PUMP STATION IMPROVEMENT PROGRAM (PSIP)

MIAMI-DADE WATER AND SEWER DEPARTMENT

SUPPLEMENTAL DESIGN GUIDELINES FOR

LIFT STATIONS AND FORCE MAINS

THIS INFORMATION IS IN ADDITION AND SUPPLEMENTAL TO THAT CONTAINED IN MD-WASD'S "CONSTRUCTION SPECIFICATIONS FOR DONATION WASTEWATER PUMP STATIONS AND FORCE MAINS" DATED OCTOBER, 1989

ISSUED
MAY, 1994

REVISED
JANUARY 1999

SUPPLEMENTAL DESIGN GUIDELINES FOR LIFT STATIONS AND FORCE MAINS

TABLE OF CONTENTS

SECTION 5
WET WELLS

SECTION 6
SUBMERSIBLE PUMPS

SECTION 7
MECHANICAL

SECTION 8
HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 9
ELECTRICAL

SECTION 10
INSTRUMENTATION

SECTION 11
VARIABLE FREQUENCY DRIVES

SECTION 1

SECTION 1

SCOPE

1.1 PURPOSE

These Supplemental Design Guidelines for Lift Stations and Force Mains provide requirements, criteria, and considerations associated with the design of lift stations and force mains for the Miami-Dade Water and Sewer Department (MD-WASD) wastewater collection and transmission system. These guidelines address the design of new lift stations and force mains, and the rehabilitation and upgrading of existing lift stations and force mains. The guidelines represent WASD direction for an overall project, but the Design Consultant is responsible for tailoring these guidelines to site specific requirements.

1.2 EVALUATION OF EXISTING LIFT STATIONS

For the evaluation of existing lift stations the Consultant should consider life cycle cost utilizing a detailed and site-specific evaluation. Where the estimated construction cost of rehabilitation of an existing lift station is equal to or greater than 50 percent of the estimated construction cost to construct a replacement lift station, WASD generally prefers a replacement lift station, if one or more of the following conditions apply:

- The existing lift station has at least 20 years of service and is reaching the end of its useful service life. The life cycle cost for long-term operation and maintenance is believed to favor the replacement lift station over rehabilitation of the existing lift station.

- The existing lift station location is not desirable for service access and neighborhood acceptance.

- If the estimated construction cost to rehabilitate a lift station is greater than 25 percent of the estimated value of the existing lift station, then the lift station must be upgraded to meet current building, electrical, and plumbing codes.

- Project constraints related to such items as construction phasing and bypass pumping may result in increased costs, unacceptable interim operation or community impact.

END OF SECTION

SECTION 2

SECTION 2

LIFT STATION CONFIGURATION

2.1 STANDARD SUBMERSIBLE LIFT STATION

2.1.1 A standard submersible lift station will be used in locations requiring up to approximately 60 hp per pump, generally less than 24 feet wet well depth, and 2 pumps.

2.2 WET WELL VERSUS DRY WELL CONFIGURATIONS

2.2.1 Wet well/dry well configuration will generally be used when the lift station requires individual pumps greater than 60 hp.

2.3 CONFINED SPACE ENTRY

2.3.1 Designs must address confined space entry conditions and requirement for wet wells, dry wells and valve vaults.

2.3.2 MD-WASD considers all wet wells to be "Permit Required Confined Spaces." Design of such spaces should address proper identification and ventilation.

2.3.3 All confined space entries must conform to OSHA requirements (29 CFR 1910.146).

END OF SECTION

SECTION 3

SECTION 3

HYDRAULICS

3.1 DESIGN FLOWS

3.1.1 MD-WASD will furnish the designer with the following design flow values:

a. 1998 (or previous year's) billed water amount (as a safety factor, 100% of domestic waste should be considered as being returned to the sewer)

b. 1998 (or previous year's) peak domestic flow

c. Estimated infiltration/inflow (I/I) for 1999 and 2000 (or current and following year) flows (average of wet and dry weather)

d. Estimated 2000 (or following year's) domestic sewage flow

e. Estimated 2000 (or following year's) peak domestic sewage flow

f. Estimated 2009 (or next tenth year's) domestic sewage flow

g. Estimated 2009 (or next tenth year's) peak domestic sewage flow

h. Estimated I/I for 2009 (or next tenth year's)

3.1.2 Normally, I/I data will be the average of wet season and dry season flow measurements.

3.1.3 Design flow should normally be the higher of the peak daily domestic flow plus I/I for 2000 (or the following year) or 2009 (or next tenth year's) or the flow necessary to pump 2009 daily domestic sewage flow plus I/I within nine hours.

3.2 DESIGN CRITERIA

3.2.1 Normally, use a Hazen-Williams C-value of 120. A C-value of 100 is used by the MD-WASD only for existing old pipe of unknown material or unlined cast iron pipe where head losses in fittings are not calculated separately. A C-value of 120 can be used for existing pipe depending upon material, size and whether or not fitting and other minor losses have been taken into account.

3.2.2 Use Hydraulic Institute Standards for fitting and valve velocity head k-factors. Use of equivalent pipe lengths can also be used even though such lengths are subject to interpretation.

3.2.3 The velocity of the pump suction line (where provided) should not exceed 5 fps. Suction configuration to be in accordance with the Hydraulic Institute Standards.

3.2.4 Verify that the receiving sewer has sufficient capacity to accept the peak discharge rate (not just the design rate) from the proposed force main connection.

3.3 PUMP DESIGN CONDITIONS

3.3.1 The Design Consultant will be required to submit a proposed pump selection which will include pump and system head curves and selected operation points.

3.4 WET WELL VOLUME AND LEVEL CONTROLS

3.4.1 Wet well levels for pump operation should be set to minimize the vertical drop of wastewater into the wet well. The LEAD PUMP ON level should preferably be set at the invert of the inlet sewer at the immediate upstream manhole, but no higher than the spring line of the lowest pipe entering the wet well.

3.4.2 Water surface elevation(s) for LAG PUMP(S) ON controls should be based upon incremental wet well volume calculations. High water alarm and all pumps on should occur when the crown of the lowest pipe into the wet well becomes submerged.

3.4.3 The operating depth between the PUMP OFF level and the LEAD PUMP ON level should be determined by the following formula:

$$V = (q \times t) / 4$$

Where: V = Wet-well volume (gal),

q = pump rate (gpm), and

t = cycle time between pump starts (minutes) with allowance for automatic alternation of pumps.

Use the following table for design values of cycle time (t):

Cycle Time (t)	Pump Size
6 min.	< 50 hp
10 min.	50 - 100 hp
15 min.	> 100 hp

3.4.4 An elapsed time meter for each pump should record the amount of running time in "hours" and "tenths of hours" that occurs when each pump is running. <u>A separate elapsed time meter shall record, in "hours" and "tenths of hours", the time when all pumps are operating.</u>

END OF SECTION

SECTION 4

SECTION 4

STRUCTURAL

4.1 GEOTECHNICAL COORDINATION

4.1.1 A minimum of 3 soil borings should be positioned into the competent bearing stratum and below the outside bottom of the structure at least 1 to 2 times the minimum outside planimetric dimension of the structure and a minimum of 20 feet.

4.1.2 At least one boring should be positioned below the foundation of the lift station at a minimum depth equivalent to the longest planimetric dimension of the lift station or 20 feet, whichever is greatest.

4.1.3 Unless indicated by special site considerations, evaluation of soil corrosion is not required.

4.1.4 Foundations should be designed using recommendations from a geotechnical engineer licensed to practice in the State of Florida.

4.1.5 For pipelines greater than 24-inches inside diameter soil borings should be taken, as a minimum, at 500 foot intervals and should extend a minimum of ten feet below the flowline of the pipe.

END OF SECTION

SECTION 5

SECTION 5

WET WELLS

5.1 ADDITIONAL CAPACITY

5.1.1 A number of lift stations to be renovated or replaced under the PSIP do not have adequate wet well capacity. If there is room available onsite or in an adjacent right-of-way or easement, single speed pumps will be used and additional wet well capacity will be provided. The additional capacity will be provided in the following order:

a. Replacement of the existing wet well.

b. Addition of a second wet well. "Dead-end wet well" shall never be used on new station designs. They shall only be considered by the Department on existing pump station improvements when there is no other way to avoid them and only on a case-by-case basis.

c. Conversion of a dry well to a wet well, provided the size of each existing pump is less than or equal to 20 hp.

5.1.2 If the Design Consultants cost comparison of providing increased wet well capacity shows that the total present value of providing the capacity exceeds the total present value of other alternatives by at least 50%, MD-WASD will accept other alternatives in the following order:

a. The use of 2-speed motors, provided the design consultants can demonstrate that 2-speed motors will meet the required operating conditions.

b. The use of variable frequency drives for motor horsepowers greater than or equal to 75 hp, provided the resulting noise level is not inappropriate for the neighborhood and adequate air conditioning space can be provided.

c. The conversion of a dry well to a wet well for stations with a motor horsepower greater than 20 hp.

d. The use of variable frequency drives for motor horsepowers less than 75 hp, provided the resulting noise level is not inappropriate for the neighborhood and adequate air-conditioned space can be provided.

e. The consideration of additional alternatives as presented by the design consultant on a case-by-case basis.

END OF SECTION

SECTION 6

SECTION 6

SUBMERSIBLE PUMPS

6.1 DESIGN CRITERIA

6.1.1 The pumps shall be the standard product of a manufacturer which has produced and sold such pumps for a period of at least five (5) years for similar service. The pumps shall be designed specifically for use in municipal wastewater applications.

6.1.2 Each pump station shall generally have a minimum of two (2) pumps that are totally submersible, electrically operated, capable of handling raw unscreened sewage.

6.1.3 Each pump shall be so designed that it may be lowered to or raised from its place in the wet well by chain or cable and accurately guided by at least two (2) separate Type 316 stainless steel guide rails.

6.1.4 The specifications will include the following (See Specification Section 11205):

a. Design flow conditions

b. Minimum efficiency at design flow conditions

c. Motor speed

d. Motor horsepower

e. Minimum shutoff head

6.2 PUMP SELECTION AND MATERIALS

6.2.1 Each pump, with its appurtenances and cable, shall be capable of continuous submersion under water without loss of water-tight integrity.

6.2.2 Major pump components shall be ASTM A48-94a "Gray Iron Castings," Class 35 cast iron. They shall have smooth surfaces devoid of blow holes and other irregularities and of sufficient strength, weight, and metal thickness to insure long life, accurate alignment and reliable operation. (See Specification Section 11205 for current submersible pump requirements.)

6.2.3 All surfaces coming into contact with sewage other than stainless steel shall be protected by a coating resistant to sewage.

6.2.4 The pump exterior shall be sprayed first with PVC epoxy primer and then with chloric rubber paint finish.

6.2.5 Miscellaneous surfaces where a watertight seal is required shall be machined and fitted with nitrile rubber "O" rings.

6.2.6 Fittings shall be such that the sealing is accomplished by metal-to-metal contact between the machined surfaces. No secondary sealing compounds, rectangular gaskets, elliptical "O" rings, grease, or other devices shall be used.

6.2.7 All exposed bolts and nuts shall be Type 304 stainless steel.

6.2.8 The cable entry water seal shall be designed to insure a watertight seal. It shall be comprised of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function separate from the function of sealing the cable. The assembly shall bear against the top shoulder of the pump.

6.2.9 The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board which shall isolate the motor interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

6.2.10 The pump motor cable shall be suited for submersible pump applications with Underwriters Laboratory approval permanently embossed on the cable. Cable sizing shall conform to the National Electric Code Specifications for pump motors.

6.2.11 The impeller shall be of grey cast iron, Class 35B, dynamically balanced, double shrouded, non-clogging design having a thru-let without acute turns. The impeller shall be capable of handling solids, fibrous material, heavy sludge, and other matter found in normal sewage applications. The impeller shall be capable of passing solids having a spherical size of 3". The volute shall be of single piece design and shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller. One impeller tool shall be provided with each pump. A wearing system shall be installed to provide efficient sealing between the volute and impeller.

6.3 PUMP SHAFT

6.3.1 The pump shaft shall be ANSI Type 400 series stainless steel or approved equal.

6.3.2 Pumps shall be provided with a tandem mechanical rotating shaft seal system. Seals shall run in an oil reservoir. Lapped seal faces must be hydrodynamically lubricated at a constant rate. The lower seal unit between the pump and the oil chamber shall contain one stationary and one positively driven rotating tungsten carbide ring. The upper seal unit between the oil sump and the motor housing shall contain one stationary tungsten carbide ring and one positively driven rotating carbon ring. Each interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment but shall be easily inspected and replaceable. Each pump shall be provided with an oil chamber for the shaft sealing system. The oil chamber shall house a pressure equalizer ring filled with air for oil pressure compensation. The drain and inspection plug shall have a positive anti-leak seal and shall be easily accessible from the outside. The pump shaft shall rotate on two (2) permanently lubricated bearings with a minimum L 10 rating of 50,000 hours.

6.4 PUMP MOTOR

6.4.1 The motor shall be squirrel cage induction shell type design housed in an air filled, watertight chamber and be of NEMA type B design. The stator winding and stator leads shall be insulated with moisture resistant Class F insulation which will resist a temperature of 155 degrees centigrade. The stator shall be dipped and baked 3 times in Class F varnish. The motor shall be designed for continuous duty capable of sustaining a minimum of 15 starts per hour. Oil-filled motors are not acceptable. Motors shall have a 1.15 service factor. Three (3) thermal switches shall be embedded in the end coils of the stator (one per phase). Thermal switches shall trip after a temperature of 125 degrees C.

6.4.2 Each motor shall be provided with an adequately designed cooling system to permit continuous operation in totally, partially, or non-submerged condition. Thermal radiators (cooling fins) integral to the stator housing shall be adequate to provide the cooling required by the motor without water jackets or other devices on pumps 10 hp and smaller. Larger pumps shall have a cooling jacket. The water jacket shall be provided with a separate circulation of the pumped liquid. Cooling media channels and ports shall be sized to be nonclogging.

6.5 PUMP TESTS

6.5.1 The manufacturer shall perform the following inspections and tests on each pump prior to shipment from the factory:

a. Impeller, motor rating and electrical connections shall be checked for compliance with the customer's purchase order.

b. Motor and cable insulation tests for moisture content or insulation defects shall be made.

c. The pump shall be run for 30 minutes submerged a minimum of 6 feet under water.

d. After the operation, the insulation test is to be performed again. A written report signed by a professional engineer registered in the state where the tests were performed stating that "a" through "c" (above) were performed and that the tests were completed satisfactorily shall be supplied with each pump at the time of shipment.

6.6 START-UP SERVICES

6.6.1 The supplier shall provide start-up services to place the pumps and controls in proper operation. At this time the operation of the equipment will be reviewed and the station will be inspected for proper installation and operation. This service shall be provided by a representative of the manufacturer. The pumps shall be tested at start-up and the voltage, current, and other significant parameters recorded. The manufacturer shall provide a formal test procedure and forms for recording the data. The supplier shall submit a written report to the engineer stating the results of the start-up inspection. Start-up services shall be included in the proposed price of the pump, no extra compensation will be allowed for start-up services.

6.7 PUMP WARRANTY

6.7.1 The pump manufacturer shall warrant the units supplied to the owner against defects in workmanship and materials for a period of five (5) years or 10,000 hours of operation in normal use, operation, and service. The warranty shall be in printed form and shall apply to all similar units. A copy of the warranty shall be supplied with each pump. The warranty shall consist of the following:

a. From 0- 18 months or 0-3000 hours, 100% warranty

b. From 19-39 months or 3001-6500 hours, 50% warranty

c. From 40-60 months or 6501-10,000 hours, 25% warranty

END OF SECTION

SECTION 7

SECTION 7

MECHANICAL

7.1 DESIGN CRITERIA

7.1.1 Individual pump performance requirements should be specified for the following conditions:

a. Minimum shutoff head

b. Design flow condition

7.2 PUMP SELECTION

7.2.1 All submersible pumps should be specified to be able to run dry.

7.2.2 Pumps should be capable of passing solids having sphere size of 3 inches in diameter.

7.2.3 Where dry well type designs are employed, and there is a possibility of flooding the pump station, consider the use of dry-mount submersible pumps instead of vertical open-shaft (VOS) type pump installations.

7.2.4 Dry well vertical type pumps shall include electric motor "P" base, when available.

7.3 PUMP MOTOR SELECTION CRITERIA

7.3.1 Motor horsepower for submersible pumps for MD-WASD Standard Lift Stations should generally be limited to 60 hp maximum and no more than 1800 pounds in weight.

7.3.2 Specify size of motors such that nominal horsepower rating is not exceeded over the full flow range of the pump curve.

7.3.3 Vertical electric motors shall be "P" base type, when available.

7.4 PUMP SUPPORT CRITERIA

7.4.1 Use stainless steel supports and stainless steel anchors and hardware for attachment of appropriate items.

7.5 LIFTING/REMOVAL HOISTING SYSTEM CONSIDERATIONS

7.5.1 Where dry well designs are used with motors installed inside an enclosing superstructure, provide permanently installed hoisting facilities for pump, motor, and other equipment servicing and removal.

7.6 PIPING

7.6.1 All piping from isolation valve to pump discharge header should be hard flanged without thrust-rod tie elements. This is valid for submersible pump piping and for dry well suction and discharge piping.

a. Isolation valves in pump suction lines of dry well/wet well type stations should be hard mounted on the flange of the suction wall pipe.

b. Mechanical joints, flanged coupling adapters, victaulic couplings or other non-continuous flexible pipe joining methods should not be incorporated between wet well wall and isolation valve.

7.6.2 Submersible pump discharge pipes should be provided with lateral support at not greater than 10 feet on centers. Supports should not be below normal operating liquid levels.

7.6.3 Thrust tier and commercial pipe supports should be designed with a safety factor of 5.

7.7 VALVE SELECTION

7.7.1 Isolation Valves

a. Wastewater valves should have fall stainless steel trim. Experience in the Miami area indicates that bronze fitted valves are undesirable for wastewater applications.

b. Eccentric plug valves (non-lubricated) with elastomeric coated plug and geared handwheel operators are acceptable. Lubricated plug valves with metal seats are unacceptable.

(1) In large dry well installations, where possible, the eccentric plug shaft should be installed horizontally with the plug stored in the top position when the valve is OPEN to minimize the potential for grit accumulation in the valve seat or the shaft bearing.

c. Provide chain wheel operators for all valves mounted with their centerlines more than 6 feet above the operating floor.

7.7.2 Check Valves

a. Only full-body flanged check valves should be utilized. Wafer body valves are not acceptable.

(1) Swing-type check valves with an outside lever and spring or weight unit should be provided.

(2) Check valves should have outside lever so that operators are able to see that the valve is OPEN.

b. As a general rule flow velocities through check valves should not exceed 5 fps to avoid high surge pressures associated with pump shutdown. The design should eliminate surge pressures and valve slamming. Provide cushioned valve operation accessories when necessary for surge control. Consideration should be given for use of cushioned valves in pipe sizes 12" and larger or heads of 70 feet or greater.

c. Mount check valves at elevations that permit servicing from floor without scaffolds or ladders.

d. Check valves should be mounted horizontally if possible.

7.7.3 Cushion swing check valve bodies shall be cast iron per AWWA C508 with integral flanges (not wafer) and have a centrifugally cast bronze body seat. The seat shall be locked in place with stainless lock screws and be field replaceable without use of special tools. The cover shall be ductile iron with a large opening for inspection or clean-out purposes. The body shall have a drain hole. The shaft shall be one (1) piece hi-strength Type 17-4PH stainless steel extending through both sides of the valve body. The disc shall be ductile iron and be connected to a ductile iron disc arm. The disc arm assembly shall be suspended from the stainless steel shaft. The disc seat shall be Buna-N (replaceable) to provide water-tight shut off.

a. Oil control top mounted hydraulic cylinder or side-mounted hydraulic cylinders shall provide slow open and three stage control closing speeds for the prevention of surge and water hammer. The cylinder must have two (2) stages of control during the closing cycle and a third stage, by means of a timing valve, to permit instant closure of the disc from full open to any degree of closure on pump stop. Typically as follows:

1st stage:	instant closure to any degree
2nd stage:	variable slow closing towards final closure
3rd stage:	variable closure to shut off

Each stage shall be infinitely and independently adjustable and the oil system self contained and separate from the main line media. The hydraulic cylinder shall directly control the disc movement to relieve any torque induced to the pivot shaft during opening or closing of the valve. The valve shall control-close while flow reverses in the pipeline during normal pump shut off or power failure in a time sequence to prevent water hammer. Each state of closure shall be field adjustable.

b. Materials shall be as follows and conform to the appropriate listed standards:

disc	ductile iron	ASTM A536
body	cast iron	ASTM Al 26, GR.B
body seat ring	aluminum bronze	ASTM B148
shaft	stainless steel	Type 17-4PH
disc seat	Buna-N	
disc arm	ductile iron	ASTM A536
dashpot cylinder	steel	per NFPA standards
exterior paint	phenolic primer red oxide	FDA approved for potable water contact

7.7.4 Vacuum/Air Release

Vacuum/air release connection will be provided from downstream of the pump discharge back to the wet well using a 1" PVC line and manual shut-off valve.

7.7.5 Open Bottom Valve Vaults

Valve vaults should NOT be constructed with an open bottom gravel pad. Vault walls and top can be either pre-cast concrete or cast-in-place concrete. Top hatch opening shall be aluminum in a non-traffic situation. Top hatch opening shall be cast iron or steel where traffic loads must be considered. If in a public right-of-way hatches must meet Metro-Dade Public Works requirements.

7.7.6 Backflow Preventers

Backflow preventers shall be in accordance with the South Florida Building Code, Dade Version. (See table at the end of Section 15130, "Miscellaneous Valves", for approved backflow preventers.

END OF SECTION

SECTION 8

SECTION 8

HEATING, VENTILATING AND AIR CONDITIONING

8.1 DESIGN STANDARDS

8.1.1 Heating, ventilating and air conditioning systems shall meet Florida DEP, South Florida Building Code (Dade Version), OSHA standards and NFPA standards.

8.1.2 Ventilation should be provided for areas such as submersible lift stations, wet-wells, vented dry-wells, and valve vaults where applicable.

8.2 AREA CLASSIFICATIONS

8.2.1 A wet-well shall be classified as a Class I, Division 2 area.

8.2.2 If dry-well pump stations are employed, the dry-well area, if not vented, should be considered a Class I, Division 2 area.

8.2.3 Valve vault space is to be considered unclassified.

8.2.4 Electrical/control building is to be considered unclassified.

8.3 MOTOR CONTROL HOUSING

8.3.1 Preferred method of housing motor control centers and instrumentation and controls is in a separate electrical/control building as opposed to field-mounted exterior panels.

8.3.2 Where field-mounted exterior panels are used they shall meet MD-WASD standards.

8.4 AIR CONDITIONING (A/C)

8.4.1 A/C will only be used on selected large installations approved in advance by WASD.

8.5 VENTILATION

8.5.1 Ventilation requirements for entry conditions must meet OSHA standards.

a. A wet well shall have continuous forced ventilation. However, a switch shall be provided to interrupt and restore operation of forced ventilation. In addition, a galvanized steel protective enclosure shall be provided as shown on Drawing# S-12726-A, of the Standard Pump Station drawings.

b. Dry wells should be ventilated with an exhaust fan to provide a minimum of 30 air changes per hour. The ventilation fan should be equipped with an intake duct from the floor and interlocked to operate when the lighting is engaged.

c. Should an electrical control building be provided, it should be air conditioned only, not ventilated, to provide a minimum of 6 air changes per hour and to provide a maximum indoor temperature of 80 degrees F when the outdoor temperature is 100 degrees F. The air conditioner unit should be wall mounted and designed to reject all heat loads from electrical equipment in the building.

8.5.2 Permanently installed valve vault or pump station dry-well ventilation fan should be an exhaust fan with the intake duct drawing from the bottom of the structure within 18 inches of floor level. Valve vault fan should be interlocked to operate when the light is ON, located at entrance.

8.5.3 Avoid ventilation through panels because of resulting corrosion problems. Use 316 stainless steel panels instead of aluminum at exterior locations. All ventilation fans should be coated with corrosion resistant material.

8.5.4 Both active and passive systems of ventilation should be investigated.

END OF SECTION

SECTION 9

SECTION 9

ELECTRICAL

9.1 DESIGN STANDARDS

9.1.1 Design electrical systems in conformance with the National Electrical Code (NEC) as adopted by all local governmental units having jurisdiction.

9.1.2 Design electrical systems in conformance with the South Florida Building Code (Dade Version).

9.1.3 Design facilities in accordance with National Fire Protection Association (NFPA) 820 for ventilation and area classification requirements.

9.1.4 Design lightning protection in accordance with NFPA 780.

9.1.5 Design lighting system in accordance with Illuminating Engineering Society (IES) handbook.

9.2 FLORIDA POWER AND LIGHT (FPL) COORDINATION

9.2.1 Coordinate with FPL to define the limits of work between FPL and the Contractor in the Contract Documents

9.2.3 Service Requirements.

a. Service for stations should be 240 volts or 480 volts, 3-phase, 60 hertz, depending upon FPL requirements.

b. Avoid reduced voltage starters unless required by FPL.

c. Determine the location of the main distribution center (e.g., switchgear or motor control center) based on the shortest possible runs of the load branch circuits.

d. Prepare a preliminary one-line diagram.

e. Prepare an estimated fault current contribution from the loads.

f. When applying for electrical service, present the one-line diagram and the power requirements listed above to FPL for their review.

g. When the electrical service permit has been issued, inquire about the available fault current and the x/r ratio.

h. Prepare load analysis.

9.3 POWER REQUIREMENTS

9.3.1 Loads

a. Determine connected and actual brake horsepower (BHP) loads, including estimated requirements for lighting and control power.

b. Determine maximum continuous load and coincidence factor.

c. Include allowance for any future loads designated by MD-WASD.

9.4 SERVICE ENTRANCE

9.4.1 Mount meter and main service disconnect on pole or rack within the lift station parcel.

9.5 AREA CLASSIFICATION AND FIRE PROTECTION

9.5.1 Wet well is classified as Class 1, Division II area.

9.5.2 Valve vault space is unclassified.

9.5.3 Electrical control building is unclassified.

9.5.4 Determine the fire detection system to be used and the location of equipment.

9.6 GROUNDING AND LIGHTNING PROTECTION

9.6.1 Grounding

a. The ground system shall be composed of at least two 5/8"∅ x 10 FT. long copper clad ground rod, spaced a minimum of 6 feet apart. Ground rods shall also be connected to rebar in slab. Make all connections with #6 bare copper wire.

b. Maximum ground resistance shall not exceed 25 ohms under normal dry conditions. Additional ground rods shall be driven if required to maintain this level.

c. All electrical equipment, structural steel, guard rails, and other metallic objects shall be connected to the above-mentioned ground system

d. Do not use pop-riveted handrails without bonding each section to ground system.

e. Provide a warning ribbon installed at 12" depth in the ground above the ground loop conductor.

f. Grounding will be in accordance with requirements of the National Electric Code and all local codes having jurisdiction.

9.6.2 Lightning Protection

a. Provide lightning protection system in accordance with Lightning Protection Code, NFPA 780 (ANSI).

b. The lightning protection system may be shown on the grounding drawings.

9.7 MOTOR CONTROL CENTERS AND PANELS

9.7.1 The bottom of the MCCs and the control panels should be mounted at least one foot above the 100-year flood elevation at the site.

9.7.2 The MCCs should be installed indoors and above grade.

9.7.3 Provide a NEMA Class 1, Type B motor control center (MCC) at each lift station with 3 or more motors if the motors are rated approximately 20 horsepower or larger at 460 volts or approximately 10 horsepower or larger at 230 volts.

a. Provide each motor with NEMA-rated, motor circuit protector type, combination motor starter. Motor starters should not be less than NEMA Size 1.

b. Provide reduced voltage starters where required by Florida Power and Light (FPL).

c. Provide service entrance listed circuit breaker in MCC with electrical surge protection. Surge protection shall be Innovative Technology, Model AP-277/480 or AP-3D 120/240, or equal for lift stations provided with telemetry; and Model P-277/480 or P-3D 120/240 for all other lift stations.

d. Provide internal panelboard and dry-type transformer for 120/240-volt service.

(1) Panelboards shall have copper bus, bolt-on breakers, and no main breaker (main lugs only). The transformer feeder breaker will serve as a main breaker.

(2) Standard breakers shall be used; no miniature or slimline types allowed.

e. Conduits and cables should enter at the bottom of control panel and junction boxes in all outdoor locations or in any other wet, damp, or corrosive area. The lower one-third of the sides may be used for entry if watertight hubs are used.

f. Any battery provided should be installed at bottom of control panel.

g. Terminals and conductors shall be tagged with permanent ink plastic sleeve or heat shrink wire markers covered with clear plastic

9.7.6 Indoor MCCs and panels should be NEMA 12 construction.

a. Provide power/control panel compartment doors with 3-point latching closure hardware system.

9.7.7 Outdoor power and control panels, disconnects, junction boxes and other enclosures should be NEMA 3 dust-tight and rain-tight gasketed stainless steel construction. All hardware should be stainless steel. FRP and aluminum construction is not acceptable because of vandalism potential

a. For exterior mounting locations requiring weatherproof construction, provide NEMA 3-R dust-tight and rain-tight gasketed panel with 3-point latching. For concrete slab dimensions see standard drawings.

b. For control panels installed at exterior locations, provide appropriate solar shading construction to keep direct sunlight off panels and minimize potential for overheating.

c. When electrical power and control devices are mounted in outdoor panels, a safe work surface/slab should be provided in front of unit. Work surface/slab should be 4-inch minimum thickness concrete slab. Concrete slab should be extended at least 6 inches in the back of panel and 36 inches in front of panel face for its entire length. Extension should be sloped to drain away from cabinet.

9.7.8 Provide a manual transfer switch using two (2) mechanically interlocked main circuit breakers with service entrance rating. Connect one main breaker to the utility power and the other to be uses as a main for the emergency generator. Connect the generator breaker to the generator receptacle and mount the receptacle on the side of the pump lift station panel. The receptacle is, typically, of the pin and sleeve type as manufactured by CrouseHinds, Appleton, or Meltric. A matching loose plug will be connected to the generator output power cables (by others) for connection, when required, to the receptacle mounted on the side of the pump lift station panel.

9.8 ELECTRIC MOTORS

9.8.1 Submersible motors shall be UL listed for Class 1, Division II, Group D atmospheres in accordance with NEC classification for hazardous areas.

9.8.2 Define where motor amperage draw will be measured, either at the motor starter terminals or at the motor cable leads in terminal junction box.

a. Submersible motors shall be able to start within the 1300% factor allowed by NEC 430-52 or provide documentation why they cannot.

b. MCP breaker must be engineered to start motors reliably when they exceed 1300% requirement.

9.8.3 Equip submersible pump motors with thermal overload detector devices. Winding temp devices shall be in all 3 winding groups.

9.8.4 Dry-mounted motors 50 hp or greater shall be equipped with space heaters.

9.8.5 Dry-mounted motors shall be totally enclosed fan cooled, high efficiency, 1.15 S.F. designed to withstand a 5% overspeed in either direction of rotation, and to produce a maximum noise level of 95 dB or less at a distance of one meter from the surface of the unit. Insulation system shall be rated type "F" or better, suitable for a maximum temperature of 155 degrees C

9.8.6 Vertical dry-mounted motors shall be high thrust motors (NEMA Type VP) or normal thrust motors (NEMA Type HP), solid shaft.

9.9 LIGHTING

9.9.1 Prepare a design based on Illuminating Engineering Society (IES) handbook utilizing High Intensity Discharge and fluorescent fixtures.

a. Use incandescent type fixtures only in classified areas

b. Prepare lighting calculations based on actual fixture photometric tables and curves.

c. Minimize the number of different types of fixtures.

9.9.2 Interior of electrical control building and dry well.

a. Use fluorescent vapor tight light fixtures with nominal length of 4 feet and low-temperature ballasts 20 degrees minimum.

b. Have at least 2 fixtures in electrical control building activated by a single switch.

c. Provide maintained illumination level of 80 foot-candles.

9.9.3 Exterior area site fighting

a. Exterior lighting is to be provided only where lift stations include a building.

b. Use high-pressure sodium energy-efficient lights.

c. Provide one photocell-activated, low-level intensity, security light mounted near the center of site so that movement of unauthorized persons within the site can be observed.

(1) Mount on building whenever possible.

(2) Mount immediately above control building entrance door where practical.

(3) Mount on an appropriately placed pole when there is no building.

(4) Provide not less than 70-watt, high-pressure sodium, enclosed, weatherproof unit.

d. Where exterior-mounted control power panels are used, provide sufficient illumination to read panel labels and indicators.

e. Consider providing at least one motion-activated security light at strategic location.

9.9.4 Provide two receptacles inside building for connection of portable, work-light units. Receptacles shall be GFCI rated.

9.10 WIRE AND CABLE

9.10.1 Provide THHW stranded copper wiring for all conditions requiring 600-volt or less rating.

9.10.2 Provide power wiring not less than No. 12 AWG stranded.

9.10.3 Provide control wiring not less than No. 14 AWG stranded except that wiring to the PLC shall not be less than No. 16 AWG stranded.

9.10.4 Provide control panel wiring not less than 600-volt class, THHW stranded copper, and enclosed in plastic wiring channels.

9.10.5 Provide multi-conductor control cables of twisted shielded pairs not less than No. 16 AWG, PVC insulated stranded copper with 600-volt rating.

9.10.6 Provide separate continuous copper ground wire in each conduit to ensure continuous ground path.

9.10.7 Provide separate surge and lightning protection for electrical components. Provide surge protection for data line when used.

a. Use surge protection equipment designed and tested in accordance with NEMA, ANSI, and IEEE standards.

b. Surge protection equipment shall be located in close proximity to the protected equipment.

c. PLC surge protection shall be Innovative Technology, Model AP- IS 120V, or equal.

d. Data line surge protection shall be Innovative Technology, Model ITC SH/SM 95v, or equal.

9.10.8 Cables to submersible pumps shall be provided with a single support accessible from hatch cover without the use of additional equipment or rigging and without entering the wet well.

a. Strain relief support shall be stainless-steel construction which can be replaced without disconnecting the pump cable or entering the wet well.

9.11 RACEWAY

9.11.1 Aluminum conduits

Use inside of electrical control building or dry well.

9.11.2 Rigid galvanized steel conduits

a. Use at all exterior or exposed locations not inside building.

b. Use inside valve vaults and wet wells.

c. Use for conduits encased in concrete slabs.

d. Use rigid galvanized steel elbow when conduit extends upward through a concrete slab.

e. Specify Rob-Roy Red or O-Cal Blue.

9.11.3 Schedule 40 PVC conduits

a. Use in underground duct banks when encased in concrete.

b. Use Schedule 40 not Schedule 80 because of derating potential.

c. Use rigid galvanized steel elbows for stubups.

d. Use rigid galvanized steel conduct for bends in duct banks 30 degrees or greater.

9.11.4 All junction boxes shall be NEMA 4X stainless steel, except control building. Exterior boxes shall be provided with drip shield.

9.11.5 Use all stainless steel commercial channel support system and stainless steel anchors and hardware for attachment of items at all locations.

9.11.6 Do not provide exterior-mounted utility receptacles. Mount only inside control building or inside an electrical panel if free-standing exterior panels are employed. In exterior panels, receptacles shall be accessible from dead front.

a. Provide individual ground fault protected receptacles at all locations.

9.11.7 Conduits shall enter through bottom of panels and boxes. Top and side entry will normally not be permitted in exterior mounting locations.

9.11.8 All conduits from J-box to wet well for submersible pump cords, shall not have more than one (1) cord per conduit. Conduit shall be sized for single power cord pumps and according to NEC Table 4 Chapter 9, 53% fill. Provide a spare conduit from each J-box to wet well hatch equal to largest conduit. Spare conduit is to be capped in wet well and J-box. (The spare conduit that may be used is sub-motor type requiring two power cords).

END OF SECTION

SECTION 10

SECTION 10

INSTRUMENTATION

10.1 CONTROL PHILOSOPHY

10.1.1 Fully automatic unattended pump control with local override capability shall be provided for all MD-WASD standard lift station designs.

10.1.2 It is intended that remote monitoring of lift station operation shall be provided for all MD-WASD standard lift stations.

10.1.3 Remote monitoring will be installed by MD-WASD. Provisions for these installations shall be made by the designer.

END OF SECTION

SECTION 11

SECTION 11

VARIABLE FREQUENCY DRIVES

11.1 GENERAL

11.1.1 VFD's shall comply with the latest applicable standards of ANSI, NEMA, IEEE and the National Electric Code. (See Specification Section 16152)

11.2 EQUIPMENT

11.2.1 The VFD shall be microprocessor base pulse width modulated (PWM) 12-step design or 6-step design with harmonic filter as required to meet the requirements of IEEE-519. Drives that are powered from emergency generators shall be provided with harmonic filters as required to reduce the harmonic current of the drive to 5%. The drives shall meet the requirements of FPL. All drives at a new installation shall be provided by one manufacturer who shall assume responsibility for the entire system.

a. The main circuit breaker shall be mechanically interlocked with the VFD enclosure door. The circuit breaker shall be sized to have a short-circuit interrupting capacity of the motor control centers or switchgear to which the VFD is connected. The breaker shall be provided with provisions for locking open with a padlock.

b. The converter section shall consist of diode full-wave bridge rectifiers or industrial grade bipolar power transistors (IGBT's) to convert AC power to DC power.

c. The inverter shall consist of IGBT's to invert DC power into a sine-coded pulse-width modulated adjustable voltage and frequency for control of motor speed.

d. A control power transformer shall be sized to handle all the load connected to the control circuits.

e. The operator panel shall be either discrete push buttons and selector switches or a direct access soft-touch keyboard type with the following functions as a minimum:

(1) Run-Stop-Auto-Manual or Hand-Off-Auto

(2) Display motor speed, motor amp, and output volts

(3) Indicating lights for drive run, drive fault, and power on

(4) Ability to read and change the operating function settings, and monitor the operating conditions of the drive.

(5) Ability to change function setting while the motor is running.

(6) Monitor conditions at faults.

f. If an isolation transformer is not provided then an AC line reactor, minimum 5 percent impedance, shall be provided to attenuate the harmonics generated by rectification of AC power. The line reactor shall be sized to meet IEEE 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters, at the points of common coupling (PCC) which are the motor control centers or switchboards where VFD's are connected. The line reactor shall be mounted in an enclosure and wired by the manufacturer.

g. An isolation transformer, if necessary, shall be provided to attenuate the harmonics to meet IEEE 519. The isolation transformer shall be built in accordance with ANSI, NEMA and UL standards. Provide the unit having four 2-1/2 percent fall capacity primary winding taps, two above and two below rated voltage. Provide a transformer enclosure suitable for the environment.

h. A computer interface module shall be provided that is compatible with the MD-WASD instrumentation and control system. The interface module shall be able to communicate with host computers, personal computers or programmable logic controller via RS232 or RS 422 ports.

(1) Control:

- Run and stop

- Forward and reverse

(2) Monitoring:

- Output frequency

- Output voltage

- Function settings

- Conditions at trip

(3) Function settings:

- Acceleration and deceleration time and characteristics
- Voltage/frequency characteristics
- Upper and lower speed limits
- Protection levels
- Frequency jump
- Frequency setting characteristics
- Automatic restart on or off

11.2.2 The VFD shall be designed to operate from a three-phase 480 volt, 60 Hz supply and to control a standard 460 volt three phase 60 Hz squirrel cage induction motor with a 1.15 service factor without derating or requiring any motor modification. The VFD shall vary both the AC voltage and frequency simultaneously to operate the motor at required speeds.

a. The VFD shall be specifically designed for use with the variable or constant torque load it serves.

b. The VFD shall be provided with "voltage boost" at low frequency, and adjustable voltage/frequency ratios.

c. The VFD shall be provided with adjustable minimum speeds between 4 and 40 Hz and maximum speeds between 40 and 80 Hz. Factory minimum and maximum settings shall be 24 and 60 Hz, respectively.

d. The minimum VFD efficiency shall be at least 95 percent at 100 percent speed, and 85 percent at 50 percent speed.

e. The VFD shall shut down in an orderly manner when a power outage occurs. Upon restoration of power, the motor shall restart and run at the speed corresponding to the current process input signal.

f. The VFD shall be provided with additional features described below:

(1) Inrush current adjustment between 50 and 110 percent of motor full load current (factory set at 100 percent).

(2) Overload capability at 110 percent for 60 seconds.

(3) Adjustable acceleration and deceleration from 0.2 to 300 seconds.

(4) Input signal from process of 4 - 20 mA.

(5) Output speed signal of 4 - 20 mA.

(6) On loss of input signal, the VFD shall operate at a preset minimum speed.

(7) A minimum of two selectable frequency jump points to avoid critical resonance frequency of the driven system

(8) Power loss ride-through capability for power loss of 0.2 second.

(9) Additional devices and functions as follows:

- Drive system disconnect operators.

- HAND-OFF-AUTO selection.

- System speed control selector switches (LOCAL/REMOTE) (When in LOCAL position, speed controlled by a manual speed potentiometer)

- Switch for Pump 1, Pump 2 or automatic alternation

- Switch for BYPASS/MANUAL mode

- Door intrusion alarm system for VFD cabinet

- Alarm lights

g. Drive shall be sized to the KVA requirements of the motor and shall be sized such that the drive does not exceed 90% nameplate rating under any load condition.

h. Drive shall be provided with built-in PID controller.

11.2.3 The VFD shall have, as a minimum, the following protection features:

a. Input line protection with metal oxide varistor (MOV) and RC network

b. Protection against single phasing, power outage, and reverse phase rotation

c. Instantaneous overcurrent protection

d. Electronic overcurrent protection

e. Ground fault protection

f. Overtemperature protection and alarm for electronics

g. Protection against internal faults

h. Ability to start into rotating motor

I. Additional protection and control as required by the motor and driven equipment

j. Automatic reset and restart after a drive failure, two attempts and then lockout. The lockout shall latch in and not reset on a power failure.

11.2.4 Provide the VFD unit with appropriate power circuitry and auxiliary contacts for energizing and controlling devices associated with the motor, as shown on the specification drawing.

a. In case of failure, the VFD shall be bypassed to permit manual or automatic operation at maximum RPM.

b. Provide pumps to alternate (1 to 24 hrs.)

11.2.5 The VFD shall be designed and constructed to satisfactorily operate within the following service conditions:

a. Ambient temperatures: 0 degrees C to 40 degrees C

b. Humidity: 95 percent, non-condensing

c. AC line voltage variation: plus 10 percent to minus 5 percent

d. AC line frequency variation: plus and minus 2 Hz

11.2.6 The enclosure shall be suitable for the environment the drive is in.

11.2.7 Provide cabinet-mounted air conditioner except where there is already an air conditioned environment.

11.2.8 Provide, in addition to the elapsed time meter, arrangement described in paragraph 3.4.4, a device for measuring and recording pump operation speed.

11.3 FACTORY TESTING

11.3.1 All components shall be 100 percent tested. All printed circuit boards shall be burned in continuously for 5 hours at 50 degrees C. The printed circuit boards shall be tested after burn-in to insure they are functioning within specification.

a. Control power shall be applied to microprocessors, printed circuit boards, diagnostic boards and similar devices including software to test for proper operation, sequencing, logic and diagnostics.

b. All wiring shall be checked for continuity and for compliance with the wiring diagrams.

11.3.2 Testing shall proceed in the order given below:

a. Motor test: VFD, along with the actual AC motor to be provided (of VFD manufacturer test motor) shall be tested with the system logic and a dynamometer load to simulate field operation conditions at 25, 50, and 100 percent full load current.

b. VFD test: After dynamometer tests are complete, the VFD shall be load-tested in a heat room maintained at 40 degrees C for 5 hours. The motor shall be loaded at 100 percent full load current for 1 hour. Motor and dynamometer need not be in the elevated temperature room with the VFD.

c. Provide above-stated tests in addition to the manufacturer's normal factory tests.

d. Provide certified documentation of all tests performed.

e. Failure of any component during this test requires repair and commencement of a new test.

11.4 SPARE PARTS

11.4.1 The Contractor shall furnish the spare parts listed below, suitably packaged and labeled with the corresponding equipment number.

11.4.2 During the term of this contract the Contractor shall notify the Design Engineer in writing about any Manufacturer's modification of spare part numbers, interchangeabilities, or model changes. If the Engineer determines that the modified parts no longer apply to the equipment provided, the Contractor shall furnish other applicable parts at no increase in cost to the Owner.

11.4.3 The following spare parts shall be furnished:

a. Two lamp lenses of each color

b. Two dozen pilot lamps

c. One of each type of circuit board

(1) Control board

(2) Power board

(3) Diode board

(4) Transistor module

(5) One of each power diode and Transistor

11.5 MANUFACTURERS

11.5.1 Manufacturers must be regularly engaged in the design and manufacture of VFD's for at least 5 years and must possess sufficient technical competence, skill, resources, and ability to complete the work in a timely manner.

11.5.2 Manufacturers must be Baldor Electric Company, Reliance Electric or equal

11.6 SERVICES OF THE MANUFACTURER

11.6.1 An authorized service representative of the Manufacturer shall be present at the site to furnish, in entirety, the services listed below.

11.6.2 The authorized service representative shall supervise the following and certify that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.

a. Inspection, checking, and adjusting the equipment

b. Startup and field testing for proper operation

c. Performing field adjustments to insure that the equipment installation and operation comply with requirements

11.6.3 Manufacturer shall provide all appropriate O&M manuals, interconnect drawings, service information and service representative phone numbers necessary for the continued operation and maintenance of the VFD installation.

11.7 INSTALLATION

11.7.1 Conduit stub-ups for interconnected cables and remote cables shall be located and terminated in accordance with the drive manufacturer's recommendations.

11.8 FIELD TESTING

11.8.1 Testing, checkout and startup of the VFD equipment in the field shall be performed under the technical direction of the Manufacturer's service representative. Under no circumstances are any portions of the drive system to be energized without authorization from the Manufacturer's representative.

11.8.2 Harmonic analysis shall be performed at unit full load using a harmonic analyzed by Hewlett Packard, or equal. Tests shall prove that the harmonic distortion is limited to a magnitude of 5 percent of the fundamental with line reactors or isolation transformer in the circuit as indicated. The report shall include the following:

a. Expected harmonic current (THD) through the 9th harmonic, calculated with and without line reactors or isolation transformer.

b. Actual RMS value and measured percentage of the THD in the field.

11.8.3 Provide a copy of the field test data and certify that the unit(s) are installed and tested properly and meet manufacturer's requirements.

END OF SECTION