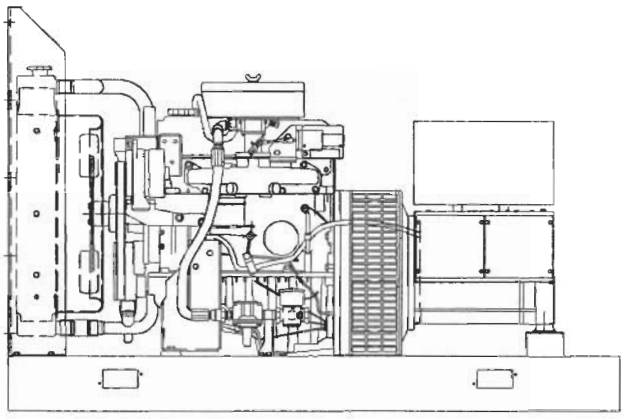
GENERATOR INFORMATION

Model: 18RY/RZ

KOHLER POWER SYSTEMS

Gas

ISO 9001 KOHLER GENERATORS INTERNATIONALLY REGISTERED



Standard Features

- Kohler Co. provides one-source responsibility for the generating system and accessories.
- The generator set and its components are prototype-tested, factory-built, and production-tested.
- The generator set accepts rated load in one step.
- A one-year limited warranty covers all systems and components. Two- and five-year extended warranties are also available.
- Alternator features:
  - Kohler's PowerBoost™ voltage regulation system provides instant response to load changes.
  - The low coolant level shutdown prevents overheating.
- Other features:
  - The low coolant level shutdown prevents overheating.
  - Integral vibration isolation eliminates the need for under-unit vibration spring isolators.
  - An electronic, isochronous governor delivers precise frequency regulation.
  - The gas fuel system includes fuel mixer, secondary gas regulator, gas solenoid valve, and flexible fuel line between the engine and the skid-mounted fuel system components.

Generator Set Ratings

Model Series	Hz	Voltage	Phase	Standby Amps LP Gas	Alternator Model	Standby kW/kVA Natural Gas	Standby kW/kVA LP Gas
18RY	60	120/240	1	75	4H7F	16/16	18/18
	50	110/220	1	68	4H7F	13/13	15/15
18RZ	60	120/240	1	75	4J7F	16/16	18/18
	60	120/208	3	64	4J7F	16/20	18/23
	60	120/240	3	55	4J7F	16/20	18/23
	60	127/220	3	60	4J7F	16/20	18/23
	60	139/240	3	55	4J7F	16/20	18/23
	60	220/380	3	35	4J7F	16/20	18/23
	60	277/480	3	28	4J7F	16/20	18/23
	50	110/220	1	64	4J7F	13/13	14/14
	50	110/190	3	57	4J7F	13/16	15/19
	50	110/220	3	49	4J7F	13/16	15/19
	50	120/208	3	52	4J7F	13/16	15/19
	50	220/380	3	29	4J7F	13/16	15/19
	50	240/416	3	26	4J7F	13/16	15/19

RATINGS: Standby ratings are continuous for the duration of any power outage. No overload capacity is specified at this rating. All single-phase units are rated at 1.0 power factor. All 3-phase units are rated at 0.8 power factor. Availability is subject to change without notice. Kohler Co. reserves the right to change the design or specifications without notice and without any obligation or liability whatsoever. Contact your local Kohler Co. generator set distributor for availability. GENERAL GUIDELINES FOR DERATION: *ALTITUDE*: Derate 4% per 1000 ft. (305 m) elevation above 500 ft. (153 m). *TEMPERATURE*: Derate 1% per 10°F (5.5°C) temperature increase above 85°F (29°C).

Alternator Specifications

Specifications	PowerBoost™ 1-Phase 4H7F (RY)	Alternator 3-Phase 4J7F (RZ)
Manufacturer	Kohler	
Output reconnectable	120/240 60 Hz and 110/220 50 Hz only	Broadrange
Type	Rotating Field	
Leads, quantity	4	12
Voltage regulator	Solid State	
Insulation:	NEMA MG1-1.66	
Material	Class H	
Temperature rise	Class F	
Bearing: quantity, type	1, Sealed	
Coupling	Flexible Disc	
Amortisseur windings	Full	
Voltage regulation, no-load to full-load	±2%	
One-step load acceptance per NFPA 110	100% of Rating	
Peak motor starting kVA:	(35% dip for 480 V, 60 Hz and 380 V, 50 Hz)	
60 Hz	42	62
50 Hz	29	45

- NEMA MG1, IEEE, and ANSI standards compliance for temperature rise and motor starting.
- Self-ventilated and dripproof construction.
- Vacuum-impregnated windings with fungus-resistant epoxy varnish for dependability and long life.
- Superior voltage waveform from a two-thirds pitch stator and skewed rotor.
- PowerBoost™ voltage regulator with ±2% no load to full load regulation.
- A rotating-field alternator with static exciter on single-phase models and a brushless alternator with rotating brushless exciter on three-phase models for excellent load response.

Application Data

Engine

Engine Specifications	60 Hz	50 Hz
Manufacturer	Ford	
Engine: model, type	LRG-425, 4-Cycle, Natural Aspiration	
Cylinder arrangement	4 Inline	
Displacement, L (cu. in.)	2.51 (153)	
Bore and stroke, mm (in.)	96.5 x 86.0 (3.80 x 3.40)	
Compression ratio	9.0:1	
Piston speed, m/min. (ft/min.)	311 (1020)	259 (850)
Main bearings: quantity, type	5, Replaceable Inserts	
Rated rpm	1800	1500
Max. power at rated rpm, kW (HP)	31 (41)	23 (31)
Cylinder head material	Iron Alloy	
Piston type and material	Aluminum Alloy	
Crankshaft material	Nodular Cast Iron	
Valves material	Forged Steel	
Governor, type	Electronic	
Frequency regulation, no-load to full-load	Isochronous	
Frequency regulation, steady state	±0.5%	
Air cleaner type, all models	Dry	

Exhaust

Exhaust System	60 Hz	50 Hz
Exhaust flow at rated kW, m^3/min. (cfm)	5.0 (180)	4.2 (150)
Exhaust temperature at rated kW, dry exhaust, °C (°F)	650 (1200)	
Maximum allowable back pressure, kPa (in. Hg)	6.7 (2.0)	
Exhaust outlet size at hookup, mm (in.)	38.5 (1.5)	

Engine Electrical

Engine Electrical System	60 Hz	50 Hz
Ignition system	Electronic, Distributorless	
Battery charging system:		
Ground (negative/positive)	Negative	
Volts (DC)	12	
Ampere rating	51	
Starter motor rated voltage (DC)	12	
Recommended battery cold cranking amps (CCA) rating for 0°F (-18°C)	630	
Batteries, quantity	1	
Battery voltage (DC)	12	
Rolling current at 0°C (32°F)	—	

Fuel

Fuel System	60 Hz	50 Hz
Fuel type	LP Gas or Natural Gas	
Fuel supply inlet	3/4-14 NPT	
Fuel supply pressure, in. H_2O (oz./$in.^2$)	7-11 (4-6)	

Lubrication

Lubricating System	60 Hz	50 Hz
Type	Full Pressure	
Oil pan capacity, L (qt.)	3.8 (4.0)	
Oil pan capacity with filter, L (qt.)	4.7 (5.0)	
Oil filter: quantity, type	1, Cartridge	
Oil drain extension with valve	Standard	

Application Data

Cooling

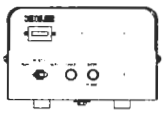
Standard Radiator	60 Hz	50 Hz
Ambient temperature, °C (°F)	49 (120)	
Engine jacket water capacity, L (gal.)	3.8 (1.0)	
Engine jacket water flow, Lpm (gpm)	60.5 (16)	49.2 (13)
Radiator system capacity, including engine, L (gal.)	16.3 (4.3)	
Heat rejected to cooling water at rated kW, wet exhaust, kW (Btu/min.)	27 (1540)	24 (1400)
Water pump type	Centrifugal	
Fan diameter, including blades, mm (in.)	436 (17.2)	
Fan, kW (HP)	1.0 (1.3)	0.6 (0.8)
Max. restriction of cooling air, intake and discharge side of rad., kPa (in. H_2O)	0.125 (0.5)	

Operation Requirements

Cooling Air Requirements	60 Hz	50 Hz
Radiator-cooled cooling air, m^3/min (cfm)	102 (3600)	91 (3200)
Combustion air, m^3/min. (cfm)	1.6 (56)	1.3 (47)
Total air Inlet Requirement, m^3/min. (cfm)	69 (2430)	57 (2024)
Heat rejected to ambient air:		
Engine, kW (Btu/min.)	7.73 (440)	6.50 (370)
Alternator, kW (Btu/min.)	3.34 (190)	3.16 (180)

Fuel Consumption	60 Hz	50 Hz
Natural Gas, cfh (m^3/hr.) at % load		
100%	7.4 (260)	6.2 (220)
75%	5.9 (210)	5.1 (180)
50%	4.8 (170)	4.2 (150)
25%	3.7 (130)	2.8 (100)
LP Gas, cfh (m^3/hr.) at % load		
100%	3.1 (110)	2.5 (90)
75%	2.5 (90)	2.0 (70)
50%	2.0 (70)	1.4 (50)
25%	1.4 (50)	1.1 (40)

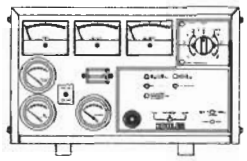
Controllers



Standard Controller Features

- Type: relay
- Power source with fuse protection: 12 volt DC
- Cyclic cranking
- Meters:
  - Running time hour meter
- Switches and Controls:
  - Master control switch: run/off-reset/auto (engine start)
  - Local/remote two-wire start control
- Common Fault Lamp:
  - High engine temperature (red)
  - Low coolant level (red)
  - Low oil pressure (red)
  - Overcrank (red)
  - Overspeed (red)

Refer to G6-31 for additional controller features and accessories.



Optional Controller Features

- Type: 5-light microprocessor (NFPA 110, level 2)
- Power source with fuse protection: 12 volt DC
- Cyclic cranking
- Engine cooldown time delay
- Panel lamps (2)
- Analog Meters:
  - AC meters, 64 mm (2.5 in.), volts, amperes, and frequency
  - DC meters, 51 mm (2 in.), DC volts, engine water temperature, and lube oil pressure
  - Running time hour meter
- Switches and Controls:
  - Master control switch: run/off-reset/auto (engine start)
  - Local/remote two-wire start control
  - Meter phase selector switch, 7-position
  - Lamp test switch
  - Alarm horn and silencing switch
  - Front-mounted voltage adjusting rheostat
- Fault and Condition Lamps:
  - High engine temperature lamp (red)
  - Low oil pressure lamp (red)
  - Low water temperature/auxiliary fault lamp (red)
  - Overcrank lamp (red)
  - Overspeed lamp (red)

Refer to G6-31 for additional controller features and accessories.

KOHLER CO., Kohler, Wisconsin 53044 USA
Phone 920-565-3381, Fax 920-459-1646
For the nearest sales and service outlet in the
US and Canada, phone 1-800-544-2444
KohlerPowerSystems.com

Kohler Power Systems
Asia Pacific Headquarters
7 Jurong Pier Road
Singapore 619159
Phone (65) 6264-6422, Fax (65) 6264-6455

Standard Features and Accessories

Enclosed Unit

- ❑ Exhaust Silencer, Critical
- ❑ Silencer Mounting Kit inside Housing
- ❑ Tail Pipe and Rain Cap Kit
- ❑ Weather Housing

Open Unit

- ❑ Exhaust Silencer, Critical (loose)
- ❑ Exhaust Silencer, Critical (engine mounted)
- ❑ Flexible Exhaust Connector, Stainless Steel

Cooling System

- ❑ Block Heater
- ❑ Radiator Duct Flange

Fuel System

- ❑ Automatic Changeover (Natural Gas to LPG Vapor)
- ❑ Flexible Fuel Line
  (required when the generator set skid is spring mounted)
- ❑ Fuel System Kit (LP Gas or Natural Gas)
- ❑ Gas Strainer
- ❑ LP Gas Liquid Withdrawal Fuel System

Electrical System

- ❑ Battery
- ❑ Battery Charger, 10 Amp NFPA, Float/Equalize
- ❑ Battery Charger, 6 Amp, Float/Equalize
- ❑ Battery Heater

Engine and Alternator

- ❑ CSA Certification
- ❑ Line Circuit Breaker
- ❑ NFPA 110 Literature
- ❑ Rodent Guards
- ❑ Skid End Caps

Maintenance

- ❑ General Maintenance Literature Kit
- ❑ Overhaul Literature Kit

Controller (Relay Controller)

- ❑ Engine Gauge Package
- ❑ Run Relay Kit

Controller (Microprocessor Controller)

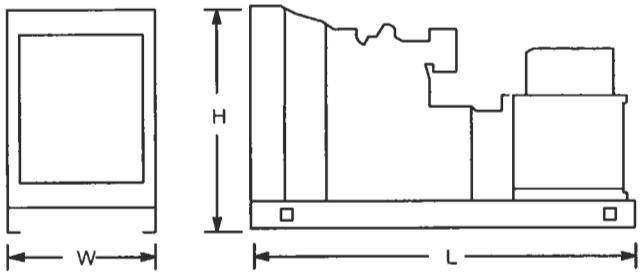
- ❑ Chime Alarm Kit
- ❑ Common Failure Relay Kit
- ❑ Customer Connection Kit
- ❑ Decision Monitor™ Remote Annunciator Panel
- ❑ Dry Contact Kit (Isolated Alarm)
- ❑ FASTCHECK® Diagnostic Fault Detector
- ❑ Overvoltage Protection Shutdown Kit
- ❑ Prealarm Sender Kit
- ❑ Remote Audiovisual Alarm Panel
- ❑ Remote Emergency Stop Kit
- ❑ Run Relay Kit

Miscellaneous Accessories

- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

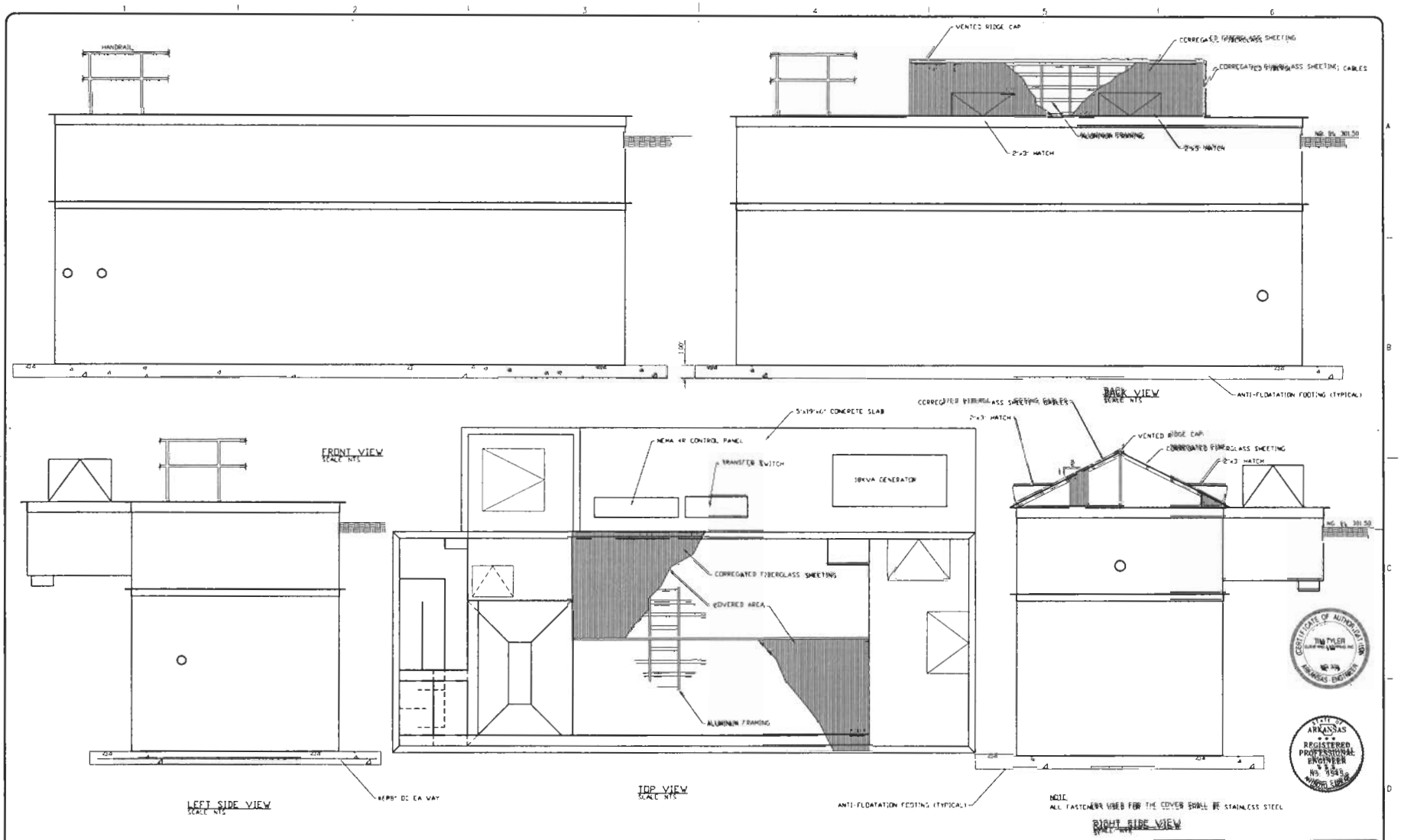
Dimensions and Weights

Overall Size, L x W x H, mm (in.):	1671 x 737 x 1114 (65.80 x 29.00 x 43.86)
Weight (radiator model), wet, kg (lb.):	18RY: 417 (920)
	18RZ: 445 (980)



NOTE: This drawing is provided for reference only and should not be used for planning installation. Contact your local distributor for more detailed information.

DISTRIBUTED BY:



TIM TYLER SURVEYING AND MAPPING

DWN	TS/SK
DR	JCW/JGK
CHK	TS/SK
APVD	TS

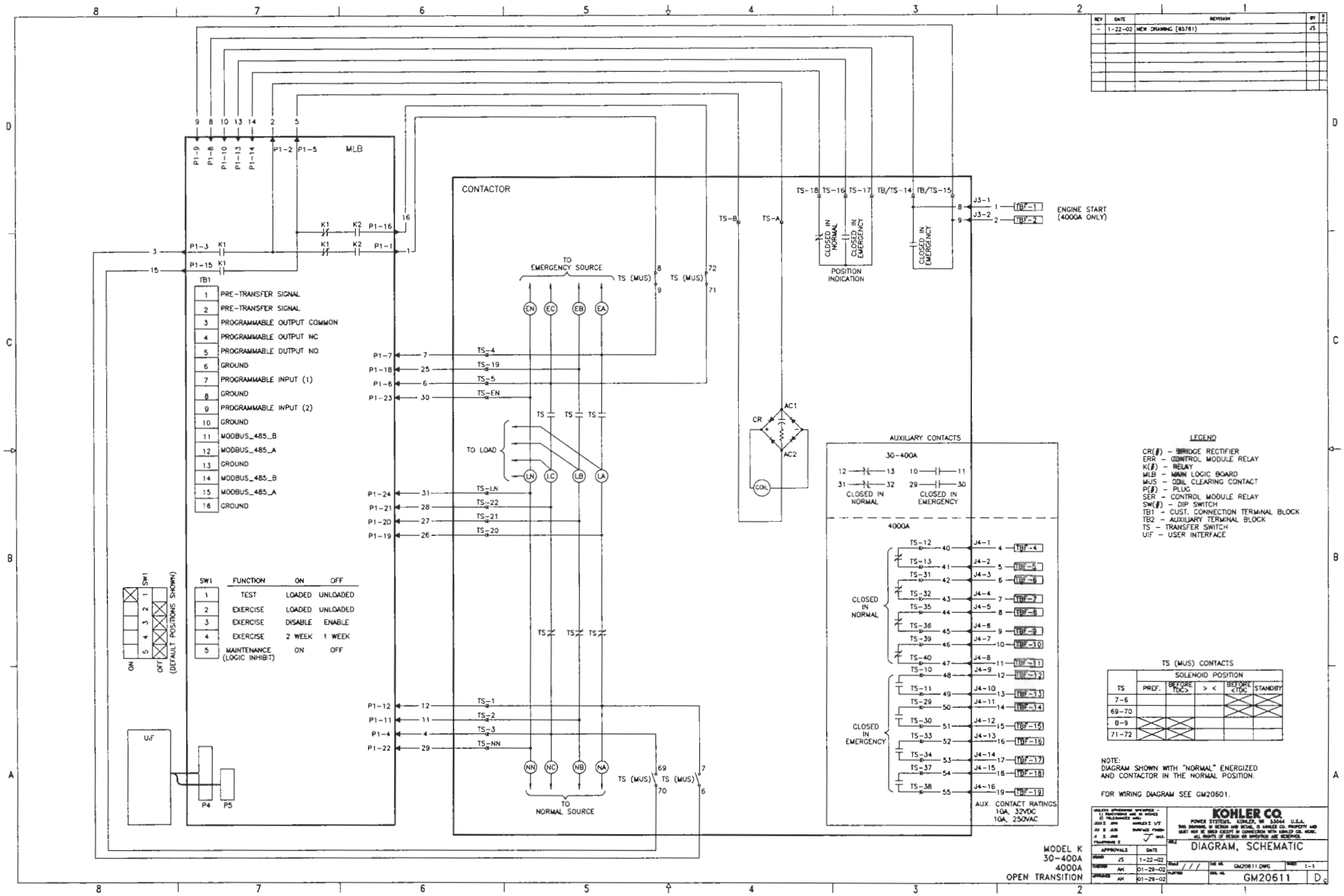
NO	DATE	REVISION	BY	APVD
1				
2				
3				
4				

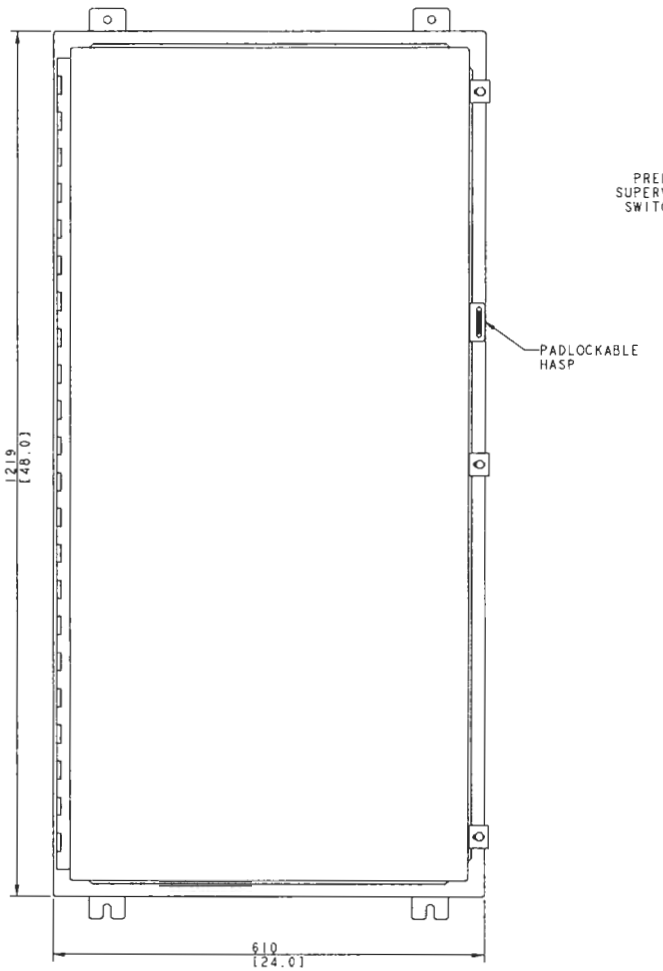
SCALE VERIFICATION
IF THIS BAR IS NOT ONE INCH ON THIS SHEET ADJUST SCALES ACCORDINGLY

SHADOW RIDGE SUBDIVISION
FAULKNER COUNTY, AR

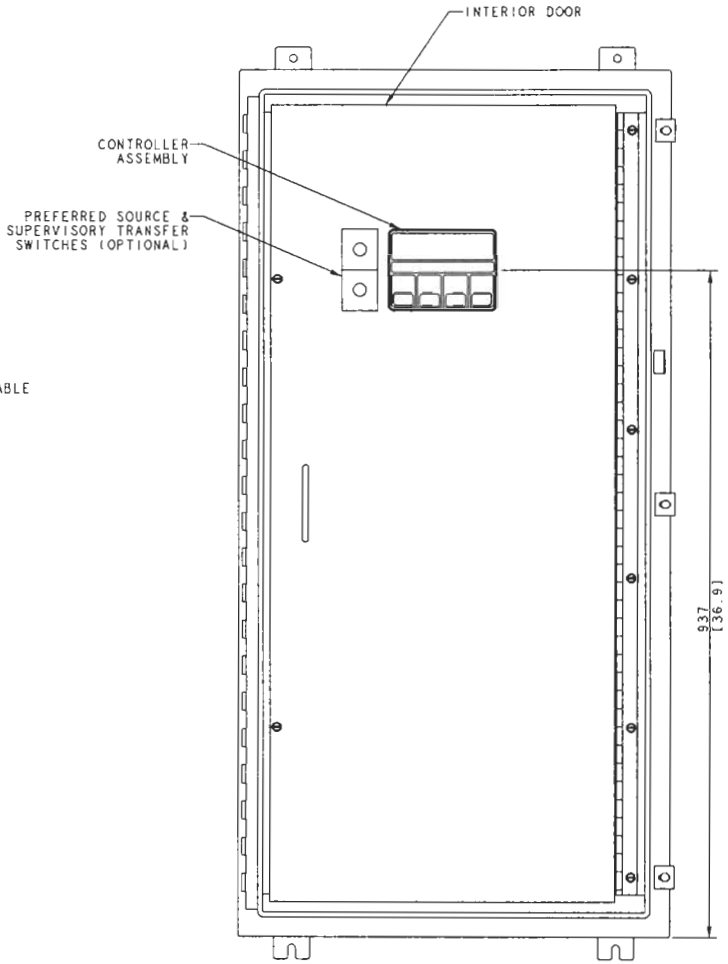
PROFILES
SEWAGE TREATMENT PLANT

SHEET 1 of
DATE MAR 2005
PROJ NO. 204-1173
SCALE AS SHOWN


REV | DATE | REVISION | BY
- | 1-22-02 | NEW DRAWING (65781) | JS
MLB
CONTACTOR
TO EMERGENCY SOURCE
TO LOAD
TO NORMAL SOURCE
TB1
1 PRE-TRANSFER SIGNAL
2 PRE-TRANSFER SIGNAL
3 PROGRAMMABLE OUTPUT COMMON
4 PROGRAMMABLE OUTPUT NC
5 PROGRAMMABLE OUTPUT NO
6 GROUND
7 PROGRAMMABLE INPUT (1)
8 GROUND
9 PROGRAMMABLE INPUT (2)
10 GROUND
11 MODBUS_485_B
12 MODBUS_485_A
13 GROUND
14 MODBUS_485_B
15 MODBUS_485_A
16 GROUND
SW1 | FUNCTION | ON | OFF
1 | TEST | LOADED | UNLOADED
2 | EXERCISE | LOADED | UNLOADED
3 | EXERCISE | DISABLE | ENABLE
4 | EXERCISE | 2 WEEK | 1 WEEK
5 | MAINTENANCE (LOGIC INHIBIT) | ON | OFF
(DEFAULT POSITIONS SHOWN)
UIF
P4 P5
POSITION INDICATION
CLOSED IN NORMAL
CLOSED IN EMERGENCY
ENGINE START (4000A ONLY)
AUXILIARY CONTACTS
30-400A
CLOSED IN NORMAL
CLOSED IN EMERGENCY
4000A
AUX. CONTACT RATINGS 10A, 32VDC 10A, 250VAC
LEGEND
CR(#) - BRIDGE RECTIFIER
ERR - CONTROL MODULE RELAY
K(#) - RELAY
MLB - MAIN LOGIC BOARD
MJS - COIL CLEARING CONTACT
P(#) - PLUG
SER - CONTROL MODULE RELAY
SW(#) - DIP SWITCH
TB1 - CUST. CONNECTION TERMINAL BLOCK
TB2 - AUXILIARY TERMINAL BLOCK
TS - TRANSFER SWITCH
UIF - USER INTERFACE
TS (MUS) CONTACTS
TS | SOLENOID POSITION | PREF. | BEFORE TDC> | > < | BEFORE <TDC | STANDBY
7-6
69-70
8-9
71-72
NOTE:
DIAGRAM SHOWN WITH "NORMAL" ENERGIZED AND CONTACTOR IN THE NORMAL POSITION.
FOR WIRING DIAGRAM SEE GM20601.
MODEL K
30-400A
4000A
OPEN TRANSITION
KOHLER CO.
POWER SYSTEMS, KOHLER, WI 53044 U.S.A.
APPROVALS | DATE
DRAWN JS 1-22-02
CHECKED AH 01-29-02
ENGINEER AH 01-29-02
TITLE DIAGRAM, SCHEMATIC
SIZE D
DWG NO. GM20611
SHEET 1-1
REV. NO. GM20611 D



FRONT VIEW



FRONT VIEW
WITH OUTER DOOR REMOVED

NOTES:
1. DIMENSIONS IN [ ] ARE INCHES.
2. FINISH:
   NEMA 4 & 12: ANSI 49 GRAY.
   NEMA 4X: STAINLESS STEEL.
3. DOOR CLAMPS VARY WITH NEMA TYPE.
4. REFER TO OPERATOR'S MANUAL PRIOR TO INSTALLATION & OPERATION OF SWITCH.
5. POWER CABLES AND CONTROL WIRING MUST BE RUN IN METAL CONDUIT.

230A 600V, 260 & 400A NEMA 4, 4X & 12

REV	DATE	REVISION	BY
-	11-01-01	NEW DRAWING (65781)	WSD
A	1-23-02	(A-2) CONDUIT NOTE ADDED (66469)	WSD
B	8-26-03	(A-2) CONDUIT NOTE UPDATED (69841)	WSD
C	12-19-03	(A-4) 230A 600V, 260 & 400A WAS 225-400A (71173)	WSD

UNLESS OTHERWISE SPECIFIED - 1) DIMENSIONS ARE IN MILLIMETERS 2) TOLERANCES ARE: SURFACE FINISH 1/64 MAX.

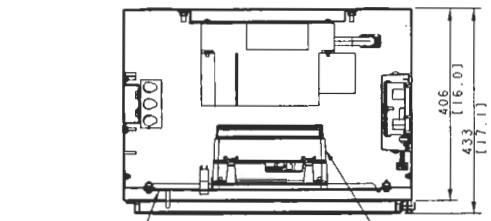
APPROVALS		DATE
DRAWN	RAC	11-01-01
CHECKED	AJH	11-12-01
APPROVED	AJH	11-12-01

KOHLER CO. METRIC PRO-
POWER SYSTEMS, KOHLER, WI 53044 U.S.A.

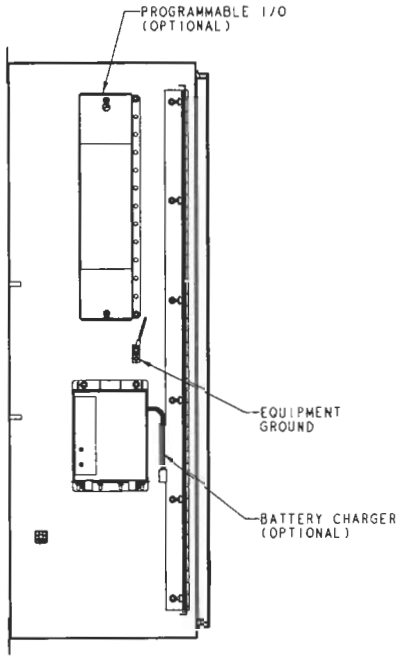
TITLE: DIMENSION PRINT

SCALE: NONE | SHEET 1 of 1

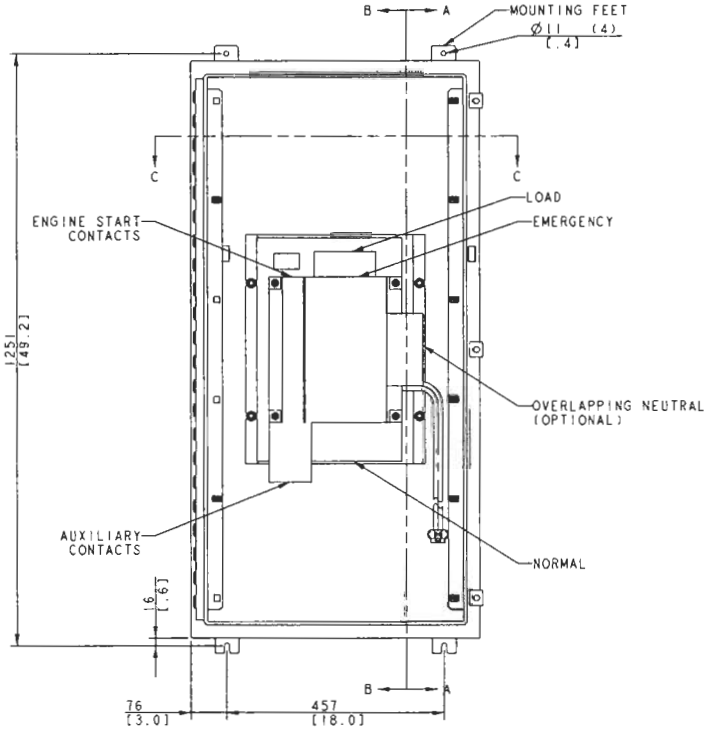
DWG NO: ADV-6701



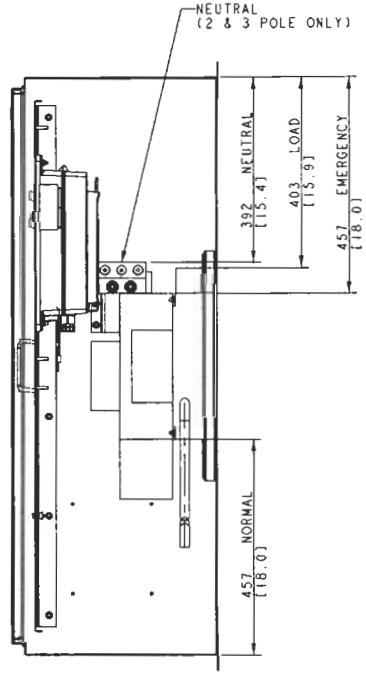
SECTION C-C



SECTION A-A



FRONT VIEW
DOORS NOT SHOWN



SECTION B-B

SCREW TYPE TERMINALS FOR EXTERNAL POWER CONNECTION			
SWITCH RATING (AMPS)	RANGE OF AL-CU WIRE SIZES PER PHASE		
	CONTACTOR	NEUTRAL	GROUND
260-400	(2) 1/0 TO 250MCM OR (1) #4 TO 600MCM	(2) 1/0 TO 250MCM OR (1) #4 TO 600MCM	#14 TO 1/0
230 600V	(1) #14 TO 4/0 CU ONLY		

WEIGHTS KG [LBS]		
2 POLE	3 POLE	4 POLE
62 [137]	66 [146]	69 [153]

230A 600V,
260 & 400A
NEMA 4, 4X & 12

REV	DATE	REVISION	BY
-	10-24-01	NEW DRAWING [65781]	RAC
A	1-23-02	SEE SHEET 1 [66469]	WSD
B	8-26-03	SEE SHEET 1 [69841]	WSD
C	12-19-03	(A-4) 230A 600V, 260 & 400A WAS 225-400A [71173]	WSD

UNLESS OTHERWISE SPECIFIED - ALL DIMENSIONS ARE IN MILLIMETERS [] TOLERANCES ARE:

SURFACE FINISH MAX.

THIRD ANGLE PROJECTION

APPROVALS	DATE
DRAWN RAC	11-01-01
CHECKED AJH	11-12-01
APPROVED AJH	11-12-01

TITLE
DIMENSION PRINT

SCALE NONE CAD NO. SHEET 2 of 2

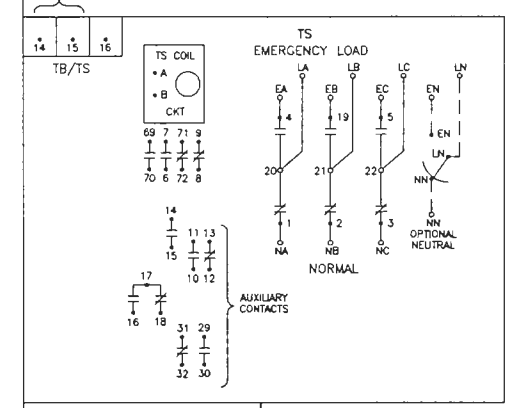
SIZE CAD NO.
ADV-6701

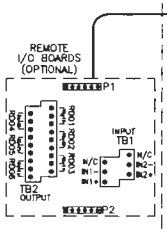
REV	DATE	REVISION	BY
–	1-22-02	NEW DRAWING (65781)	JS

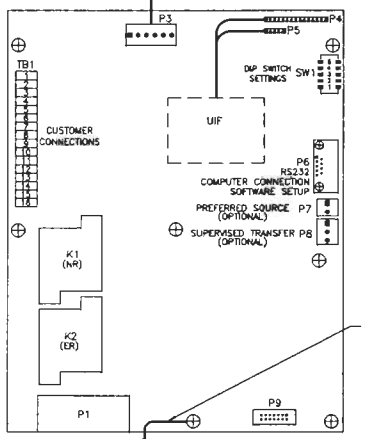
ENCLOSURE

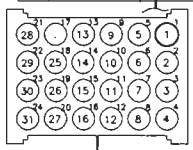
RIGHT SIDE WALL

DOOR









LEGEND

J( ) – CONNECTOR
P( ) – PLUG
TBF – TERMINAL BLOCK
TS – TRANSFER SWITCH

J1 CONNECTIONS (CONTACTOR TO MAIN LOGIC BOARD)

1	1	(TS–8)	13	13	(TS–16)
2	2	(TS–A)	14	14	(TS–18)
3	3	(TS–6)	15	15	(TS–70)
4	4	(TS–3)	16	16	(TS–72)
5	5	(TS–B)	17	N/C	
6	6	(TS–5)	18	25	(TS–19)
7	7	(TS–4)	19	26	(TS–20)
8	8	(TB/TS–14)	20	27	(TS–21)
9	9	(TB/TS–15)	21	28	(TS–22)
10	10	(TS–17)	22	29	(TS–NN)
11	11	(TS–2)	23	30	(TS–EN)
12	12	(TS–1)	24	31	(TS–LN)

FOR SCHEMATIC DIAGRAM SEE GM20611.

MODEL K
OPEN TRANSITION
260–400A
230A (600V)

APPROVALS	DATE
DRAWN JS	1-22-02
ENGINEER AM	01-29-02
CHECKED AM	01-29-02

KOHLER CO.
POWER SYSTEMS, KOHLER, WI 53044 U.S.A.

TITLE: DIAGRAM, WIRING

SIZE: D | CAD NO.: GM20615.DWG | SHEET: 1-1 | DWG NO.: GM20615 | REV.

EFFLUENT PUMP AND FORCEMAIN INFORMATION

Shadowridge Subdivision
Outfall FM to Cadron Creek

Diameter:	3	Inches
Pipe Length:	9300	feet
C factor:	130	
Peak Flow:	50	gpm
Total Average Flow for the Day:	39,600	gallons
Design Static Head:	136	Feet
Efficiency:	20.00%	

Single Pump Outputs

Motor Shaft Power:	13.58	HP
Total Head:	214.82	Feet
Run Time:	13.2	Hours
Total Energy Per Day:	133.7	KWH
Velocity:	2.27	Ft/sec
Cost of Operation:	$4,879	Per Year

SECTION 11317

DUPLEX EFFLUENT PUMP STATION

1.1 GENERAL

The contractor shall furnish all labor, materials, equipment and incidentals required to provide a duplex pumping system as specified herein. The system shall be by the same manufacturer as supplying the pump and motor control panel so as to insure suitability and assurance of experience in matching the equipment together and to insure single source responsibility for the equipment.

System shall consist of one fiber glass wetwell (42" diameter, 14.6 feet depth), two (2) sewage pumps, four (4) level control switches, discharge plumbing with disconnects, lifting chains, pedestal for mounting control panel on sump, aluminum hatch and Nema 3R control panel.

Each unit shall be capable of delivering 50 GPM at 215 Feet TDH.

1.2 RELATED SECTIONS

A. Section 02616 - Ductile Iron Pipe and Fittings.

B. Section 16010 - Basic Electrical Requirements.

1.3 SUBMITTALS

A. Submittal data shall be provided so show compliance with these specifications, plans or other specifications that will influence the proper operation of the pump(s).

B. Standard submittal data for approval must consist of:
   a. Performance Curves.
   b. Pump Outline Drawing.
   c. Detailed Electrical Data.
   d. Control Drawing and Data.
   e. Typical Installation Guides.
   f. Technical Manuals.
   g. Parts List.
   h. Printed Warranty.
   I. Manufacturer's Equipment Storage Recommendations.
   j. Manufacturer's Standard Recommended Start-Up Report form.
   k. Motor Performance Curve.

1.4 GUARANTEE

The pump unit or any part thereof shall be warranted against defects in material or workmanship within one year from date of installation or 18 months from date of manufacture, whichever comes first, and shall be replaced at no charge with new or remanufactured part, F.O.B. factory or authorized warranty service station. The warranty shall not assume responsibility for removal, reinstallation or freight, nor shall it assume responsibility of incidental damages resulting from the failure of the pump to perform.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The pump, mechanical seals, and motor shall be from the same manufacturer.

B. The pump, mechanical seals, and motor manufacturer shall be TSURUMI High Head Dewatering Pumps, Model LH311W60, as supplied by J. Richard Wolf Company, Stuttgart, Arkansas or Engineer approved equal.

C. Substitution: Make request under provision of Section 01600.

PART 3-

3.1. MATERIALS OF CONSTRUCTION –

All major parts of the pumping unit(s) including casing, impeller, motor cover and intermediate brackets shall be manufactured from recyclable, application appropriate resins. The need for a protective coating shall not be required. All exposed fasteners shall be stainless steel and shall have stainless steel mating anchors integrally cast into the mating part. All units shall be furnished with a NPT discharge companion flange.

Enclosed high chrome iron impellers, with replaceable/adjustable high chrome iron wear rings increases wear resistance when pumpage contains abrasive particles.

3.2 MECHANICAL SEAL –

Double inside mechanical seals with Silicon Carbide faces, in an oil filled chamber and further protected by a lip seal running against a replaceable stainless steel shaft sleeve, providing for the most durable seal design available.

3.3 MOTOR

The pump motors shall be 15 Hp.230 V., 60 Hz. Three Phase and shall be NEMA

MG-1, Design Type B equivalent. Motor(s) shall be rated at full load amps Motor(s) shall have a 1 15 service factor and shall be rated for 20 starts per hour. Motor(s) shall be air filled, copper wound, class F insulated with built in thermal and over amperage protection. Highly efficient, continuous duty air filled copper wound motor with class B or F insulation. Built in thermal and amperage sensing protector prevents motor failures due to overloading or accidental dry runs. Double shielded, permanently lubricated, high temperature C3 ball bearings rated for a B-10 life rating at best efficiency point of 60,000 hours. Motor(s) shall be VFD rated.

3.4. POWER CABLE AND CABLE ENTRANCE

The pump power cable shall be suitable for submersible pump applications The cable entrance shall incorporate built in strain relief, limited tightening plate, and shall feature a vulcanized, one piece, combination three way mechanical compression sealing/fatigue reducing boot The cable entrance assembly shall contain a anti-wicking block to eliminate water incursion into the motor due to capillary wicking should the power cable be accidentally damaged.

3.5 WETWELL

The pump station shall have a 42 inch diameter fiberglass wet-well with an overall depth of 14.58 feet.

3.6 ALUMINUM ACCESS DOORS

The access doors shall be cast in concrete type hatch with the size being specified on the plans. The frame shall be aluminum, one-piece, mill finish with an integral concrete anchor. Door panel shall be 1/4" thick aluminum, diamond plate, reinforced to 300 psi live load. Door shall open to 90° and automatically lock with a stainless steel hold open arm with aluminum release handle. Door shall close flush with the frame. Lifting handle, hinges and all fastening hardware shall be stainless steel. For security the access door shall be equipped with a staple for padlock. Access door shall be furnished with mill finish.

3.7 DUPLEX PUMP CONTROL

The pump control enclosure shall be a NEMA type 3R, minimum 14 gauge, galvanized and painted with gray enamel. The enclosure shall be equipped for pedestal mounting and a pad lockable hinged cover door with draw latches. All operator controls (pilot lights, selector switches, etc.) shall be installed on an interior mounted aluminum inner door and clearly labeled with engraved, two ply, laminated labels.

The pump control equipment shall include, but not limited to, combination starters, circuit breakers, hand-off-auto selectors, pump run lights, seal failure lights, and lugs for connecting all external controls. Equipment shall be mounted to a removable back panel. Equipment shall be mounted using cadmium plated

machine screws and drilling and tapping back panel, wiring on the back panel shall be enclosed in a plastic wire tray, laced wire bundles are not acceptable. An "as built" wiring diagram (ladder type schematic) shall be permanently attached to the inside of the enclosure door. All control wire shall be labeled on both ends corresponding to the numbering system on the as built diagram. A high level alarm light shall be mounted on the top of the control enclosure. The alarm shall be of the auto/reset type.

3.8 LIFT-OUT RAIL SYSTEM AND DISCHARGE PIPING

The lift-out rail system shall consist of bottom rail supports, upper rail supports, and a stainless steel lifting chain for each pump. The rails shall be constructed of minimum 1-1/2" stainless steel pipe and not less than 2 rails per pump shall be supplied. Pump Guide Systems that put a downward stress on the lift station cover (top) shall not be acceptable.

The discharge piping shall consists of 2 inch stainless steel pipe, and shall include a ball check valve with hydraulically sealed discharge flange and a gate valve for each pump. Piping configuration and size shall be as shown on the plans.

3.9 SUMP LEVEL CONTROLS

Float switches shall be supplied to control sump level and alarm signal. The switches shall be sealed in a polypropylene float for corrosion and shock resistance. The support wire shall be 18-2SJOW/A. A weight shall be attached to cord above the float to hold switch in place in sump and efficiently prevent sharp bends in the cord when float operates. A quantity of four (4) floats shall be provided to control level, and alarm conditions.

3.10 PUMP LEVEL CONTROL SEQUENCE

The level control shall be of the 4 float level type. At the low level, all pumps shall stop, as the liquid rises to the second level, the lead pump shall start and pump down to the low level (pumps will alternate lead) If the lead pump does not start at the second level or if the inflow exceeds the capability of the lead pump and the level rises to the third level, the lag pump will start if the level continues to rise to the fourth level the high level alarm light will activate.

PART 4 - EXECUTION

4.1 INSTALLATION

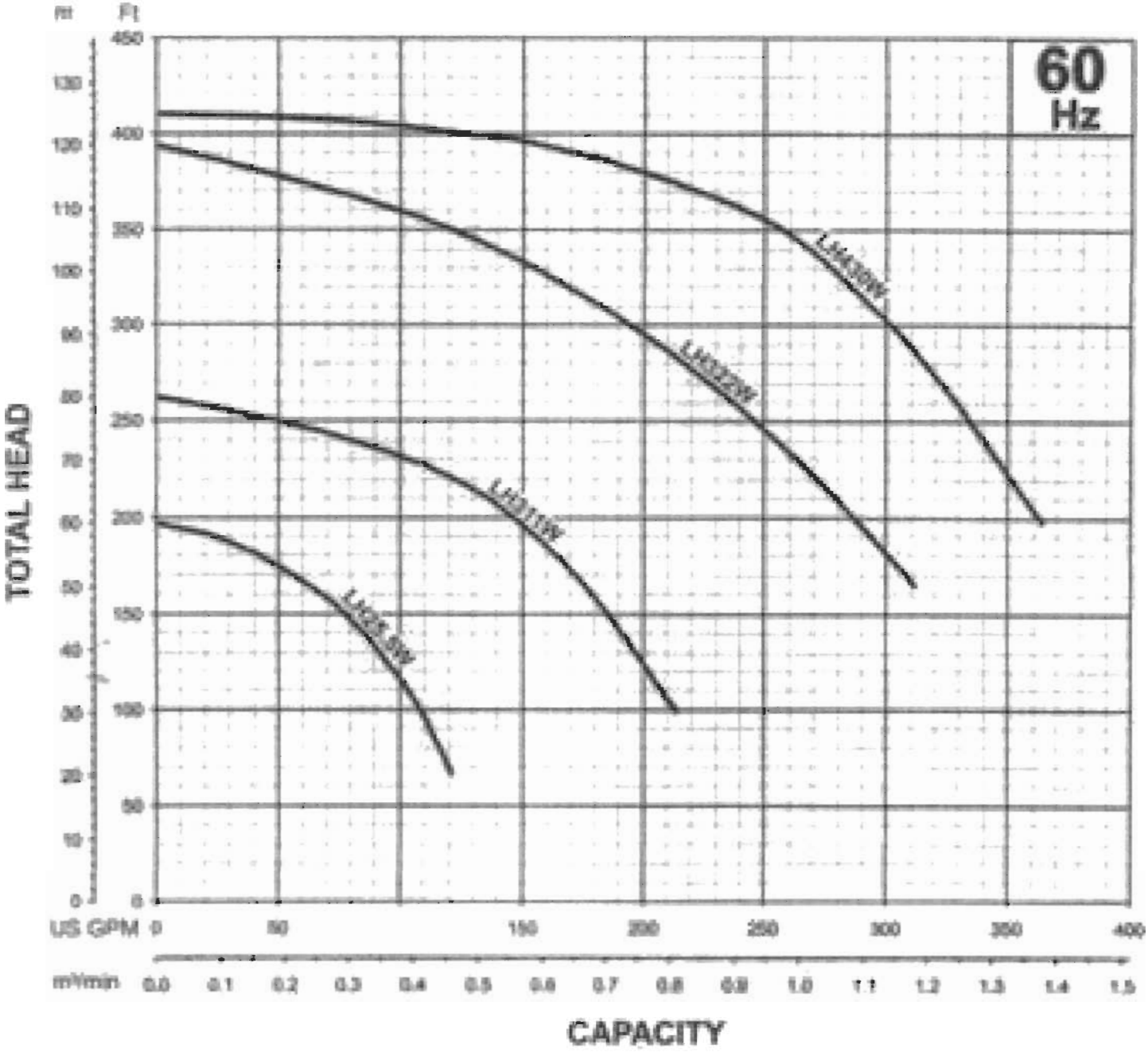
A. Equipment shall be installed as per the manufacturer's recommendations at the location as shown on the drawings.

4.2 Warranty

Manufacturer shall provide written warranty terms and conditions, and location of warranty service with the bid and with delivery. This warranty shall specifically state the equipment is warranted for use in the product to be pumped.

END OF SECTION

GROUP PERFORMANCE RANGE



■ FEATURES

1. Enclosed, high chrome iron impellers, with replaceable / adjustable high chrome iron Wear rings increases wear resistance when pumpage contains abrasive particles.

2. Double inside mechanical seals with silicon carbide faces, running in an oil filled chamber and further protected by a lip seal running against a replaceable, 400 stainless steel shaft sleeve, provides for the most durable seal design available.

3. Highly efficient, continuous duty air filled, copper wound motor with class B or F insulation, minimizes the cost of operation.

4. Built in thermal & amperage sensing, protector prevents motor failure due to overloading or accidental run - dry conditions.

5. Double shielded, permanently lubricated, high temperature C3 ball bearings rated for a B-10 life of 60,000 hours, extend operational life.

6. Top discharge, flow-thru design enables operation at low water levels for extended periods.

■ APPLICATIONS

1. Residential, commercial, industrial wastewater and construction site drainage.

2. Effluent transfer.

3. Decorative waterfalls and fountains.

4. Raw water supply from rivers or lakes.

OIL LIFTER

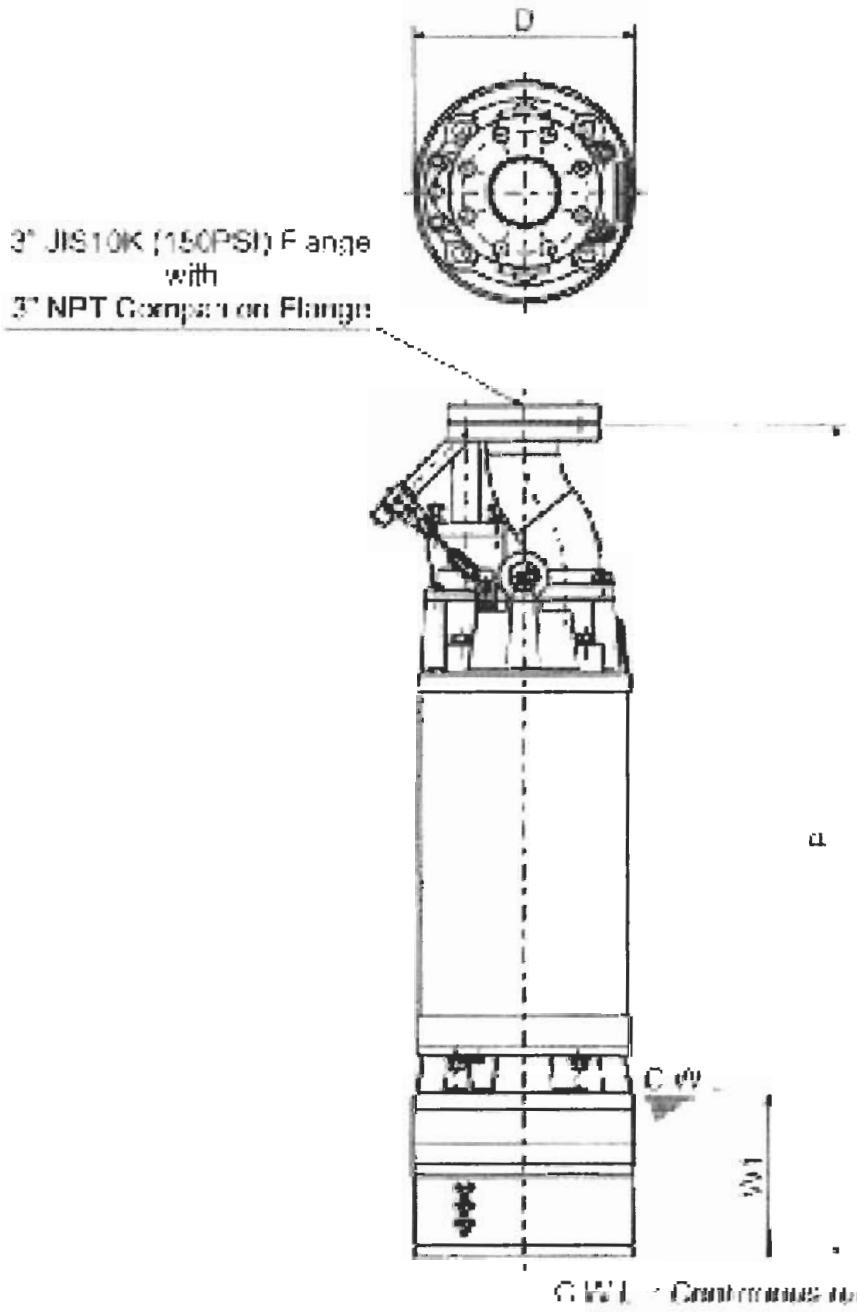
■ SPECIFICATIONS

Discharge Size	2" ~ 4" Npt (50 ~ 100 mm)
Horsepower Range	7.5 Hp. ~ 40 Hp. (5.5 ~ 30 kW)
Performance Range Capacity	30 ~ 364 Gpm. (.11 ~ 1.37 m³/min)
Head	70 Ft. ~ 400 Ft. (21. ~ 122 m)
Maximum water temperature	104 °F. (40 °C.)
Materials of Construction	
Casing	Cast Iron
Impeller	High Chrome Iron Casting
Shaft	420 Stainless Steel
Motor Frame	Cast Iron
Fasteners	304 Stainless Steel
Mechanical Seal	With seal pressure relief ports
Upper Seal	Silicon Carbide/Carbon
Lower Seal	Silicon Carbide/Silicon Carbide
Elastomers	NBR (Nitrile Rubber)
Impeller Type	Enclosed, two-stages
Solids Handling Capability	Double stages 1/3" (8.5 mm), 1/4" (6 mm, 7.5 HP)
Bearings	Prelubricated, Double Shielded
Motor Nomenclature	
Type, Speed, Hz	Air Filled, 3600 Rpm, 60 Hz.
Voltage, Phase	208/230/460/575 V., 3 Phase
Insulation	Class B, F (40 Hp.)
Accessories	Submersible Power Cable 50' (15 m)
Operational Mode	Manual

■ STANDARD

Length as Required

■ OPTIONS



C.W.L. : Continuous running Water Level

DIMENSIONS:USCS (Inch)

Model	HP	NOM. SIZE	Pump & Motor B	Pump & Motor D	C.W.L. W1	Wt. (lbs.)
LH311W-60	15	3"	40 5/16	10 5/8	7 7/8	286

DIMENSIONS:METRIC (mm)

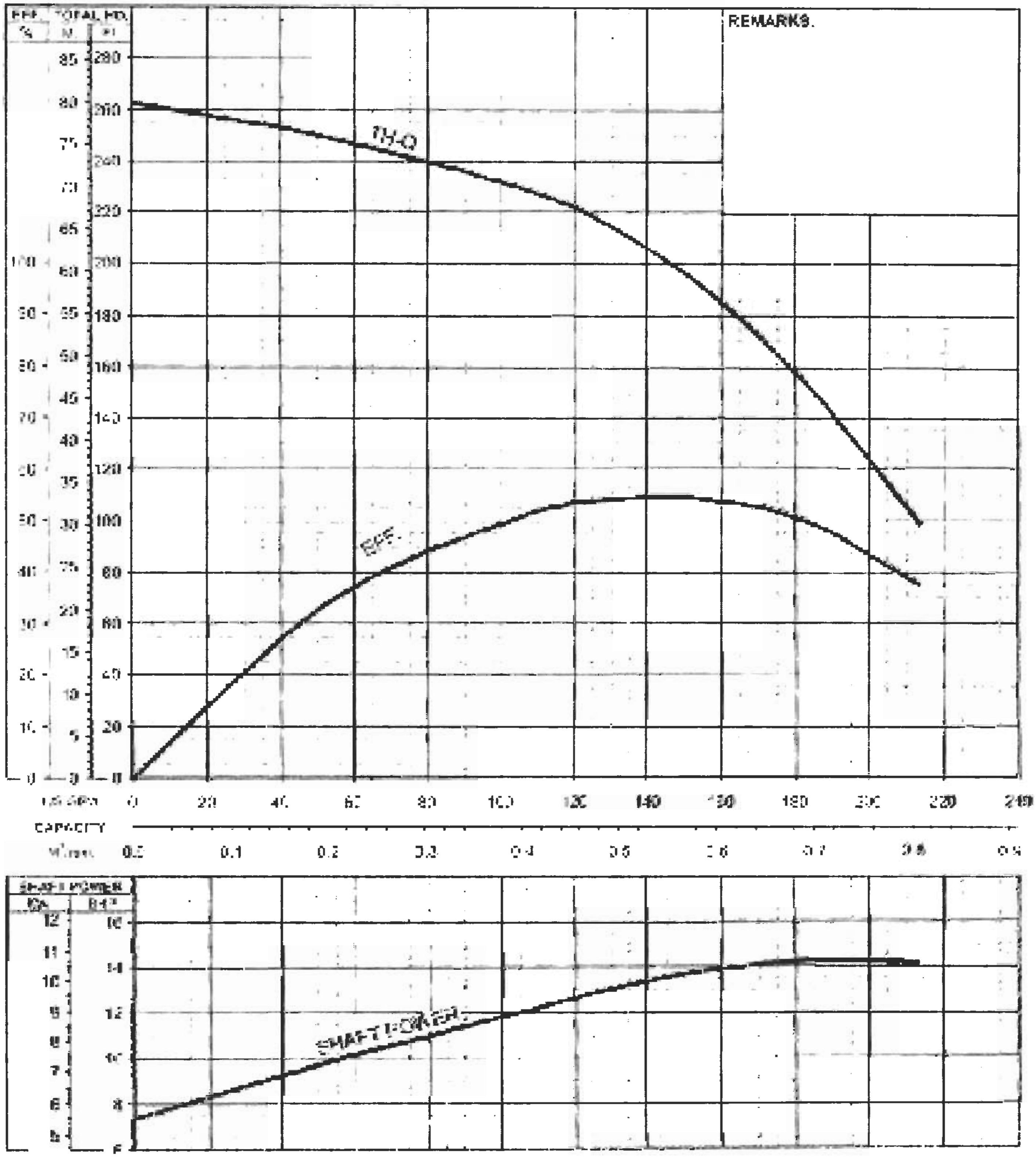
Model	kW	NOM. SIZE	Pump & Motor B	Pump & Motor D	C.W.L. W1	Wt. (kg)
LH311W-60	11	80	1024	270	200	130

TSURUMI PUMP

LH-W SERIES PERFORMANCE CURVE

LH311W-60

MODEL		BORE	HP	KW	RPM	SOLIDS DIA	LIQUID	SG.	VISCOSITY	TEMP.
LH311W-60		[illegible]mm	15	11	[illegible]	0.33"/8.5mm	Water	1.0	1.81 CST	[illegible]
PUMP TYPE		PHASE	VOLTAGE		AMPERAGE	HZ	STARTING METHOD			INS. CLASS
High Head Dewatering Pump		3	208/230/460/575		43.0/37.0/18.6/14.5	60	Direct On Line			B
CURVE No.	DATE	PHASE	VOLTAGE		AMPERAGE	HZ	STARTING METHOD			INS. CLASS
-						-	-			-



SECTION 02734

SANITARY SEWER FORCE MAIN

PART 1 - GENERAL

2.1 SECTION INCLUDES

A. Providing pipe, fittings, and appurtenances to convey sanitary sewage from lift stations to designated point of discharge into collection system.

2.2 RELATED SECTIONS

A. Section 02732 - SANITARY SEWER GRAVITY LINES

2.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM A48 Specifications for Gray Iron Castings.
   2. ASTM D1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   3. ASTM D2241 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).

B. American National Standards Institute/American Water Works Association (ANSI/AWWA):

1. ANSI/AWWA C105 Polyethylene Encasement for Gray and Ductile Cast Iron Piping for Water and Other Liquids.

PART 2 - PRODUCTS

3.1 MATERIALS

A. Ductile iron pipe and fittings: Refer to Section 02616.

B. PVC pipe, 2-inch through 12-inch size:
   1. Basic material: Poly(vinyl chloride) plastic conforming to ASTM D1784, Type I, Grade 1.
   2. Pipe: Conforming to ASTM D2241 as it applies to Type 1, Grade 1, Polyvinyl Chloride (PVC) plastic, standard thermoplastic pipe dimension ratio (SDR) 21, water pressure rating (PR) at 200 pounds per square inch (PSI) at 73.4 degrees fahrenheit (F) for 2-inch through 12-inch nominal pipe sizes.

Pipe shall bear seal of approval of National Sanitation Foundation Testing Laboratory (NSF).

3. Pipe joints: Push-on type with each section of pipe having single, molded rubber ring gasket in recess in molded PVC socket or bell on one end and beveled, plain end on other end. Gasket and angular recess shall be so designed and shaped that gasket is locked in place against displacement as joint is assembled. Gasket dimensions shall be in accordance with manufacturer's standard design dimensions and tolerances and shall be of such size and shape as to provide adequate compressive force against plain end and socket assembly to effect positive seal under all combinations of joint pressure as required for pipe. Plain end by plain end pipe con nected by coupling provided with rubber gaskets and center stop will be acceptable.
4. Pipe Lengths: Manufacturer's standard lengths of 18 to 20 feet.

C. Fittings, 6-inch pipe and larger: Ductile iron compact fittings as specified in Section 02616.

D. Markings: PVC pipe and 4-inch and smaller fittings shall have following data imprinted on exterior of each piece:
   1. Nominal size.
   2. Type of material.
   3. SDR or Class.
   4. Manufacturer's name.
   5. NSF seal of approval.

E. Select Backfill Material: Soil excavated from trench or sub-soil from site that is free of rocks larger than 1 1/2 inches in greatest dimension, and free of frozen soil, large clumps of soil, muddy soil, organic matter and foreign materials. AWWA C-605 Standards.

F. Class I Material: Angular, graded stone, 1/4-inch to 1-1/2 inch size with not more than 5 percent passing a No. 4 sieve. AWWA C-605 Standards

G. Polyethylene encasement: Polyethylene film in tube form conforming to ANSI/AWWA C105.

H. Concrete: Refer to Section 03001.

I. Detectable locator tape: Terra Tape Sentry Line 620 Underground Marking Tape, 3 inches wide, colored in accordance with American Public Works Association (AWPA) Color Codes, imprinted on one side with continuous warning message CAUTION SEWER LINE BURIED BELOW, by Reef Industries, Inc., Houston, Texas, or approved equal.

J. Concrete patching materials:
   1. Concrete mortar: Mix one part portland cement with four parts sand and add minimum quantity of water as necessary to provide workable mortar.
   2. Nonshrink grout: FIVE STAR GROUT, portland cement based, nonmetallic nonshrink grout, by Five Star Products, Inc., Fairfield, Connecticut.

PART 3 - EXECUTION

4.1 EXCAVATION - TRENCH

A. Excavate trench widths within limits established as follows for pipe size used:

Nominal Pipe Diameter	Minimum Width of Trench	Maximum Width of Trench 12" Above Top of Pipe
6"	1'-6"	2'-6"
8"	1'-8"	2'-8"
10"	1'-10"	2'-10"
12"	2'-0"	3'-0"
15"	2'-3"	3'-3"
16"	2'-4"	3'-4"
18"	2'-6"	3'-6"
20"	2'-8"	3'-8"
24"	3'-0"	4'-0"
30"	3'-6"	4'-6"

B. If necessary to reduce earth load on trench banks to prevent sliding and caving, cut trench banks on a slope above an elevation two feet above outside top of pipe.

C. Keep sides of excavation vertical from bottom of trench to 12 inches above top of pipe.

D. For rigid pipe not requiring bedding material under pipe, excavate trench to grade of bottom of pipe barrel so as to allow flowline of pipe to be layed at designated grade. Ensure that trench bottom is firm, dry, and free of loose material. If water is standing or flowing into trench bottom, attempt to provide dry, firm soil foundation for pipe by pumping water out of below-grade sump before over-excavating and backfilling with gravel.

E. Where granular bedding material under pipe is specified, excavate to below designated grade of pipe barrel to allow for depth of bedding material. Grade bottom of trench approximately level across and approximately at designated

slope of line. Ensure that trench bottom is firm, dry, and free of loose material. Extra bedding material required in bottom of trench because of inadvertent over-excavation will not be paid for as extra gravel in trench.

F. If soil in trench bottom below pipe barrel or below bedding material is mucky, or too soft to properly support the pipe, or in such condition that it cannot be properly shaped and graded, excavate to minimum depth of 6 inches below normal subgrade elevation to firm soil and refill with Class I material to the pipe subgrade elevation.

G. Where water occurs in trenches after placement of bedding material or gravel backfill, and the foundation is otherwise stable, pump water out of trench from sump below gravel so as to hold water level below bottom of pipe until joints have been placed and pipe firmly bedded in position.

H. Where water is standing in trench, attempt to provide firm, dry foundation for laying pipe by pumping water out of trench from below-grade sump. If this procedure does not remove water completely from trench or leaves trench too soft to properly support pipe, undercut to firm soil and replace with Class I material which will be paid for as "extra gravel in trench".

I. Where water rises in trench above gravel backfill placed to grade of bottom of pipe, pump water out of trench from sump below gravel so as to hold water level below bottom of pipe until pipe has been jointed and firmly bedded.

J. Do not excavate more than 300 feet ahead of pipe installation and back fill.

K. Direct surface runoff water away from trenches into existing drainage structures and ditches in such a manner as to prevent flooding of streets or private property.

L. Pile excavated material where it will not endanger the Work or obstruct sidewalks and driveways. Keep street drainage swales clear or make other satisfactory provisions for street drainage.

M. Remove excess material and material unsuitable for backfilling from public rights of way and utility line easements.

4.2 BEDDING AND BACKFILLING

A. Ductile Iron pipe, Type 2 Laying Condition, and PVC Pipe: Grade trench bottom or foundation material to provide full length support of pipe barrel at designated depth of line.

B. Excavate for bells or other joint protrusions.

C. Lay pipe as specified in this section.

D. Place 4-inch layer of select material on each side of pipe. Slice-in material under pipe haunches with shovel to eliminate voids and provide side support. Consolidate material by walking on each side of pipe from haunches of pipe to side of ditch.

E. Bring material up evenly on both sides of pipe up to centerline of pipe by placing in 4-inch layers and walking-in each layer.

F. From centerline of pipe up to 12 inches above top of pipe, hand- place select material in such manner as to minimize voids but with no consolidation or minimum layer requirements.

G. Backfill trenches not under structures or traffic areas with excavated material or subsoil up to surrounding ground surface:

H. Do not use material of a perishable, spongy, or otherwise unsuitable nature and do not place rocks larger than 6 inches in greatest dimension within 36 inches of top of pipe.

I. Do not place rock larger than 1-1/2 inches in greatest dimen sion within 12 inches of top of surrounding ground.

J. Leave trench slightly mounded above top of pipe to allow for settlement.

K. Maintaining trenches:
   1. Maintain top of trenches during guarantee period of contract, adding material as backfill material settles.
   2. Maintain road and sidewalk crossings until pavement has been placed.

4.3 LAYING PIPE

A. General:
   1. Inspect each joint of pipe before it is placed in trench, making sure no foreign material is inside pipe.
   2. Lower pipe carefully into trench one length at a time in such manner that spigot and bell will not become contaminated.
   3. If cutting of pipe is necessary, make cut straight and smooth without damage to pipe or cement mortar lining. Remove sharp edges and burrs.
   4. Lay pipe with bell facing direction of laying.
   5. Do not lay pipe in water or when trench conditions or weather is unsuitable for such Work.

6. Place pipe on bedding prepared as specified in this Section.
7. Lay pipe in straight and true alignment without sharp bends or severe breaks in grade.
8. Do no allow deflection at joints to exceed maximum deflection recommended by pipe manufacturer.
9. At end of each day's Work, and when laying of pipe must be discon tinued for an appreciable period, close open ends of pipe temporarily to prevent foreign matter and water from entering.

B. Jointing push-on joint pipe:
1. Check inside of pipe barrel for cleanliness.
2. Clean bell and spigot ends of pipe including gasket seat using wire brush as necessary.
3. Clean and insert rubber gasket in seat within bell.
4. Apply lubricant as recommended by pipe manufacturer.
5. Insert spigot end into bell of pipe to which connection is being made and force to firm contact with shoulder of bell.
6. Embed pipe and begin initial backfilling immediately after each joint has been laid and jointed.
7. Bevel cut pieces or ends of pipe that enter push-on bell as recommended by pipe manufacturer.

C. Jointing mechanical joint pipe and fittings:
1. Clean, using soapy water and cloth, plain ends of pipe and bell ends of pipe and fittings, removing foreign materials from bells including gasket seats.
2. Place cast or malleable iron follower ring on plain end of pipe or fittings followed by rubber gasket which has been cleaned and lubricated with soapy water.
3. Place plain end of pipe in bell to which connection is to be made and push to firm contact with shoulder of bell.
4. Advance rubber gasket into bell and seat in gasket seat. Bring follower ring into contact with rubber ring and enter bolts and start nuts. Give pipe necessary deflection up to maximum allowed.
5. Make joint tight by advancing nuts with wrench on bolts 180 degrees apart until tight joint is made. Tighten bolts to following torque range:

Bolt Size (Inches)	Torque Range (Foot-Pounds)
5/8	45-60
3/4	75-90
1	85-100
1-1/4	105-120

D. Jointing flange joint pipe and fittings:
   1. Clean faces of flanges and remove burrs or imperfections with steel brush.
   2. Place rubber gasket of 1/16-inch minimum thickness between flanges.
   3. Clean and lubricate bolts and nuts prior to tightening bolts.
   4. Prevent strain on flanges when aligning and tightening bolts.
   5. Tighten bolts alternately on opposite sides to torque listed in this section for mechanical joints.

E. Placing polyethylene encasement: Install in accordance with ANSI/AWWA C105, Method A or B, at locations where ductile iron force main crosses steel, cast iron, or ductile iron pipe line.

4.4 INSTALLING DETECTOR LOCATOR TAPE

A. Place locator tape flat in trench backfill vertically above pipe with warning message facing up and at depth between 6 inches and 12 inches below finish ground surface.

4.5 ROADWAY AND RAILROAD BORES

A. Bore and encase roadway and railroad crossings as specified in Section 02205.

B. Push or pull force main, or carrier pipe, through the completed casing pipe as specified in Section 02205.

C. Joint pipe as specified in this section.

4.6 CONNECTION TO EXISTING MANHOLE

A. Do not connect force main to existing manhole until force main has been tested and approved and collecting system and pumping system have been completed, tested, and approved for connection by Engineer.

B. Cut hole of sufficient size in wall of existing manhole to permit proper installation of proposed pipe at designated line and grade.

C. Break out manhole bottom as necessary to form invert, allowing for thickness of concrete mortar during final shaping.

D. Extend pipe through wall of manhole and fill opening around pipe with nonshrink grout. Plaster wall surface on both sides with concrete mortar.

E. Shape invert with concrete mortar for smooth flow of sewage through manhole.

4.7 CONCRETE THRUST BLOCKS

A. General: At changes in direction of pipeline, place concrete against undisturbed soil and against bend fittings, plugs, tees, valves on ends of line, and fire hydrants as brace to resist movement from thrust pressures that occur during operation of distribution system. Use concrete having minimum 28-day compressive strength of 2,500 PSI. Refer to detail Drawing.

B. Place concrete against vertical wall of undisturbed soil and on dry bottom excavation. Hand shape excavation and remove loose material. Use forms to confine concrete in areas other than part that is in contact with undisturbed soil in direction of thrust.

C. Do not place concrete around part of joint where it would interfere with removal of joint accessories such as bolts, followers, threads, collars, and couplings. Do not restrict fire hydrant drains.

D. Strike off top of concrete thrust block with wood straight edge or float.

E. Do not place concrete when temperature is below 40 degrees F and dropping or below 35 degrees F if temperature is rising.

F. Do not use admixtures in concrete mix without approval of Architect/Engineer.

G. Place concrete only in presence of Architect/Engineer.

H. Do not place backfill over concrete thrust blocks before concrete has attained initial set.

I. Do not install thrust blocks with less than 6 inches between pipe or appurtenance and undisturbed soil in the direction of thrust.

J. Place concrete and reinforcement steel in accordance with Section 03001.

K. Clean surfaces of pipe or appurtenances where concrete is to be in direct contact.

L. Ensure that area of contact of thrust blocks is sufficient to resist thrust. Use as guide suggested safe soil bearing values as follows:

Type of Soil	Suggested Safe Bearing Values (tons per square foot)
Solid Rock	25
Hard Slate	6

Medium Shale	4
Soft Shale	2
Dry Clay Gravel	4
Soft Clay	1.5
Dry Sand or Loam	2.5
Wet Clay	0.75

M. Where soil in wall of excavation is unstable or is in recent fill area, use following procedures either singly or in combination:
   1. Make thrust blocks of adequate size to restrain pipe or appurtenance by mass alone.
   2. Extend excavation deep enough to contact firm soil and bring block up to pipe or appurtenance so that clock acts as beam and will provide restraint required.
   3. Construct anchor blocks in firm soil and extend tie rods to pipe or appurtenance.

N. For vertical bends ensure that thrust blocks are adequate to resist thrust by mass alone when thrust is upward.

O. Ensure that thrust blocks are adequate to restrain pipe line and appurtenances at specified test pressure. Refer to following table which lists resultant thrust at certain fittings at test pressure of 100 PSI:

Thrust Per 100 PSI Pressure
(tons)

	Fitting Size (inches)									
Fitting	6"	8"	12"	16"	20"	24"	30"	36"	42"	48"
11¼° bend	0.3	0.5	1.1	2.0	3.1	4.4	6.9	10.0	13.6	17.7
15°	0.4	0.7	1.5	2.6	4.1	5.9	9.2	13.3	18.1	23.6
22½°	0.6	1.0	2.2	3.9	6.1	8.8	13.8	19.9	27.0	35.3
30°	0.7	1.3	2.9	5.2	8.1	11.7	18.3	26.3	35.9	46.8
45°	1.1	1.9	4.3	7.7	12.0	17.3	27.1	39.0	53.0	69.2
90°	2.0	3.6	8.0	14.2	22.2	32.0	50.0	72.0	98.0	128.0
Plug	1.4	2.5	5.7	10.1	15.7	22.6	35.3	50.3	69.3	90.5

4.8 SEPARATION OF WATER LINES AND FORCE MAINS

A. Do not lay force main closer horizontally than 10 feet from potable water line.

B. Where force main crosses water line, or force main is installed closer than 10 feet horizontally from water line, lay with minimum 18 inches vertical separation between pipe barrels.

C. Where force main crosses water line of similar material, wrap force main 10 feet in both directions from crossing at rate of three wraps in every 10 feet of force main. Where force main is installed parallel to and within 10 feet of water line of similar material, wrap force main at rate of three wraps in every 10 feet for distance that force main and water line are within 10 feet of each other.

4.9 PAVEMENT REPAIRS

A. General: Remove minimum amount of street, driveway, sidewalk, parking lot, or other pavement required to permit installation of the pipe lines or appurtenances. Score pavement surfaces in straight lines with suitable equipment before removal. Score concrete surfaces with suitable concrete saw unless material is removed between existing concrete joints.

B. Asphalt and Concrete Pavement: Backfill trench as specified in this section. Replace surface to its original condition by repairing and replacing base and surface. Refer to Section 02513 for asphalt concrete paving repairs and to Section 03001 for portland cement concrete work. Refer to Detail Drawings for construction details for replacement of both type surfaces.

C. Gravel Surfaced drives and streets: Either strip existing gravel surface and place in stockpile and replace after backfilling trench, or provide new gravel. Repair surface to original undisturbed thickness. Refer to Section 02512.

4.10 FILLING PIPE LINES

A. After force mains and appurtenances have been installed, concrete thrust blocking has cured adequately, and upon approval of Engineer, fill main, or segments of main, with water from water utility's distribution system.

B. Expel air from pipe line.

C. Provide drainage at blowoff points. Avoid property damage and do not create nuisance.

D. Before leakage testing, clean lines by flushing.

4.11 FORCE MAIN LEAKAGE TESTS

A. General: After force mains or isolated sections of mains has been filled with water, perform leakage tests in presence of Engineer. Furnish necessary pressure gages, meters, and pumps. Make taps and connections as required.

B. Fill force main with water and increase pressure to testing pressure of 150 percent of working pressure. Hold pressure for two hours.

C. Allowable Leakage:

$$L = \{ ND \sqrt{P} \} \text{ over } 7400$$

Where:

L = Allowable leakage in gallons per hour.
N = Number of joints in segment of line tested.
D = Nominal diameter in inches.
P = Test pressure in pounds per square inch.

D. Repair leaks found during test.

E. Force main, or any segment of force main, will not be accepted until actual leakage is equal to or less than allowable.

F. If test of pipe laid discloses leakage greater than allowable leakage as calculated from above formulas or table, locate leak or leaks, remedy defect, and stop leak. Stop known leaks regardless of this test requirement. Retest if necessary and place system in service.

4.12 CLEANUP

A. Cleanup ground surface along route of force main immediately following completion of backfilling operations. Restore to original condition terrain features in areas disturbed or damaged by Work.

B. Smoothly grade ground surfaces disturbed by the Work, leaving tops of trenches not under pavement replacement areas slightly mounded to allow for settlement. Remove and dispose of excess excavated materials including rocks larger than 1-1/2-inch size, trash, and unused materials. In turfed areas normally maintained by mowing, rake surface clean, removing rocks and hard clay particles greater than 1/2-inch size. Spread stockpiled or borrow topsoil and organic matter. Re-

seed or re-sod as necessary to restore surface to condition of adjacent mowed areas not disturbed by Work.

C. If no separate item for line cleanup is included in Bid Schedule, include cost of cleanup Work in unit price of item of which it is a part.

END OF SECTION