742
12.	Motor, Pump, Non-Operator 3/4HP	Baldor	34F181W198	F1607110912
13.	Pump, Non-Operator Side	Price Pump	XT200AB-525-21111-75-18C-1D6	167389
14.	Pump, Operator Side	Price Pump	XT200AB-525-21111-75-18C-1D6	167388
15.	Slope Limit Switch (2)	Honeywell	BZE6-2RN	
16.	Sprocket, Gear Reducer	Martin	35B16-1	
17.	Sprocket, Idler	Martin	35B16-3/4	
18.	Sprocket, Jacking Screw (2)	Martin	35B16-5/8	

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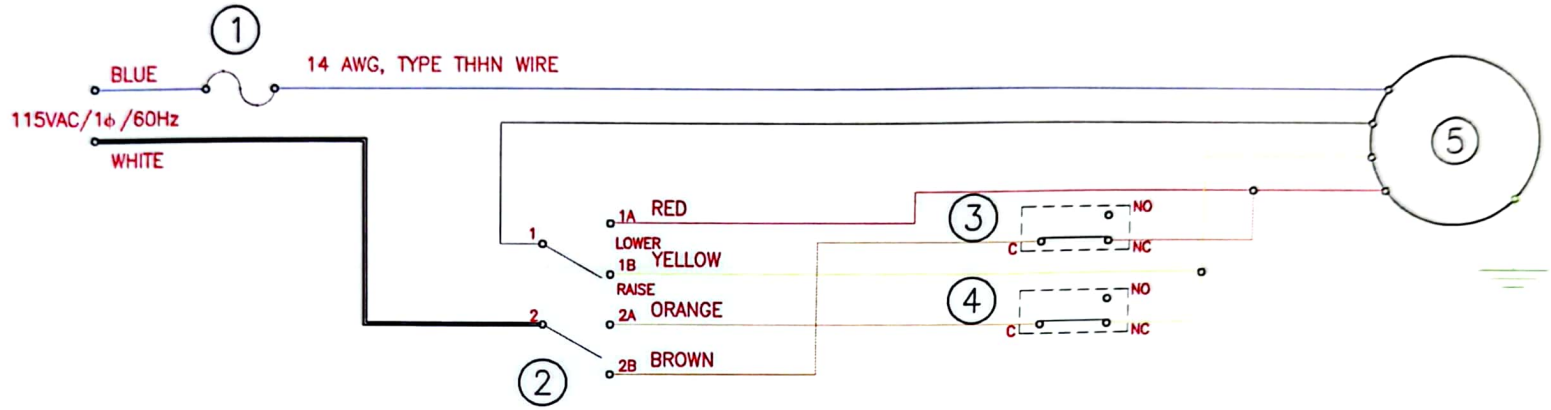
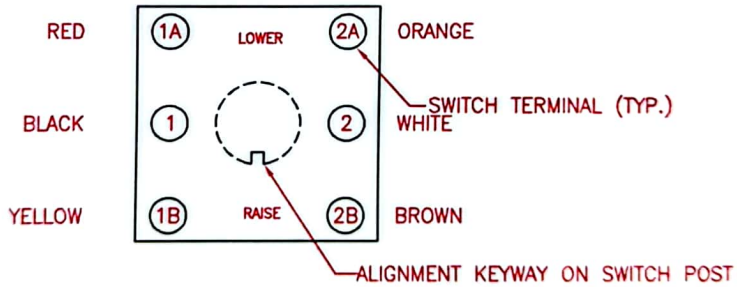
SERVICE CENTERS

Company:	Component(s):	Local Representative:	Telephone No.:	Fax No.:
Baldor Electric www.baldor.com	3/4HP ODP Pump Motors	Lubbock Elec Co 1108 34th St Lubbock, TX 79411	(806) 744-2336	(806) 744-5690
Mitutoyo, Inc. www.mitutoyo.com	Digimatic Scale Unit	M & M Sales Equip Inc 2639 Kermit Hwy Odessa, TX 79763	(432) 332-1481	(432) 332-7433
Price Pump, Inc. www.pricepump.com	All Bronze Centrifugal Pumps	Centripump Inc. 2206 N. F.M. 1788 Midland, TX 79707	(432) 563-5700	(432) 563-5704
W. W. Grainger, Inc. www.grainger.com	Fuses Slope Gear Motor Headgate Gear Motor Tailgate Linear Actuator Wave Generator Motor Wave Generator Controller	W. W. Grainger, Inc. Branch No. 456 502 E. 40th St Lubbock, TX 79404	(800) 687-6807	

No.	Component	Manufacturer	Part No.
1.	Fuse, Headgate Motor, 2.5Amp, Type FNM	Bussman	A 2-1/2
2.	DPDT (Momentary) Toggle Switch	Eaton	7803K37
3.	Limit Switch (Upper) Lever Type	Omron	Z15GW-B7-K
4.	Limit Switch (Lower) Lever Type	Omron	Z15GW-B7-K
5.	Motor, Gear, Headgate, Right Angle, 12.8 RPM	Dayton	1LRA2





HEADGATE SWITCH
TERMINAL DETAIL
(TERMINAL SIDE OF SWITCH)

ENGINEERING LABORATORY DESIGN, INC.
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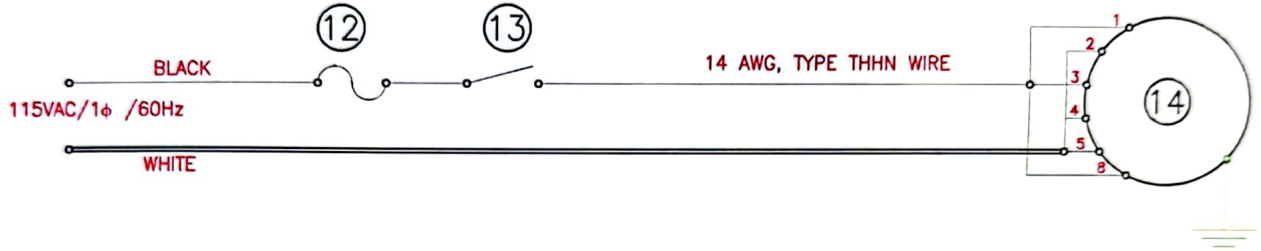
PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL
HEADGATE WIRING DIAGRAM

ORGANIZATION: TEXAS TECH UNIVERSITY

REFERENCE:	DATE:	SCALE:
PO NO. P0475390	08/08/16	NTS

No.	Component	Manufacturer	No.
12.	Fuse, Pump No. 1, 15Amp, Type FNM	Bussman	FNM 15
13.	SPST Toggle Switch, Pump No. 1	Carlingswitch	2FA53-73
14.	Motor, Pump No. 1, 0.75 ODP	Baldor	34F181W198



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P.O. Box 278
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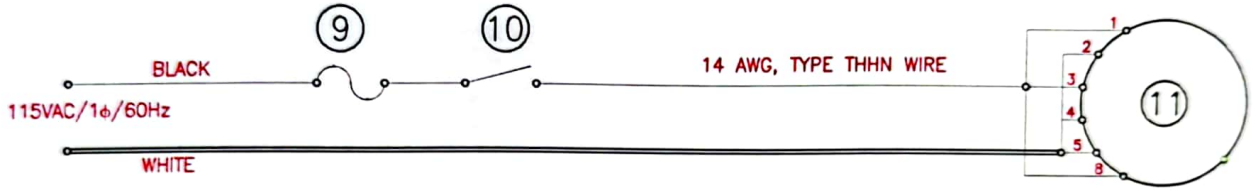
800-795-8536 FAX 651-345-5095

PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL
PUMP NO. 1 WIRING DIAGRAM

ORGANIZATION: TEXAS TECH UNIVERSITY

REFERENCE:	DATE:	SCALE:
PO NO. P0475390	08/08/16	NTS

No.	Component	Manufacturer	P/N
9.	Fuse, Pump No. 2, 15Amp, Type FNM	Bussman	FNM 15
10.	SPST Toggle Switch, Pump No. 2	Carlingswitch	2FA53-73
11.	Motor, Pump No. 2, 0.75HP ODP	Baldor	34F181W198



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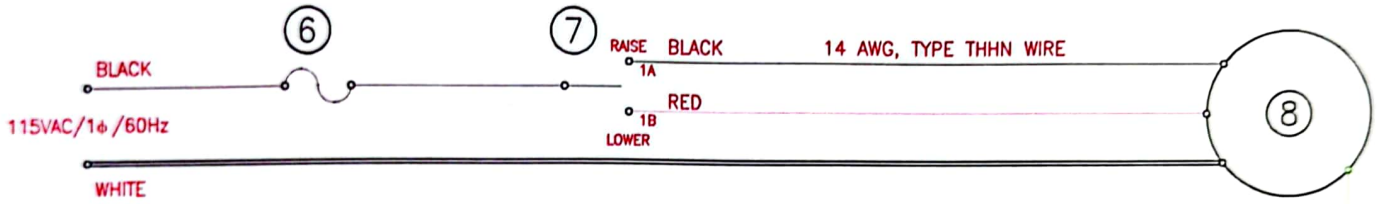
P.O. Box 278
Lake City, Minnesota 55041 USA
800-795-8536 FAX 651-345-5095

PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL
PUMP NO. 2 WIRING DIAGRAM

ORGANIZATION: TEXAS TECH UNIVERSITY

REFERENCE:	DATE:	SCALE:
PO NO. P0475390	08/08/16	NTS

No.	Component	Manufacturer	P. No.
6.	Fuse, Tailgate 2.5Amp, Type FNM	Bussman	FNM 2-1/2
7.	SPDT, (Momentary) Toggle Switch	Carlingswitch	6FC54-73
8.	Linear Actuator, Tailgate, 115VAC, 12" Travel	Dayton	1XFX9



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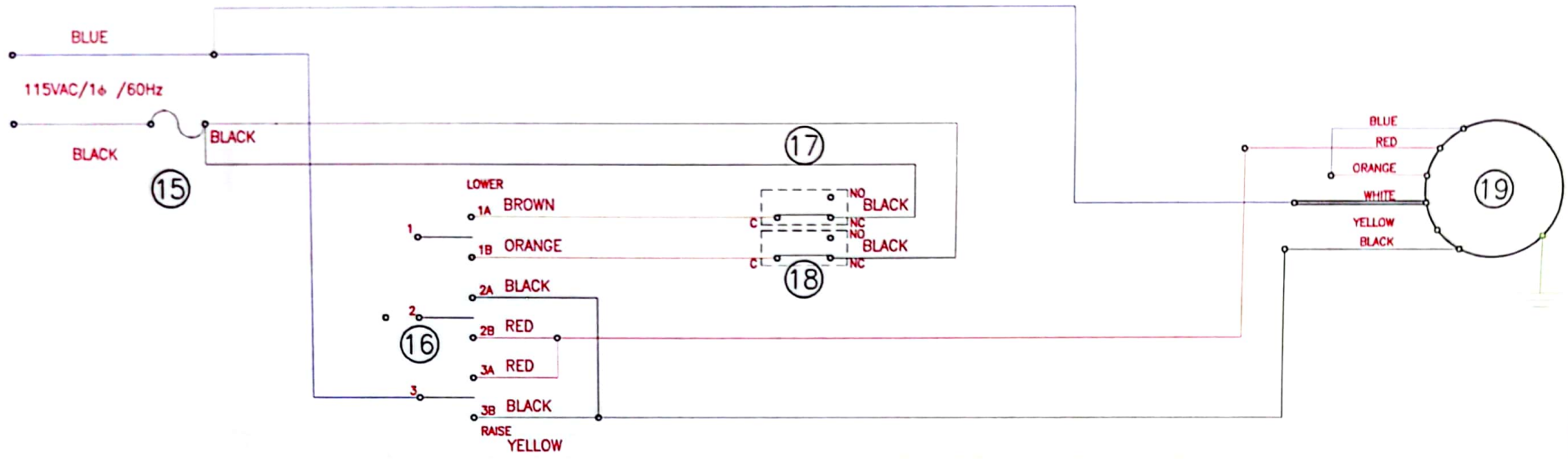
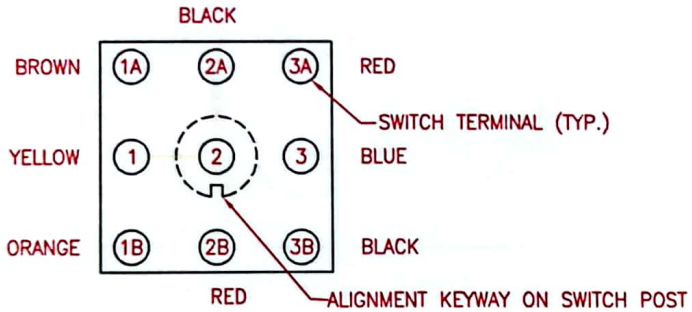
PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL
TAILGATE WIRING DIAGRAM

ORGANIZATION: TEXAS TECH UNIVERSITY

REFERENCE:	DATE:	SCALE:
PO NO. P0475390	08/08/16	NTS

No.	Component	Manufacturer	Part No.
15.	Fuse, Slope, 8Amp, Type FNM	Bussman	FNM 8
16.	3PDT Toggle Switch	McGill	0140-3027
17.	Limit Switch (Negative), Plunger Type	Honeywell	BZE6-2RN
18.	Limit Switch (Positive), Plunger Type	Honeywell	BZE6-2RN
19.	Capacitor Starter, Slope Motor, 1/3HP TEFC	Dayton	4CVU1





SLOPE SWITCH TERMINAL DETAIL
(TERMINAL SIDE OF SWITCH)

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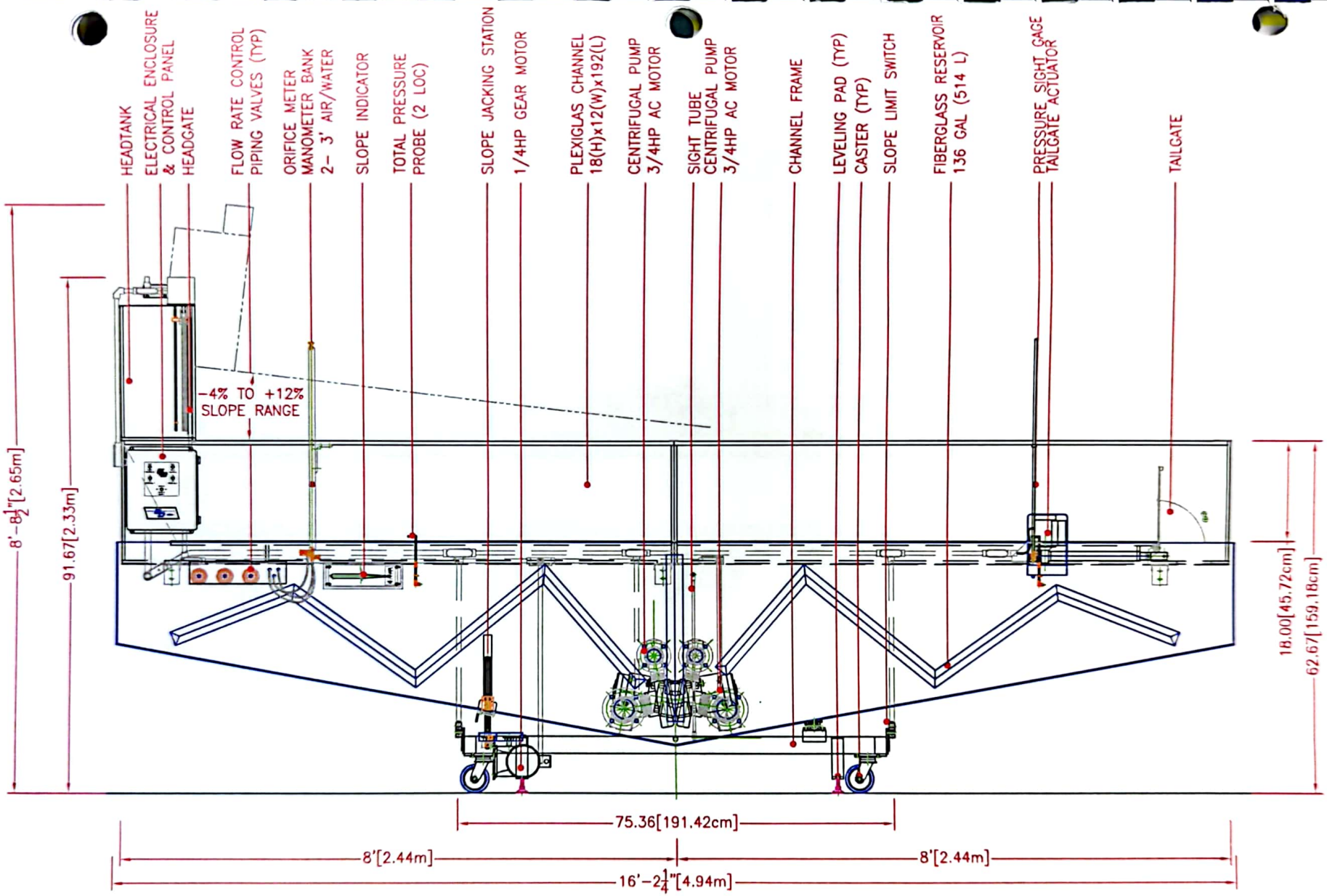
PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL ELEVATING ASSEMBLY WIRING DIAGRAM

ORGANIZATION: TEXAS TECH UNIVERSITY

REFERENCE:	DATE:	SCALE:
PO NO. P0475390	08/08/16	NTS



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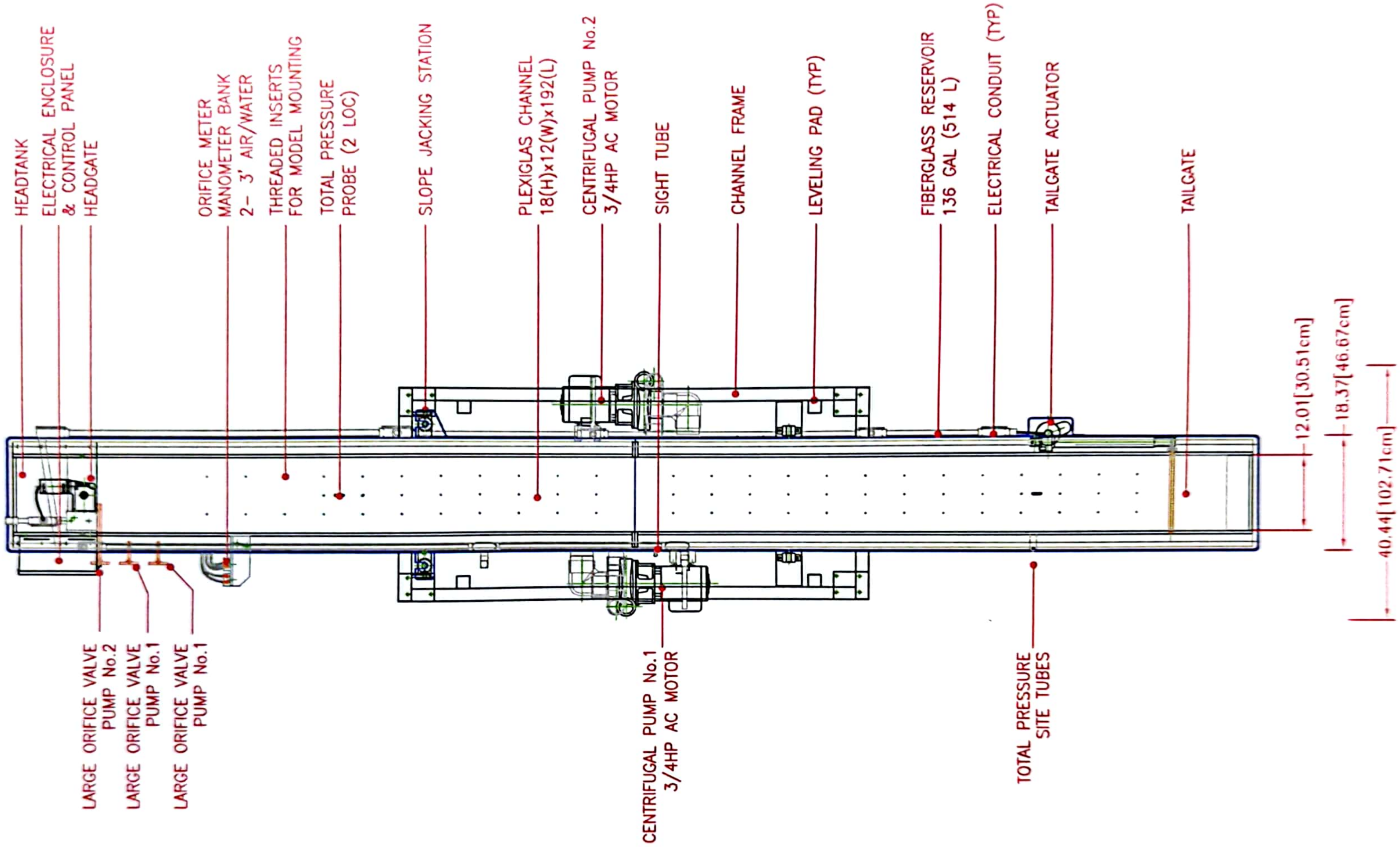
PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL OVERALL ELEVATION

ORGANIZATION: TEXAS TECH UNIVERSITY

REFERENCE:	DATE:	SCALE:
PO NO. P0475390	08/08/16	1/2" = 1'-0"



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PROJECT: B-16 HYDRAULIC DEMONSTRATION CHANNEL OVERALL PLANVIEW

ORGANIZATION: TEXAS TECH UNIVERSITY

REFERENCE:	DATE:	SCALE:
PO NO. P0475390	08/08/16	1/2" = 1'-0"