



PUMP STATION AND FORCE MAIN REPORT

Monarch Subdivision

New Castle County, Delaware

PREPARED BY

Davis, Bowen & Friedel, Inc.

1 Park Avenue
Milford, DE 19963



12/04/2023

Final Submission: December 4, 2023

Revised: October 11, 2021

Revised: July 31, 2023

Revised: May 25, 2023

March 16, 2023

DBF#0818C048.B01



EXHIBITS

- A. Design Narrative
- B. Buoyancy Calculation
- C. Pump Sizing and Selection
- D. Generator Calculations
- E. Radio Survey Report
- F. Supply Fan Calculation
- G. Specifications
- H. Geo-Technical Report

EXHIBIT A

Design Narrative

PUMP STATION DESIGN NARRATIVE

The proposed Monarch Pump Station is located on the north side of King's Crossing Road approximately 1,250 linear feet west of its intersection with Majesty Lane. The pump station will serve the Monarch Subdivision within Whitehall and will consist of 500 single family homes and will discharge to a gravity manhole S-503 located outside of the pavement along relocated Ratledge Road near Station 31+00.

Per the pump manufacturer, each high point and the end point must be independently evaluated to determine which point controls the hydraulic design. Multiple calculations are only required if the end point elevation is lower than the high point(s). The traditional method of pump calculations uses the highest elevation and total force main length, which works if the end point is the highest elevation. However, if the high point is higher than the end point, the traditional method results in an over designed condition points and can lead to cavitation. Independently evaluating the high points uses the specific high point elevation and force main length at that point. The redesigned force main has two points that could control the design; High Point at elevation 61.49' with 2,378 L.F. of pipe or End Point at elevation 59.56' with 3,361 L.F. of pipe. We're evaluating which point produces more pressure at the design flow rate. The system head curves show that at 430 GPM, the high point produces 46.1' of pressure and the end point produces 47.2' of pressure at 417 GPM. This indicates that the end point controls the hydraulic design. Additionally, because the high point elevation is greater than the end point, a portion of the force main will drain after each pump cycle. The force main will drain until the water level elevation is equal to the end point elevation (approximately Sta. 25+50 at elevation 59.56'). When a pump cycle starts, the pumps must first fill the empty part of the force main. This results in the pumps producing a higher flow at the cycle start until the system transitions to the design point.

The pump station has been designed to utilize two (2) 10 hp Gorman Rupp Self Priming Centrifugal Pump Model T6A3S-B with 1,750 RPM pump speed. The pumps are designed to pump 417 GPM at 47.2' of total dynamic head (TDH). The head for the respective flow is shown graphically on the attached pump curve. The force main pipes are 8" PVC (DR-18).

GTA completed a soil boring at the wet well location and their findings can be found in this report.

The pump selection and calculations were prepared by Envirep, Inc. Fayda Engineering and Energy Solutions prepared the specifications, antennae calculations and generator calculations.

EXHIBIT B

Buoyancy Calculation

I. Wet Well Buoyancy (square/rectangle wet well)

Description	Amount	Units
Cross-sectional areal of square/rectangle Wet Well	54	s.f
Wall Thickness	8	Inches
Outside Cross-sectional area of Wet Well	75.8	s.f
Depth of Wet Well (to Top of Base)	21.1	Feet
Volume of Water Displaced by the Wet Well	1,598.9	c.ft.
Weight of Water	62.4	lbs/c.ft.
Bouyant Force (Weight of Water Displaced)	99,772	pounds
Safety Factor	1.50	
Counteractive Weight Required	149,658	pounds
Weight of Concrete	145	lbs/c.ft.
Weight of Concrete in Wet Well Walls	66,629	pounds
Proposed Dimension of Square/Rectangle Base	137.8	s.f.
Volume of Saturated Soil Over Extended Base	1,308	c.ft.
Weight of Saturated Soil (Loose Sand)	65.0	lbs/c.ft.
Weight of Saturated Soil Over Extended Base	85,033	pounds
Depth of Concrete Base	0.00	inches
Volume of Concrete Base	0	c.ft.
Weight of Concrete in Base	0	pounds
Top Slab Width	0.0	ft
Top Slab Length	0.0	ft
Top Slab Thickness	0	in
Volume of Concrete in Top Slab	0	c.ft.
Weight of Top Slab	0	lbs/c.ft.
Required Weight of Ballast	-73,955	pounds
Volume of Ballast (If less than 0 ballast = 0 CY)	-0.51	CY

EXHIBIT C

Pump Sizing and Selection

PUMP SIZING AND SELECTION RECOMMENDATIONS

SUCTION LIFT PUMP STATION

I. GENERAL INFORMATION

DATE PRINTED: 10/9/2023

PROJECT: New Castle County
Monarch Subdivision Pump Station
New Castle, DE

DESIGN ENGINEER: Davis, Bowen & Friedel, Inc.
1 Park Avenue
Milford, DE 19963
Contact: Ring Lardner, P.E.
Email: rwl@dbfinc.com
Phone: 302-424-1441
Fax: 302-424-0430

EQUIPMENT: Suction Lift Duplex Pump Station

PIPING SIZES: 7.98 inch Force Main Piping
6 inch Header Piping
6 inch Suction Piping

MANUFACTURER: The Gorman-Rupp Company

MANUFACTURER'S REPRESENTATIVE: Envirep, Inc.
3705 Trindle Road
Camp Hill, PA 17011
Contact: Bill LaPorte
Email: wlaporte@envirep.com
Phone: 717-761-7884
Fax: 717-737-5817
Calculations by: Will Hesse

COMMENTS: Dwgs dated 9/15/2023; EndPoint Sta33+61
0

DISCLAIMERS:

Recommendations contained herein are based upon information provided by the Design Engineer. They are for review and evaluation by the Design Engineer and for incorporation into the project design consistent with his/her best professional judgement.

Gravity sewers, upstream of pumping stations, should be designed such that pump station failures will not cause backflow into residential homes or commercial establishments.

II. DESIGN INFORMATION

A. ELEVATIONS

Force Main Discharge Invert (High Point)	<u>59.56</u> FT
Pump Suction Centerline	<u>49.36</u> FT
Pump Slab Elevation (Ground Level)	<u>47.00</u> FT
Wet Well Influent Invert	<u>32.10</u> FT
Wet Well Bottom (for existing wet well only)	<u>25.90</u> FT

B. SUCTION PIPING

Pipe Diameter	<u>6</u> IN
Pipe Length	<u>25</u> FT
Inlet Opening Diameter	<u>10</u> IN
Distance between Wet Well Bottom and Inlet High Point	<u>0.83</u> FT
Hazen & Williams C-Factors for Friction Loss Calculation:	
High Roughness	C= <u>100</u>
Design Roughness	C= <u>120</u>
Low Roughness	C= <u>140</u>

Standard Fittings

Description	Quantity
90° Standard Bend	1
90° Long Radius Bend	0
45° Bend	0
22.5° Bend	0
Plug Valve	0
Swing Check valve	0
Std Tee, Thru Flow	0
Std Tee, Side Flow	1
Gate Valve, Fully Open	0
Increaser 6 x 8	1
Increaser 8 x 10	1
Decreaser 6 x 4	0
Decreaser 4 x 3	0

Nonstandard Fittings

Description	Quantity	Equivalent Length
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

C. HEADER PIPING

Pipe Diameter	<u>6</u> IN
Pipe Length	<u>15</u> FT
Hazen & Williams C-Factors for Friction Loss Calculations:	
High Roughness	C= <u>100</u>
Design Roughness	C= <u>120</u>
Low Roughness	C= <u>140</u>

Standard Fittings

<i>Description</i>	<i>Quantity</i>
90° Standard Bend	3
90° Long Radius Bend	0
45° Bend	0
22.5° Bend	0
Plug Valve	0
Swing Check valve	1
Std Tee, Thru Flow	1
Std Tee, Side Flow	0
Gate Valve, Fully Open	1
Increaser 6 x 8	1
Increaser 8 x 10	0
Decreaser 6 x 4	0
Decreaser 4 x 3	0

Nonstandard Fittings

<i>Description</i>	<i>Quantity</i>	<i>Equivalent Length</i>
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

D. FORCE MAIN #1

Pipe Diameter 7.98 IN
 Pipe Length 3361 FT
 Hazen & Williams C-Factors for Friction Loss Calculations:
 High Roughness C= 110
 Design Roughness C= 130
 Low Roughness C= 140

Standard Fittings

<i>Description</i>	<i>Quantity</i>
90° Standard Bend	0
90° Long Radius Bend	0
45° Bend	5
22.5° Bend	2
Plug Valve	0
Swing Check valve	0
Std Tee, Thru Flow	4
Std Tee, Side Flow	0
Gate Valve, Fully Open	1
Increaser 7.98 x 10	0
Increaser 10 x 12	0
Decreaser 7.98 x 6	0
Decreaser 6 x 4	0

Nonstandard Fittings

<i>Description</i>	<i>Quantity</i>	<i>Equivalent Length</i>
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

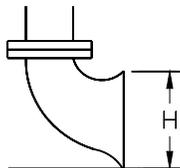
E. PUMPING RATE

Initial Design 417 GPM
 Future Design 417 GPM

F. SUCTION INLET OPENING CONFIGURATION

Inlet Opening Inside Diameter 10 IN
 Distance from Wet Well Bottom to Inlet Elevation (H) 0.83 FT

Configuration:
 Vertical



G. WET WELL SIZING

Rectangular

Length 6.00 FT
 Width 9.00 FT

Distance Between Influent Sewer Invert and Alarm On 0.00 FT
 (Recommend 0.0 FT Without Basket Strainer)
 (Recommend 1.0 FT With Basket Strainer)

H. PUMP CYCLE TIME

Cycle Time - Minimum Allowable Cycle Time 15 MINUTES
 (Use 10 Minutes for 15 HP Motors and Less)
 (Use 15 Minutes for 20 HP to 100 HP)

I. NET POSITIVE SUCTION HEAD

Correction for Elevation Above Sea Level 0 FT
 (Use -1.0 FT For 0 FT To 800 FT Above Sea Level)
 (Use -2.0 FT For 800 FT To 1500 FT Above Sea Level)
 Vapor Pressure -1 FT
 (Use -1.0 FT For Municipal Wastewater)
 Safety Factor -5 FT
 (Recommended -5.0 FT Minimum)
 NPSH Req, Initial Pumping Rate (From Pump Curve) 5 FT
 NPSH Req, Future Design Pumping Rate (From Pump Curve) 5 FT

J. PUMP INFORMATION

Pump Model No. T6A3S-B
 Pump Size 6 IN
 Number of Pumps: 2
 Flow Rates for System Head Curves:
 Minimum 0 GPM
 Maximum 1400 GPM

III. WET WELL SIZING

A. MINIMUM DEPTH

Determines the minimum distance between the wet well bottom and the pump off elevation to prevent vortexing. Design calculations are based on the future design pumping rate.

Determine velocity at inlet opening using $V=Q/A$

Q = Future Design Pumping Rate	417.00 GPM
A = Area At Inlet Opening	
Inlet Opening Diameter (D)	0.83 FT
Inlet Opening Area	0.545 SQ FT
V = Inlet Velocity at Diameter D	1.70 FPS

(Refer to Metcalf & Eddy, Wastewater Engineering, Table 9-3, page 360)

Minimum submergence (S)	1.5 FT
Bottom of wet well to inlet high point distance	0.83 FT
Minimum Depth (MD)	2.33 FT

RECOMMENDED MINIMUM DEPTH (MD)	2.50 FT
---------------------------------------	----------------

B. DRAWDOWN DEPTH

Determine minimum drawdown depth from the operating volume required to prevent short cycling of pumps

(Refer to Metcalf & Eddy, Wastewater Engineering, Equation 9-1, page 354)

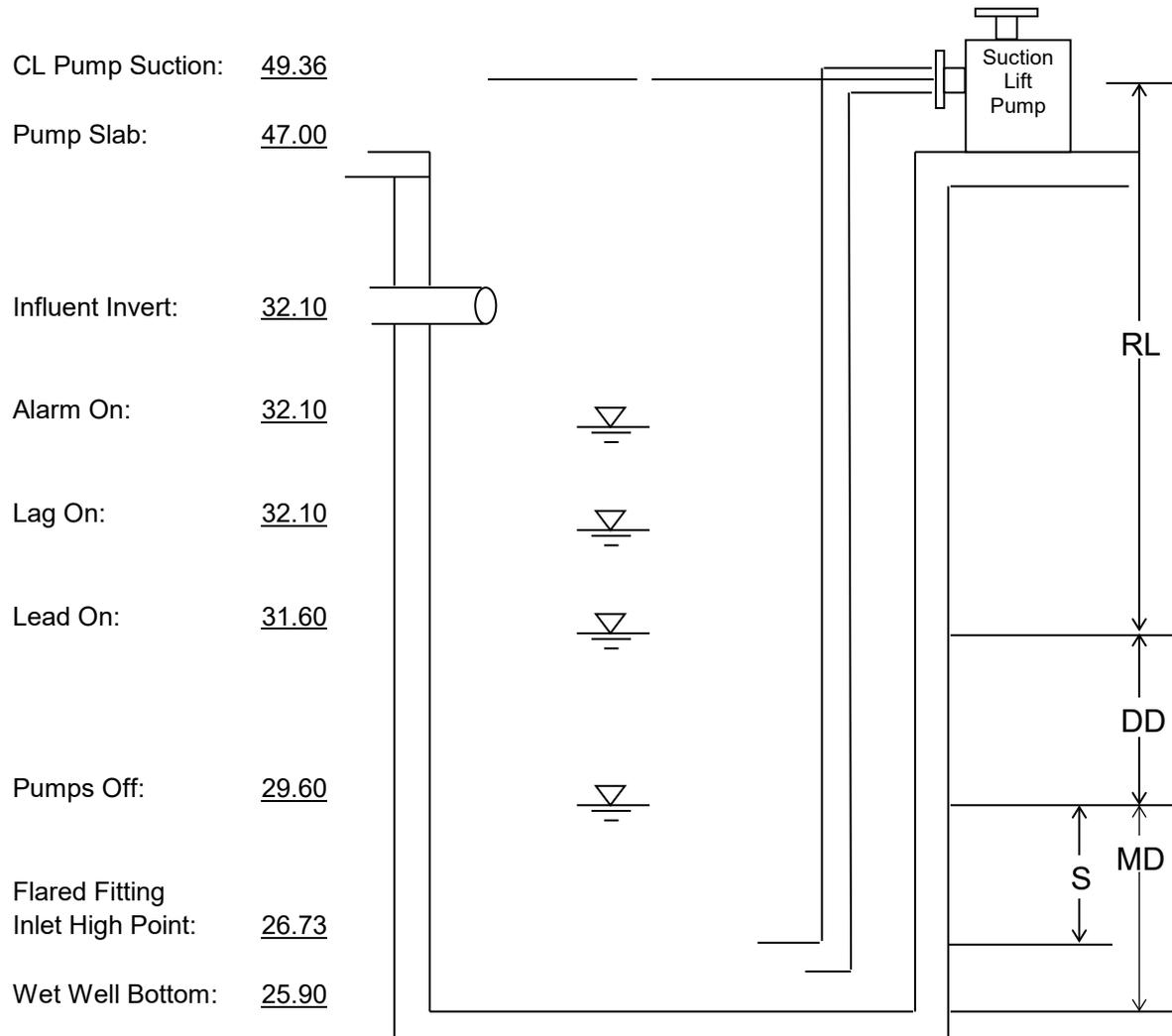
$$V = (T * Qd/4)*f = (15 * 417 / 4) * 0.5$$

T = Minimum Allowable Time for One Pump Cycle	15.00 MIN
Qd = Future Design Pumping Rate, GAL/MIN	417.00 GPM
f = Factor for Identical Pumps with Alternation	0.50
V = Minimum Drawdown Volume = 781.88 GAL / 7.481 =>	104.51 CU FT
Rectangular Length & Width	6.0 x 9.0 FT
Vol/FT. of Elev.	54.00 CU FT/FT
Calculated Drawdown Depth	1.94 FT

RECOMMENDED DRAWDOWN DEPTH (DD)	2.00 FT
--	----------------

Effective Drawdown Volume	108.00 CU FT	807.95 GAL
---------------------------	--------------	------------

C. WET WELL ELEVATION DIAGRAM



Legend:

Minimum depth based on submergence (MD)	3.70 FT
Submergence (S)	2.87 FT
Drawdown depth (DD)	2.00 FT
Reprime lift (RL)	17.76 FT

IV. PIPING SYSTEM

A. SYSTEM HEAD CURVE

1. STATIC SUCTION LIFT:

Pump Off Elevation	29.60 FT
Pump Suction Center Line Elevation	<u>-49.36 FT</u>
Static Suction Lift	-19.76 FT

2. SUCTION PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 6 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				25.00
Standard				
90° Standard Bend	1	16	x 1.25	20.00
90° Long Radius Bend	0	10	x 1.25	0.00
45° Bend	0	7	x 1.25	0.00
22.5° Bend	0	4	x 1.25	0.00
Plug Valve	0	50	x 1.25	0.00
Swing Check valve	0	40	x 1.25	0.00
Std Tee, Thru Flow	0	11	x 1.25	0.00
Std Tee, Side Flow	1	33	x 1.25	41.25
Gate Valve, Fully Open	0	4	x 1.25	0.00
Increaser 6 x 8	1	4	x 1.25	5.00
Increaser 8 x 10	1	4	x 1.25	5.00
Reducer 6 x 4	0	4	x 1.25	0.00
Reducer 4 x 3	0	4	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				96

3. STATIC DISCHARGE HEAD:

Force Main Discharge Invert. Elev. (High Pt.)	59.56 FT
Pump Suction Centerline Elevation	<u>-49.36 FT</u>
Static Discharge Head	10.20 FT

4. DISCHARGE HEADER PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 6 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				15.00
Standard				
90° Standard Bend	3	16	x 1.25	60.00
90° Long Radius Bend	0	10	x 1.25	0.00

45° Bend	0	7	x 1.25	0.00
22.5° Bend	0	4	x 1.25	0.00
Plug Valve	0	50	x 1.25	0.00
Swing Check valve	1	40	x 1.25	50.00
Std Tee, Thru Flow	1	11	x 1.25	13.75
Std Tee, Side Flow	0	33	x 1.25	0.00
Gate Valve, Fully Open	1	4	x 1.25	5.00
Increaser 6 x 8	1	4	x 1.25	5.00
Increaser 8 x 10	0	4	x 1.25	0.00
Reducer 6 x 4	0	4	x 1.25	0.00
Reducer 4 x 3	0	4	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				149

5. FORCE MAIN PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 8 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				3361.00
Standard				
90° Standard Bend	0	20	x 1.25	0.00
90° Long Radius Bend	0	15	x 1.25	0.00
45° Bend	5	10	x 1.25	62.50
22.5° Bend	2	5	x 1.25	12.50
Plug Valve	0	60	x 1.25	0.00
Swing Check valve	0	55	x 1.25	0.00
Std Tee, Thru Flow	4	14	x 1.25	70.00
Std Tee, Side Flow	0	42	x 1.25	0.00
Gate Valve, Fully Open	1	5	x 1.25	6.25
Increaser 7.98 x 10	0	5	x 1.25	0.00
Increaser 10 x 12	0	5	x 1.25	0.00
Reducer 7.98 x 6	0	5	x 1.25	0.00
Reducer 6 x 4	0	5	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				3512

B. PIPE VELOCITIES

	Initial	Design
Suction Piping	4.73	4.73 FPS
Header Piping	4.73	4.73 FPS
Force Main Piping	2.67	2.67 FPS
Interconnection Piping	N/A	N/A FPS

V. SYSTEM HEAD CALCULATION TABLE

Note: Uses Cameron Hydraulic Data Hazen and Williams Equation (page 27) to calculate friction losses in pipes carrying water

$$f = .2083 \left(\frac{100}{C} \right)^{1.85} \left(\frac{q}{d^{4.8655}} \right) \left(\frac{L}{100} \right)$$

f = Friction head in feet of water
 C = Constant accounting for surface roughness
 d = Inside diameter of pipe in inches
 q = Flow in gallons per minute
 L = Equivalent length of pipe in feet

		d = 6 INCH SUCTION PIPING L = 96 FT			d = 6 INCH HEADER PIPING L = 149 FT		d = 7.98 INCH FORCE MAIN PIPING L = 3512 FT			
FLOW RATE	STATIC SUCTION LIFT	SUCTION PIPING FRICTION LOSSES	TOTAL DYNAMIC SUCTION LIFT	STATIC DISCHARGE HEAD	HEADER PIPING FRICTION LOSSES	FORCE MAIN PIPING FRICTION LOSSES	TOTAL DYNAMIC DISCHARGE HEAD	TOTAL DYNAMIC HEAD	TOTAL DYNAMIC HEAD	
q = GPM	FT	f = FT	FT	FT	f = FT	f = FT	FT	FT	FT	
High Roughness		C= 100			C= 100		C= 110			
	0	-19.76	0.00	-19.76	10.20	0.00	10.20	30.0		
	100	-19.76	-0.16	-19.92	10.20	0.25	11.71	31.6		
	300	-19.76	-1.25	-21.01	10.20	1.94	21.73	42.7		
	400	-19.76	-2.13	-21.89	10.20	3.31	29.83	51.7		
	417	-19.76	-2.30	-22.06	10.20	3.57	31.40	53.5		
	500	-19.76	-3.22	-22.98	10.20	5.00	39.86	62.8		
	600	-19.76	-4.51	-24.27	10.20	7.00	51.76	76.0		
	800	-19.76	-7.68	-27.44	10.20	11.93	80.97	108.4		
	900	-19.76	-9.55	-29.31	10.20	14.83	98.20	127.5		
	1000	-19.76	-11.61	-31.37	10.20	18.02	117.14	148.5		
	1100	-19.76	-13.85	-33.61	10.20	21.50	137.76	171.4		
1400	-19.76	-21.64	-41.40	10.20	33.58	165.69	209.48	250.9		
Design Roughness		C= 120			C= 120		C= 130			
	0	-19.76	0.00	-19.76	10.20	0.00	10.20	30.0		
	100	-19.76	-0.12	-19.88	10.20	0.18	11.30	31.2		
	300	-19.76	-0.89	-20.65	10.20	1.39	18.62	39.3		
	400	-19.76	-1.52	-21.28	10.20	2.36	24.54	45.8		
	417	-19.76	-1.64	-21.40	10.20	2.55	25.69	47.1		
	500	-19.76	-2.30	-22.06	10.20	3.57	31.87	53.9		
	600	-19.76	-3.22	-22.98	10.20	5.00	40.57	63.6		
	800	-19.76	-5.48	-25.24	10.20	8.51	61.91	87.2		
	900	-19.76	-6.82	-26.58	10.20	10.58	74.50	101.1		
	1000	-19.76	-8.29	-28.05	10.20	12.86	88.34	116.4		
	1100	-19.76	-9.88	-29.64	10.20	15.34	103.40	133.0		
1400	-19.76	-15.44	-35.20	10.20	23.97	155.81	191.0			
Low Roughness		C= 140			C= 140		C= 140			
	0	-19.76	0.00	-19.76	10.20	0.00	10.20	30.0		
	100	-19.76	-0.09	-19.85	10.20	0.14	11.14	31.0		
	300	-19.76	-0.67	-20.43	10.20	1.04	17.38	37.8		
	400	-19.76	-1.14	-20.90	10.20	1.78	22.42	43.3		
	417	-19.76	-1.24	-21.00	10.20	1.92	23.40	44.4		
	500	-19.76	-1.73	-21.49	10.20	2.68	28.67	50.2		
	600	-19.76	-2.42	-22.18	10.20	3.76	36.08	58.3		
	800	-19.76	-4.12	-23.88	10.20	6.40	54.26	78.1		
	900	-19.76	-5.13	-24.89	10.20	7.96	64.99	89.9		
	1000	-19.76	-6.23	-25.99	10.20	9.67	76.78	102.8		
	1100	-19.76	-7.43	-27.19	10.20	11.54	89.62	116.8		
1400	-19.76	-11.61	-31.37	10.20	18.02	134.28	165.7			

VI. PUMP SELECTION

A. NET POSITIVE SUCTION HEAD

	Initial Design	Future Design	
Pumping Rate=	417	417	GPM
Atmospheric Pressure at Sea Level		33.90	FT
Correction For Elev. Above Sea Level		0.00	FT
Static Suction Lift		-19.76	FT
Suction Piping Friction Losses (Design Roughness)		-1.64	FT
Vapor Pressure		-1.00	FT
Safety Factor		-5.00	FT
NPSH Available		6.50	FT
NPSH Required		5.00	FT
NPSH Excess Available		1.50	FT

B. REPRIME LIFT

Center Line of Pump Suction	49.36 FT
Lead Pump on Elevation	31.60 FT
Reprime Lift	<u>17.8 FT</u>

C. PUMPING CONDITIONS

	Initial Design	Future Design
Pump Capacity	417	417 GPM
Total Dynamic Head	47.1	47.1 FT

D. EQUIPMENT RECOMMENDATION

	Initial Design	Future Design
Pump Model	T6A3S-B	T6A3S-B
Pump Size	6	6 IN
Pump Speed	1050	1050 RPM
Reprime Lift Capability	18	18 FT
Motor Horsepower	15	15 HP
Motor Speed	1750	1750 RPM

PUMP SIZING AND SELECTION RECOMMENDATIONS SUCTION LIFT PUMP STATION

I. GENERAL INFORMATION

DATE PRINTED: 7/3/2023

PROJECT: New Castle County
Monarch Subdivision Pump Station
New Castle, DE

DESIGN ENGINEER: Davis, Bowen & Friedel, Inc.
1 Park Avenue
Milford, DE 19963
Contact: Ring Lardner, P.E.
Email: rwl@dbfinc.com
Phone: 302-424-1441
Fax: 302-424-0430

EQUIPMENT: Suction Lift Duplex Pump Station

PIPING SIZES: 7.98 inch Force Main Piping
6 inch Header Piping
6 inch Suction Piping

MANUFACTURER: The Gorman-Rupp Company

MANUFACTURER'S REPRESENTATIVE: Envirep, Inc.
3705 Trindle Road
Camp Hill, PA 17011
Contact: Bill LaPorte
Email: wlaporte@envirep.com
Phone: 717-761-7884
Fax: 717-737-5817
Calculations by: Will Hesse

COMMENTS: Dwgs dated 9/15/2023; High Point Sta23+78
0

DISCLAIMERS:

Recommendations contained herein are based upon information provided by the Design Engineer. They are for review and evaluation by the Design Engineer and for incorporation into the project design consistent with his/her best professional judgement.

Gravity sewers, upstream of pumping stations, should be designed such that pump station failures will not cause backflow into residential homes or commercial establishments.

II. DESIGN INFORMATION

A. ELEVATIONS

Force Main Discharge Invert (High Point)	<u>61.49</u> FT
Pump Suction Centerline	<u>49.36</u> FT
Pump Slab Elevation (Ground Level)	<u>47.00</u> FT
Wet Well Influent Invert	<u>32.10</u> FT
Wet Well Bottom (for existing wet well only)	<u>25.90</u> FT

B. SUCTION PIPING

Pipe Diameter	<u>6</u> IN
Pipe Length	<u>25</u> FT
Inlet Opening Diameter	<u>10</u> IN
Distance between Wet Well Bottom and Inlet High Point	<u>0.83</u> FT
Hazen & Williams C-Factors for Friction Loss Calculation:	
High Roughness	C= <u>100</u>
Design Roughness	C= <u>120</u>
Low Roughness	C= <u>140</u>

Standard Fittings

Description	Quantity
90° Standard Bend	1
90° Long Radius Bend	0
45° Bend	0
22.5° Bend	0
Plug Valve	0
Swing Check valve	0
Std Tee, Thru Flow	0
Std Tee, Side Flow	1
Gate Valve, Fully Open	0
Increaser 6 x 8	1
Increaser 8 x 10	1
Decreaser 6 x 4	0
Decreaser 4 x 3	0

Nonstandard Fittings

Description	Quantity	Equivalent Length
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

C. HEADER PIPING

Pipe Diameter	<u>6</u> IN
Pipe Length	<u>15</u> FT
Hazen & Williams C-Factors for Friction Loss Calculations:	
High Roughness	C= <u>100</u>
Design Roughness	C= <u>120</u>
Low Roughness	C= <u>140</u>

Standard Fittings

<i>Description</i>	<i>Quantity</i>
90° Standard Bend	3
90° Long Radius Bend	0
45° Bend	0
22.5° Bend	0
Plug Valve	0
Swing Check valve	1
Std Tee, Thru Flow	1
Std Tee, Side Flow	0
Gate Valve, Fully Open	1
Increaser 6 x 8	1
Increaser 8 x 10	0
Decreaser 6 x 4	0
Decreaser 4 x 3	0

Nonstandard Fittings

<i>Description</i>	<i>Quantity</i>	<i>Equivalent Length</i>
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

D. FORCE MAIN #1

Pipe Diameter 7.98 IN
 Pipe Length 2379 FT
 Hazen & Williams C-Factors for Friction Loss Calculations:
 High Roughness C= 110
 Design Roughness C= 130
 Low Roughness C= 140

Standard Fittings

<i>Description</i>	<i>Quantity</i>
90° Standard Bend	0
90° Long Radius Bend	0
45° Bend	4
22.5° Bend	0
Plug Valve	0
Swing Check valve	0
Std Tee, Thru Flow	4
Std Tee, Side Flow	0
Gate Valve, Fully Open	1
Increaser 7.98 x 10	0
Increaser 10 x 12	0
Decreaser 7.98 x 6	0
Decreaser 6 x 4	0

Nonstandard Fittings

<i>Description</i>	<i>Quantity</i>	<i>Equivalent Length</i>
Fitting #1	0	0 FT
Fitting #2	0	0 FT
Total Length		0 FT

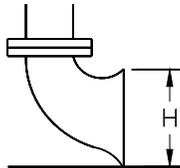
E. PUMPING RATE

Initial Design 430 GPM
 Future Design 430 GPM

F. SUCTION INLET OPENING CONFIGURATION

Inlet Opening Inside Diameter 10 IN
 Distance from Wet Well Bottom to Inlet Elevation (H) 0.83 FT

Configuration:
 Vertical



G. WET WELL SIZING

Rectangular

Length 6.00 FT
 Width 9.00 FT

Distance Between Influent Sewer Invert and Alarm On 0.00 FT
 (Recommend 0.0 FT Without Basket Strainer)
 (Recommend 1.0 FT With Basket Strainer)

H. PUMP CYCLE TIME

Cycle Time - Minimum Allowable Cycle Time 15 MINUTES
 (Use 10 Minutes for 15 HP Motors and Less)
 (Use 15 Minutes for 20 HP to 100 HP)

I. NET POSITIVE SUCTION HEAD

Correction for Elevation Above Sea Level 0 FT
 (Use -1.0 FT For 0 FT To 800 FT Above Sea Level)
 (Use -2.0 FT For 800 FT To 1500 FT Above Sea Level)
 Vapor Pressure -1 FT
 (Use -1.0 FT For Municipal Wastewater)
 Safety Factor -5 FT
 (Recommended -5.0 FT Minimum)
 NPSH Req, Initial Pumping Rate (From Pump Curve) 5 FT
 NPSH Req, Future Design Pumping Rate (From Pump Curve) 5 FT

J. PUMP INFORMATION

Pump Model No. T6A3S-B
 Pump Size 6 IN
 Number of Pumps: 2
 Flow Rates for System Head Curves:
 Minimum 0 GPM
 Maximum 1400 GPM

III. WET WELL SIZING

A. MINIMUM DEPTH

Determines the minimum distance between the wet well bottom and the pump off elevation to prevent vortexing. Design calculations are based on the future design pumping rate.

Determine velocity at inlet opening using $V=Q/A$

Q = Future Design Pumping Rate	430.00 GPM
A = Area At Inlet Opening	
Inlet Opening Diameter (D)	0.83 FT
Inlet Opening Area	0.545 SQ FT
V = Inlet Velocity at Diameter D	1.76 FPS

(Refer to Metcalf & Eddy, Wastewater Engineering, Table 9-3, page 360)

Minimum submergence (S)	1.5 FT
Bottom of wet well to inlet high point distance	0.83 FT
Minimum Depth (MD)	2.33 FT

RECOMMENDED MINIMUM DEPTH (MD)	2.50 FT
---------------------------------------	----------------

B. DRAWDOWN DEPTH

Determine minimum drawdown depth from the operating volume required to prevent short cycling of pumps

(Refer to Metcalf & Eddy, Wastewater Engineering, Equation 9-1, page 354)

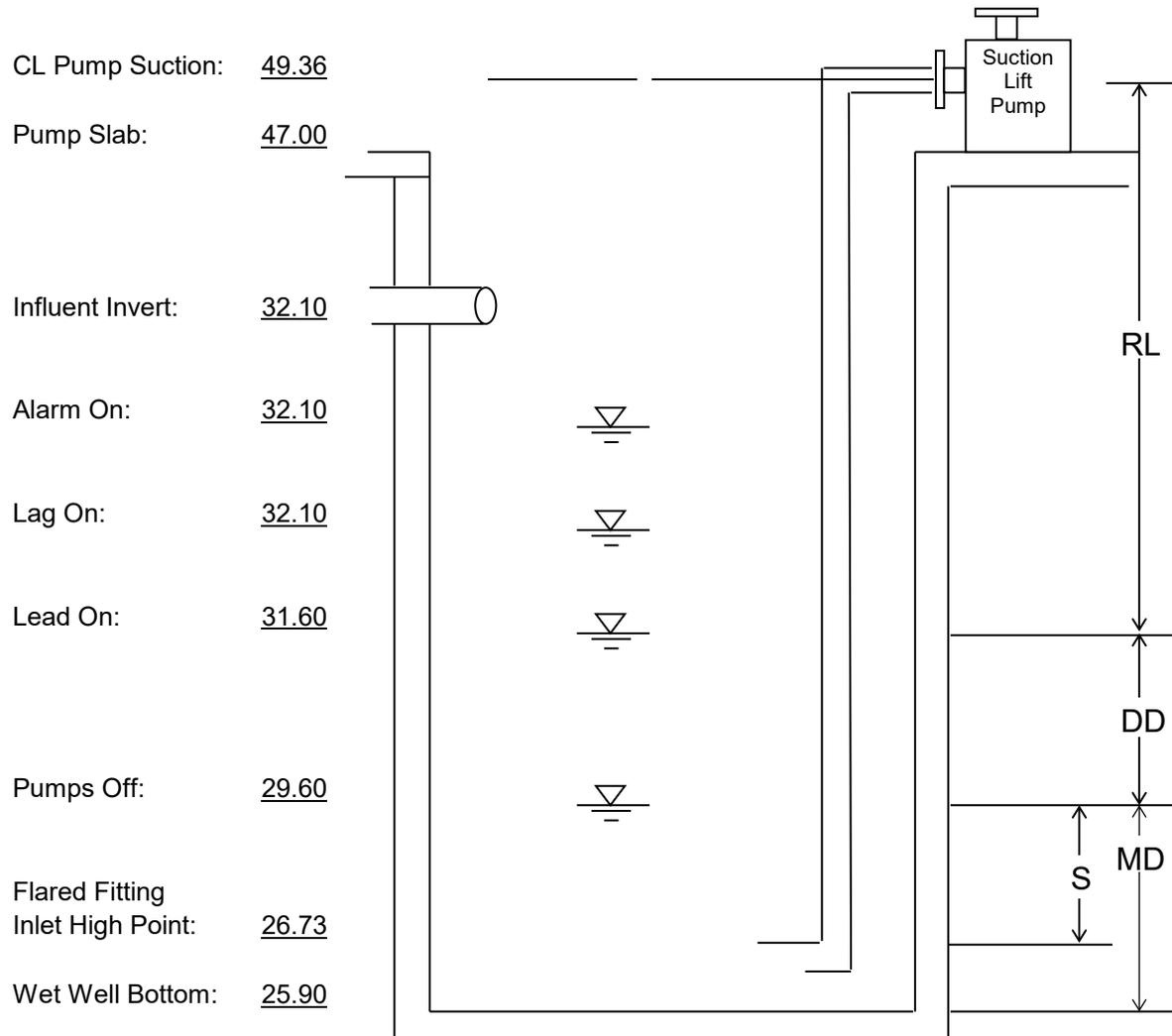
$$V = (T * Qd/4)*f = (15 * 430 / 4) * 0.5$$

T = Minimum Allowable Time for One Pump Cycle	15.00 MIN
Qd = Future Design Pumping Rate, GAL/MIN	430.00 GPM
f = Factor for Identical Pumps with Alternation	0.50
V = Minimum Drawdown Volume = 806.25 GAL / 7.481 =>	107.77 CU FT
Rectangular Length & Width	6.0 x 9.0 FT
Vol/FT. of Elev.	54.00 CU FT/FT
Calculated Drawdown Depth	2.00 FT

RECOMMENDED DRAWDOWN DEPTH (DD)	2.00 FT
--	----------------

Effective Drawdown Volume	108.00 CU FT	807.95 GAL
---------------------------	--------------	------------

C. WET WELL ELEVATION DIAGRAM



Legend:

Minimum depth based on submergence (MD)	3.70 FT
Submergence (S)	2.87 FT
Drawdown depth (DD)	2.00 FT
Reprime lift (RL)	17.76 FT

IV. PIPING SYSTEM

A. SYSTEM HEAD CURVE

1. STATIC SUCTION LIFT:

Pump Off Elevation	29.60 FT
Pump Suction Center Line Elevation	<u>-49.36 FT</u>
Static Suction Lift	-19.76 FT

2. SUCTION PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 6 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				25.00
Standard				
90° Standard Bend	1	16	x 1.25	20.00
90° Long Radius Bend	0	10	x 1.25	0.00
45° Bend	0	7	x 1.25	0.00
22.5° Bend	0	4	x 1.25	0.00
Plug Valve	0	50	x 1.25	0.00
Swing Check valve	0	40	x 1.25	0.00
Std Tee, Thru Flow	0	11	x 1.25	0.00
Std Tee, Side Flow	1	33	x 1.25	41.25
Gate Valve, Fully Open	0	4	x 1.25	0.00
Increaser 6 x 8	1	4	x 1.25	5.00
Increaser 8 x 10	1	4	x 1.25	5.00
Reducer 6 x 4	0	4	x 1.25	0.00
Reducer 4 x 3	0	4	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				96

3. STATIC DISCHARGE HEAD:

Force Main Discharge Invert. Elev. (High Pt.)	61.49 FT
Pump Suction Centerline Elevation	<u>-49.36 FT</u>
Static Discharge Head	12.13 FT

4. DISCHARGE HEADER PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 6 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				15.00
Standard				
90° Standard Bend	3	16	x 1.25	60.00
90° Long Radius Bend	0	10	x 1.25	0.00

Envirep, Inc.

45° Bend	0	7	x 1.25	0.00
22.5° Bend	0	4	x 1.25	0.00
Plug Valve	0	50	x 1.25	0.00
Swing Check valve	1	40	x 1.25	50.00
Std Tee, Thru Flow	1	11	x 1.25	13.75
Std Tee, Side Flow	0	33	x 1.25	0.00
Gate Valve, Fully Open	1	4	x 1.25	5.00
Increaser 6 x 8	1	4	x 1.25	5.00
Increaser 8 x 10	0	4	x 1.25	0.00
Reducer 6 x 4	0	4	x 1.25	0.00
Reducer 4 x 3	0	4	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				149

5. FORCE MAIN PIPING, EQUIVALENT LENGTH OF PIPE:

Pipe Diameter 8 IN

	Number Needed	Eq Len/ Fitting FT	Safety Factor 1.25	Total Eq Len FT
Length of Pipe				2379.00
Standard				
90° Standard Bend	0	20	x 1.25	0.00
90° Long Radius Bend	0	15	x 1.25	0.00
45° Bend	4	10	x 1.25	50.00
22.5° Bend	0	5	x 1.25	0.00
Plug Valve	0	60	x 1.25	0.00
Swing Check valve	0	55	x 1.25	0.00
Std Tee, Thru Flow	4	14	x 1.25	70.00
Std Tee, Side Flow	0	42	x 1.25	0.00
Gate Valve, Fully Open	1	5	x 1.25	6.25
Increaser 7.98 x 10	0	5	x 1.25	0.00
Increaser 10 x 12	0	5	x 1.25	0.00
Reducer 7.98 x 6	0	5	x 1.25	0.00
Reducer 6 x 4	0	5	x 1.25	0.00
Non-standard				
Fitting #1	0	0 FT	x 1.25	0.00
Fitting #2	0	0 FT	x 1.25	0.00
TOTAL EQUIVALENT LENGTH				2505

B. PIPE VELOCITIES

	Initial	Design
Suction Piping	4.88	4.88 FPS
Header Piping	4.88	4.88 FPS
Force Main Piping	2.76	2.76 FPS
Interconnection Piping	N/A	N/A FPS

V. SYSTEM HEAD CALCULATION TABLE

Note: Uses Cameron Hydraulic Data Hazen and Williams Equation (page 27) to calculate friction losses in pipes carrying water

$$f = .2083 \left(\frac{100}{C} \right)^{1.85} \left(\frac{q^{1.85}}{d^{4.8655}} \right) \left(\frac{L}{100} \right)$$

f = Friction head in feet of water
 C = Constant accounting for surface roughness
 d = Inside diameter of pipe in inches
 q = Flow in gallons per minute
 L = Equivalent length of pipe in feet

		d = 6 INCH SUCTION PIPING L = 96 FT			d = 6 INCH HEADER PIPING L = 149 FT		d = 7.98 INCH FORCE MAIN PIPING L = 2505 FT			
FLOW RATE	STATIC SUCTION LIFT	SUCTION PIPING FRICTION LOSSES	TOTAL DYNAMIC SUCTION LIFT	STATIC DISCHARGE HEAD	HEADER PIPING FRICTION LOSSES	FORCE MAIN PIPING FRICTION LOSSES	TOTAL DYNAMIC DISCHARGE HEAD	TOTAL DYNAMIC HEAD		
q = GPM	FT	f = FT	FT	FT	f = FT	f = FT	FT	FT		
High Roughness		C= 100			C= 100		C= 110			
	0	-19.76	0.00	-19.76	12.13	0.00	0.00	12.13	31.9	
	100	-19.76	-0.16	-19.92	12.13	0.25	0.90	13.28	33.2	
	300	-19.76	-1.25	-21.01	12.13	1.94	6.84	20.91	41.9	
	400	-19.76	-2.13	-21.89	12.13	3.31	11.64	27.08	49.0	
	430	-19.76	-2.44	-22.20	12.13	3.78	13.31	29.22	51.4	
	500	-19.76	-3.22	-22.98	12.13	5.00	17.59	34.72	57.7	
	600	-19.76	-4.51	-24.27	12.13	7.00	24.65	43.78	68.1	
	800	-19.76	-7.68	-27.44	12.13	11.93	41.97	66.03	93.5	
	900	-19.76	-9.55	-29.31	12.13	14.83	52.19	79.15	108.5	
	1000	-19.76	-11.61	-31.37	12.13	18.02	63.42	93.57	124.9	
	1100	-19.76	-13.85	-33.61	12.13	21.50	75.65	109.27	142.9	
	1400	-19.76	-21.64	-41.40	12.13	33.58	118.18	163.90	205.3	
Design Roughness		C= 120			C= 120		C= 130			
	0	-19.76	0.00	-19.76	12.13	0.00	0.00	12.13	31.9	
	100	-19.76	-0.12	-19.88	12.13	0.18	0.66	12.97	32.8	
	300	-19.76	-0.89	-20.65	12.13	1.39	5.02	18.54	39.2	
	400	-19.76	-1.52	-21.28	12.13	2.36	8.55	23.04	44.3	
	430	-19.76	-1.74	-21.50	12.13	2.70	9.77	24.60	46.1	
	500	-19.76	-2.30	-22.06	12.13	3.57	12.92	28.61	50.7	
	600	-19.76	-3.22	-22.98	12.13	5.00	18.10	35.23	58.2	
	800	-19.76	-5.48	-25.24	12.13	8.51	30.81	51.45	76.7	
	900	-19.76	-6.82	-26.58	12.13	10.58	38.31	61.03	87.6	
	1000	-19.76	-8.29	-28.05	12.13	12.86	46.56	71.55	99.6	
	1100	-19.76	-9.88	-29.64	12.13	15.34	55.54	83.01	112.7	
	1400	-19.76	-15.44	-35.20	12.13	23.97	86.76	122.86	158.1	
Low Roughness		C= 140			C= 140		C= 140			
	0	-19.76	0.00	-19.76	12.13	0.00	0.00	12.13	31.9	
	100	-19.76	-0.09	-19.85	12.13	0.14	0.57	12.84	32.7	
	300	-19.76	-0.67	-20.43	12.13	1.04	4.38	17.55	38.0	
	400	-19.76	-1.14	-20.90	12.13	1.78	7.45	21.36	42.3	
	430	-19.76	-1.31	-21.07	12.13	2.03	8.52	22.68	43.7	
	500	-19.76	-1.73	-21.49	12.13	2.68	11.26	26.07	47.6	
	600	-19.76	-2.42	-22.18	12.13	3.76	15.78	31.67	53.8	
	800	-19.76	-4.12	-23.88	12.13	6.40	26.86	45.39	69.3	
	900	-19.76	-5.13	-24.89	12.13	7.96	33.41	53.49	78.4	
	1000	-19.76	-6.23	-25.99	12.13	9.67	40.59	62.39	88.4	
	1100	-19.76	-7.43	-27.19	12.13	11.54	48.42	72.09	99.3	
	1400	-19.76	-11.61	-31.37	12.13	18.02	75.65	105.80	137.2	

VI. PUMP SELECTION

A. NET POSITIVE SUCTION HEAD

	Initial Design	Future Design	
Pumping Rate=	430	430	GPM
Atmospheric Pressure at Sea Level		33.90	FT
Correction For Elev. Above Sea Level		0.00	FT
Static Suction Lift		-19.76	FT
Suction Piping Friction Losses (Design Roughness)		-1.74	FT
Vapor Pressure		-1.00	FT
Safety Factor		-5.00	FT
NPSH Available		6.40	FT
NPSH Required		5.00	FT
NPSH Excess Available		1.40	FT

B. REPRIME LIFT

Center Line of Pump Suction	49.36 FT
Lead Pump on Elevation	31.60 FT
Reprime Lift	<u>17.8 FT</u>

C. PUMPING CONDITIONS

	Initial Design	Future Design
Pump Capacity	430	430 GPM
Total Dynamic Head	46.1	46.1 FT

D. EQUIPMENT RECOMMENDATION

	Initial Design	Future Design
Pump Model	T6A3S-B	T6A3S-B
Pump Size	6	6 IN
Pump Speed	1050	1050 RPM
Reprime Lift Capability	18	18 FT
Motor Horsepower	15	15 HP
Motor Speed	1750	1750 RPM

EXHIBIT D

Generator Calculations



Power Generation

Recommended Generator Report - C50 D6

Project - 22-1529 Monarch Subdivision Pump Station-SS-20HP

Comments - 2x20HP motors with Soft Starting

Project Requirements

Frequency, Hz	: 60.0	Generators Running in Parallel	: 1
Duty	: Standby	Site Altitude, ft(m)	: 361(152)
Voltage	: 277/480, Series Wye	Site Temperature, °C	: 25
Phase	: 3	Max. Altr Temp Rise, °C	: 125
Fuel	: Diesel	Project Voltage Distortion Limit, %	: 10
Emissions	: EPA, stationary emergency application		

Calculated Individual Generator Set Load Running and Peak Requirements

Running kW	: 48.9	Max. Step kW	: 50.0 In Step 1	Cumulative Step kW	: 67.0
Running kVA	: 54.8	Max. Step kVA	: 92.8 In Step 1	Cumulative Step kVA	: 111.9
Running PF	: 0.89	Peak kW	: None	Cumulative Peak kW	: None
Running NLL kVA	: 0.0	Peak kVA	: None	Cumulative Peak kVA	: None
Alternator kW	: 48.9			Pct Rated Capacity	: 98.0

Generator Set Configuration

Alternator	: CA125-J14	Engine	: 4BTAA3.3-G7
BCode	: B943	Fuel	: Diesel
Excitation	: PMG	Displacement, cu in. (Litre)	: 199.0(3.3)
Voltage Range	: 220/440-240/480	Cylinders	: 4
Number of Leads	: 6	Altitude Knee, ft(m)	: 4100(1250)
Reconnectable	: Yes	Altitude Slope, % per 985ft(300.2m)	: 6
Full Single Phase Output	: No	Temperature Knee, °F(°C)	: 104(40)
Increased Motor Starting	: No	Temperature Slope, % per 18°F(10.0°C)	: 10
Extended Stack	: No	Emissions	: Tier 3
		Cooling Package	: High Ambient

Set Performance

Load Requirements

Running At	: 98.0% Rated Capacity		
Max. Step Voltage Dip, %	: 21	Max. Allowed Step Voltage Dip	: 35 In Step 1
Max. Step Frequency Dip, %	: 5	Max. Allowed Step Frequency Dip	: 10 In Step 1
Peak Voltage Dip, %	:	Peak Voltage Dip Limit %	: 35.0
Peak Frequency Dip, %	:	Peak Frequency Dip Limit %	: 10
Site Rated Standby kW/kVA	: 50 / 63	Running kW	: 48.9
		Running kVA	: 54.8
Site Rated Max. SkW	: 58	Effective Step kW	: 54.3
Max. SkVA	: 181	Effective Step kVA	: 105.6
Temp Rise at Full Load, °C	: 120	Percent Non-Linear Load	: 0.0
Voltage Distortion	:	Voltage Distortion Limit	: 10
Site Rated Max Step kW Limit	:	Max Step kW	:

*Note: Higher temperature rise at full rated load.

*Note: All generator set power derates are based on open generator sets.



Power Generation

Loads Summary Report

Project - 22-1529 Monarch Subdivision Pump Station-SS-20HP

Comments - 2x20HP motors with Soft Starting

Project Requirements

Frequency, Hz	: 60.0	Generators Running in Parallel	: 1
Duty	: Standby	Site Altitude, ft(m)	: 361(152)
Voltage	: 277/480, Series Wye	Site Temperature, °C	: 25
Phase	: 3	Max. Altr Temp Rise, °C	: 125
Fuel	: Diesel	Project Voltage Distortion Limit, %	: 10
Emissions	: EPA, stationary emergency application		

Loads Summary List

*Note: Detailed Loads and Step Report available below

Step No.	Load Name	Quantity	Running		Starting		Peak		Dip Limits, %		VTHD% Limit
			kW	kVA	kW	kVA	kW	kVA	Vdip	Fdip	
Step01	Pump #1	1	16.95	19.04	35.03	76.16	None	None	35.0	10.0	10.0
Step01	Miscellaneous Pumpstation Load	1	15.0	16.67	15.0	16.67	None	None	35.0	10.0	0.0
Step Summary			32.0	36.0	50.0	93.0	None	None	35.0	10.0	10.0
Step02	Pump #2	1	16.95	19.04	35.03	76.16	None	None	35.0	10.0	10.0
Step Summary			17.0	19.0	35.0	76.0	None	None	35.0	10.0	10.0
Project Summary			Running		Max Starting		Cumulative Step		Cumulative Peak		Project VTHD% Limit
			kW	kVA	kW	kVA	kW	kVA	kW	kVA	
			48.9	54.8	50.0	92.8	67.0	111.9	0.0	0.0	

*Note: Detailed Loads and Step Report available below



Power Generation

Loads and Steps Detail Report

Project - 22-1529 Monarch Subdivision Pump Station-SS-20HP

Comments - 2x20HP motors with Soft Starting

Project Requirements

Frequency, Hz	: 60.0	Generators Running in Parallel	: 1
Duty	: Standby	Site Altitude, ft(m)	: 361(152)
Voltage	: 277/480, Series Wye	Site Temperature, °C	: 25
Phase	: 3	Max. Altr Temp Rise, °C	: 125
Fuel	: Diesel	Project Voltage Distortion Limit, %	: 10
Emissions	: EPA, stationary emergency application		

Calculated Individual Generator Set Load Running and Peak Requirements

Running kW	: 48.9	Max. Step kW	: 50.0 In Step 1	Cumulative Step kW	: 67.0
Running kVA	: 54.8	Max. Step kVA	: 92.8 In Step 1	Cumulative Step kVA	: 111.9
Running PF	: 0.89	Peak kW	: None	Cumulative Peak kW	: None
Running NLL kVA	: None	Peak kVA	: None	Cumulative Peak kVA	: None
Alternator kW	: 48.9				

Step1

Calculated Individual Generator Set Step Load Requirements

Running kW	: 32.0	Starting kW	: 50.0	Cumulative Step kW	: 50.0
Running kVA	: 36.0	Starting kVA	: 93.0	Cumulative Step kVA	: 93.0
Running Amps	: 43.0	Starting Non-linear kVA	: 76.0		
Running Non-linear kVA	: 0.0				
Alternator kW	: 31.95				
Voltage Distortion Limit for step	: 10				

Pump #1		Three Phase	Quantity	: 1 In this Step
Category	: Motor			

Running kW	: 16.95	Starting kW	: 35.03	Peak kW	: None
Running kVA	: 19.04	Starting kVA	: 76.16	Peak kVA	: None
Running PF	: 0.89	Starting PF	: 0.46	Cyclic	: No
Running Amps	: 22.93	Max. % Voltage Dip	: 35.0	Max. % Frequency Dip	: 10.0
Running NLL kVA	: 0.0				
Starting NLL kVA	: 76.16			Voltage	: 480
Alternator kW	: 16.95				

Shaft Hp	: 20.0	Method	: Solid State
Shaft kW	: 14.92	Current Limit	: 400.0
Efficiency (%)	: 0.88	LRkVA Factor	: 5.9
Design	: Standard NEMA Design B,C or D	LRkVA Code	: G



Power Generation

Steps and Dips Details Report

Project - 22-1529 Monarch Subdivision Pump Station-SS-20HP

Project Requirements

Frequency, Hz	: 60.0	Generators Running in Parallel	: 1
Duty	: Standby	Site Altitude, ft(m)	: 361(152)
Voltage	: 277/480, Series Wye	Site Temperature, °C	: 25
Phase	: 3	Max. Altr Temp Rise, °C	: 125
Fuel	: Diesel	Project Voltage Distortion Limit, %	: 10
Emissions	: EPA, stationary emergency application		

Calculated Individual Generator Set Load Running and Peak Requirements

Running kW	: 48.9	Max. Step kW	: 50.0 In Step 1	Cumulative Step kW	: 67.0
Running kVA	: 54.8	Max. Step kVA	: 92.8 In Step 1	Cumulative Step kVA	: 111.9
Running PF	: 0.89	Peak kW	: None	Cumulative Peak kW	: None
Running NLL kVA	: 0.0	Peak kVA	: None	Cumulative Peak kVA	: None
Alternator kW	: 48.9				

Generator Set Configuration

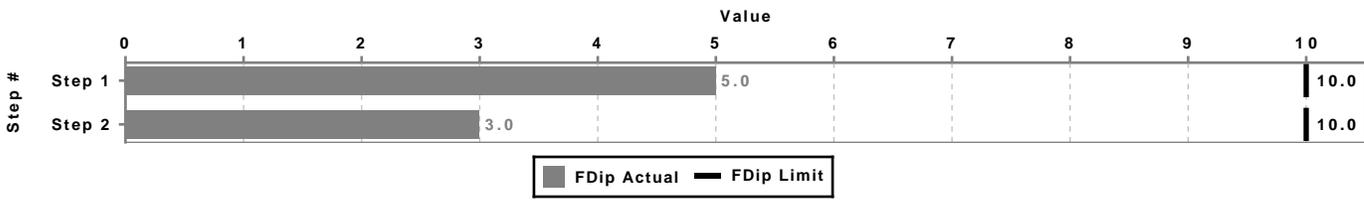
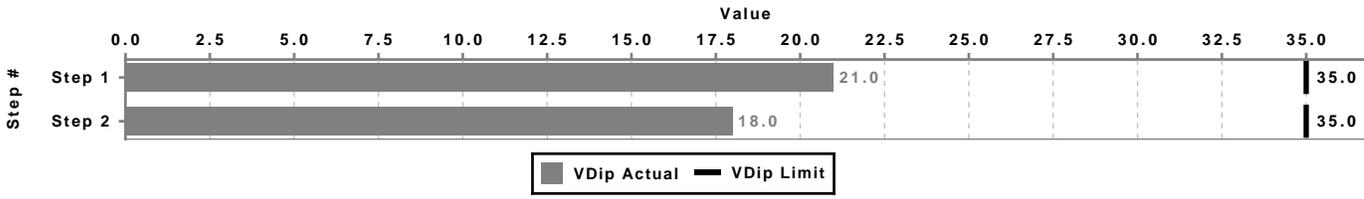
Model	: C50 D6	Alternator	: CA125-J14
Engine Model	: 4BTAA3.3-G7	Excitation	: PMG
Fuel	: Diesel		: High Ambient

Step Level Dips Summary

Step #	Voltage Dip Limit (%)	Expected Step Voltage Dip (%)	Voltage Recovery Time (s) **	Frequency Dip Limit (%)	Expected Frequency Dip (%)	Frequency recovery Time (s) **
1	35	21	2.9	10	5	1.1
2	35	18	2.5	10	3	0.6

Note: Please refer to the model Spec. sheet for bandwidths used to report recovery times. For products manufactured in the United Kingdom it may be assumed that recovery times are based on ISO8528-5 G2 class bandwidths. Voltage and frequency recovery times are estimates. Typically, allow five to ten seconds between application of load steps when designing your system.

**Please note that in some cases the voltage and frequency recovery time estimates are not shown in list. This is a result of "dummy" data points temporarily being used to fill data gaps in the GenSize database. Please disregard these blank results.





Diesel generator set

50 kW - 60 kW
EPA emissions
stationary Standby



Description

Cummins® generator sets are fully integrated power generation systems providing optimum performance, reliability and versatility for stationary Standby applications.

Features

Cummins heavy-duty engine - Rugged 4-cycle, liquid-cooled, industrial diesel engine delivers reliable power, low emissions and fast response to load changes.

Alternator - Several alternator sizes offer selectable motor starting capability with low reactance 2/3 pitch windings, low waveform distortion with non-linear loads and fault clearing short-circuit capability.

Control system - The PowerCommand® 1.1 electronic control is standard equipment and provides total generator set system integration including automatic remote starting/stopping, precise frequency and voltage regulation, alarm and status message display, output metering, auto-shutdown at fault detection and NFPA 110 Level 1 compliance.

Cooling system - Standard cooling package provides reliable running at up to 50 °C (122 °F) ambient temperature.

Enclosures - The aesthetically appealing enclosure incorporates special designs that deliver one of the quietest generators of its kind. Aluminum material plus durable powder coat paint provides the best anti-corrosion performance. The generator set enclosure has been evaluated to withstand 180 MPH wind loads in accordance with ASCE7-10. The intelligent design has removable panels and service doors to provide easy access for service and maintenance.

Fuel tanks - Two dual wall sub-base fuel tank series are offered as optional features, providing economical and flexible solutions to meet extensive code requirements on diesel fuel tanks.

NFPA - The generator set accepts full rated load in a single step in accordance with NFPA 110 for Level 1 systems.

Warranty and service - Backed by a comprehensive warranty and worldwide distributor network.

Model	Standby rating 60 Hz		Prime rating 60 Hz		Data sheets 60 Hz
	kW	kVA	kW	kVA	
C50 D6	50.0	62.5	45.0	56.25	NAD-5863
C60 D6	60.0	75.0	54.0	67.50	NAD-5864

Generator set specifications

Governor regulation class	TBC
Voltage regulation, no load to full load	± 1.0%
Random voltage variation	± 1.0%
Frequency regulation	Isochronous
Random frequency variation	TBD
Radio frequency emissions compliance	FCC code Title 47 Part 15 Class B

Engine specifications

Design	Turbocharged and charge air-cooled
Bore	95.0 mm (3.74 in.)
Stroke	115.0 mm (4.53 in.)
Displacement	3.26 litres (199 in ³)
Cylinder block	Cast iron, in-line, 4 cylinder
Battery capacity	550 amps at ambient temperature of 0 °F to 32 °F (-18 °C to 0 °C)
Battery charging alternator	50 amps
Starting voltage	12 volt, negative ground
Fuel system	Direct injection, number 2 diesel fuel, fuel filter, electric fuel shut off
Fuel filter	Single element, 10 micron filtration, spin-on fuel filter with water separator
Air cleaner type	Dry replaceable element
Lube oil filter type(s)	Spin-on, full flow
Standard cooling system	50 °C (122 °F) ambient cooling system
Rated speed	1800 rpm

Alternator specifications

Design	Brushless, 4 pole, drip proof, revolving field
Stator	2/3 pitch
Rotor	Direct coupled, flexible disc
Insulation system	Class H per NEMA MG1-1.65
Standard temperature rise	120 °C (248 °F) Standby
Exciter type	Torque match (shunt) with PMG as option
Alternator cooling	Direct drive centrifugal blower
AC waveform Total Harmonic Distortion (THDV)	< 5% no load to full linear load, < 3% for any single harmonic
Telephone Influence Factor (TIF)	< 50 per NEMA MG1-22.43
Telephone Harmonic Factor (THF)	3%

Available voltages

Single phase	3 phase
• 120/240	• 120/208 • 120/240 delta • 277/480 • 347/600

Note: Consult factory for other voltages.

Generator set options

Fuel system

- Basic fuel tanks
- Regional fuel tanks

Engine

- Engine air cleaner – normal or heavy duty
- Shut down – low oil pressure
- Extension – oil drain
- 120 V 1000 W coolant heater

Alternator

- One size up alternator
- PMG
- Alternator heater, 120 V

Control

- AC output analog meters (bargraph)
- Stop switch – emergency
- Auxiliary output relays (2)
- Auxiliary configurable signal inputs (8) and relay outputs (8)

Electrical

- Single circuit breaker
- Dual circuit breakers

Enclosure

- Aluminum enclosure sound level 1 or level 2, with muffler installed, sandstone or green color
- Open set

Cooling system

- Shutdown – low coolant level
- Warning – low coolant level
- Extension – coolant drain
- Coolant heater – 120 V, 1 Ph

Exhaust system

- Exhaust connector - NPT

Generator set application

- Battery rack
- Battery rack, heavy duty

Generator set options (continued)

Warranty

- Base warranty – 2 year, 1000 hour, Standby
- Standby, 3 year, 1500 hour, parts
- Standby, 5 year, 2500 hour, parts
- Standby, 3 year, 1500 hour, parts and labor
- Standby, 5 year, 2500 hour, parts and labor
- Standby, 3 year, 1500 hour, parts, labor and travel
- Standby, 5 year, 2500 hour, parts, labor and travel

Note: Some options may not be available on all models - consult factory for availability.

Generator set accessories

- Coolant heater
- Extreme cold weather components
- HMI211RS in-home display, including pre-configured 12" harness
- HMI211 remote display, including pre-configured 12" harness
- HMI220 remote display
- Auxiliary output relays (2)
- Auxiliary configurable signal inputs (8) and relay outputs (8)
- Annunciator – RS485
- Remote monitoring device – PowerCommand 500
- Battery charger – stand-alone, 12 V
- Circuit breakers
- Enclosure Sound Level 1 to Sound Level 2 upgrade kit
- Enclosure paint touch up kit
- Mufflers – industrial, residential or critical
- Alternator PMG
- Alternator heater
- Maintenance and service kit
- Engine lift kit
- Various fuel tanks and accessories

Control system PowerCommand 1.1



PowerCommand control is an integrated generator set control system providing voltage regulation, engine protection, operator interface and isochronous governing (optional). Major features include:

- Battery monitoring and testing features and smart starting control system.
- Standard PCCNet interface to devices such as remote annunciator for NFPA 110 applications.
- Control boards potted for environmental protection.
- Control suitable for operation in ambient temperatures from -40 °C to +70 °C (-40 °F to +158 °F) and altitudes to 5000 meters (13,000 feet).
- Prototype tested; UL, CSA, and CE compliant.
- InPower™ PC-based service tool available for detailed diagnostics.

Operator/display panel

- Manual off switch
- Alpha-numeric display with pushbutton access for viewing engine and alternator data and providing setup, controls and adjustments (English or international symbols)
- LED lamps indicating generator set running, not in auto, common warning, common shutdown, manual run mode and remote start
- Suitable for operation in ambient temperatures from -40 °C to +70 °C
- Bargraph display (optional)

AC protection

- Over current warning and shutdown
- Over and under voltage shutdown
- Over and under frequency shutdown
- Over excitation (loss of sensing) fault
- Field overload

Engine protection

- Overspeed shutdown
- Low oil pressure warning and shutdown
- High coolant temperature warning and shutdown
- Low coolant level warning or shutdown
- Low coolant temperature warning
- High, low and weak battery voltage warning
- Fail to start (overcrank) shutdown
- Fail to crank shutdown
- Redundant start disconnect
- Cranking lockout
- Sensor failure indication
- Low fuel level warning or shutdown

Alternator data

- Line-to-Line and Line-to-Neutral AC volts
- 3-phase AC current
- Frequency
- Total kVa

Engine data

- DC voltage
- Lube oil pressure
- Coolant temperature
- Engine speed

Other data

- Generator set model data
- Start attempts, starts, running hours
- Fault history
- RS485 Modbus® interface
- Data logging and fault simulation (requires InPower service tool)

Digital governing (optional)

- Integrated digital electronic isochronous governor
- Temperature dynamic governing

Digital voltage regulation

- Integrated digital electronic voltage regulator
- 2-phase Line-to-Line sensing
- Configurable torque matching

Control functions

- Time delay start and cooldown
- Cycle cranking
- PCCNet interface
- (2) Configurable inputs
- (2) Configurable outputs
- Remote emergency stop
- Automatic Transfer Switch (ATS) control
- Generator set exercise, field adjustable

Options

- Auxiliary output relays (2)
- Remote annunciator with (3) configurable inputs and (4) configurable outputs
- PMG alternator excitation
- PowerCommand 500/550 for remote monitoring and alarm notification (accessory)
- Auxiliary, configurable signal inputs (8) and configurable relay outputs (8)
- Digital governing
- AC output analog meters (bargraph)
 - Color-coded graphical display of:
 - 3-phase AC voltage
 - 3-phase current
 - Frequency
 - kVa
- Remote operator panel

Ratings definitions

Emergency Standby Power (ESP):

Applicable for supplying power to varying electrical load for the duration of power interruption of a reliable utility source. Emergency Standby Power (ESP) is in accordance with ISO 8528. Fuel Stop power in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Limited-Time Running Power (LTP):

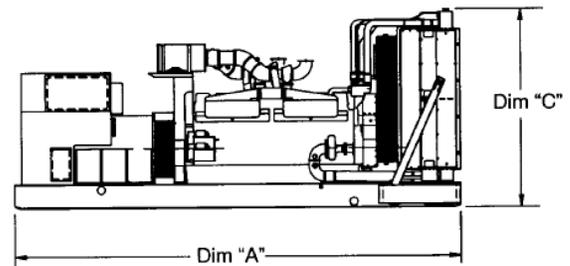
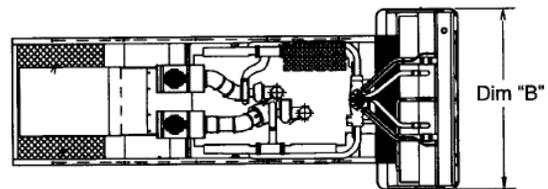
Applicable for supplying power to a constant electrical load for limited hours. Limited-Time Running Power (LTP) is in accordance with ISO 8528.

Prime Power (PRP):

Applicable for supplying power to varying electrical load for unlimited hours. Prime Power (PRP) is in accordance with ISO 8528. Ten percent overload capability is available in accordance with ISO 3046, AS 2789, DIN 6271 and BS 5514.

Base Load (Continuous) Power (COP):

Applicable for supplying power continuously to a constant electrical load for unlimited hours. Continuous Power (COP) in accordance with ISO 8528, ISO 3046, AS 2789, DIN 6271 and BS 5514.



This outline drawing is for reference only. See respective model data sheet for specific model outline drawing number.

Do not use for installation design

Model	Dim "A" mm (in.)	Dim "B" mm (in.)	Dim "C" mm (in.)	Set weight* dry kg (lbs)	Set weight* wet kg (lbs)
Open set					
C50 D6	2224 (87.5)	864 (34)	1121 (44.13)	648 (1434)	669 (1480)
C60 D6	2224 (87.5)	864 (34)	1121 (44.13)	701 (1550)	721 (1596)
Sound attenuated enclosure Level 1					
C50 D6	2384 (93.8)	864 (34)	1156 (45.5)	695 (1538)	716 (1584)
C60 D6	2384 (93.8)	864 (34)	1156 (45.5)	748 (1654)	768 (1700)
Sound attenuated enclosure Level 2					
C50 D6	2629 (103.5)	864 (34)	1156 (45.5)	714 (1580)	735 (1626)
C60 D6	2629 (103.5)	864 (34)	1156 (45.5)	767 (1696)	787 (1742)

* Weights represent a set with standard features. See outline drawings for weights of other configurations.

Codes and standards

Codes or standards compliance may not be available with all model configurations – consult factory for availability.

	This generator set is designed in facilities certified to ISO 9001 and manufactured in facilities certified to ISO 9001 or ISO 9002.		The generator set is available Listed to UL 2200, Stationary Engine Generator Assemblies.
	The Prototype Test Support (PTS) program verifies the performance integrity of the generator set design. Cummins products bearing the PTS symbol meet the prototype test requirements of NFPA 110 for Level 1 systems.	U.S. EPA	Engine certified to U.S. EPA SI Stationary Emission Regulation 40 CFR, Part 60.
	All low voltage models are CSA certified to product class 4215-01.	International Building Code	The generator set is certified for seismic application in accordance with International Building Code (IBC) 2012.

Warning: Back feed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is open.

For more information contact your local Cummins distributor or visit power.cummins.com

Our energy working for you.™



EXHIBIT E

Radio Survey Report



INTERFACE, INC.
752 ARDENWOOD DRIVE
ELDERSBURG, MD. 21784

PHONE: (410) 795-6795
CELL: (410) 562-7604
lbopst@aol.com
12/13/22

To: Ed Fayda - Fayda Engineering & Energy Solutions

From: L. Lee Bopst - Interface, Inc.

Subject: Monarch Pump Station - Radio Survey

1. SURVEY

Attached is the path profile for the **Monarch Pump Station** location to the existing Middletown hub associated with this system. The site coordinates for the new station are:

39° 31' 19.44" N & 75° 42' 6.58" W

2. TEST EQUIPMENT

- a. Decibel Products Model DB499, 10 dB gain Yagi Antenna
- b. 30 feet of RG8 coaxial cable
- c. Microwave Data Model 9810 Data Transceiver
- d. Microwave Data Model 9710 Data Transceiver
- e. Microwave Data Hand Held Data Terminal
- f. Laptop computer running MDS diagnostic software
- g. Antenna mast raised to 20 feet
- h. Antenna Heights MOT 175 ', Lums Pond 100' and Delaware City 110'

3. PHOTOS

Attached are photographs of the **Monarch Pump Station** location to show the test setup and various site views.

4. RESULTS

The measured radio signal levels are as follows:

<u>To site location</u>	<u>RSSI Reading</u>	<u>Network Address</u>
Odessa Hub	-88 dBm	8291
Lums Pond Hub	-110 dBm	4619
Delaware City Hub	-115 dBm	7130

RESULTS - Continued

The best-measured signal level (and the second shortest distance of 4.76 miles - see plots attached) was attained at the **Odessa (MOT) Hub**. An analysis based on distance and height indicates that an antenna height of 40 feet would provide a signal level of approximately -88 dBm which exceeds our minimum recommended signal level of -90 dBm. (*See note at end of report*)

Enclosure - Control Wave Micro with MDS 9810B Radio Modem

- Control Wave Micro-8 Slot Chassis
 - S1 = PSSM Module-24 VDC Powered
 - S2 = CPU-2 RS-232 Ports, 1 RS-485 Port, 4 Meg RAM
- Terminations
 - S3 = 4AI, 6DI/O, 1 HSC Mixed I/O Card with Local Terminations
 - S4 = 4AI, 6DI/O, 1 HSC Mixed I/O Card with Local Terminations
 - S5 = Blank
 - S6 = Blank
 - S7 = Blank
 - S8 = Blank
- LCD Display, 2 Button, LCD, 2 x 20, Mounted to the Inside of Door
- Configuration & Communications Cable for Display
- **The above items are mounted in the enclosure described below and are priced elsewhere.**
- Enclosure, NEMA 4, Steel, Wall Mount, Single Door, Light Gray, 24" x 20" x 10" Includes: Back Panel, Mounting Foot Kit, Data Pocket, & Battery Vent
- Enclosure Modifications for Display, RF Surge Protector, & Battery Vent
- Power Supply/Charger Assembly, 120 VAC/24 VDC @ 4.2 Amperes & 12 VDC @ 5.0 Amperes
- One (1) Battery, Lead Acid, 12 Volts @ 7 Ampere-Hours
- Radio Modem Transceiver, Spread Spectrum, 902 To 928 MHz Operating Band, 10.5 To 30 VDC Input # MDS-9810
- Radio Mounting Bracket
- RF Surge Protector
- Data Cable, RS-232 Interface, CW Micro to Radio
- RF Cable, Coaxial, Radio to RF Surge Protector
- Radio Antenna, 896 To 970 MHz Range, 6dB Gain, "Maxrad" # MYG9303-ED or Equal

Enclosure - Continued

- Co-Axial Jumper Cable, 3 Feet, Antenna to Heliax Cabling
- Eighty (80) Feet, $\frac{1}{2}$ " Heliax Cable, N Male & N Female Connectors * (The exact cable length needs to be field verified due to the actual distance from the SCADA panel)
- Two (2) Antenna Grounding Kits
- AC Power Distribution Assembly, Includes Main CB, AC Surge Protector, & Fuse to Power Supply
- DC Power Distribution Assembly, Includes Fuses to CW Micro, Battery, & Radio Modem
- Duplex Receptacle
- Miscellaneous Wire, Cable, DIN Rail, Connectors, etc.
- Test
- Documentation-Includes Assembly Drawing, Wiring Diagram, & Standard Signal Termination Drawings at Enclosure End of Loop

TOWER

The Trylon TSF 5.94.0100.040 TITAN 40-ft self-supporting tower is ideal for lightweight, commercial duty tower applications like those found in internet service and SCADA networks. The TITAN model 4.95.0209.000 tower is survival-rated only and does not meet EIA design standards. The tower sections are built-to-order from 100% hot-dip galvanized all-angle components by TESSCO and will ship in a nested configuration to your job site, ready to assemble.

The 5.94.0300.040 40-ft tower kit includes all of the 10-ft tower sections you'll need to assemble the complete freestanding structure. You get:

5.94.0031.000 Knocked-down section #3

5.94.0041.000 Knocked-down section #4

5.94.0051.000 Knocked-down section #5

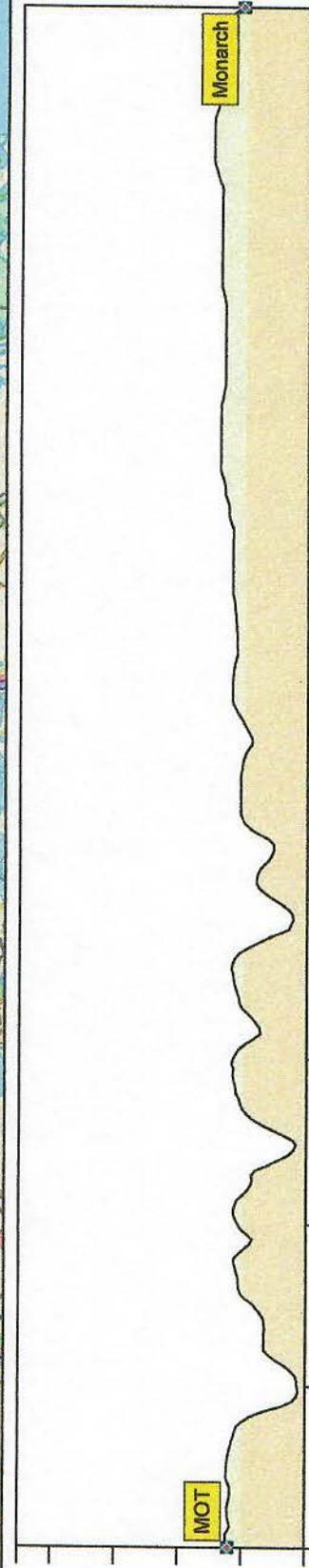
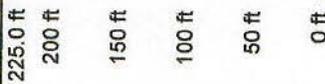
5.94.0061.000 Knocked-down section #6

5.81.0207.000 Base section #6

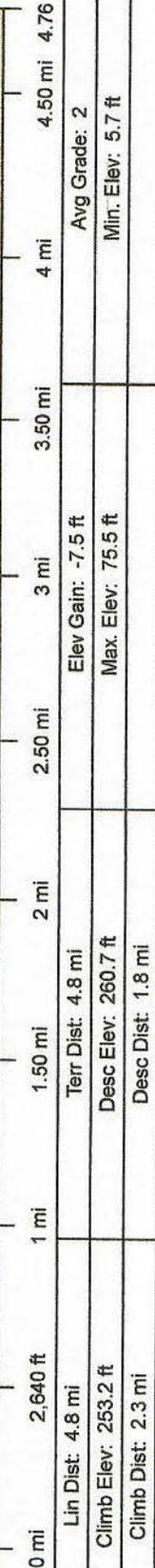
Anti-Climb Shields

All necessary splice hardware for connecting the sections together

Note: At 20 feet, we were measuring signal strength of -92 dBm. By using the standard 40-foot tower, we expect to see a level around -88 dBm. Based on the above data, the signal strength at this station will be well within the Counties normal standard.



Lin Dist: 4.8 mi	Terr Dist: 4.8 mi	Elev Gain: -7.5 ft	Avg Grade: 2
Climb Elev: 253.2 ft	Desc Elev: 260.7 ft	Max. Elev: 75.5 ft	Min. Elev: 5.7 ft
Climb Dist: 2.3 mi	Desc Dist: 1.8 mi		



Data use subject to license.

© Delorme. Topo North America™ 10.

www.delorme.com

TN

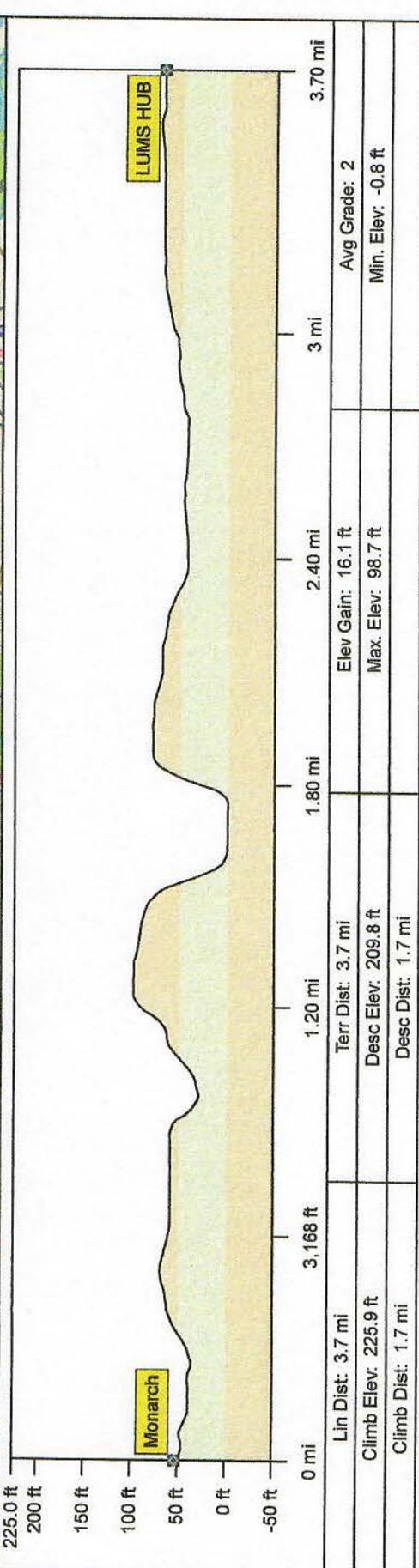
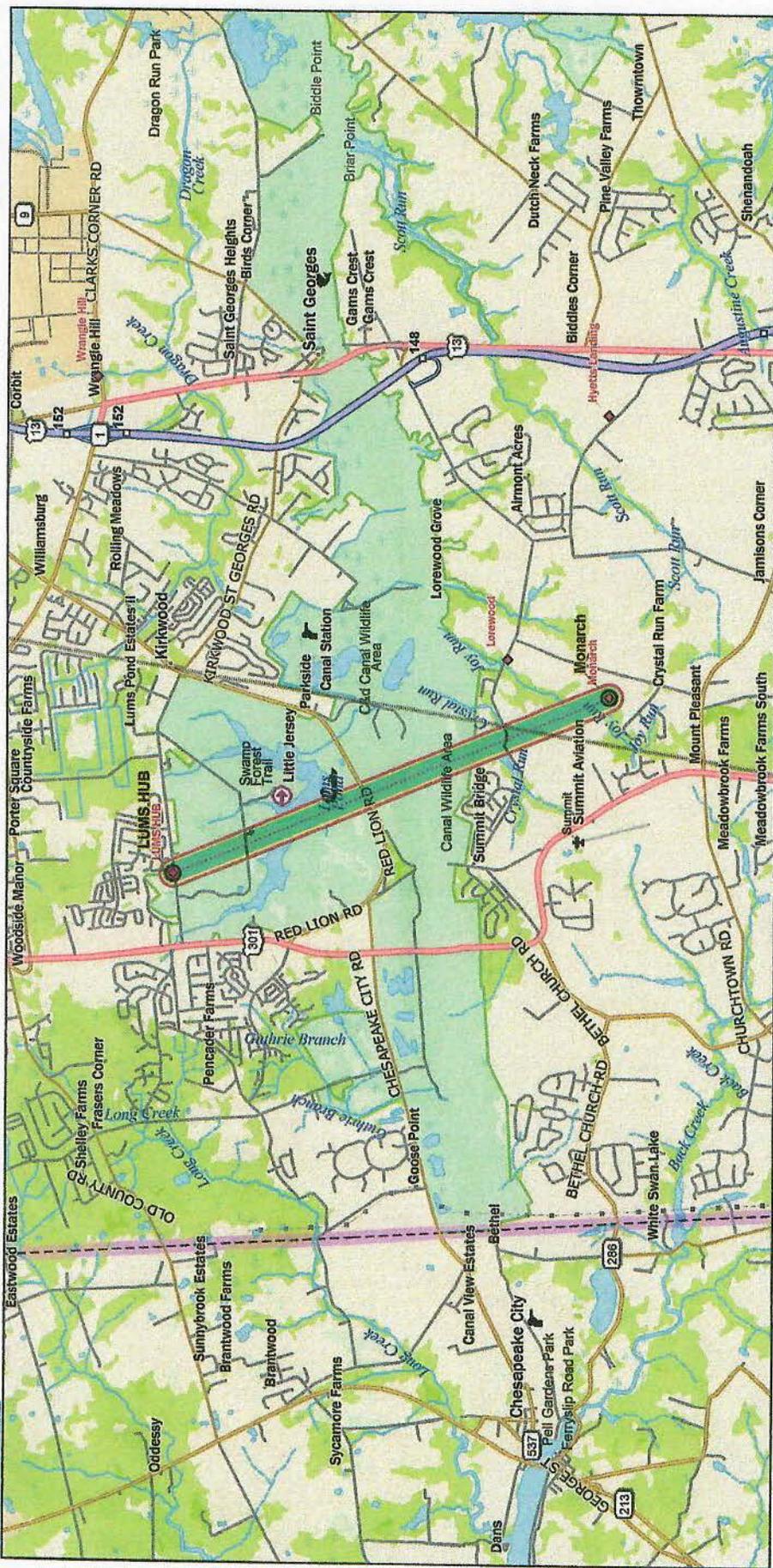


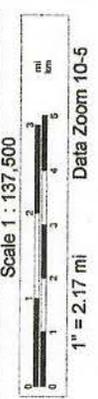
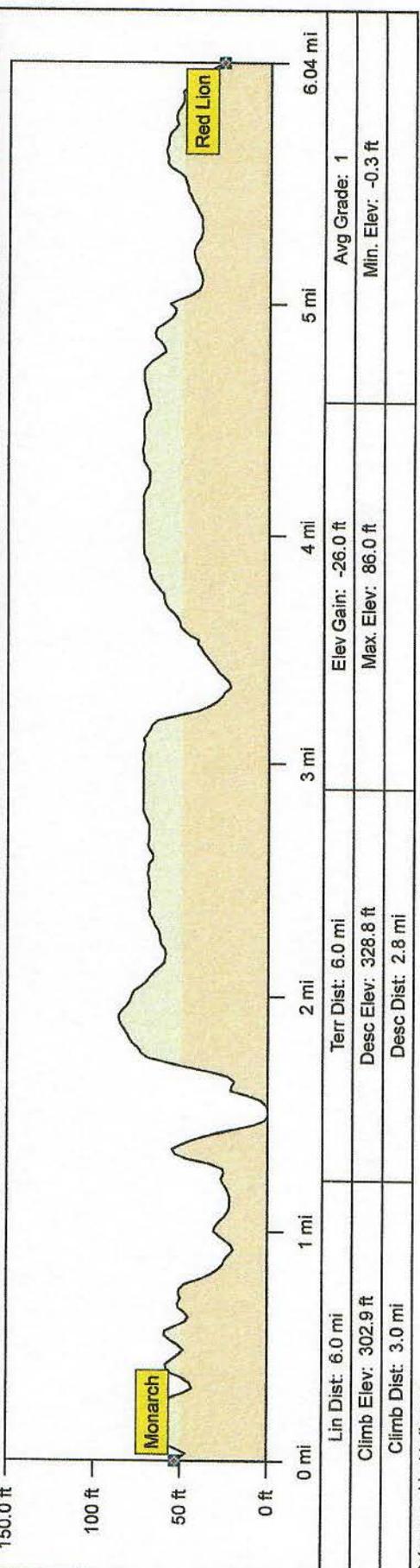
Scale 1 : 100,000

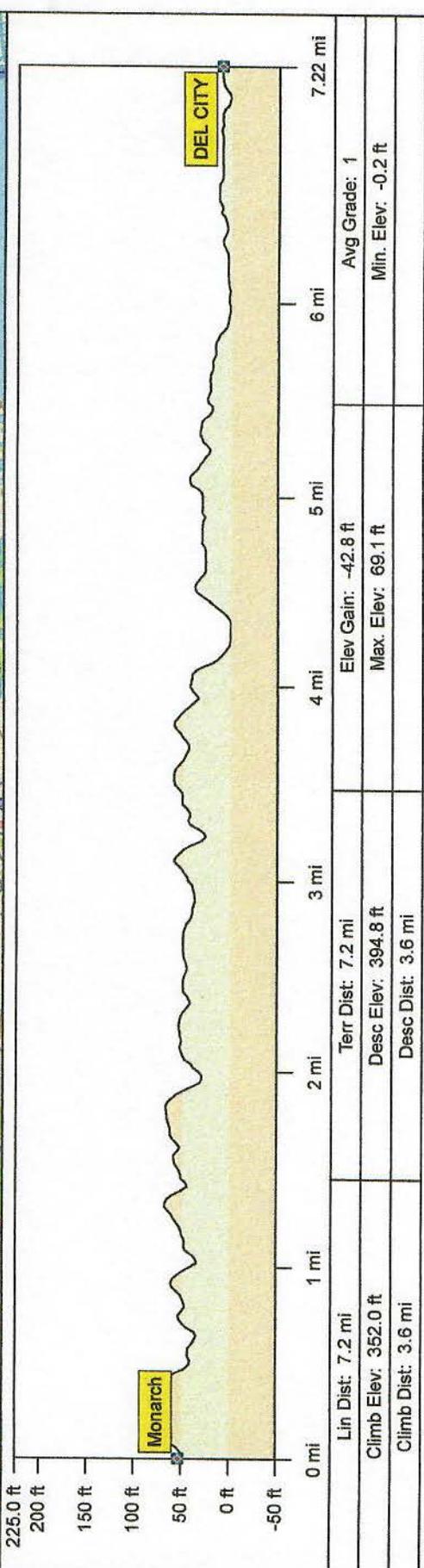
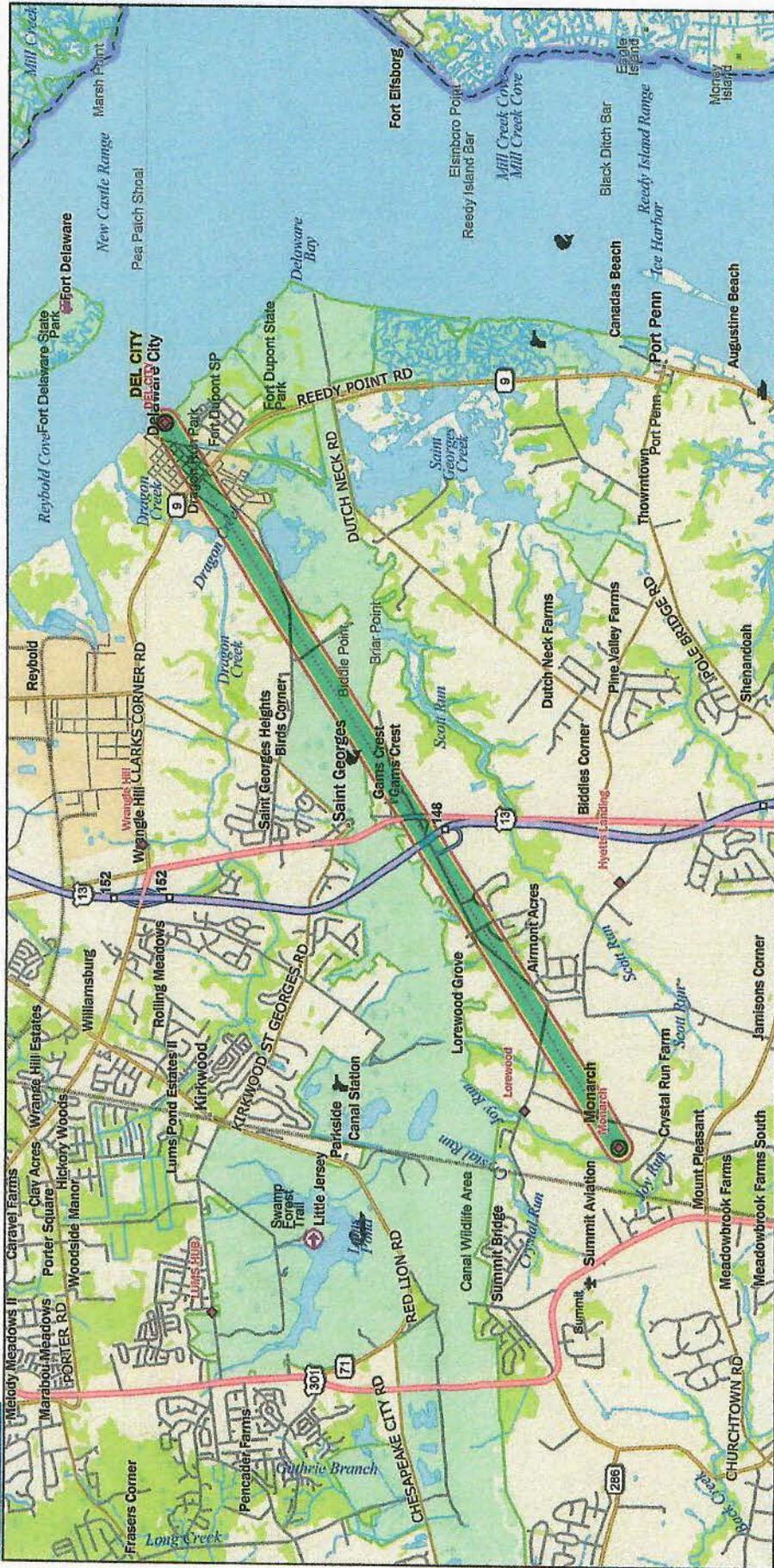


1" = 1.58 mi

Data Zoom 11-0







Data use subject to license.
 © DeLorme, Topo North America™ 10.
 www.delorme.com

Scale 1 : 87,500
 1" = 1.38 mi
 Data Zoom 11-2

MONARCH PUMP STATION

GENERAL AREA



TOWARD PUMP STATION



TOWARD REPEATER - MOT



GENERAL AREA



EXHIBIT F

Geo-Technical Report

GEO-TECHNOLOGY ASSOCIATES, INC.

GEOTECHNICAL AND
ENVIRONMENTAL CONSULTANTS

A Practicing Geoprofessional Business Association Member Firm

To: Tim Green; SB North, LLC
Jim Lober; KCI Technologies

From: Meghan McDonough, P.E. – Geo-Technology Associates

Re: Monarch Subdivision
Pump Station Subsurface Exploration and Soil Design Parameters Memo
New Castle County, Delaware



In accordance with our agreement dated September 15, 2023, Geo-Technology Associates, Inc. (GTA) has performed a subsurface exploration for the pump station located along Ratledge Road for the proposed Monarch Subdivision in New Castle County, Delaware. The subsurface exploration consisted of drilling a test boring at the proposed location of the pump station on September 26, 2023 using our Diedrich D-50 drill rig equipped with hollow stem augers and an automatic hammer. Standard Penetration Testing was performed in the borehole, with soil samples obtained continuously in the upper 10 feet, and then at 5-foot intervals thereafter.

A layer of topsoil/cultivated soil was encountered at the surface that measured about 6 inches in thickness. Below the topsoil, granular soils believed to be the Columbia Formation were visually classified as silty sand and poorly-graded sand with silt were encountered to 30 feet. The clayey sand encountered at a depth of 33 feet the termination depth of 35 feet is believed to be the Mount Laurel Formation.

The uncorrected SPT N-values for the silty sand and poorly-graded sand with silt soils ranged 4 to 10 bpf, indicating these soils are generally loose to medium dense. Groundwater was encountered during drilling at a depth of 17.0 feet below existing grade; however, the sample taken from 13 to 15 feet was saturated. Refer to the attached boring log for detailed information.

We assume the pump station will have a subgrade level of approximately EL 25.9, requiring an excavation of approximately 21 feet and 12+ feet below the water table. We have considered that the pump house will be a lightly loaded structure with wall loads of less than 3 kips per linear foot. Temporary excavation support using a slide rail system or sheet piles will likely be used given the depth of excavation and groundwater. Temporary dewatering will also be necessary to control ground water until the wet well can be set and backfilled to resist uplift.

Problems associated with groundwater include seepage into the excavation, running sands, loss of stability, sidewall collapse, and sloughing of soils. These problems can be reduced through the use of sumps, but deep wells will likely be more effective, particularly if sheetpiles are not used to cut-off inflow. Due to the potential for collapse of unsupported excavations in granular soils, the contractor should be prepared to provide adequate earth support systems during utility construction.

Pump Station Subsurface Exploration and Soil Design Parameters Memo

Monarch Subdivision, New Castle County, Delaware

September 26, 2023

Page 2 of 2

Recommended soil design parameters for temporary excavation support and the wet well precast concrete sections are listed in the following table:

Depth (ft)	USCS Classification	Moist Unit Weight (pcf)	Buoyant Unit Weight (pcf)	Friction Angle (ϕ)
0 – 6	Silty SAND (SM)	125	---	34°
6 – 44	Poorly-graded SAND with Silt (SM)	120	65	32°
30 – 35	Clayey SAND (SC)	---	70	34°

The wet well walls should be designed for an equivalent fluid pressure of 60H pounds per square foot (psf) above the water table and 95H psf below the water table, where H is the height of backfill in feet, when considering use of the on-site soils. Groundwater was encountered at a depth of about 13 feet and the seasonal high groundwater table is estimated at a depth of about 10 feet below existing ground surface or approximately EL 40. The wet well will need to be designed to resist uplift. A buoyant unit weight of 65 pcf can be used for calculating uplift resistance. A factor of safety of at least 1.5 is recommended for calculating uplift resistance. A 12-inch thick layer of AASHTO No. 57 aggregate should be placed at the wet well subgrade and possibly for the initial lifts of backfill to protect the subgrade and facilitate temporary dewatering. A thicker stone layer may be necessary if running sands are encountered due to unbalanced hydrostatic pressure.

The pump house footings can be designed for a maximum net allowable bearing pressure of 3,000 psf. Minimum widths for wall footings of 18 inches are recommended when design based on 3,000 psf results in a narrower footing. Settlement of less than 1-inch total and ½-inch differential can be anticipated, based on the assumed loads. Exterior footings should be founded a minimum of 32 inches below the final exterior grades to provide protection from frost action. Footings should be supported on the medium dense natural soils or properly compacted structural fill. If loose soils are encountered at the footing subgrade, the footings should be over-excavated to suitable soils. The over-excavations can be backfilled with AASHTO No. 57 aggregate or additional concrete.

Temporary dewatering and temporary excavation shoring will be required to perform the excavation to the wet well subgrade level and backfill to grade. Temporary dewatering and shoring should be maintained until the backfill is placed to finished grade to control uplift, unless the design engineer allows otherwise. The wet well backfill placed should be placed in lifts not to exceed eight inches in loose thickness and should be compacted to a minimum 95 percent of ASTM D698 (Standard Proctor) maximum dry density. On-site materials from above the water table are considered suitable for use in structural fill construction. Each lift of fill should be observed and tested on a full-time basis as required by the 2018 IBC.

This report, including all supporting exploration logs, field data, field notes, calculations, estimates and other documents prepared by GTA in connection with this Project have been prepared for the exclusive use of SB North LLC pursuant to agreements between GTA and SB North LLC in accordance with generally accepted engineering practice. All terms and conditions set forth in the Agreement and the General Provisions attached thereto are incorporated herein by reference. Use and reproduction of this report by any other person without the expressed written permission of GTA and SB North LLC is unauthorized and such use is at the sole risk of the user.

The analysis and recommendations contained in this report are based on the data obtained from limited observation and testing of the encountered materials. Explorations indicate soil conditions only at specific locations and times, and only at the depths penetrated. They do not necessarily reflect strata or variations that may exist between exploration locations. Consequently, the analysis and recommendations must be considered preliminary until the subsurface conditions can be verified by direct observation at the time of construction. If variations of subsurface conditions from those described in this report are noted during construction, recommendations in this report may need to be re-evaluated.

In the event that any changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report are verified in writing. Geo-Technology Associates, Inc. is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or reuse of the subsurface data or engineering analysis without the expressed written authorization of Geo-Technology Associates, Inc.

The scope of our services for this geotechnical exploration did not include any environmental assessment or investigation for the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater or air, on or below or around this site. Any statements in this report or on the logs regarding odors or unusual or suspicious items or conditions observed are strictly for the information of SB North LLC.

This report and the attached logs are instruments of service. The subject matter of this report is limited to the facts and matters stated herein. Absence of a reference to any other conditions or subject matter shall not be construed by the reader to imply approval by the writer.

LOG OF BORING NO. B-1

PROJECT: **Monarch Pump Station**
 PROJECT NO.: **211543**
 PROJECT LOCATION: **New Castle County, Delaware**

WATER LEVEL (ft): ∇ **17.3** ∇ **Dry** ∇ _____
 DATE: **9/18/23** **9/18/23** _____
 CAVED (ft): **In Augers** **10.1** _____

DATE STARTED: **9/18/23**
 DATE COMPLETED: **9/18/23**
 DRILLING CONTRACTOR: **Geo-Technology Associates, Inc.**
 DRILLER: **D. Hans, Jr.**
 DRILLING METHOD: **Hollow Stem Auger**
 SAMPLING METHOD: **Split Spoon**

WATER ENCOUNTERED DURING DRILLING (ft) **13.0**
 GROUND SURFACE ELEVATION: **50.0**
 DATUM: **Topo**
 EQUIPMENT: **Diedrich D50**
 LOGGED BY: **H. Carr**
 CHECKED BY: **M.McDonough**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION		REMARKS
					50.0	0			Topsoil +/- 5 Inches		
S-1	0.0	17	1-2-2-3	4	49.6		ML		Orange and brown, moist, loose, Silty SAND, contains gravel		
S-2	2.0	11	2-2-2-2	4	48.0		SM		Orange and brown, moist, loose, Silty SAND		
S-3	4.0	19	2-2-3-3	5					Same		
S-4	6.0	18	3-3-3-3	6		6.5			Same		
S-5	8.0	14	2-2-3-3	5					Tan, moist, loose, Silty SAND		
					37.0	13	SP-SM		Orange-brown, wet, loose, Poorly-graded SAND with Silt		∇
S-6	13.0	20	1-2-2-3	4					Same, loose		∇
S-7	18.0	24	2-3-4-4	7		19.5			Same, brown		
S-8	23.0	18	3-5-5-6	10		26			Same, brown		
S-9	28.0	21	3-4-4-5	8					Same, brown		
S-10	33.0	19	3-5-5-7	10	17.0	32.5	SC		Gray, moist, medium dense, Clayey SAND		
					15.0				Boring terminated at 35.0 feet.		

NOTES: **Elevation and location should be considered approximate.**



GEO-TECHNOLOGY ASSOCIATES, INC.

18 Boulden Circle, Suite 36
 New Castle, DE 19720

LOG OF BORING NO. B-1

EXHIBIT G

Specifications

TECHNICAL SPECIFICATIONS

MONARCH SUBDIVISION PUMP STATION

NEW CASTLE COUNTY, DELAWARE

DATE: DECEMBER 2023
ISSUED FOR APPROVAL
FE&ES COMM. NO.: 22-1529



801 W. Newport Pike, Wilmington, DE 19804

Tel: 302-999-1060 * Fax: 302-999-1053

* www.FaydaEES.com

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 08 91 19 - FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fixed extruded-aluminum louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing according to AMCA 540.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.

2. Show mullion profiles and locations.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Windborne-debris-impact-resistance test reports.
- C. Sample Warranties: For manufacturer's special warranties.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 WARRANTY

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on a uniform pressure of 20 lbf/sq. ft., acting inward or outward.
- B. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade shall pass basic protection, when tested according to AMCA 540.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal Drainable-Blade Louver :

1. Manufacturers:
 - a. Greenheck
 - b. Ruskin
 - c. NCA Manufacturing
2. Louver Depth: 6 inches.
3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
4. Mullion Type: Exposed.
5. Louver Performance Ratings:
 - a. Air Performance: Not more than 0.10-inch wg static pressure drop at 800-fpm free-area exhaust velocity.
6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Fasteners: Use types and sizes to suit unit installation conditions.
 1. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 3. For color-finished louvers, use fasteners with heads that match color of louvers.
- C. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless-steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E488/E488M conducted by a qualified testing agency.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.5 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Exterior flange unless otherwise indicated.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide subsills made of same material as louvers for recessed louvers.
- F. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 91 19

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 23 04 99-COMMON WORK REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

- A. The conditions of Division 01 GENERAL REQUIREMENTS apply to each and every Contract and Contractor or other person or persons supplying any material or labor entering this building, either directly or indirectly.
- B. HVAC Contractors are bound by provisions of Conditions as described above.
- C. One (1) Contractor will be covered by these General Requirements.
 - 1. HVAC.
- D. For simplicity, these Sub-Contracts and Sub-Contractors will be referred to further herein as the HVAC Contracts or Contractors.

1.02 DRAWINGS AND SPECIFICATIONS

- A. It is the intent of the specifications and drawings to include under each item all materials, apparatus and labor necessary to properly install, equip, adjust and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- B. Any apparatus, machinery, small items not mentioned in detail which may be found necessary to complete or perfect any portion of the installation in a substantial manner and in compliance with the requirements stated, implied or intended shall be furnished without extra cost to the Owner. This shall include all materials, devices or methods peculiar to the machinery, apparatus or systems furnished and installed by the HVAC Contractors.
- C. In referring to drawings, figured dimensions take precedence over scale measurements. Discrepancies must be referred to the Engineer for decision. Each Contractor shall certify and verify all dimensions before ordering material or commencing work.
- D. In the case of a conflict between the specifications and the drawings, not clarified by addendum, the specified item or greater quantity shall be provided without exception. If determined during construction that the lesser quality product is required by the Engineer, a credit change order will be obtained for the difference in cost.
- E. Any work called for in the specifications, but not mentioned or shown on the drawings, or called for on the drawings, but not mentioned in the specifications, shall be furnished as though called for in both.
- F. When any device or part of equipment is herein referred to in the singular number, such as "the motor" such reference shall be deemed to apply to as many such devices as required to complete the installation.
- G. The term "Provide" shall mean "Furnish and Install". Neither term will be used generally in these specifications, but will be assumed. The term "Furnish" shall mean to obtain and deliver on the job for installation by other trades.

1.03 LAWS, ORDINANCES, REGULATIONS AND PERMITS

- A. The entire HVAC Systems in all and or part shall conform to all pertinent laws, ordinances and regulations of all bodies having jurisdiction, notwithstanding anything in these drawings or specifications to the contrary.
- B. Each Contractor shall pay all fees and obtain and pay for all permits and inspections required by any authority having jurisdiction in connection with their work.
- C. HVAC work shall comply with the requirements of the International Mechanical Code, International Energy Conservation Code, NFPA and other boards and departments having local jurisdiction. HVAC Contractor shall obtain and pay for Certifications of Inspection by local, municipal and state approving agencies.

1.04 CONNECTIONS TO UTILITIES

- A. Apply for and obtain services from Utility Companies and municipalities. All charges for which Utility Companies and municipalities must be reimbursed shall be paid for by the respective Contractor at no additional cost to the Owner.

1.05 TESTS

- A. The following requirements are supplementary to tests specified for individual equipment or systems in HVAC work sections.
 - 1. Give written notice of date of test in ample time to all concerned.
- B. Concealed work shall remain uncovered until all required tests have been completed; but if construction schedule requires, arrange for prior tests on parts of systems as approved.
- C. As soon as conditions permit, conduct preliminary tests of equipment to ascertain compliance with specified requirements. Make needed changes, adjustments and or replacements as preliminary tests may indicate, prior to acceptance tests.
- D. Conduct performance and operating tests as specified or required for each system or equipment unit in presence of the Engineer as well as a representative of agencies having jurisdiction.
- E. Obtain Certificates of Approval and/or Acceptance as specified or required in compliance with regulations of agencies having jurisdiction. Work shall not be deemed complete until such Certificates have been delivered to the Engineer.
- F. Testing shall prove conclusively that HVAC systems operate properly and efficiently in accordance with intent of drawings and specifications.

1.06 CLEANING

- A. Each Contractor and/or Sub-Contractor who is responsible for execution of individual sections of work shall be responsible for the following:
 - 1. Removal of all lumber, refuse, metal, piping and debris from site resulting from their work.
 - 2. Cleaning drippings resulting from their work, etc., from finished work of other trades.
 - 3. Cleaning, polishing, waxing of their work as required.

- B. After testing, and acceptance of all work by the Engineer and the Owner, each Contractor shall thoroughly clean all equipment and material involved in their Contract to the satisfaction of the Engineer.

1.07 INSTRUCTING OWNER'S PERSONNEL

- A. After all tests and adjustments have been made, each Contractor shall fully instruct the representatives of the Owner in all details of operation of the equipment installed under their contract.
- B. Each Contractor shall operate their equipment for sufficient length of time to satisfy Engineer that requirements of Contract Documents have been fulfilled.

1.08 OPERATING AND MAINTENANCE MANUALS

- A. Each Contractor shall provide one (1) electronic (Original PDF) and three (3) copies of printed instructions to the Engineer upon completion of installation. Instructions shall be bound in separate, hardback, 3-ring loose leaf binders.
- B. Instruction books shall be prepared by sections and contain detailed operating and maintenance instructions for all components of all systems, including wiring, and schematic diagrams necessary for clarity. The cover of each binder shall be identified with the name of the project and the words "Operating and Maintenance Manuals".
- C. Each section shall have labeled tabs and be clearly marked with equipment or system name and contain detailed parts list data, ordering information therefore and the name, address and telephone number of the closest supply source.
- D. All instructional data shall be neatly and completely prepared to the satisfaction of the Engineer.
- E. One (1) copy of each final, approved shop drawing shall be included in each Operating & Maintenance Manual.

1.09 GUARANTEE

- A. All material, equipment and workmanship provided by each Contractor shall be in proper operating condition in every respect at time of acceptance by Owner. Acceptance by the Owner shall be by letter to this effect written to each Contractor.
- B. Each Contractor shall unconditionally guarantee in writing all materials, equipment and workmanship for a period of two (2) years from date of acceptance by Owner. During the guarantee period each Contractor shall repair or replace, at their own expense, any materials, equipment or workmanship in which defects may develop and shall also provide free service for all equipment and systems involved in the contract during this guarantee period.
- C. Guarantee shall also include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- D. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.
- E. Guarantees furnished by Sub-Contractors and/or equipment manufacturers shall be counter-signed by the related Contractor for joint and/or individual responsibility for subject item.
- F. Manufacturers' equipment guarantees or warranties extending beyond the guarantee period described above shall be transferred to the Owner along with the contractor's guarantees.

1.10 ENTRANCE OF EQUIPMENT

- A. Each Contractor shall perform all necessary rigging required for completion of work under their contract.

1.11 VISIT TO SITE

- A. Due to the nature of the work involved under this contract, all bidders are required to thoroughly examine the site.
- B. Bidding Contractors shall thoroughly review Contract Documents prior to visiting the site, take Contract Documents to site and thoroughly explore to any extent necessary, the existing conditions as relating to fulfilling the requirements of this Contract.
- C. If discrepancies are noted between requirements of Contract Documents and existing conditions, Contractor shall so indicate to Engineer during bidding period and receive clarification before bidding. Failure to comply with this requirement will result in Engineer's interpretation during the construction period and Engineer's decision will be final and binding as the sole interpreter of the contract requirements.
- D. Extras will not be considered for any work relating to connections with existing systems or adaptability of new systems to existing structures.
- E. Submission of proposals shall be considered evidence that Contractors have complied with the requirements of this Article.

1.12 AS-BUILT DRAWINGS

- A. During the course of the work, maintain a record set of drawings on which shall be marked the actual physical location of all underground, above ground and crawl space piping, ductwork and all other components of the work performed by the Division 23 (HVAC) contractor and their subcontractors.
- B. As built drawings shall be maintained by the contractor and updated on a daily basis. Current As-Built drawings shall be brought to each construction meeting.
- C. Include on the record set, all formal modifications to the contract documents including but not limited to: addendum items, responses to RFI's (field directives), ASI's, change order items and underground obstructions.
- D. At project completion, obtain a READ ONLY set of contract documents from the Engineer in AutoCAD 2019 (or later) .dwg format. Copy the source documents and create new documents, modifying the original files by incorporating all items noted on the record drawings onto the source AutoCAD files.
- E. For each drawing, make one (1) .dwg file and one (1).pdf file and copy all files onto a single thumb drive memory stick. Make one (1) additional copy of the thumb drive memory stick. Using the new AutoCAD files, make four (4) prints of the As Built drawings. Incorporate one set of prints in each O&M manual.
- F. In cases where the prime contractor or subcontractors are required to design and/or submit original shop drawing documents, prepared by the respective contractors for submission to State Agencies (i.e.: sprinkler, fire alarm, etc.), each respective contractor or subcontractor shall revise their drawings accordingly and include all As-Built information, thereon. Submit As-Built in the same

format, (i.e.: Two (2) thumb drive memory sticks), one (1) mylar reproducible and three (3) prints as with the project As-Built information contained thereon.

1.13 SERVICING OF EQUIPMENT AND SYSTEMS

- A. After work has been completed under the HVAC contract, and prior to final acceptance tests, each Contractor shall have manufacturers or their authorized agents of the equipment and material installed, completely check their equipment and put it into actual operation. In each case, the respective Contractor shall have the manufacturers thoroughly check the complete installation of the equipment produced by him for proper and correct operation under the service intended.
- B. Six months after final acceptance of the work under the HVAC contract, each Contractor shall have the manufacturers again check their equipment for proper operation. Coincidentally, this contractor shall assure that the building maintenance personnel are properly instructed in the servicing of the equipment.
- C. Prior to expiration of the guarantee period, each contractor shall check all equipment, materials and systems installed under his contract, make necessary adjustments and/or replacements, and leave systems in first class operating condition.

1.14 CONTINUITY OF SERVICES

- A. Generally, no action shall be taken by the HVAC Contractor that will interrupt any of the existing building services for this building or any other building until previously arranged with the Engineer and Owner or their authorized representative.
- B. Should any service be interrupted by this Contractor, the Contractor causing such interruption shall provide immediately all labor, including overtime if necessary, and all material and equipment necessary for restoration of such service.

1.15 TEMPORARY FACILITIES, UTILITIES AND HEATING

- A. Refer to Section TEMPORARY FACILITIES AND CONTROLS in Division 1 of these specifications.

1.16 GENERAL COORDINATION

- A. Installation work of all indicated HVAC equipment shall include providing all labor, supervision, and all means of construction to install the indicated equipment and systems.
- B. All work shall be installed a first class, neat, and workmanlike manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically correct. Should the Engineer direct removal, change, or installation of any equipment or systems not installed in a neat and workmanlike manner, such changes shall be made by the HVAC Contractor at no expense to the Owner.
- C. Drawings are generally indicative of the work to be installed, but do not indicate all bends, fittings, offsets, or the exact locations of all piping and ductwork. Contractor shall investigate structure and finish conditions affecting his work and arrange his work accordingly, furnishing such fittings as may be required to meet such conditions.
- D. HVAC valves, dampers, equipment and other apparatus requiring periodic maintenance and operation shall be accessible. Provide access panels as required.
- E. Review by the Engineer of materials, drawings, or equipment submitted by the Contractor in the shop drawing review phase shall be considered general only, and shall be an aid to the Contractor in carrying out his work. Such review does not relieve the Contractor from the necessity of furnishing the materials

and performing all work required by the drawings and specifications to provide a complete and operating HVAC system as described.

1.17 CODE COMPLIANCE

- A. The contractor shall comply with the requirements of the latest International Mechanical Code, International Energy Conservation Code all state and local codes and all other authorities having jurisdiction, regardless of what is indicated on the drawings or specified herein.
- B. Provide approved HVAC Inspection Certificate at project completion. Provide one copy in each of the Operating & Maintenance Manuals.

1.18 CUTTING AND CHASES

- A. Provide the General Contractor, location of all chases, openings, recesses, etc., in a timely manner so that he may provide them.
- B. All cutting and patching shall be performed in such a manner and with such materials as the Engineer may direct.

1.19 ENERGY STAR CERTIFICATION

- A. All equipment furnished on this project shall carry the Energy Star Certification. Modify equipment selections, as required to conform to this requirement. Provide documentation satisfying this requirement.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S AND SUB-CONTRACTORS LIST

- A. Before ordering any material or equipment unit, and not later than twenty (20) working days after signing of contracts each Contractor shall submit a list of Manufacturers, Sub-Contractors and Suppliers showing make, type, manufacturers name and trade designation of all materials, and equipment, proposed for use under this contract. List shall be prepared by reference to specifications.
- B. The list, when accepted, shall be supplementary to specifications, and no variations therefrom will be permitted except with the approval of the Engineer.
- C. No shop drawings will be processed until the Contractor has satisfactorily completed the requirements of this Article.

2.02 SHOP DRAWINGS

- A. In general, shop drawings will be processed electronically. For each shop drawing submitted, submit a high quality color original in Adobe (.pdf) format and attach a separate Letter of Transmittal for each submission.
- B. All shop drawings shall be submitted in ample time to coordinate features of construction with the fabrication and installation requirements of the project. Allow fourteen (14) days for Drawings required for General Construction and fourteen (14) days for Drawings required for Mechanical or HVAC work.
- C. Where a Shop Drawing or sample is required by the Specifications, any related work performed prior to ENGINEER's review of the pertinent submission will be the sole expense and responsibility of the CONTRACTOR.

- A. Prior to submission of shop drawings, the Contractor shall notify the Engineer of any site conditions differing from those indicated or specified.
- B. Prepare shop drawings by careful reference to drawings and specifications.
- C. Identify each shop drawing by Job Name and reference to applicable Specification Article number.
- D. Shop drawing data for all equipment, shall include, but not be limited to, the following:
 - 1. Manufacturers' catalog designation, photographs and specifications.
 - 2. Full HVAC data, including specifically, HVAC characteristics.
 - 3. Dimensions, capacities, ratings, material and finish.
 - 4. Such other detailed information as required for proper evaluation.
- E. Review Time:
 - 1. Allow two (2) weeks for the Engineer's processing of each submittal, exclusive of Owner or others in the processing chain. Allow a longer time period where processing must be delayed for coordination with subsequent submittals.
- F. Submission of shop drawings for electric motor starters shall include a tabulation listing:
 - 1. The equipment the starter is intended to control.
 - 2. Horsepower.
 - 3. Voltage.
 - 4. Phase.
 - 5. Full load amperes.
 - 6. The manufacturer's number or type.
 - 7. Overload heater numbers and amperage.
 - 8. Quantity of auxiliary contacts.
 - 9. Pushbutton arrangement.
 - 10. Pilot light arrangement if applicable.
- G. Each Contractor shall examine all shop drawings before submission for review. Each Contractor shall then forward all shop drawings with their initialed approval shop drawing stamp and by so doing the Contractor thereby represents that he has determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data, has notified the Engineer of site conditions varying from those indicated or specified, and that he has checked and coordinated each item with other applicable accepted shop drawings and the contract requirements. Shop drawings and catalog data submitted without the contractor's stamp of acceptance will be returned to the Contractor without review.

- H. Material and equipment installed or used without shop drawing review are subject to rejection by the Engineer.
- I. Corrections or comments made on shop drawings during review by the Engineer do not relieve the contractor from compliance with requirements of the drawings and specifications. Such review shall be only for general conformance with the design concept and general compliance with the information given in the Contract Documents. It shall not include review of quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with the work of other trades, or construction safety precautions, all of which are the sole responsibility of the Contractor. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component. The Engineer shall not be responsible for any deviations from the Contract Documents not clearly noted by the Contractor, nor shall the Engineer review partial submissions or those for which submissions for correlated items have not been received. The Contractor is responsible for: confirming and correlating all quantities, clearance and dimensions, selecting fabrication processes and techniques of construction coordinating work with that of all other trades, and performing their work in a safe and satisfactory manner.

2.03 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be new and shall conform to the grade, quality and standards specified herein.
- B. All equipment offered under these specifications shall be limited to products regularly produced and recommended for service ratings in accordance with engineering data or other comprehensive literature made available to the public and in effect at the time of opening of bids.
- C. Items such as motors, starting equipment, vibration isolating devices, and all other equipment and material, where applicable and practicable, shall each be of one manufacturer.
- D. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. These contractors shall obtain these instructions which will be considered part of these specifications. Type, capacity and application of equipment shall be suitable and shall operate satisfactorily for the purpose intended in the HVAC System.

2.04 EQUIPMENT SUBSTITUTIONS (VARIATIONS)

- A. Refer specifically to Section 00 21 13-Article 3.3 and Section 00 26 00 for product substitution requirements.

2.05 VIBRATION ELIMINATION

- A. The HVAC Contractor shall provide vibration isolation support provisions for all moving or rotating equipment and machinery when such provisions are not furnished and/or integrally mounted by the equipment manufacturers.
- B. Provide all rotating or moving machinery or equipment suspended from building structure with approved resilient suspension mountings.
- C. All systems shall operate free from objectionable vibration and noise resulting therefrom, and each Contractor shall take all necessary steps required to achieve this result without additional cost to the Owner.

2.06 ANCHOR BOLTS

- A. HVAC Contractor shall provide and set in place at the time foundations, bases or curbs are poured or formed, all necessary anchor bolts as required for the various equipment specified herein. Hook type anchor bolts of proper size and length to suit the apparatus. Set bolts in pipe sleeves of approximately twice the bolt diameter and of length equal to the embedded length of the bolt, with sleeves terminating flush with finished surfaces of foundations, bases or curbs.
- B. When the equipment is set in its proper position and aligned with the anchor bolts, the space between the anchor bolts and the inside wall of the sleeves shall be completely filled with non-shrink cementitious grout equal to crystex as manufactured by L & M Construction Chemicals, Inc., Master Builders or approved equal.
- C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by them under these specifications, and must have a representative present at the time foundations, bases or curbs are poured or formed.
- D. All anchor bolts shall be of sufficient strength to withstand any loading imposed by the attached materials or equipment.
- E. ALL exterior, pad mounted equipment shall be set in place and secured to the pad with anchor bolts and mechanical fasteners.

PART 3 - EXECUTION

3.01 GENERAL

- A. The drawings accompanying these specifications are diagrammatic and intended to cover the approximate and relative locations of the HVAC Systems.
- B. Installation, connection and interconnection of all components of these systems shall be complete and made in accordance with the manufacturers' instructions and best trade practices.
- C. Each Contractor shall erect all parts of equipment to be furnished by them under their contract at such time and in such manner as not to delay or interfere with other Contractors on the work.
- D. All piping shall be plugged as required during construction to prevent entering of dirt.
- E. Before material is ordered or any work performed, each Contractor shall verify all measurements, including lines, conduit and elevations at the building and shall be responsible for the correctness thereof. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated in the Contract Documents. Any discrepancies discovered shall be submitted to the Engineer for consideration before proceeding with the work.
- F. Each Contractor shall lay out their work and be responsible for the establishment of heights, grades, etc., for all interior and exterior fixtures, conduit, etc., included in Contract Documents, in strict accordance with the intent expressed thereby; and all the physical conditions to be met at the building and finished grade, and shall be responsible for accuracy thereof. The establishment of the location of all work shall be performed in consideration of the finished work. In case of conflict, equipment and/or materials shall be relocated without cost to the Owner, as directed by the Engineer, regardless of which equipment was installed first.
- G. Each Contractor shall cooperate with other Contractors for the proper securing and anchoring of all work included within these specifications. Extraordinary care shall be used in the erection and installation of all equipment and materials to avoid marring surfaces of the work of other Contractors, as each Contractor will be held financially responsible for all such injury caused by the lack of precaution and due to negligence on the part of their workmen.

- H. All piping, ductwork and other HVAC materials and equipment shown to be mounted below ceilings are to be kept as close to ceiling areas as possible unless otherwise noted.

3.02 PROTECTION

- A. All openings in piping, ductwork and all other materials shall be effectively sealed to exclude dirt, sand, and other foreign materials.
- B. Exercise every precaution to exclude dust, dirt and all other foreign materials from all HVAC equipment rooms during construction. Rooms and equipment contained therein shall be vacuum cleaned at regular intervals. Sufficient electric heaters shall be installed and maintained in equipment rooms and equipment to keep equipment dry and protected from freezing during construction.

3.03 SUPPORTS

- A. Except where noted otherwise in the specifications and shown on drawings, each Contractor shall provide all materials, equipment supports, supplies and labor necessary as required to adequately support, brace and strengthen equipment and materials furnished as part of their contract.
- B. The design, materials, fabrication and erection of structural steel supports shall conform to "Specification for Design, Fabrication and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction, "Code of Standard Practice for Steel Buildings and Bridges". Welding where required shall conform to "Code of Arc and Gas Welding in Building Construction" of the American Welding Society.

END OF SECTION

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.2 MATERIALS

- A. Aluminum: ASTM B221.
- B. Stainless Steel: ASTM A240/A240M.
- C. Threaded Rods: Continuously threaded. Stainless steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi , 28-day compressive strength.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Stainless-steel.
2. Outdoor Applications: Stainless steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

B. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

C. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Use stainless steel hangers and supports for piping and equipment that will not have field-applied finish.
- C. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. C-Clamps (MSS Type 23): For structural shapes.
 - 2. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

END OF SECTION

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Equipment labels.
- 2. Stencils.
- 3. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

- 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- 2. Letter Color: White.
- 3. Background Color: Black.
- 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 DUCT LABELS

- A. Letter Color: White.
- B. Background Color: Green
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

- E. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Green: For exhaust- and outside-air ducts.
- B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.
- C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 5 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 23 05 53

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - 2. Control system verification.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.
- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Certified TAB reports.
- C. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.

- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan and pump curves.
 - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine operating safety interlocks and controls on HVAC equipment.
- J. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 - 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 - 3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.7 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.8 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
 2. Manufacturers' test data.
 3. Field test reports prepared by system and equipment installers.
 4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
 2. Name and address of the TAB specialist.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings. Notes to explain why certain final data in the body of reports vary from indicated values.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
- E. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data:

- a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
- a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- F. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
- a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.

G. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

END OF SECTION 23 05 93

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 23 34 23 - DIRECT DRIVE SIDEWALL CAST ALUMINUM PROPELLER FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Direct Drive Sidewall Cast Aluminum Propeller Fans.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Certified fan performance curves with system operating conditions indicated.
 - 4. Certified fan sound-power ratings.
 - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 6. Material thickness and finishes, including color charts.
 - 7. Dampers, including housings, linkages, and operators.

- B. Shop Drawings:

- 1. Include plans, elevations, sections, and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For Direct Drive Sidewall Cast Aluminum Propeller Fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

PART 2 - PRODUCTS

2.1 DIRECT DRIVE SIDEWALL CAST ALUMINUM PROPELLER FANS

- A. Manufacturers:
1. Greenheck, Model TCB
 2. Penn Barry
 3. Car-Mon
- B. Description:
1. Direct Drive Sidewall Cast Aluminum Propeller Fans.
 2. UL/cUL 705 Listed- Power Ventilators
- C. Airflow Direction: Supply
- D. Propeller:
1. Propeller constructed of cast aluminum tapered airfoil blades and cast aluminum hubs
 2. Securely attached to motor shaft with a standard square key, set screw and tapered bushing
 3. Statically and dynamically balanced in accordance with AMCA Standard 204-05
 4. The propeller and fan inlet will be aligned and shall have precise running tolerances for maximum performance and operating efficiency.
- E. Electronically Commutated Motor
1. Motor enclosures: Open type
 2. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 3. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
 4. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
 5. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by a potentiometer dial mounted at the motor.
 6. Motor shall be a minimum of 85% efficient at all speeds.
 7. Motor access shall be from interior of building.
- F. Drive Frame:
1. Drive frames and fan panels shall be bolted construction
 2. Drive frame assemblies and fan panels shall be galvanized steel or painted steel
 3. Drive frame shall be formed steel and fan panels shall have pre-punched mounting holes, formed flanges, and a deep formed inserted venturi
- G. Disconnect Switches:

1. NEMA rated: 7&9

H. Dampers:

1. Type: Motorized
 - a. Prevents outside air from entering back into the building when fan is off.
 - b. Balanced for minimal resistance to flow.
 - c. Galvanized frames with pre-punched mounting holes.
 - d. 115V actuator.

I. Finishes:

1. Coated with Permatector, Concrete Gray-RAL 7023, Fan And Attached Accessories

J. Wall Housing:

1. Mounting arrangement: Flush exterior
2. Constructed of painted steel with heavy gauge mounting flanges and pre-punched mounting holes
3. Housing shall include OSHA approved motor guard

K. Wall Collar:

1. Constructed of galvanized steel or painted steel with heavy gauge mounting flanges and pre-punched mounting holes

L. Weatherhood kit:

1. Shall shield wall opening and dampers from rain and snow
2. Material Type: Painted Steel
3. Turndown angel: 90 degrees
4. Screen: Bird screen
5. Finishes: Permatector

M. Accessories:

1. Wiring Pigtail, External, Auto Duty with Bond Bushings, 9 ft from Unit of Metallic Liquid-Tite.

2.2 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Compliance: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311 and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan

efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

- E. Operating Limits: Classify fans according to AMCA 99.

PART 3 - EXECUTION

3.1 INSTALLATION OF DIRECT DRIVE SIDEWALL CAST ALUMINUM PROPELLER FANS

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting:
 - 1. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings
- E. Install units with clearances for service and maintenance.
- F. Label fans according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."

3.3 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that there is adequate maintenance and access space.
 - 4. Verify that cleaning and adjusting are complete.
 - 5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 6. Adjust belt tension.
 - 7. Verify lubrication for bearings and other moving parts.
 - 8. See Section 23 05 93 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
 - 9. Remove and replace malfunctioning units and retest as specified above.
- D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- C. Lubricate bearings.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 23 34 23

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 23 82 39.16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes propeller unit heaters with electric-resistance heating coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. PTFE: Polytetrafluoroethylene plastic.
- C. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include location and size of each field connection.
 - 4. Include details of anchorages and attachments to structure and to supported equipment.
 - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 6. Indicate location and arrangement of piping valves and specialties.
 - 7. Indicate location and arrangement of integral controls.
 - 8. Wiring Diagrams: Power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. TPI
 - 2. Airthem
 - 3. QMark

2.2 DESCRIPTION

- A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 2021.
- D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- D. Universal wall/ceiling mounting bracket

2.5 COILS

- A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
 - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
 - 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated.

2.7 CONTROLS

- A. Control Devices:
 - 1. Wall-mounted thermostat.
 - 2. 24V transformer and contactor.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.
- C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

- D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

- A. Comply with safety requirements in UL 1995.
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature set points.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 23 82 39.16

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 04 99 - COMMON WORK REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

- A. Electrical Contractors are bound by provisions of Conditions as described above.
- B. One (1) Contractor will be covered by these General Requirements.
 - 1. Electrical.
- C. For simplicity, these Sub-Contracts and Sub-Contractors will be referred to further herein as the Electrical Contracts or Contractors.

1.02 DRAWINGS AND SPECIFICATIONS

- A. It is the intent of the specifications and drawings to include under each item all materials, apparatus and labor necessary to properly install, equip, adjust and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- B. Any apparatus, machinery, small items not mentioned in detail which may be found necessary to complete or perfect any portion of the installation in a substantial manner and in compliance with the requirements stated, implied or intended shall be furnished without extra cost to the Owner. This shall include all materials, devices or methods peculiar to the machinery, apparatus or systems furnished and installed by the Electrical Contractors.
- C. In referring to drawings, figured dimensions take precedence over scale measurements. Discrepancies must be referred to the Engineer for decision. Each Contractor shall certify and verify all dimensions before ordering material or commencing work.
- D. In the case of a conflict between the specifications and the drawings, not clarified by addendum, the better quality or greater quantity shall be provided without exception. If determined during construction that the lesser quality product is required by the Engineer, a credit change order will be obtained for the difference in cost.
- E. Any work called for in the specifications, but not mentioned or shown on the drawings, or called for on the drawings, but not mentioned in the specifications, shall be furnished as though called for in both.

- F. When any device or part of equipment is herein referred to in the singular number, such as "the motor" such reference shall be deemed to apply to as many such devices as required to complete the installation.
- G. The term "Provide" shall mean "Furnish and Install". Neither term will be used generally in these specifications, but will be assumed. The term "Furnish" shall mean to obtain and deliver on the job for installation by other trades.

1.03 LAWS, ORDINANCES, REGULATIONS AND PERMITS

- A. The entire Electrical Systems in all and or part shall conform to all pertinent laws, ordinances and regulations of all bodies having jurisdiction, notwithstanding anything in these drawings or specifications to the contrary.
- B. Each Contractor shall pay all fees and obtain and pay for all permits and inspections required by any authority having jurisdiction in connection with their work.
- C. Electrical work shall comply with the requirements of the National Electrical Code, National Electric Safety Code, NFPA and other boards and departments having local jurisdiction. Electrical Contractor shall obtain and pay for Certifications of Inspection by an authorized Electrical Inspection Agency and by local, municipal and state approving agencies.

1.04 CONNECTIONS TO UTILITIES

- A. Apply for and obtain services from Utility Companies and municipalities. All charges for which Utility Companies and municipalities must be reimbursed shall be paid for by the respective Contractor at no additional cost to the Owner.

1.05 TESTS

- A. The following requirements are supplementary to tests specified for individual equipment or systems in Electrical work sections.
 - 1. Give written notice of date of test in ample time to all concerned.
- B. Concealed work shall remain uncovered until all required tests have been completed; but if construction schedule requires, arrange for prior tests on parts of systems as approved.
- C. As soon as conditions permit, conduct preliminary tests of equipment to ascertain compliance with specified requirements. Make needed changes, adjustments and or replacements as preliminary tests may indicate, prior to acceptance tests.

- D. Conduct performance and operating tests as specified or required for each system or equipment unit in presence of the Engineer as well as a representative of agencies having jurisdiction.
- E. Obtain Certificates of Approval and/or Acceptance as specified or required in compliance with regulations of agencies having jurisdiction. Work shall not be deemed complete until such Certificates have been delivered to the Engineer.
- F. Testing shall prove conclusively that Electrical systems operate properly, efficiently and quietly in accordance with intent of drawings and specifications.

1.06 CLEANING

- A. Each Contractor and/or Sub-Contractor who is responsible for execution of individual sections of work shall be responsible for the following:
 - 1. Removal of all lumber, refuse, metal, piping and debris from site resulting from their work.
 - 2. Cleaning drippings resulting from their work, etc., from finished work of other trades.
 - 3. Cleaning, polishing, waxing of their work as required.
- B. After testing, and acceptance of all work by the Engineer and the Owner, each Contractor shall thoroughly clean all equipment and material involved in their Contract to the satisfaction of the Engineer.

1.07 INSTRUCTING OWNER'S PERSONNEL

- A. After all tests and adjustments have been made, each Contractor shall fully instruct the representatives of the Owner in all details of operation of the equipment installed under their contract.
- B. Each Contractor shall operate their equipment for sufficient length of time to satisfy Engineer that requirements of Contract Documents have been fulfilled.
- C. Digitally record all Instruction to Owner's Personnel and include a copy of each in the electronic O&M Manuals.

1.08 OPERATING AND MAINTENANCE MANUALS

- A. Each Contractor shall provide three (3) copies of printed instructions to the Engineer upon completion of installation. Instructions shall be bound in separate, hardback, 3-ring loose leaf binders.

- B. Instruction books shall be prepared by sections and contain detailed operating and maintenance instructions for all components of all systems, including wiring, and schematic diagrams necessary for clarity. The cover of each binder shall be identified with the name of the project and the words "Operating and Maintenance Manuals".
- C. Each section shall have labeled tabs and be clearly marked with equipment or system name and contain detailed parts list data, ordering information therefore and the name, address and telephone number of the closest supply source.
- D. All instructional data shall be neatly and completely prepared to the satisfaction of the Engineer.
- E. One (1) copy of each final, *Approved* shop drawing shall be included in each Operating & Maintenance Manual.
- F. Two (2) copies of the Operating and Maintenance Manual shall be provided in electronic format on CD/DVD. Everything included in the bound O&M Manual shall be included in electronic format.

1.09 GUARANTEE

- A. All material, equipment and workmanship provided by each Contractor shall be in first class operating condition in every respect at time of acceptance by Owner. Acceptance by the Owner shall be by letter to this effect written to each Contractor.
- B. Each Contractor shall unconditionally guarantee in writing all materials, equipment and workmanship for a period of two (2) years from date of acceptance by Owner. During the guarantee period each Contractor shall repair or replace, at their own expense, any materials, equipment or workmanship in which defects may develop and he shall also provide free service for all equipment and systems involved in his contract during this guarantee period.
- C. Guarantee shall also include restoration to its original condition of all adjacent work that must be disturbed in fulfilling this guarantee.
- D. All such repairs and/or replacements shall be made without delay and at the convenience of the Owner.
- E. Guarantees furnished by Sub-Contractors and/or equipment manufacturers shall be counter-signed by the related Contractor for joint and/or individual responsibility for subject item.

- F. Manufacturers' equipment guarantees or warranties extending beyond the guarantee period described above shall be transferred to the Owner along with the contractor's guarantees.

1.10 ENTRANCE OF EQUIPMENT

- A. Each Contractor shall perform all necessary rigging required for completion of work under their contract.

1.11 VISIT TO SITE

- A. Due to the nature of the work involved under this contract, all bidders are required to thoroughly examine the site.
- B. Bidding Contractors shall thoroughly review Contract Documents prior to visiting the site, take Contract Documents to site and thoroughly explore to any extent necessary, the existing conditions as relating to fulfilling the requirements of this Contract.
- C. If discrepancies are noted between requirements of Contract Documents and existing conditions, Contractor shall so indicate to Engineer during bidding period and receive clarification before bidding. Failure to comply with this requirement will result in Engineer's interpretation during the construction period and Engineer's decision will be final and binding as the sole interpreter of the contract requirements.
- D. Extras will not be considered for any work relating to connections with existing systems or adaptability of new systems to existing structures.
- E. Submission of proposals shall be considered evidence that Contractors have complied with the requirements of this Article.

1.12 AS-BUILT DRAWINGS

- A. During the course of the work, maintain a record set of drawings on which shall be marked the actual physical location of all underground, above ground and crawl space conduit, outlets, wiring devices, lighting fixtures, panelboards, access panels, junction boxes, circuit breakers, disconnect switches, starters, transformers, and all other components of the work performed by the Division 26 (Electrical) contractor and their subcontractors.
- B. As built drawings shall be maintained by the contractor and updated on a daily basis. Current As-Built drawings shall be brought to each construction meeting.

- C. Include on the record set, all formal modifications to the contract documents including but not limited to: addendum items, responses to RFI's (field directives), ASI's, change order items and underground obstructions.
- D. At project completion, obtain a READ ONLY set of contract documents from the Engineer in AutoCAD 2016 (or later) .dwg format. Copy the source documents and create new documents, modifying the original files by incorporating all items noted on the record drawings onto the source AutoCAD files.
- E. For each drawing, make one (1) .dwg file and one (1).pdf file and copy all files onto a single Digital Video Disk (DVD). Make one (1) additional copy of the DVD. Using the new AutoCAD files, make four (4) prints of the As Built drawings. Incorporate one set of prints in each O&M manual.
- F. In cases where the prime contractor or subcontractors are required to design and/or submit original shop drawing documents, prepared by the respective contractors for submission to State Agencies (i.e.: sprinkler, fire alarm, etc.), each respective contractor or subcontractor shall revise their drawings accordingly and include all As-Built information, thereon. Submit As-Built information in the same format, (i.e.: Two (2) DVD's and three (3) prints) as with the project As-Built information contained thereon.

1.13 SERVICING OF EQUIPMENT AND SYSTEMS

- A. After work has been completed under the Electrical contract, and prior to final acceptance tests, each Contractor shall have manufacturers or their authorized agents of the equipment and material installed, completely check their equipment and put it into actual operation. In each case, the respective Contractor shall have the manufacturers thoroughly check the complete installation of the equipment produced by him for proper and correct operation under the service intended.
- B. Six months after final acceptance of the work under the Electrical contract, each Contractor shall have the manufacturers again check their equipment for proper operation. Coincidentally, this contractor shall assure that the building custodian is properly instructed in the servicing of the equipment.
- C. Prior to expiration of the guarantee period, each contractor shall check all equipment, materials and systems installed under his contract, make necessary adjustments and/or replacements, and leave systems in first class operating condition.

1.14 CONTINUITY OF SERVICES

- A. Generally, no action shall be taken by the Electrical Contractor that will interrupt any of the existing building services for this building or any other building until

previously arranged with the Engineer and Owner or their authorized representative.

- B. Should any service be interrupted by this Contractor, the Contractor causing such interruption shall provide immediately all labor, including overtime if necessary, and all material and equipment necessary for restoration of such service.

1.15 MANUFACTURER'S AND SUB-CONTRACTORS LIST

- A. Before ordering any material or equipment unit, and not later than twenty (20) working days after signing of contracts each Contractor shall submit a list of Manufacturers, Sub-Contractors and Suppliers showing make, type, manufacturers name and trade designation of all materials, and equipment, proposed for use under this contract. List shall be prepared by reference to specifications.
- B. The list, when accepted, shall be supplementary to specifications, and no variations therefrom will be permitted except with the approval of the Engineer.
- C. No shop drawings will be processed until the Contractor has satisfactorily completed the requirements of this Article.

1.16 SHOP DRAWINGS

1. In general, shop drawings will be processed electronically. For each shop drawing submitted, submit a high quality color original in Adobe (.pdf) format and attach a separate Letter of Transmittal for each submission. On all shop drawings that are based on a drawing format greater than 8.5" x 11" (letter size paper), submit five (5) paper copies at full scale. All drawing submissions shall be made in both electronically and hard copy formats.
2. All shop drawings shall be submitted in ample time to coordinate features of construction with the fabrication and installation requirements of the project. Allow fourteen (14) days for Drawings required for General Construction and fourteen (14) days for Drawings required for Mechanical or Electrical work.
3. Where a Shop Drawing or sample is required by the Specifications, any related work performed prior to ENGINEER's review of the pertinent submission will be the sole expense and responsibility of the CONTRACTOR.
 - A. Prior to submission of shop drawings, the Contractor shall notify the Engineer of any site conditions differing from those indicated or specified.
 - B. Prepare shop drawings by careful reference to drawings and specifications.

- C. Identify each shop drawing by Job Name and reference to applicable Specification Article number.
- D. Shop drawing data for all equipment, shall include, but not be limited to, the following:
 - 1. Manufacturers' catalog designation, photographs and specifications.
 - 2. Full electrical data, including specifically, electrical characteristics.
 - 3. Dimensions, capacities, ratings, material and finish.
 - 4. Such other detailed information as required for proper evaluation.
- E. Review Time:
 - 1. Allow two (2) weeks for the Engineer's processing of each submittal, exclusive of Owner or others in the processing chain. Allow a longer time period where processing must be delayed for coordination with subsequent submittals.
- F. Submission of shop drawings for electric motor starters shall include a tabulation listing:
 - 1. The equipment the starter is intended to control.
 - 2. Horsepower.
 - 3. Voltage.
 - 4. Phase.
 - 5. Full load amperes.
 - 6. The manufacturer's number or type.
 - 7. Overload heater numbers and amperage.
 - 8. Quantity of auxiliary contacts.
 - 9. Pushbutton arrangement.
 - 10. Pilot light arrangement if applicable.

- G. Each Contractor shall examine all shop drawings before submission for review. Each Contractor shall then forward all shop drawings with their initialed approval shop drawing stamp and by so doing the Contractor thereby represents that he has determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers, and similar data, has notified the Engineer of site conditions varying from those indicated or specified, and that he has checked and coordinated each item with other applicable accepted shop drawings and the contract requirements. Shop drawings and catalog data submitted without the contractor's stamp of acceptance will be returned to the Contractor without review.
- H. Material and equipment installed or used without shop drawing review are subject to rejection by the Engineer.
- I. Corrections or comments made on shop drawings during review by the Engineer do not relieve the contractor from compliance with requirements of the drawings and specifications. Such review shall be only for general conformance with the design concept and general compliance with the information given in the Contract Documents. It shall not include review of quantities, dimensions, weights or gauges, fabrication processes, construction methods, coordination with the work of other trades, or construction safety precautions, all of which are the sole responsibility of the Contractor. Review of a specific item shall not indicate acceptance of an assembly of which the item is a component. The Engineer shall not be responsible for any deviations from the Contract Documents not clearly noted by the Contractor, nor shall the Engineer review partial submissions or those for which submissions for correlated items have not been received. The Contractor is responsible for: confirming and correlating all quantities, clearance and dimensions, selecting fabrication processes and techniques of construction coordinating work with that of all other trades, and performing their work in a safe and satisfactory manner.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be new and shall conform to the grade, quality and standards specified herein.
- B. All equipment offered under these specifications shall be limited to products regularly produced and recommended for service ratings in accordance with engineering data or other comprehensive literature made available to the public and in effect at the time of opening of bids.

- C. Items such as motors, starting equipment, vibration isolating devices, and all other equipment and material, where applicable and practicable, shall each be of one manufacturer.
- D. Equipment shall be installed in strict accordance with manufacturer's instructions for type and capacity of each piece of equipment used. These contractors shall obtain these instructions which will be considered part of these specifications. Type, capacity and application of equipment shall be suitable and shall operate satisfactorily for the purpose intended in the Electrical System.

2.02 EQUIPMENT SUBSTITUTIONS

- A. The materials and products mentioned in these specifications are given to establish a standard of quality, design and performance. The phrases "equivalent acceptable", "or equal", and "equal to" shall be used to indicate that other similar products may be used provided such substitutes are accepted by the Engineer as meeting all standards necessary to perform the function intended. Where 3 or more manufacturers are mentioned for an item, selection shall be made from among those manufacturers. Specific products listed without reference to equals or substitutions shall be provided as specified, unless a written request for substitution is submitted to the Engineer for approval ten (10) days prior to the date for receipt of bids. Such requests shall include a complete description of the proposed substitute, along with sufficient documentation and other information necessary for a complete evaluation of the proposed substitution. If approved, substitute produce will be listed in an addendum so that all bidders are alerted to it.
- B. The Contract Documents have been prepared to provide for the incorporation of at least one of the specified items or assemblies of every category of materials, products or pieces of equipment. In the event that the incorporation into the work of an approved substituted item or assembly will require revisions or additions to the contractual requirements of either the contractor proposing the substitution or any other contractor, the contractor proposing the substitution shall bear the cost of such revisions or additions to the work of all trades affected, and shall pay for all engineering or architectural services required at no change in the contract sum.

2.03 VIBRATION ELIMINATION

- A. The Electrical Contractor shall provide vibration isolation support provisions for all moving or rotating equipment, machinery and transformers when such provisions are not furnished and/or integrally mounted by the equipment manufacturers. Equal to Amber/Booth Company or Korfund Company, Inc., installed in accordance with vibration isolation manufacturers' recommendations unless specified otherwise herein.

- B. Provide all rotating or moving machinery or equipment suspended from building structure with approved resilient suspension mountings.
- C. All final electrical connections to moving or vibrating equipment, such as motors, generators, transformers, etc., shall be made by use of flexible metallic conduit.
- D. No rigid conduit or other extended machine assemblies connected to vibration isolated equipment shall be tied in directly with the building construction. Such elements shall be connected to the equipment through flexible fittings, and be supported by isolating equipment as required.
- E. All systems shall operate free from objectionable vibration and noise resulting therefrom, and each Contractor shall take all necessary steps required to achieve this result without additional cost to the Owner.

2.04 INSERTS, HANGER SUPPORTS, CLAMPS, FASTENINGS

- A. All materials, designs and types of inserts, hanger supports and clamps shall meet the requirements of the Manufacturers Standardization Society Document MSS-SP-58, latest edition and also Underwriters Laboratories, Inc., National Electrical Code and Factory Mutual Engineering Division Standards where applicable. Insert, hanger support and clamp types referenced herein are shown in MSS-SP-58.
- B. Each Contractor shall be responsible for and provide all necessary inserts, hanger supports, fastenings, clamps and attachments necessary for support of his work. The types of all inserts, hanger supports, fastenings, clamps and attachments to be used shall be selected to suit both new and existing building construction conditions and applied specifically for the purposes intended.
- C. In new overhead cast-in-place concrete construction, provide type 18 steel concrete inserts and fasten to form work before concrete is cast. For cast concrete floor or roof sections too thin to permit the use of inserts extend the hanger rod through the slab and terminate with a nut and large washer, recessed into the top face of the slab as approved by the Engineer.
- D. Clamps and attachments shall be selected on the basis of the required load to be supported. Provide all necessary steel angle iron or channel between bar joists, or steel beams where direct attachment cannot be made. No holes are to be drilled or burned in structural building steel for hanger rod supports.
- E. Metallic masonry anchors shall be provided for all pre-cast concrete, masonry and cast concrete construction, and may be provided as an alternate for cast-in-place construction]. Locate in pre-cast and cast-in-place concrete as directed by the Engineer. Dynabolt, Ram-In and/or Tru-Bolt masonry anchors as manufactured by Ramset shall be provided as recommended by the anchor manufacturer for the

various applications, stresses and services involved. Redhead, Hilti or Wej-It equivalents acceptable. Installation of masonry anchors shall be accomplished by pre-drilling concrete or masonry to diameters and depths required to properly accommodate anchor bolts.

- F. Toggle bolts may be used in dry wall and lath and block plaster walls. The use of toggle bolts shall be restricted to the weight limitations imposed by the toggle bolt manufacturer for the size used.
- G. Except where noted otherwise herein, attachment to wood or material of similar fibrous nature shall be made with lag screws and/or wood screws of required size.
- H. Screws with wooden or plastic plugs, or lead caulking anchors are not acceptable.

2.05 ANCHOR BOLTS

- A. Electrical Contractor shall provide and set in place at the time foundations, bases or curbs are poured or formed, all necessary anchor bolts as required for the various equipment specified herein. Hook type anchor bolts of proper size and length to suit the apparatus. Set bolts in pipe sleeves of approximately twice the bolt diameter and of length equal to the embedded length of the bolt, with sleeves terminating flush with finished surfaces of foundations, bases or curbs.
- B. When the equipment is set in its proper position and aligned with the anchor bolts, the space between the anchor bolts and the inside wall of the sleeves shall be completely filled with non-shrink cementitious grout equal to crystex as manufactured by L & M Construction Chemicals, Inc., Master Builders or approved equal.
- C. Each Contractor shall assume all responsibility for the location of all anchor bolts for the equipment furnished by them under these specifications, and must have a representative present at the time foundations, bases or curbs are poured or formed.
- D. All anchor bolts shall be of sufficient strength to withstand any loading imposed by the attached materials or equipment.
- E. ALL exterior, pad mounted equipment shall be set in place and secured to the pad with anchor bolts and mechanical fasteners.

2.06 SLEEVES

- A. Each Contractor shall furnish and set all sleeves required for their work and be fully responsible for the final and permanent locations thereof.
- B. Sleeves shall be provided in the following locations:

1. All conduits passing through cast-in-place waterproof concrete construction and waterproof masonry walls.
- C. Sleeves shall extend through construction and finished flush with each surface except where noted otherwise. Each sleeve shall provide for a minimum 1/2" clearance around pipe or its covering in the instance of pipe covered with insulation.
- D. All sleeves in waterproof walls shall be fitted and sealed with positive hydrostatic "Link Seals" as manufactured by Thunderline Corporation. Sleeves shall be sized accordingly. Link Seals shall be placed around conduit and inserted into void between inner wall of sleeve and piping and/or conduit. Tighten link seals as required for watertight seal.
- E. All sleeves shall be Schedule 40 steel pipe finished with smooth edges. Sleeves in waterproof walls shall be fabricated with minimum 1/4" thick rectangular steel plate placed around mid-point of sleeve, continuously welded to sleeve and then the entire/plate assembly placed into proper position prior to erection of walls. Otherwise sleeves shall be provided with a minimum of three (3) lugs for anchoring.
- F. Voids between sleeves and conduit, where located in fire partitions or masonry walls shall be packed with mineral fiber rope.
- G. All sleeves shall be set prior to or during erection of walls. Cutting or drilling of walls after erection will not be permitted.
- H. If sleeves are omitted or located incorrectly the particular contractor who is at fault shall at their own expense, engage the trade which originally installed the work to cut and patch to the satisfaction of the Engineer.
- I. Any conduit that must pass through pre-cast floors and will be exposed, in finished areas, that have floor drains including areas such as Janitors Closets, Toilet Rooms and the like shall be made watertight by use of "Link Seals" inserted into void between conduit and openings thereto.

PART 3 - EXECUTION

3.01 METHOD OF PROCEDURE

- A. The drawings accompanying these specifications are diagrammatic and intended to cover the approximate and relative locations of the Electrical Systems.

- B. Installation, connection and interconnection of all components of these systems shall be complete and made in accordance with the manufacturers' instructions and best trade practices.
- C. Each Contractor shall erect all parts of equipment to be furnished by them under their contract at such time and in such manner as not to delay or interfere with other Contractors on the work.
- D. All conduit shall be plugged as required during construction to prevent entering of dirt.
- E. Before material is ordered or any work performed, each Contractor shall verify all measurements, including lines, conduit and elevations at the building and shall be responsible for the correctness thereof. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated in the Contract Documents. Any discrepancies discovered shall be submitted to the Engineer for consideration before proceeding with the work.
- F. Each Contractor shall lay out their work and be responsible for the establishment of heights, grades, etc., for all interior and exterior fixtures, conduit, etc., included in Contract Documents, in strict accordance with the intent expressed thereby; and all the physical conditions to be met at the building and finished grade, and shall be responsible for accuracy thereof. The establishment of the location of all work shall be performed in consideration of the finished work. In case of conflict, equipment and/or materials shall be relocated without cost to the Owner, as directed by the Engineer, regardless of which equipment was installed first.
- G. Each Contractor shall cooperate with other Contractors for the proper securing and anchoring of all work included within these specifications. Extraordinary care shall be used in the erection and installation of all equipment and materials to avoid marring surfaces of the work of other Contractors, as each Contractor will be held financially responsible for all such injury caused by the lack of precaution and due to negligence on the part of their workmen.
- H. Do not run conduit for Electrical Systems in any concrete slab three inches (3") or less in thickness. Do not place any conduit in any slab where the outside diameter of the pipe or conduit is more than one-quarter the thickness of the slab.
- I. All conduit and other Electrical materials and equipment shown to be mounted below ceilings are to be kept as close to ceiling areas as possible unless otherwise noted.

3.02 PROTECTION

- A. All openings in conduit and all other materials shall be effectively sealed to exclude dirt, sand, and other foreign materials.
- B. Exercise every precaution to exclude dust, dirt and all other foreign materials from switchgear rooms, transformers, and all electrical equipment rooms during construction. Rooms and equipment contained therein shall be vacuum cleaned at regular intervals. All relays, meters and mechanical equipment contained with electrical components shall be protected with heavy paper held in place with approved mastic tape to exclude fine dust and particles. Sufficient electric heaters shall be installed and maintained in equipment rooms and transformer compartments to keep equipment dry and protected from freezing during construction.

3.03 CONCRETE AND MASONRY WORK

- A. Electrical Contractor shall provide all cast-in-place concrete, pre-cast concrete and masonry work (brick and block) required for completion of their contracts.
- B. Engineer shall review and approve materials used.
- C. Unless shown or specified otherwise, all interior equipment foundations shall be four inches 4" minimum from floor, of sufficient mass, and secured to the floor.

3.04 SUPPORTS

- A. Except where noted otherwise in the specifications and shown on drawings, each Contractor shall provide all materials, equipment supports, supplies and labor necessary as required to adequately support, brace and strengthen equipment and materials furnished as part of their contract.
- B. The design, materials, fabrication and erection of structural steel supports shall conform to "Specification for Design, Fabrication and Erection of Structural Steel for Buildings" of the American Institute of Steel Construction, "Code of Standard Practice for Steel Buildings and Bridges". Welding where required shall conform to "Code of Arc and Gas Welding in Building Construction" of the American Welding Society.

3.05 LINTELS

- A. The General Contractor will furnish and install all lintels required for the installation and completion of all work of Electrical Contractors, provided that the General Contractor is advised in advance of such requirements.
- B. Failure to give proper notice and/or to comply with the above requires the Sub-Contractor involved to be financially liable for all work and material necessary for the completion of required work.

3.06 PAINTING AND FINISHING

- A. All painting, generally, will be provided by the General Contractor, except where specifically noted otherwise in the Electrical Specifications.
- B. Equipment and material furnished with factory enamel finish will not be painted unless finish has been damaged, in which case the equipment or material shall be refinished by the Contractor who furnished it, to the satisfaction of the Engineer.

3.07 LUBRICATION

- A. Each Contractor shall be responsible for the proper and necessary lubrication of any items of operating, rotating or moving equipment which they will furnish, install or which must operate as part of the systems on which they work.
- B. When an item of operating equipment is furnished and installed by a Contractor, it will be their responsibility to accomplish the lubrication.
- C. When an item of operating equipment is furnished by one Contractor and the installation by another, it shall be the responsibility of the Contractor furnishing the equipment to apply the lubricants.
- D. All rotating or moving equipment shall be lubricated prior to energizing and operating the equipment. Should the Contractor responsible for the lubrication fail to apply lubricants prior to initial start-up and the equipment is damaged as a result of their negligence, that Contractor shall be required to provide all corrective action necessary including replacement, if required, for the proper operation of equipment.
- E. Lubrication shall be accomplished in the manner prescribed or recommended by the manufacturer of the specific item. For motor driven equipment this precaution of lubrication will apply individually to the driver and the driven.
- F. The lubricants shall be of the type, grade, specification and manufacture as prescribed or recommended by the manufacturer of the specific equipment item.
- G. The Contractor who supplies any item of rotating equipment will have the responsibility of securing written instructions on the lubricating procedure and shall furnish not less than one year's supply of all necessary lubricants properly identified so they can be replaced.
- H. Any moving or rotating equipment furnished by the Owner that is to be installed, reused and/or serviced shall also be lubricated. Except where noted otherwise in the Electrical specifications, the Contractor installing, reusing and or servicing all such equipment shall be responsible for the proper lubrication thereof including

obtaining proper lubricating instructions from the various manufacturers involved, furnishing and applying the necessary lubricants and leaving the Owner with a one (1) year supply of lubricant.

3.08 ELECTRICAL MOTORS AND STARTERS

- A. All motors furnished by Electrical Contractor, unless specified to the contrary in Electrical Specifications, shall conform to the following requirements:
1. Characteristics, dimensions, tolerances, temperature rise, insulation, rating, noise, vibration, and all other characteristics in accordance with the latest standards of IEEE or NEMA.
 2. Unless required by the driven unit, motors shall have normal starting torque, NEMA Design B characteristics. Horsepower rating of motor shall be equal to or greater than that required by driven equipment. Current density design of motor rating shall be limited so that overload protection provided by standard motor starters will be adequate to prevent damaging overheating during stall, single phasing or slightly prolonged acceleration.
 3. Use NEMA Class A or B insulation with motor frames amply sized to prove 1.15 service factor and an ambient of 40°C maximum. Insulation systems shall be designed for an average life of 60,000 hours.
 4. Each motor shall be mounted on the same bedplate as the equipment driven and be complete with pulleys, slide rails or flexible couplings as required.
 5. Each Contractor is responsible in each instance for the proper selection of motors of suitable characteristics with details submitted for approval to the Engineer prior to installation.
- B. All starters furnished by all Contractors shall conform with the following requirements, unless specified to the contrary in the Electrical Specifications:
1. All starters for 3-phase equipment shall be fully enclosed, across-the-line type equipped with thermal overload protection for all three phases, low voltage protection, all necessary auxiliary contacts as required and indicating pilot lights. Starters which are controlled automatically shall have two-wire control with "ON-OFF-AUTO" switches. Starters which are controlled manually shall have 3-wire control with Start-Stop pushbuttons.
 2. All 3-phase starters remotely controlled shall have 120 volt coils and control transformers with disconnecting means.

3. Starters for single phase motors shall be manual toggle switches with thermal overload protection and pilot light. Omit pilot light for unit heaters.
 4. General Purpose NEMA-1 enclosure for indoor use under normal atmospheric conditions. Watertight enclosure NEMA-4 or NEMA-5 for outdoor use or where starters are subjected to the splashing or dripping of water. Explosion-proof enclosure NEMA-7, 9 or 12 for dusty or hazardous locations as required by Article 500 of the National Electrical Code.
- C. All controllers, starters and other electrical components furnished as an integral part of any apparatus shall be furnished complete with integral wiring as required.
- D. Submit motor and starter data sheet.

3.09 EXCAVATION AND BACKFILLING

- A. Each Contractor shall perform all excavation, backfilling, pumping and dewatering necessary for completion of work under their contract, unless noted otherwise. All excavation shall be considered classified.
- B. Remove from premises or deposit as directed by Engineer all material excavated and not required or suitable for backfilling.
- C. Carefully remove and store topsoil, shrubbery and sod until underground work is complete and trenches are backfilled and then re-install. Replace any damaged items to the satisfaction of the Engineer.
- D. Trench depth shall be as indicated on the drawings. Under no circumstances shall trench depth be less than that called for in the NEC or the Utility serving the premises. Trench depth shall allow adequate cover over ducts and conduit. Walls shall be perpendicular to the top of piping and ducts and trench bottoms shall be instrument graded in the direction of flow as required. Earth shall be scooped out under conduit couplings to provide a solid bearing for the duct or conduit on undisturbed earth. Cinder fill, stones or bricks beneath piping are prohibited.
- E. Each Contractor shall provide sheathing, shoring and bracing necessary to complete their excavation and backfilling work and shall exercise every precaution necessary to prevent accident, injury or death to any human and damage to property of others. Remove all sheathing, shoring and bracing upon completion of work.
- F. It shall be the responsibility of each Contractor to check with the various utility companies, Miss Utility and make the necessary arrangements to avoid damage to property. Since this campus maintains all privately owned utilities, this contractor

shall hire an independent testing agency to identify all underground obstructions in the path and area of their excavations. Each Contractor is responsible for damage during excavation to existing piping or equipment. Such damage shall be repaired promptly without cost to the Owner.

- G. Backfill after inspection and approval. Backfill shall be made with clean earth, free from rocks, frozen particles, debris or other foreign materials. Deposit in uniform layers not over six inches (6") thick with each layer mechanically tamped to 90% before the next layer is applied. When approved backfill material is not available from the site, each Contractor, at his own expense shall provide additional select backfill to complete installation. Final backfill only after testing procedures have been approved.
- H. All trenches that pass under wall foundations shall be backfilled with lean concrete, full height, directly under wall footing, and at a 1:1 slope away from wall or column footing. Trenches that are parallel with and deeper than wall foundations shall be backfilled with lean concrete on a 1:1 slope away from the bottom of the wall or column footing.
- I. Each Contractor shall perform all cutting and patching to sidewalks, curbs, bituminous paving, walls, etc. required by performance of excavation and backfilling. Install and maintain temporary paving as directed by Engineer. Make repairs to sidewalks in complete blocks, partial patching will not be acceptable. Provide all materials for patching in strict accordance with applicable Articles of the General Construction Specifications.
- J. Where rock is encountered during installation of underground conduit systems, carry trenches to a point six inches (6") below bottom of conduit and provide a six inch (6") layer of crushed stone or gravel as a cushion.
- K. All excavation work shall include all pumping equipment, materials and labor necessary to keep all excavations free of water. Provide well points as required with disposition of water as directed by Engineer.
- L. Each Contractor shall provide suitable indemnity for all accidents to humans, animals or equipment caused by their excavating and backfilling work. They shall provide suitable guards, barricades, red lanterns, flares and take the necessary precaution for an approved and safe installation. All trenches shall be backfilled at the end of each working day. Where a trench must be left open, provide snow fencing and coverings of adequate size and strength over entire open area.

END OF SECTION 26 04 99

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 05 00 - BASIC MATERIALS AND METHODS, ELECTRICAL

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

- A. Applicable provisions of the entire specification, including Addenda, shall govern this section as fully as if repeated herein.
- B. Refer specifically to the technical provisions of the COMMON WORK REQUIREMENTS FOR ELECTRICAL Section 26 04 99.

1.02 SCOPE OF WORK

- A. The work under this section of the specification shall include all labor, materials, appliances and services necessary for and incidental to the primary completion of the electrical system for this structure and related work as shown, implied or required by the drawings and/or described hereinafter.
- B. The precise nature of the work is specified in detail in other Sections. As a guide to the general concept of the electrical design, the work herein described shall include, but not be limited to the following:
 - 1. Receptacles and general power circuits.
 - 2. Panelboards, circuit breakers and distribution equipment.
 - 3. Wiring and conduit systems, boxes, enclosures and devices.
 - 4. Connections to new, existing and relocated equipment.
 - 5. Disconnects and removals.
 - 6. Relocation of existing equipment & wiring extensions thereto.
 - 7. Grounding.
 - 8. Generators
 - 9. Transfer Switches
 - 10. Antenna poles and foundations

1.03 AS-BUILT DRAWINGS

- A. Refer Specifically to Section 26 04 99 for specific As-Built Drawing requirements.

1.04 DATA SUBMITTAL REQUIREMENTS

- A. Refer to the Article MANUFACTURERS AND SUB-CONTRACTORS LIST of COMMON WORK REQUIREMENTS FOR ELECTRICAL. This list shall include all equipment for which shop drawings are required.

1.05 SPECIAL SHOP DRAWING SUBMITTAL REQUIREMENTS

- A. Refer Specifically to Section 26 04 99 for specific Shop Drawing requirements.
- B. Shop drawings for electrical equipment shall consist of blueprints, line drawings, data sheets, catalog cuts, or other data necessary to provide specific and complete installation on all items of material and equipment to be used in the project.
- C. All shop drawings must specifically designate the service and location at which the material or equipment is to be used, and identify manufacturer and catalog number.
- D. Shop drawings shall show construction arrangements, and wiring of any special parts, equipment, or systems of the electrical installation furnished under these specifications.
- E. Shop drawings to be furnished by the Contractor for review include but are not limited to the following:
 - 1. 480Y/277VAC Distribution Panels.
 - 2. 208Y/120VAC Branch circuit panelboards.
 - 3. Circuit breakers and safety switches.
 - 4. Molded Case Switches.
 - 5. Nema Enclosed Circuit Breakers
 - 6. Contactors, starters and combination starters
 - 7. Terminal Blocks

8. Nema Rated Enclosures and boxes
 9. Wiring devices and coverplates.
 10. Transfer switches.
 11. Generator
 12. Pump Control Panel
 13. RTU & Radio Equipment
 14. Light Fixtures & Lighting controls
 15. Surge Protective Device
 16. Seal Off Fittings
 17. Power System (Coordination, Short Circuit and Arc Flash) Study.
- F. Provide one (1) copy of each final shop drawing in each Operating and Maintenance Manual.

1.06 CURRENT CHARACTERISTICS AND LOAD RATINGS OF MOTORS AND EQUIPMENT

- A. The intended electrical characteristics of all motors and equipment are noted only on the Electrical Drawings.
- B. Furnish to all other contractors, data relating to the electrical characteristics of their equipment as shown on the Electrical Drawings, that they may furnish correct equipment. Assume all responsibility for correction of problems arising from failure to do so.

1.07 CUTTING AND CHASES

- A. Provide the General Contractor, location of all chases, openings, recesses, etc., in a timely manner so that he may provide them.
- B. All cutting and patching shall be performed in such a manner and with such materials as the Engineer may direct.

1.08 INSTRUCTION OF ATTENDANT - OPERATING AND MAINTENANCE MANUAL

- A. Upon completion and final acceptance of the work, instruct the Owner's maintenance representative fully in the operation and maintenance of the electrical installation.
- B. Furnish to the Engineer, complete and comprehensive "Operating and Maintenance Manuals", as specified in Section 26 04 99.

1.09 UTILITY COMPANY CONNECTIONS

- A. The information given regarding methods and materials for connection to the existing electric equipment or any other system and Electric Company represents the best information available to the Engineer at time of design. This Contractor shall contact each Utility into whose lines they must connect, and determine their requirements for such connection, and any costs or fees involved, and shall include the costs thereof in their bid. They shall do all their work in accordance with such requirements, notwithstanding any differences between these requirements and information given herein or on the drawings.
- B. Delmarva Power is the Electric utility serving the premises. Coordinate new service entrance and metering requirements with their representative. Representative is Mr. Andrew Moseley tel. 302-388-4893.

1.10 TESTING AND ADJUSTING

Refer to Article TESTS of Section 26 04 99.

- A. Electrical balancing.
 - 1. Connect all electrical loads to achieve a balanced electrical loading of all single phase systems to within 10%. Verify motor rotation.
- B. Thoroughly test all components of special systems for correct operation.
- C. Test all wiring of equipment free of grounds, opens and short circuits.
- D. Provide a Fall of Potential test, performed by a NETA testing firm at EACH pumpstation.

1.11 CODE COMPLIANCE

- A. The contractor shall comply with the requirements of the latest National Electrical Code, all state & local codes and all other authorities having jurisdiction, regardless of what is indicated on the drawings or specified herein.
- B. Provide approved Electrical Inspection Certificate at project completion. Provide one copy in each of the Operating & Maintenance Manuals.

1.12 DISCONNECT AND REMOVALS

- A. The Contractors shall visit the site prior to submitting their bid and shall include in their bid all labor and material necessary to remove, relocate or modify the items which interfere with new construction. This shall include wiring extensions, removals and modifications.
- B. Incidental items such as cover plates, boxes, and appurtenances shall be provided by this contractor.
- C. Patch all holes through floors and walls where conduits have been removed and maintain integrity of fire rating.
- D. Existing items that are to remain but become de-energized due to removals shall be re-energized by this Contractor who shall provide necessary wiring extensions as required. Contractor shall investigate wiring in area of construction and ascertain wiring that must remain in order to maintain operation of items outside of new work area.

PART 2 - MATERIALS

2.01 MATERIAL AND EQUIPMENT

- A. All material used for this contract shall be unused and of the latest model or design available.
- B. Equipment shall be installed in strict accordance with manufacturer's recommendations and details.
- C. Materials not specifically described but indicated or incidentally required shall be acceptable to the Architect and/or Engineer. Submit shop drawings if such are required by Architect or Engineer.
- D. Materials shall be delivered, stored and handled so as to preclude injury by weather, dirt or abrasion.

2.02 FASTENINGS AND SLEEVES

- A. Support exposed conduits with rust proofed, malleable iron clamps or "mineralac" hangers securely fastened to the building structure. Group all large conduits as conditions permit, and support on steel channel racks. Supports shall be spaced as required by Article 346-12 of the National Electrical Code for metal conduits, and by Article 347-8 for non-metallic conduit.
- B. Use lead anchors or toggle bolts as fastenings in masonry. Use machine screw expansion shields as fastenings in concrete.
- C. Provide sleeves for conduits passing through poured concrete decks, footings, walls, etc. Cut all openings for conduits passing through precast concrete. Such holes shall not be cut with hammer and chisel, or with any power tool depending on impact for its cutting power.

2.03 WIRE AND CABLE (600 VAC INSULATION)

- A. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.
- B. All wire and cable shall be of 98% conductivity copper, single conductor in all sizes. Wire in sizes #8 AWG and smaller may be solid conductor. Wire in sizes #6 AWG and larger shall be stranded. Interior wiring and wiring in dry locations shall have type THHN insulation. Exterior wiring and wiring in damp or wet locations shall have type THWN insulation.
- C. Wiring installed in flexible steel conduit shall be stranded conductor in all sizes. Maximum length shall be limited to 3'-0".
- D. All wiring shall be color coded throughout the length of the conductor. Field color coding is unacceptable. Color coding shall be consistent throughout the work, i.e., same color used for same phase leg, one color switch legs, etc. In all cases, ground conductor shall be green.
- E. The following color code shall be observed:

On systems of 208Y/120 VAC, the following color code shall be observed:

- 1. Phase A: Black
- 2. Phase B: Red
- 3. Phase C: Blue
- 4. Neutral: White

On systems of 480Y/277 VAC, the following color coding shall be observed:

1. Phase A: Brown
2. Phase B: Orange
3. Phase C: Yellow
4. Neutral: White with dark gray or black stripe

F. Minimum wire sizes shall be as follows:

Control and Signal = # 14 AWG

Power and Lighting = # 12 AWG

2.04 CONDUIT AND FITTINGS

- A. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.
- B. Rigid steel conduit shall be UL listed, and in accordance with the latest edition of Federal Specification WW-C-581, and ANSI Standard C80.1. Rigid steel conduit shall be zinc coated on the outside, and either zinc-coated, or coated with an approved corrosion resistant coating on the inside.
- C. Electrical metallic tubing (EMT) shall be UL listed and in accordance with the latest edition of UL 797 and ANSI Standard C80.3. EMT shall be zinc-coated on the outside and shall be either zinc-coated or coated with an approved corrosion resistant coating on the inside.
- D. Rigid non-metallic conduit for underground use shall be Schedule 80 polyvinyl chloride, unless otherwise noted. Conduit shall be U.L. listed. Appropriately sized ground wire shall be run in all non-metallic conduits.
- E. Rigid non-metallic conduit for work inside equipment enclosures shall be Schedule 40 polyvinyl chloride, unless otherwise noted. Conduit shall be U.L. listed. Appropriately sized ground wire shall be run in all non-metallic conduits.
- F. Liquid tight flexible metal conduit shall be U.L. listed, and consist of a core of flexible galvanized steel tubing over which is an extruded, a liquid tight jacket of polyvinyl chloride (PVC).
- G. Liquid tight flexible non-metallic conduit shall not be used.
- H. Flexible metal conduit ("Greenfield") shall be U.L. listed, and in accordance with the latest edition of Federal Specification WW-C-566.

- I. Fittings for rigid steel conduit shall be in accordance with the latest edition of Federal Specification W-F-408, except that the material shall be either iron or steel only.
- J. Fittings for rigid non-metallic conduit shall be polyvinyl chloride, sleeve type, applied with a solvent recommended by the manufacturer.
- K. Couplings and connectors for EMT shall be made of either steel or malleable iron only, shall be "Concrete tight" or "Rain tight". Conduits 2" and smaller shall be the gland and ring compression type. Conduits greater than 2" shall use set screw connectors. All connectors shall have insulated throats.
- L. Bushings for rigid steel and for EMT shall be of the insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system. The insulating insert material shall be thermo-plastic of fiber, molded or locked into the metallic body of the fittings. Where grounding bushings are specified, either wedge type ground clips or grounding bushings with pressure type ground clip terminals or copper grounding lugs shall be provided.
- M. Fittings for liquid tight flexible conduit shall be of a type with a nylon or equal plastic compression ring and a gland for tightening. Fittings shall be made of either steel or malleable iron only, shall have insulated throats and shall be of a type having a male thread and locknut or male bushing with or without "O" ring seal. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.
- N. Fittings for flexible metal conduit shall be made of either steel or malleable iron only, shall have insulated throats, and shall be of one of the following types:
 - 1. Wedge and screw type having an angular wedge fitting between the convolutions of the conduit.
 - 2. Squeeze or clamp type having a bearing surface contoured to wrap around the conduit and clamped by one or more screws.
- O. Die-cast zinc-alloy fittings and fittings made of inferior materials, such as "white metal", shall not be used on any type of rigid or flexible conduit or EMT.

2.05 CONNECTORS, LUGS, TAPS AND SPLICES

- A. All connections between conductor sizes #8 AWG and larger and devices or apparatus rated over 30 amperes shall be made with solderless mechanical connectors of appropriate type and current carrying capacity. Connectors and lugs

shall be of the Allen set-screw type and shall be O.Z., Burndy, Frankel, Dossert or National.

- B. Connectors for wire #10 AWG and smaller shall be "Skotch-Lock" spring connectors with plastic jacket or Ideal "Wingnut" with nylon jacket.
- C. Insulated "Wire-Nuts" will not be acceptable.
- D. Splices occurring in the conductors #8 and larger shall be made with bolted type pressure connectors and then installed with "Scotchfill" electrical putty with No. 88 "Scotch" electrical tape, or by an equal method.
- E. All lugs and connectors for wires and cables shall be provided by this Contractor. This shall include all lugs at safety switches, circuit breakers and other equipment not supplied with lugs.

2.06 EQUIPMENT IDENTIFICATION

- A. Identify electrical conductor terminations and splices in outlet boxes, receptacles, light fixtures, pull boxes, panel cabinets or other locations when directed with manufacturer's standard vinyl cloth, self-adhesive cable/conductor markers of wrap-around type; either pre-numbered, plastic-coated type, or write-on type with clear plastic, self-adhesive cover flap; numbered to show circuit identification. Identification shall include panel or switchboard number, and circuit or feeder number. Before tagging, lace or ty-wrap together all conductors forming a circuit or feeder.
- B. Identify all electrical distribution and control cabinets and all equipment throughout the facility as to nature, service and purpose, by means of permanently attached, laminated phenolic nameplates with beveled edges, dull black with white core, and 1/2 inch lettering. Fasten with sheet metal screws, drive rivets, or "pop" rivets. Glue or other forms of adhesive shall be used as a means of supplementary attachment only. Provide engraved device plate with voltage, phase, and amperage on all receptacles operating at other than 120 VAC.
- C. All wiring devices shall be labeled indicating the source panel and circuit. Label shall be a clear, adhesive backed with black letters (ex: DP1-14).
- D. All junction boxes and pull boxes shall be labeled with indelible marker indicating all circuits contained within the junction box.
- E. All panelboards incorporating "100 ampere" frame or larger circuit breakers shall be provided with laminated phenolic nameplates which identify each circuit

breaker. All circuit breakers in each Main Distribution switchboard shall be provided with same.

- F. All Electrical Rooms where main service equipment is located, shall be provided with a sign, secured to each door at 5'-0" AFF, bearing the following inscription: "DANGER - HIGH VOLTAGE KEEP OUT".
- G. Panelboards that are replaced shall have existing circuit directories transcribed onto new panel directories via typewritten schedules. Neatly transcribe circuits. In the event that existing directories are removed and discarded prior to transcribing directory information, Contractor at no additional cost shall field verify all existing branch circuits so that an accurate directory can be provided.

2.07 SAFETY SWITCHES

- A. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.
- B. A safety switch, fused or unfused, shall be provided wherever, indicated, or wherever required by the NEC, using only switches with quick-make, quick-break operating mechanisms, Heavy Duty NEMA Type "HD", with provisions for padlocking. All switches shall be rated 600 VAC.
- C. Safety switches shall be horsepower rated for service intended, in NEMA enclosure Type 1 (indoor or within service enclosure) or NEMA 4 Stainless Steel (outdoor) as indicated.
- D. Safety switches shall be manufactured by Square D or pre-approved equal.
- E. Identify all safety switches with nameplates in accordance with EQUIPMENT IDENTIFICATION.

2.08 ENCLOSED CIRCUIT BREAKERS

- A. Provide individually enclosed circuit breakers where indicated. Enclosures shall be NEMA 1 for interior locations, 3R for exterior applications. Enclosures shall have provisions for padlocking, minimum two padlocks.
- B. Breakers shall be Electronic Trip, Square D Micrologic with L,S & I adjustable trip settings with ampacity as shown on the drawings. Settings shall be determined by the Power System Study.

- C. Minimum short circuit interrupting rating shall be 10 KAIC. Breakers used as service entrance devices shall be UL labeled for such use.
- D. Furnish circuit breakers as manufactured by Square D or pre-approved equivalents acceptable.

2.09 FUSES

- A. Provide a fuse for each gap in the work.
- B. Fuses specified to be current limiting type, shall be NEMA Class J, and Class L, and shall be coordinated with circuit breakers. Dual element fuses shall be Class RK-5. Provide three (3) spare fuses for each different fuse installed on project. Fuses shall be manufactured by Bussman.
- C. All fuses for mechanical equipment shall be dual element, time delay, with size as required by equipment manufacturer.
- D. The fuse size indicated on the drawings are for bidding purposes only. Actual fuse sizes shall be determined by the manufacturer of all equipment.
- E. Submit an equipment fuse selection chart during shop drawing review that will indicate the quantity, size and type of each fuse to be installed at each disconnect. Identify listing by HVAC equipment label, disconnect switch size, fuse type and trip characteristic (size). Mechanical Contractor shall review and approve the fuse chart submission, prior to forwarding to the Engineers office.

2.10 BRANCH CIRCUIT PANELBOARDS

- A. Panelboards shall be of the dead front type and have branch circuit protectors in the quantity and of ratings indicated on the drawings. Panelboards shall be provided with separate neutral and ground bar. Lugs shall be suitable for copper or aluminum. Panelboards with main breakers shall be U.L. listed for service entrance use. Service entrance equipment shall have ground and neutral bars bonded in accordance with the NEC. Panelboard maximum width shall be 14”.
- B. Bus bars and all current carrying parts of panelboards exclusive of circuit breaker, shall be copper and sized in accordance with the requirements of the Underwriters' Laboratories, Inc.
- C. The branch circuit portions of each panelboard shall comprise the required and indicated number of interchangeable bolt-on non-combustible thermal magnetic de-

ion circuit breaker sections; single or multiple pole, rated not less than 20 amperes, 125 volts and higher as noted.

- D. In all other cases, use circuit breakers of size and type required by potential, trip rating and interrupting capacity shown on the drawings, but not less than Q-frame breakers.
- E. Circuit breakers shall be readily removable from front of panelboard without disturbing adjacent units. They shall have quick-make and quick-break toggle mechanisms, non-fusible contacts with inverse time, short circuit characteristics, and be ambient compensated. Breakers shall trip free of over load. They shall indicate clearly whether they are in the open or closed position. Multi-polar units shall have thermal element in each pole and shall have a single handle.
- F. Circuit breakers shall be manufactured and tested in strict conformance with NEMA Standards, and shall comply with Federal Specifications W-C-375.
- G. Use bolted, "quick-lag" type circuit breakers of minimum 10,000 AIC when:
 - 1. The phase-to-phase potential is 240 volts or less.
 - 2. No breaker in the panel has a frame size greater than 100 amps.
 - 3. No specific interrupting capacity is noted on the drawings.
- H. Use bolted, "quick-lag" type circuit breakers of minimum 14,000 AIC when:
 - 1. The phase-to-phase potential is 600 volts or less.
 - 2. No breaker in the panel has a frame size greater than 100 amps.
 - 3. No specific interrupting capacity is noted on the drawings.
- I. Branch circuits shall be distinctly numbered. Panelboard wiring shall be tagged at each circuit breaker with proper circuit number.

2.11 PANELBOARD CABINETS - BRANCH CIRCUIT

- A. All panelboards shall be mounted in a sheet metal enclosing cabinet designed for surface mounting as indicated on the drawings. Cabinets shall be fabricated of code gauge, galvanized sheet steel. The rear of the cabinets shall be provided with a suitable means of supporting the panelboard in such a manner that adjustments may be made in all directions.

- B. Cabinets shall have suitable lugs for mounting and be provided with steel trims and hinged doors. Doors shall be hung on trim with heavy flush butt hinges. Doors and trims shall be of integral single-door construction. Doors 48 inches high or less shall be equipped with spring locks and catches. Doors larger than 48 inches in height shall be provided with a vault type handle having 3-point shoot bolts. Covers shall be hinged door-in-door construction.
- C. In general, cabinets shall be installed so that the operating handle of the top branch circuit protector will not exceed 78 inches above finished floor and the bottom of the cabinet be not less than 12 inches above finished floor.
- D. All cabinets shall have wiring gutters at top, bottom and sides of sufficient size to adequately accommodate the conduits, wires and cables entering and leaving same. All panelboards shall conform to Article 384 of the NEC.
- E. All cabinets shall be provided with the proper number and size openings for conduits installed. No openings will be permitted which are not to be activated.
- F. In instances where it is necessary to group-install cabinets, a common trim shall be employed.
- G. Circuit directory holders shall be metal frames welded to the inside of each cabinet door and have transparent cover under which shall be placed neatly typed schedules out-lining circuit control. Adhesive backed, or self-stick transparent circuit directory holders shall be deemed unacceptable.
- H. Panelboards shall be as manufactured by Square D or pre-approved equal.

2.12 LOCKS AND KEYS

- A. All locks for lighting, power and miscellaneous panelboards, telephone cabinets and all other electrical systems having locked apparatus shall be similarly keyed.

2.13 JUNCTION, PULL AND OUTLET BOXES

- A. Junction, pull and outlet boxes shall be code sized, constructed of code gauge galvanized sheet steel, provided with screwed or removable covers. Flanged covers on flush boxes shall be smooth, square and set parallel with walls and ceilings.
- B. All box covers shall be identified by nameplates, of black laminated nameplates with white core 1/4" engravings. Non-metallic boxes shall not be used.

- C. Under no circumstances will stacked junction boxes be used. Each section of conduit requiring a pull or splice box shall be provided with a box conforming to Article 370 of the NEC for Conductor Fill Requirements.

2.14 DISTRIBUTION PANELBOARDS

- A. Standard of Design& Construction is Square D I-LINE Style.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- D. Mains: Circuit breaker or Lugs only as shown on panel schedules.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug on circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- G. The standard of design distribution panel manufactured by Square D offers the ability to install any frame size circuit breaker in the panel that they design, up to a 400 ampere frame. Should an equivalent manufacturer provide a distribution panel for this project, the entire panel shall be provided with buss bars, and breaker mounting hardware. "Provisions" or "Space Only" sections will be unacceptable. Mounting hardware to permit the installation of 100 ampere, 250 ampere and 400 ampere breakers shall be provided in the proposed panel to the maximum permitted within the panel.

2.15 WEATHERPROOF EQUIPMENT

- A. All electrical apparatus such as outlet boxes, switches, manual starters, disconnect switches, combination switches, and starters, motor starters, receptacles and plugs, etc., in the following areas shall be of the weather resistant or weatherproofed gasketed type, NEMA type 3R or 4:
 - 1. At all locations on drawings where equipment is noted "WP".
 - 2. Where required by local authorities or the NEC.
 - 3. On exterior face of buildings, except under canopies, case boxes must be used with gasket connection to fixtures. Where conduit enters or leaves a weatherproof junction box, seal the end of the conduits entering the box.
 - 4. In those areas requiring weatherproof installation, the following equipment shall be flush type: tumbler switches, thermal switches or manual motor

switches, and receptacles unless noted; except floor motor outlets and receptacles which shall extend above floor approximately six (6) inches or as noted.

5. Equipment other than that listed above, in areas to be weatherproofed, shall be of the surface type and shall generally include disconnect switches, combination switches and starters and motor starters.
6. Surface mounted boxes with electrical apparatus in areas requiring weatherproof installation shall be cast conduit type with matching covers. All switch receptacle covers shall be of rust resisting metal.

2.16 WIREWAY

- A. NEMA 1 construction, sized as indicated length as required, with hinged front cover. Unit shall be constructed of code gauge steel, without knockouts. Finish shall be ANSI-49 epoxy paint. Furnish Square D, Class 5100, or approved equal.

2.17 GROUND FAULT CIRCUIT INTERRUPTER, 120/240 VAC

- A. Ground fault interruption shall be provided at points indicated or as required by NEC; shall be accomplished through the use of receptacles with integral ground fault circuit interrupter. Receptacles shall be rated NEMA 5-20R.
- B. Each receptacle location shown on drawings that requires GFCI protection shall be provided with a GFCI receptacle. Feed thru wiring of devices is unacceptable.

2.18 GROUNDING

- A. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.
- B. All electrical systems shall be grounded and bonded in accordance with Article 250 of the National Electrical Code, and as required by the Utility Company servicing the premises.
- C. All non-current-carrying metal parts of the raceway system shall be continuous. Provide bonding jumpers as required maintaining such continuity. Where non-metallic raceways or cable assemblies are permitted and employed, a continuous, green-insulated conductor of size required by NEC shall be run in the raceway or shall be an integral part of the cable.
- D. Each and every branch circuit or feeder conduit shall contain a full size ground conductor. Absolutely no conduits shall be used as the sole means of grounding.

- E. Extend a service grounding conductor of adequate size to a grounding electrode as defined in the NEC. All connections shall be made with approved solderless connectors. The maximum resistance to ground shall be 10 ohms. Install additional electrodes using 3/4" x 10' ground rods, until such resistance is reached. All connections between cables and to ground rods shall be of the exothermic-welded type. (Cadweld or approved equal).
- F. Ground rods shall be the one-piece type with copper encased steel construction.
- G. Each ground rod shall be dye stamped near the top of the rod with the name or trademark of the manufacturer and the length of the rod in feet.
- H. Ground rods shall be driven full length, plus 6 inches. In areas which do not permit complete insertion, insert full length, less 4".
- I. Provide bonding jumpers to all underground piping systems (gas, water, etc).
- J. Provide a Fall-In-Potential ground test on all new electric service grounding systems prior to energization of the main switchboard.

2.19 SURGE PROTECTION DEVICE

- A. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.
- B. Provide a Surge Protective Device (SPD) unit to protect the pumpstation electrical distribution system from damaging transients imposed by external factors.
- C. Standard of design is Square D Model EMA, Rated 160kA for Panel DP. Panel MDP shall receive an integral SPD with the Distribution panel rated 240kA.
- D. Unit shall be rated for connection to the 208Y/120VAC, 3 Phase, 4 Wire Distribution Systems.
- E. Unit shall protect the following sequences in all modes:
 - 1. Line to Ground
 - 2. Line to Line
 - 3. Line to Neutral
- F. System performance shall be based on UL 1449 listing ratings for IEEE C62.41 Category B impulse waveforms of 600V - 1.2 x 50 microsecond equipment.

- G. Install unit per manufacturers written recommendations.
- H. Provide 3 spare modules.

2.20 LIGHTING

- A. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.
- B. The Electrical Contractor shall furnish a complete complement of luminaries and required associated appurtenances including all hangers, lamps and accessory wiring. Provide all labor and materials necessary to assemble, install and test the specified equipment in the manner indicated. Lighting equipment shall be as described under "Lighting Fixture Schedule" on the drawings.
- C. Provide all miscellaneous factory furnished supports required to span steel joints or as required.
- D. Fixtures installed in damp areas shall be equipped with neoprene gaskets and anodized aluminum frames.
- E. Coordinate fixture installation and connection with all other trades on the job. Failure to coordinate this will result in relocation of components as directed by the Engineer.
- F. A manufacturers' standard fixture is designated on the drawings for each of the fixtures in order to establish a standard of quality, a finish, and a desired effect. The catalog numbers used for this designation are not intended to completely specify the fixture mounting requirements and coordination of such mountings with final finished ceiling. Such coordination is the responsibility of the Contractor. All recessed fixtures shall be provided with thermal cutout protection per N.E.C.
- G. All inoperable lamps shall be replaced with new lamps during the course of construction, up to and including the date of final acceptance of the building.
- H. Fixture sound levels shall not exceed ASHRAE NC-30 design goals in area to which they are applicable. Fluorescent ballast acoustic noise level shall be no louder than General Electric Company rating "A".

2.21 TERMINAL BLOCKS

- A. Terminal blocks shall be provided for all field wiring transitioning into Service Enclosure. Terminal Blocks shall equal Square D Class and Type as follows:
 - 1. Line Voltage (600V): Class 9080, Type LB.
 - 2. Low Voltage (24V): Class 9080, Type G with DIN Rail Mounting.

2.22 PHASE FAILURE RELAY

- A. Phase failure relay shall be Square D/Schneider Electric Class 8430 Type MPD.
- B. The Class 8430 Type MPD phase failure relay is a voltage sensing device that trips on phase loss, phase reversal, voltage unbalance, or undervoltage. Voltage unbalance trips the device when any voltage drops 10% below the average. Undervoltage is externally adjustable from 75–100% of the rated voltage. The LED on the front of the device lights when the device is energized.
- C. Two 600 V Form C output contacts shall be provided for interconnection to the SCADA system.

2.23 UNISTRUT FRAMING

- A. Steel framing for mounting of electrical equipment shall be as manufactured by Unistrut or pre-approved equal, Type PS200 and have nominal dimensions of 1-5/8" x 1-5/8".
- B. All framing shall be hot dipped galvanized by the factory. Apply cold galvanizing applied with brush (no spray galvanizing) on all cut ends.
- C. Provide all fittings as required for a complete and rigid assembly.
- D. All sections shall be continuous, do not splice any sections to develop required lengths.

2.24 CONCRETE EQUIPMENT PADS

- A. Concrete pads for Service Enclosure and Generator shall be furnished by the General Contractor. Provide required dimensions to allow for proper placement of all equipment. All equipment shall have 4" clearance to edge of pads.

2.25 PUMP CONTROL PANEL

- A. The pump control panel shall be provided by the pump manufacturer. Standard of Design is Gorman/Rupp. Refer to Specification Section 26 70 00 for specific pump control panel requirements.

2.26 RTU/RADIO SYSTEM

- A. Refer to specification section 26 19 16 for detailed specifications for this equipment.

PART 3 - METHODS

3.01 GENERAL

- A. Installation work of all indicated electrical equipment shall include providing all labor, supervision, and all means of construction to install the indicated equipment and systems.
- B. All work shall be installed a first class, neat, and workmanlike manner by mechanics skilled in the trade involved. All details of the installation shall be mechanically and electrically correct. Should the Engineer direct removal, change, or installation of any equipment or systems not installed in a neat and workmanlike manner, such changes shall be made by the Electrical Contractor at no expense to the Owner.
- C. Drawings are generally indicative of the work to be installed, but do not indicate all bends, fittings, boxes, and specialties which may be required, or the exact locations of all conduits. Contractor shall investigate structure and finish conditions affecting his work and arrange his work accordingly, furnishing such fittings as may be required to meet such conditions.
- D. Electrical junction boxes, pull boxes, switches and controls and other apparatus requiring periodic maintenance and operation shall be accessible. Provide access panels as required.
- E. Review by the Engineer of materials, drawings, or equipment submitted by the Contractor in the shop drawing review phase shall be considered general only, and shall be an aid to the Contractor in carrying out his work. Such review does not relieve the Contractor from the necessity of furnishing the materials and performing all work required by the drawings and specifications to provide a complete and operating electrical system as described.

3.02 WIRING METHODS

- A. In all cases, a continuous conduit-and-box system shall be provided for all wiring, equipment, devices, etc. Provide a continuous ground wire of size required by National Electrical Code in all conduits. Minimum conduit size shall be 3/4 inch. In exterior applications, above grade, the following conduit system shall be used: rigid steel. In addition, this type of conduit system shall be used outdoors, or where moisture may enter the conduit system. EMT shall not be used.
- B. In exterior applications, below grade, the following conduit system shall be used: PVC SCHEDULE 80, rigid non-metallic. Provide all required transition sections to go from one conduit system to another.
- C. In exterior applications, above grade, use galvanized rigid steel.
- D. Aluminum conduit shall not be used for mechanical protection of bare copper conductors. Aluminum conduit shall not be mixed indiscriminately with other types of conduit in the same system. Aluminum rigid conduit and EMT may be used in extensions from rigid steel conduits turned up from floor slabs or fill into partitions not made of concrete, provided the steel conduit extends at least nine inches above the slab or fill. Couplings connecting rigid steel conduit and EMT shall be rigid, concrete tight, of a type that will not twist loose, and designed to insure a positive, low resistance ground connection.
- E. Flexible metallic conduit shall be employed in making final connections to motor terminals. Rigid metal raceways may be supplemented in limited lengths by flexible metallic conduit if necessary to overcome building obstructions. Liquid tight flexible metal conduit shall be employed in making final connections in wet locations.
- F. Common neutral circuits shall not be used. Each and every circuit requiring a neutral shall be served by a dedicated neutral conductor.

3.03 CONDUIT INSTALLATION

- A. Obtain Engineer's prior written approval on installation of all work that may affect structural values.
- B. All raceways shall be run parallel with, or perpendicular to, the lines of the Building.
- C. Carefully ream the ends of all field-cut conduits, and fit them together firmly and truly at the joints.

- D. Where using rigid steel or aluminum conduit, waterproof all couplings, box connections, etc., and turn them up sufficiently tight to ensure a good electrical bond.
- E. Slip-type fittings shall be provided in all raceways at construction joints with a copper bonding jumper or other approved grounding device.
- F. A separation of at least six inches shall be maintained between electrical conduits and hot water and steam piping. Run all exterior underground conduits at least 24 inches below finished grade.
- G. All conduits which are to remain empty for future introduction of conductors or for installation of cabling by others shall be provided with a polyethylene pullrope and insulated bushing on the end of the conduit.
- H. Conduits terminating in steel boxes shall be provided with approved locknuts inside and outside of the box and fitted with an approved insulating bushing.
- I. Where conduits penetrate masonry walls, the contractor shall seal the exterior of the conduit with hydrostatic link seals and provide a UL listed waterproof sealant within the conduit.

3.04 CONDUCTOR INSTALLATION

- A. Use properly-insulated, UL-Listed solderless pressure connectors for all branch circuit splices. "Wire nuts" are not to be used. When pulling conductors into their raceways, use no grease, oil or compound that might cause deterioration of the braid or insulation on the conductors. All pulling compounds used must be UL-Listed. Swab out all raceways before installing wires.
- B. Do not install wires in any raceways until the conduit system has been completed and all inspections performed.
- C. Minimum wire size for all lighting and power shall be as specified on the drawings or hereinafter. Loading of branch circuits shall be as indicated on panel schedules on drawings. Voltage drop shall not exceed that permitted by NEC, and this Contractor shall increase wire and conduit size as required to maintain these values.

3.05 EQUIPMENT MOUNTING HEIGHT & LOCATIONS

- A. Examine all interior details of Engineer's drawing for outlet locations to verify conformance with listed schedules.

- B. Where more than one wiring device occurs in any one location, arrange devices in gangs with common cover plate.
- C. The Owner or Engineer, reserves the right to move any outlet, lighting fixture or component of the electrical system a distance of 10 feet prior to installation free of additional cost.

END OF SECTION 26 05 00

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Identification for raceways.
- 2. Identification of power and control cables.
- 3. Identification for conductors.
- 4. Underground-line warning tape.
- 5. Warning labels and signs.
- 6. Instruction signs.
- 7. Equipment identification labels, including arc-flash warning labels.
- 8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

- B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

- C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

- D. Delegated-Design Submittal: For arc-flash hazard study.

1.4 GENERAL/COORDINATION

- A. Identify electrical conductor terminations and splices in outlet boxes, receptacles, light fixtures, pull boxes, panel cabinets or other locations when directed with manufacturer's standard vinyl cloth, self-adhesive cable/conductor markers of wrap-around type; either pre-numbered, plastic-coated type, or write-on type with clear plastic, self-adhesive cover flap; numbered to show circuit

identification. Identification shall include panel or switchboard number, and circuit or feeder number. Before tagging, lace or ty-wrap together all conductors forming a circuit or feeder.

- B. Identify all electrical distribution and control cabinets and all equipment throughout the facility as to nature, service and purpose, by means of permanently attached, laminated phenolic nameplates with beveled edges, dull black with white core, and 1/2 inch lettering. Fasten with sheet metal screws, drive rivets, or "pop" rivets. Glue or other forms of adhesive shall be used as a means of supplementary attachment only. Provide engraved device plate with voltage, phase, and amperage on all receptacles operating at other than 120 VAC.
- C. All wiring devices shall be labeled indicating the source panel and circuit. Label shall be a clear, adhesive backed with black letters (ex: DP1-14).
- D. All junction boxes and pull boxes shall be labeled with indelible marker indicating all circuits contained within the junction box.
- E. All panelboards incorporating 100 ampere frame or larger circuit breakers shall be provided with laminated phenolic nameplates which identify each circuit breaker. All circuit breakers in the Main Distribution panel shall be provided with same.
- F. All electrical feeders shall have color coded insulation. Field color coding of feeders is not acceptable.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70 & 70E.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. White letters on black field
 - 2. Legend: Indicate voltage and system or service type.

2.3 LABELS

- A. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - a. Seton
 - b. Thomas & Betts
 - c. Brady

- B. Snap-Around Labels for Raceways and Cables Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceways they identify, and that stay in place by gripping action.
 - a. Seton
 - b. Thomas & Betts
 - c. Brady

- C. Self-Adhesive Labels:
 - a. Seton
 - b. Brady
 - c. P-Touch
 - 2. Preprinted, 3-mil- (0.08-mm-) thick, polyester flexible label with acrylic pressure-sensitive adhesive.
 - a. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the cable diameter, such that the clear shield overlaps the entire printed legend.

 - 3. Polyester, thermal, transfer-printed, 3-mil- (0.08-mm-) thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
 - a. Nominal Size: 3.5-by-5-inch (76-by-127-mm).

 - 4. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

 - 5. Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

- D. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm) .

- E. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. inches (129 sq. cm), minimum 1/16-inch- (1.6-mm-).
 - b. For signs larger than 20 sq. inches (129 sq. cm), 1/8 inch (3.2 mm) thick.

- c. Engraved legend with white letters on a black face.
- d. Punched or drilled for mechanical fasteners.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- G. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- H. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.
- I. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- J. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact,

side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

- K. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

3.3 IDENTIFICATION SCHEDULE

- A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch- (100-mm-) wide black stripes on 10-inch (250-mm) centers over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- (75-mm-) high black letters on 20-inch (500-mm) centers. Stop stripes at legends. Apply stripes to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inches (300 mm) of a floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor to identify the phase.
 - 1. Color-Coding for Phase-and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - a. **All feeders shall have color coded insulation. No color code labels shall be used.**
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.

- d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign, including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
- F. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine plastic label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - c. Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Equipment To Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - e. Emergency system boxes and enclosures.

- f. Motor-control centers.
- g. Enclosed switches.
- h. Enclosed circuit breakers.
- i. Enclosed controllers.
- j. Variable-speed controllers.
- k. Push-button stations.
- l. Power-transfer equipment.
- m. Contactors and timers.
- n. Photocells
- o. Remote-controlled switches, dimmer modules, and control devices.
- p. Battery-inverter units.
- q. Battery racks.
- r. Monitoring and control equipment.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 05 70 - POWER SYSTEM STUDY

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

- A. Applicable provisions of the entire Project Manual, including Addenda, shall govern this section as fully as if repeated herein.
- B. Refer specifically to the technical provisions of the COMMON WORK REQUIREMENTS FOR ELECTRICAL Section 26 04 99.

1.02 SCOPE OF WORK

- A. The switchgear manufacturer shall provide a short circuit, arc flash, and protective device coordination study for the new electrical distribution system based on NFPA 70E-2015.
- B. It is important to note that the submission of the Power System Study is in the project's critical path and none of the new switchgear (panelboards, transformers disconnects, etc.) can be released for production until the Power System Study is submitted and approved. As such, the need for the contractor to obtain all pertinent field data and collect new equipment shop drawings is critical such that the Power System Study can commence as promptly as possible. The subsequent creation and submission of the Power System Study must be made within 8 weeks after the issuance of the Contractors Purchase Order.
- C. The studies shall include all portions of the electrical distribution system from the Utility Company fuses and to all equipment. Normal system connections and those connections which will result in maximum fault conditions shall be adequately defined in the study. All components identified on the single line diagram shall be included in the Study.
- D. The Power System Study shall be performed by the Switchgear manufacturer under the direction of a Registered Delaware Professional Engineer.
- E. The studies shall be submitted to the Engineer for review and approval prior to the release of equipment for manufacturing.
- F. All field data required to complete the Power System Study shall be provided by the Contractor. This includes but is not limited to serial/catalog numbers of all overcurrent devices, transformer impedances, distribution equipment, cable and conduit sizes, lengths, etc.

- G. Once the final Power System Study is approved by the Engineer of Record, the contractor shall perform all field settings to circuit breakers and overcurrent devices to reflect the device settings identified in the Study.
- H. Contractor shall apply all Arc Flash labels on all distribution equipment.

1.03 UTILITY COMPANY INFORMATION

- A. The contractor shall contact the utility company to obtain the following information for the Power System Study:
 - a. Phase & Neutral Primary Fault Current
 - b. Service X/R Ratio
 - c. Transformer kVA Rating
 - d. Transformer Impedance

1.04 REPORTS

- A. An initial report shall be provided electronically along with one (1) color printed copy to the Engineer for review and approval within FOUR (4) weeks after the issuance of the contractor's purchase order. This review will establish minimum ratings of all equipment. All revisions shall be submitted in no more than 3 weeks after Engineers formal review. Failure to provide the prompt submissions of the initial and subsequent Studies in the stated period of time will cause the vendor and contractor to be in default of the contract and subject to a penalty of \$2,500.00.
- B. Upon review of the initial report by the Engineer and within 14 business days of the return of the initial report, participate in a conference call to review all Engineer's comments. Included in the call will be the Owner, Engineer, Contractor, Distributors of all new equipment and the Engineer preparing the Power System Study. Incorporate any required changes to allow proper coordination and ratings of equipment and submit a subsequent report that documents the required changes. Initial approval of this report is required prior to the release of any switchgear for the project.
- C. Repeat this process until all outstanding discrepancies are rectified. Once the final Power System Study is approved, switchgear shall be constructed to conform to the study and released for production. This final Power System Study shall be used to set all overcurrent devices to proper set points and Arc Flash labels printed and applied to switchgear.
- D. Provide one (1) electronic and five (5) copies of all final reports. Ensure one (1) complete short circuit and overcurrent coordination study is included in each of the three (3) operating and maintenance manuals.

1.05 REFERENCES

- A. The Short Circuit Study shall be prepared in accordance with the most recent ANSI, IEEE and NEC Standards; IEEE STD 141 (1986), IEEE STD 242 (1986), IEEE STD 399 (1990).

1.06 SHORT CIRCUIT STUDY

- B. The short circuit study shall be performed with the aid of SKM Power Tools licensed software.
- C. The short circuit study input data shall include the utility company's short circuit contribution, resistance and reactance component of the branch impedances, the X/R ratios, base quantities selected and other source impedances.
- D. Short circuit momentary duty values and interrupting values shall be calculated on the basis of assumed bolted three-phase bolted short circuits at the incoming switchgear bus (unless specific short circuit information is available); at all significant locations throughout the system. The short circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, the total duty on the bus in addition to the individual contribution from each connecting branch shall be listed with its respective X/R ratio.

1.07 ARC-FLASH STUDY

- A. The Arc-Flash Hazard Analysis shall be performed with the aid SKM Power Tools licensed software and will result in Arc-Flash Incident Energy (AFIE) levels and approach boundary distances.
- B. The Arc-Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.
- C. Results of the Analysis shall be submitted in tabular form, and shall include device or node bus name, bolted fault and arcing fault current levels, approach boundary distances, personal-protective equipment classes and AFIE levels.
- D. The analysis shall be performed under worst-case Arc-Flash conditions, and described in the final report, how these conditions differ from worst-case bolted fault conditions.
- E. The Arc-Flash Hazard Analysis shall be performed by a registered professional engineer.

- F. The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584-2002, the IEEE Guide for Performing Arc-Flash Calculations.
- G. The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety.
- H. The proposed vendor shall demonstrate experience with Arc-Flash Hazard Analysis by submitting names of at least ten (10) actual Arc-Flash Hazard Analyses it has performed in the past year.
- I. The proposed vendor shall demonstrate capabilities in providing equipment, services, and training to reduce Arc-Flash exposure and train workers in accordance with NFPA 70E and other applicable standards.
- J. The proposed vendor shall demonstrate experience in providing equipment labels in compliance with NEC-2002 Section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes.

1.08 PROTECTIVE DEVICE COORDINATION STUDY

- A. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or check the selection of power fuse ratings, protective relay characteristic and settings, ratios and characteristics of associated current transformers and low voltage circuit breaker trip characteristics and settings. The objective of the study is to obtain optimum protective and coordination performance from these devices to a level of 0.1 seconds.
- B. The coordination study shall include all medium and low voltage classes of equipment from the utility incoming line protective device and emergency generator down to and including all 480 volt and 208 volt rated branch circuit panelboards and equipment.

The phase and ground over current protection shall be included as well as settings of all other adjustable protective devices.

- C. The time-current characteristics of the specified protective devices shall be drawn on log-log paper. The plots shall include complete titles representative of one-line diagrams and legends, associated utility company's relay or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breaker trip curves and fuse curves. The coordination plots shall indicate the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault

currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be supplied on a system basis. A significant number of separate curves shall be used to clearly indicate that coordination is achieved.

- D. The selection and settings of the protective devices shall be provided separately in a tabular form listing circuit identification, IEEE device number, current transformer ratios and connections, manufacturer and type, range of adjustment and recommended settings. A tabulation of the recommended power fuse or relay setting selection shall be provided where applied in the system.
- E. All field data required to perform the Power System Study shall be provided by the Contractor. This includes serial/catalog numbers, cable sizes, lengths, etc. as well as contacting the utility company to obtain transformer impedance and available short circuit current.
- F. Provide device setting changes on circuit breakers or relays to conform to study requirements. Prior to ordering switchgear or generator, Power System Study shall be completed in order to ensure new overcurrent devices and panel interrupting ratings are adequately sized and rated. Modify AIC ratings of panels and circuit breakers to conform to Power System Study requirements at no additional cost to the owner.

END OF SECTION 26 05 70

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 09 16 - REMOTE TELEMETRY UNIT

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

1. Applicable provisions of the entire specifications, including Addenda, shall govern this section as fully as if repeated herein.
2. Refer specifically to the technical provisions of 26 04 99, "COMMON WORK REQUIREMENTS FOR ELECTRICAL.
3. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.
4. All work to be completed under this specification shall be performed by Interface, Inc. Attn.: Lee Bopst, 752 Ardenwood Drive, Eldersburg, Md. 21784. 410-795-6795 (Office), 410-562-7604 (Cell), (email) lbopst@aol.com , **There are No Equals.**

1.2 NOTE

1. The requirements of Section 26 04 99 General Requirements-Electrical shall apply to all work specified under this section.

Abbreviations:

I/O	Input / Output
RTU	Remote Telemetry Unit
SCADA	Supervisory Control and Data Acquisition
UL	Underwriters Laboratory

1.3 SCOPE

- A. The work includes providing all labor, materials, equipment and services necessary for and incidental to the complete and satisfactory installation of the RTU and supervisory control and data acquisition system components including but not limited to radio RTU transceiver, antenna, etc. The RTU will be integrated into the County's SCADA system. This system provides alarm annunciation, system monitoring and data collection. The Contractors scope under this project shall include integrating the controls at the station, and programming.

- B. System Integrator will be responsible for assisting in integrating the status, alarms, etc. into the SCADA system on the pumping station side as typically required by the owner for complete and satisfactory installation as determined by the Engineer and Owner. The Contractor will work with the County to integrate information from the RTU into the SCADA system.

1.4 SYSTEM INTEGRATOR

The Contractor shall utilize the county's approved RTU System Integrator for the equipment and work required in this section. The county's approved RTU systems integrator is Interface, Inc., no other System Integrator shall be used for this work.

1.5 DESCRIPTION OF WORK

- A. For the convenience of all parties concerned, the major items included in the project are briefly outlined below. Note that this is a general check list only, not necessarily complete.
 - 1. Provide a RTU as described in this specification. The System Integrator shall be responsible for RTU configuration and programming.
 - 2. Provide RTU components for radio communications, back up power, etc., as specified. All communications equipment shall be installed and certified by the manufacturer's authorized communication technician.
 - 3. Install RTU, radio components, etc., in enclosures as shown on the contract drawings and integrate with station equipment and pump control panel. All control panels shall be fabricated and certified in accordance with U.L. 508 certification guidelines.
 - 4. Perform signal strength testing to finalize radio tower height. The transmit site for testing is existing. All communications test results shall be submitted for review with shop drawings.
 - 5. Provide operation and maintenance manuals, training, spare parts, etc., as specified.

1.6 SUBMITTALS

Submittals for approval shall be as specified in SUBMITTALS and include, but not be limited to the following:

- A. Manufacturers descriptive literature and data sheets indicating relevant features, certifications, capacities and identification numbers, and RTU's, radio equipment, surge protection devices, panel devices and all other incidental equipment.
- B. Drawings showing dimensions, mounting, and external connection details for the RTU's and radios. Provide legend of engravings for control panel nameplates on submittal drawings.
- C. Wiring schematics for connections between radio and RTU hardware. Include panel wiring schematics for control power distribution, fuses, circuit breaker and other relevant information.
- D. Written description of the attributes of programming developed for the installation of the RTU, including procedures for modifications, downloading, and programmer operation, if applicable. Provide hard and soft copy of RTU program documentation including ladder logic, cross reference, memory usage, symbols and descriptions.
- E. Provide fully documented RTU program on CD-ROM and printed for review and approval. Provide one copy of final RTU program on CD-ROM and printed on 8-1/2" x 11" paper in O&M manuals.
- G. RF signal strength test results including dB fade margin, etc.

1.7 WARRANTY

- A. The warranty shall provide (a) a minimum of next-day, on-site service for emergency failures, and (b) replacement of the defective component within one week, if repairs cannot be effected within that time. A five day response time, on-site service, is required for non-critical failures. Work under the warranty shall be provided by the System Integrator responsible for the system installation. This warranty shall cover a period of one year from the date of final acceptance of the project. The County shall be the sole determiner of the severity of a failure and whether the failure is an emergency or non-critical failure.

1.8 CONTRACTORS (SYSTEM INTEGRATOR) RESPONSIBILITY

- A. It shall be the System Integrator's responsibility to furnish a complete and functional, fully integrated RTU system as described in this bid package. This includes all software and hardware devices necessary to interface the components of the pumping station, programming and configuration of

devices, installation and testing of all control and instrumentation equipment.

- B. System Integrator responsibility shall include review of all appropriate drawings and specification sections for this entire project. This shall include review of specifications for all equipment, electrical contract drawings and specifications, and any other equipment interfacing to the RTU, as required to provide necessary point-to-point wiring schematics and compliance with the functional requirements of these Specifications.
- C. All special cables, such as communication cables, co-axial cable, or sensor/transmitter specialty interconnection wiring, shall be furnished.
- D. The System Integrator shall be responsible for the detailed design, installation and the proper functioning and performance of the RTU System, the preparation of the required submittal data, conducting all tests, calibrations and operational demonstrations, and providing technical supervision for the installation and connections to equipment. The system supplier shall not necessarily be the manufacturer of the equipment to be furnished.
- E. The System Integrator shall, for the duration of this contract and the guarantee period, provide next day, on site service for all RTU problems as discussed in other areas of this specification.
- F. Provide integrated operation and maintenance manuals and operation training.

1.9 MANUFACTURER'S CERTIFICATE

The System Integrator shall furnish the Owner with a Manufacturer's Certificate, as specified under Section SUBMITTALS certifying that the RTU SYSTEM and associated components have been installed under either the continuous or periodic supervision of the manufacturer's authorized representatives, that they have been tested, adjusted and initially operated in the presence of the manufacturer's authorized representatives and are operating in accordance with the specified requirements to the manufacturer's satisfaction.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The RTU system shall be configured as shown on the Contract Drawings and as specified herein. It shall be capable of the I/O specified on Contract Drawings.

- B. All components of the RTU system shall be supplied as a complete, fully integrated package by the same System Integrator responsible for system installation. Control Panels shall be fabricated and certified by a UL certified Industrial Control panel fabricator, and in accordance to U.L. 508 certification standards for industrial control panels.

2.2 TELEMETRY UNIT

- A. Refer to Appendix A for Radio Survey report, specific to this location.
- B. Refer to Appendix B for system component requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The System Integrator shall install the RTU system and all appurtenances in conjunction with pump controller and in accordance with the manufacturer's recommendations, U.L. guidelines and local code requirements.
- B. Installation of the Pump RTU system shall proceed according to the System Integrators approved progress schedule.

3.2 TESTING

- A. In conjunction with the pump station testing, the System Integrator shall provide a demonstration of the RTU system. A test procedure shall be developed by the System Integrator and transmitted to the County for approval no later than 14 days prior to the test date. The factory test shall be performed at the System Integrator's facility and witnessed by the Engineer and the Owner's representative(s).
- B. Upon installation of the RTU, the system shall be tested, deficiencies resolved and retested as required to satisfactorily demonstrate the following:
 - 1. Test all RTU input devices to verify operability and calibration.
 - 2. Test RTU battery backup and UPS system in the event of loss of power and the push-button activated self-test program.

3.3 TRAINING

The RTU system supplier shall provide and/or arrange for training of personnel at the job site. Training shall be for a minimum of one 8 hour day at each station. The training shall occur after successful startup of the system. As described in Manufacturer's certification & start up, the training program shall include operator training, programming and maintenance courses in conjunction with pump station definition.

3.4 SPARE PARTS

The contractor shall furnish to the engineer all necessary spare parts and components required to maintain the system. Prior to final acceptance of work, the contractor shall provide a spare parts listing of all necessary spare parts and quantities for review by the engineer.

- a. Display/Keypad Module
- b. Display/Keypad Ribbon Cable
- c. Transmitter Interface
- d. Discrete Output Board
- e. Discrete Input Board
- f. Analog Input Board
- g. Analog Output Board
- h. Communications Board
- i. CPU Board

END OF SECTION 26 09 16

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Snap switches and wall-box dimmers.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 SHOP DRAWINGS

- A. Submit product literature for each device specified.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Hubbell
2. Pass & Seymour
3. Or approved equal

- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

2.4 GFCI RECEPTACLES

- A. General Description:
1. Straight blade.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A
1. Single Pole, Two Pole, 3 way, 4 way:
- C. Pilot-Light Switches, 20 A:

1. Description: Single pole, with neon-lighted handle, illuminated when switch is "off."
- D. Barrel Style Key-Operated Switches, 120/277 V, 20 A:
1. Description: Single pole, with factory-supplied key in lieu of switch handle.

2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: 0.035-inch thick, satin-finished, Type 302 stainless steel.
 3. Material for Unfinished Spaces: 0.035-inch thick, satin-finished, Type 302 stainless steel.
 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with cord connected.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 4. Existing Conductors:

- a. Cut back and pigtail, or replace all damaged conductors.
- b. Straighten conductors that remain and remove corrosion and foreign matter.
- c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use P-Touch type machine printing with Black letters on white field.
- C. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 3. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 4. Using a test plug, verify that the device and its outlet box are securely mounted.
 5. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- D. Wiring device will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 32 13 - EMERGENCY/STANDBY GENERATOR

PART 1 GENERAL

1.1 GENERAL PROVISIONS

- A. Applicable provisions of the entire specifications, including Addenda, shall govern this section as fully as if repeated herein.
- B. Refer specifically to the technical provisions of the Common Work Requirements for Electrical, Specification Section 26 04 99.
- C. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.

1.2 RELATED DOCUMENTS

- A. The work covered by this section of the specifications includes the furnishing of all labor, material, equipment and performance of all operations in connection with furnishing a new Emergency/Standby generator and an automatic transfer switch as indicated on the drawings and as specified herein.
- B. The requirements of the conditions of the contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.
- C. The complete installation shall conform to the applicable sections of the latest edition of the National Electrical Code, Local Authorities having jurisdiction and the local utility serving the premises.
- D. The work covered by this section of the specifications shall be coordinated with the related work.

1.3 SCOPE

- A. This specification covers requirements for providing a factory built, prototype tested, production tested, field tested, complete and operable emergency/standby electric generating system, including all devices and equipment specified herein, shown on the drawings, and/or as required for the service. Materials and equipment shall be new and current, delivered to the site completely wired, tested, and ready for installation. This system shall include the following:

1. One (1) Engine-generator set rated 50kW/62.5KVA at 80% P.F., open unit with 105°C Rise, extended stack alternator, 24 hour sub-base fuel tank at full load.
 2. Mounted and loose accessories, parts, tests, documents, and services, as needed to meet the performance requirements of this specification.
- B. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.
 - C. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
 - D. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service for a period of five (5) years. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.
 - E. Contractor shall fill the generator fuel tank with 15ppm low sulfur diesel fuel.

1.4 CODES AND STANDARDS

- A. The generator set and its installation and on-site testing shall conform to the requirements of the following codes and standards:
 1. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
 2. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 3. FCC Part 15, Subpart B.
 4. IEC8528 part 4. Control Systems for Generator Sets
 5. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
 6. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 7. IEEE587 for voltage surge resistance.

8. Mil Std 461D –1993. Military Standard, Electromagnetic Interference Characteristics.
 9. Mil Std 462D - 1993. Military Standard, Measurement of Electromagnetic Interference Characteristics.
 10. NEMA ICS10-1993 – AC Generator sets.
 11. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 12. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
 13. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
 14. UL2200. The genset shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.
 15. EPA and DNREC Compliant Engine Certified to current EPA Tier 4 emission standards for units of this size and fuel source.
- B. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.5 ACCEPTABLE MANUFACTURERS

- A. Only approved bidders shall supply equipment provided under this contract. Equipment specifications for this project are based on generator sets manufactured by Cummins with microprocessor-based controls. Kohler Power Systems equivalents acceptable subject to footprint limitations. Equipment by other suppliers that meets the requirement of this specification is acceptable, if approved not less than ten (10) days before scheduled bid date. Proposals must include a line-by-line compliance statement based on this specification.
- B. The manufacturers may offer products similar in type, style and features. Listing does not indicate their product meets the requirements of this specification. It is the

vendor and contractor's responsibility to ensure full compliance subject to the terms of these specifications. In the event that a listed approved manufacturer does not meet the specifications during the submittal phase of the project, the contractor shall provide one that does at no additional cost to the owner.

- C. Use of any manufacturer other than the standard of design that requires changes to equipment pad dimensions, rough in locations, etc shall be included. No extras for revised requirements.

1.6 SUBMITTALS

- A. Within ten (10) days after award of contract, provide one (1) electronic submission of the following information for review:
 - 1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
 - 2. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
 - 3. Manufacturer's certification of prototype testing.
 - 4. Manufacturer's published warranty documents.
 - 5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
 - 6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
 - 7. Manufacturer's installation instructions.
 - 8. Upon final approval of the submission, provide five (5) bound copies for record purposes.

1.7 LITERATURE

- A. The manufacturer shall have printed literature and brochures describing the standard series specified (not a one of a kind fabrication). Unless specified otherwise herein, all performance data and other information shall be as on the manufacturer's printed literature. Performance data shall be the result of test procedures in accordance with nationally recognized standards, plus such other procedures that are judged necessary by the manufacturer to insure maximum service reliability by the Engineer upon request.

1.8 SUBMITTALS

- 1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
- 2. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.

3. Manufacturer's certification of prototype testing.
4. Manufacturer's published warranty documents.
5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
7. Manufacturer's installation instructions.

1.9. AS-BUILT DRAWINGS

1. As-built drawings will be required for all work covered under this specification section. Refer specifically to Section 26 04 99 for special As-Built requirements.

1.10. FACTORY TESTING

1. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance. Test shall be conducted at 0.8 PF and run for 2 Hours at full load. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.
2. Complete engine/generator and transfer switch shall be shipped by the manufacturer, F.O.B. to the job site. Contractor shall be responsible for receiving storage and installation of equipment as indicated on the drawings.

1.11. ON SITE ACCEPTANCE TEST

1. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
2. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a four hour full load test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

3. Upon verification that all systems are compliant, generator shall be started and tested for proper operation and adjusted to ensure output characteristics as specified herein.
4. Upon successful completion of test, a report shall be prepared, indicating the following items:
 - a. Time & date of report
 - b. Personnel present
 - c. KW rating of load bank
 - d. Output characteristics under no-load and full load conditions to include:
 - (1) Voltage - line to line, line to neutral (All Phases)
 - (2) Amperage
 - (3) Frequency
 - (4) Oil Pressure
 - (5) Coolant Temperatures
 - (6) Run time at start
 - (7) Run time at completion
 - e. Generator start time
 - f. Generator transfer
 - g. Generator re-transfer
 - h. Generator time delay stop
 - i. Any abnormalities found

One (1) copy of the report shall be provided in each of the Operating & Maintenance Manuals as described in Section 26 04 99.

5. During the final inspection of the system, the system will be re-tested under actual load conditions in the presence of the Owner, Engineer, Contractor and manufacturer's authorized representative who performed the load bank test.

1.12. WARRANTY

1. The complete standby electric power system, including 1800 r/min engine-generator set, transfer switch, enclosure, fuel tank and all appurtenances, shall be warranted for a period of five (5) years or fifteen hundred (1,500) operating hours, whichever occurs first, from the date of commissioning against defects in materials and workmanship. Multiple warranties for individual components (engine, generator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. This warranty shall be detailed in available written documents. In the judgment of the Engineer, the manufacturer supplying the warranty for the complete system must have necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

2. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.
3. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

1.14 SEQUENCE OF OPERATION

- A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.
- B. The generator set shall complete a time delay start period as programmed into the control.
- C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.
 2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.
 3. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
 4. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous state.
 5. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

6. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
7. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

PART 2 PRODUCTS

2.1 GENERATOR SET

A. Ratings

1. The generator set shall be Cummins Model C50 D6 and operate at 1800 rpm and at a voltage of: 480Y/277 Volts AC, three phase, 4-wire, 60 hertz.
2. The generator set shall be rated at 50 kW/62.5 kVA at 0.8 PF, Standby rating, based on site conditions of: Altitude 100 feet (30.5 meters), ambient temperatures up to 122°F (50°C).
3. The generator set rating shall be based on emergency/standby service.

B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.
3. The diesel engine-generator set shall accept a single step load of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Motor starting capability shall be a minimum of 225 kVA. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%.

5. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

2.2 ENGINE AND ENGINE EQUIPMENT

- A. The engine shall be diesel fired, EPA Certified to Tier 3, four (4) cycle, turbocharged and charge air cooled. Minimum displacement shall be 3.26 Liter, with 4 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:

1. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.
2. Skid-mounted radiator and cooling system rated for full load operation in 122°F (50°C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H₂O restriction. Radiator shall be sized based on a core temperature that is 20°F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.
3. Electric starter(s) capable of three complete cranking cycles without overheating.
4. Positive displacement, mechanical, full pressure, lubrication oil pump.
5. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
6. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
7. Replaceable dry element air cleaner with restriction indicator.
8. Flexible supply and return fuel lines.
9. Provide fully regulated, constant voltage, current limited, and battery charger for each battery bank. The chargers shall be designed for heavy-duty industrial service, primarily to quickly recharge and maintain batteries that start internal combustion engines. Charger shall be rated a minimum of 10 amps, and be capable of operating in parallel with another like charger for reliability and added charging capacity.

10. Provide LED indication of general charger condition, including charging, fault, and equalize. Provide a 2 line LCD display to indicate charge rate, battery voltage, faults, and provide for charger set up.
11. The charger shall be compliant to the same RFI/EMI and voltage surge performance as are specified for the genset control.

B. Coolant heater

1. Engine-mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL 499 listed and labeled.
2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
3. The 120V, 1 phase coolant heater shall be provided with a 120VAC or 240VAC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104°F (40°C) in a 40°F (4°C) ambient, in compliance with NFPA 110 requirements, or the temperature required for starting and load pickup requirements of this specification.

C. Provide vibration isolators, spring type, in quantities as recommended by the generator set manufacturer. Do not mount generator skid directly to concrete pad.

D. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40°F ambient temperature when fully charged.

- E. Provide critical exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards. For housed units, the silencer must be mounted within the genset enclosure.
- F. Provide pre-wired connections inside generator enclosure to a main output circuit breaker as follows:
 - 1. 3P-225A trip, Square D Type JG with LI electronic trip settings. Circuit Breaker frame size rating plug and settings shall be as determined by the Power System Study.

2.3 AC GENERATOR

- A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL 1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 105°C.
- B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5% above or below rated voltage.
- C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- D. The subtransient reactance of the alternator shall not exceed 12%, based on the standby rating of the generator set.

2.4 GENERATOR SET CONTROL AND PROTECTION

- A. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, protection and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- B. The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is

available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

2.5 CONTROL FEATURES AND FUNCTIONS

A. Control Switches

1. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
2. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
3. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
4. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

B. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

1. Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
2. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (kW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output. Both analog and digital metering are required.

3. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
4. The control system shall log total number of operating hours, total kWh, and total control on hours, as well as total values since reset.

C. Generator Set Alarm and Status Display

1. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:
 - a. The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).
 - b. The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.
 - c. The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
 - d. The control shall include an amber common warning indication lamp.
2. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:
 - a. low oil pressure (warning)
 - b. low oil pressure (shutdown)
 - c. oil pressure sender failure (warning)
 - d. low coolant temperature (warning)
 - e. high coolant temperature (warning)
 - f. high coolant temperature (shutdown)

- g. high oil temperature (warning)
- h. engine temperature sender failure (warning)
- i. low coolant level (warning)
- j. fail to crank (shutdown)
- k. fail to start/overcrank (shutdown)
- l. overspeed (shutdown)
- m. low DC voltage (warning)
- n. high DC voltage (warning)
- o. weak battery (warning)
- p. low fuel-daytank (warning)
- q. high AC voltage (shutdown)
- r. low AC voltage (shutdown)
- s. under frequency (shutdown)
- t. over current (warning)
- u. over current (shutdown)
- v. short circuit (shutdown)
- w. ground fault (warning) (optional--when required by code or specified)
- x. over load (warning)
- y. emergency stop (shutdown)
- z. (4) configurable conditions

3. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

D. Engine Status Monitoring

1. The following information shall be available from a digital status panel on the generator set control:
 - a. engine oil pressure (psi or kPA)
 - b. engine coolant temperature (degrees F or C)
 - c. engine oil temperature (degrees F or C)
 - d. engine speed (rpm)
 - e. number of hours of operation (hours)
 - f. number of start attempts
 - g. battery voltage (DC volts)
2. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications

on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

E. Engine Control Functions

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
6. The following settings shall be field set and verified upon final installation of the emergency system:
 1. Generator Start: 1 second minimum, 2 seconds maximum.
 2. Generator Transfer: 5 seconds minimum, 8 seconds maximum.
 3. Generator Re-Transfer: 15 minutes minimum, 20 minutes maximum.
 4. Generator Cool Down: 15 minutes.

A. Alternator Control Functions

1. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear

rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

2. A microprocessor-based protection device shall be provided to individually monitor all phases of the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The device shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA 70 Article 445.
3. A microprocessor-based protection device shall be provided to monitor all phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA 70 Article 445.
4. Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
5. A microprocessor-based AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds. The system shall monitor individual phases and be connected line to neutral on 3-phase 4-wire generator sets, and for systems that are solidly grounded.
6. When required by National Electrical Code or indicated on project drawings, the control system shall include a ground fault-monitoring relay.

The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.

B. Other Control Functions

1. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

C. Control Interfaces for Remote Monitoring

1. No field connections for control devices shall be made in the AC power output enclosure. Provide the following features in the control system:
2. Form "C" dry contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
3. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
4. A fused 10 amp switched 24 or 12 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
5. A fused 20 amp 24 or 12 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

2.6 ACCESSORIES

- A. The generator set shall be provided with a 3 pole, 100 ampere, mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

B.

C. Miscellaneous

1. Mounted & Wired battery Charger

2. Externally Mounted & Insulated Exhaust System
 3. All Connections to the generator set shall be flexible and all conduit within enclosure shall be EMT.
 3. UL 142 Dual Wall Sub-base Tank, 24 hour capacity with Low & Leak Alarms, Vents. And Stub-Up Access. Include Line-X type coating on sub-base tank to minimize corrosion.
- D. Provide a lockable Fill station on the exterior of the enclosure with Visual Low Fuel & High Fuel Alarms. Include an integral overflow protection basin.
- E. Stub up Access.

PART 3 EXECUTION

3.1 FACTORY TESTING

- A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance. Test shall be conducted at 0.8 PF and run for 2 Hours at full load. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.
- A. Complete engine/generator and transfer switch shall be shipped by the manufacturer, F.O.B. to the job site. Contractor shall be responsible for receiving storage and installation of equipment as indicated on the drawings.

3.2 INSTALLATION

- A. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

- C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- D. Equipment shall be initially started and operated by representatives of the manufacturer.
- E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.3 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
- B. Provide a four (4) hour load bank test. First hour, unit shall operate at 25% load; second hour, unit shall operate at 50% load; third hour unit shall operate at 75%; fourth hour, unit shall operate at 100% of rated standby load. Provide test results including oil pressure and temperature, coolant temperature, amperage, voltage and kW in 15-minute intervals. Report shall include unit serial number, model number, date of test and name of service technician.
- B. Upon verification that all systems are compliant, generator shall be started and tested for proper operation and adjusted to ensure output characteristics as specified hereinbefore.
- C. Upon successful completion of test, a report shall be prepared, indicating the following items:
 - 1. Time & date of report
 - 2. Personnel present
 - 3. KW rating of load bank
 - 4. Output characteristics under no-load and full load conditions to include:
 - (1) Voltage - line to line, line to neutral (All Phases)
 - (2) Amperage
 - (3) Frequency
 - (4) Oil Pressure
 - (5) Coolant Temperatures
 - (6) Run time at start

(7) Run time at completion

5. Generator start time
6. Generator transfer
7. Generator re-transfer
8. Generator time delay stop
9. Any abnormalities found

One (1) copy of the report shall be provided in each of the Operating & Maintenance Manuals as described in Section 23 04 99.

3.4 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than four (4) hours in duration and the class size shall be limited to five (5) persons. Training date shall be coordinated with the facility owner and not held on the date of generator startup.

3.5 SERVICE AND SUPPORT

- A. The manufacturer of the generator set shall maintain service parts inventory at a central location, which is accessible to the service location 24 hours per day, 365 days per year.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 10 years.

3.6 WARRANTY

- A. The complete standby electric power system, including 1800 r/min engine-generator set, transfer switch, enclosure, fuel tank, load bank, and all equipment furnished by the generator manufacturer, shall be warranted for a period of five (5) years or fifteen hundred (1,500) operating hours, whichever occurs first, from the date of Substantial Completion against defects in materials and workmanship. Multiple warranties for individual components (engine, generator, controls, etc.) will not be acceptable. Satisfactory warranty documents must be provided. This warranty shall be detailed in available written documents. In the judgment of the

Engineer, the manufacturer supplying the warranty for the complete system must have necessary financial strength and technical expertise with all components supplied to provide adequate warranty support.

- B. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.
- C. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION 26 32 13

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 36 00 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1. GENERAL PROVISIONS

1. Applicable provisions of the entire specifications, including Addenda, shall govern this section as fully as if repeated herein.
2. Refer specifically to the technical provisions of 26 04 99, "COMMON WORK REQUIREMENTS FOR ELECTRICAL.
3. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.

1.2. RELATED DOCUMENTS

1. The requirements of the conditions of the contract, Supplementary Conditions and General Requirements, apply to the work specified in this section.
2. The complete installation shall conform to the applicable sections of the latest edition of the National Electrical Code, Local Authorities having jurisdiction and the local utility serving the premises.
3. The work covered by this section of the specifications shall be coordinated with the related work.

1.3. SCOPE OF WORK

1. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.
2. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided. Technicians specifically trained to support the product and employed by the generator set supplier shall service the transfer switches.

1.4. CODES AND STANDARDS

1. The automatic transfer switch shall conform to the requirements of the following codes and standards:
 - i. EN55011, Class B Radiated Emissions
 - ii. EN55011, Class B Conducted Emissions
 - iii. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991
 - iv. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
 - v. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
 - vi. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
 - vii. IEC 1000-4-6 Conducted Field Immunity
 - viii. IEC 1000-4-11 Voltage Dip Immunity
 - ix. NFPA20 – Fire Pumps. Transfer switches serving fire pumps shall be specifically listed and labeled for that application.
 - x. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - xi. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
 - xii. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 - xiii. NEMA ICS10-1993 – AC Automatic Transfer Switches.
 - xiv. UL 891 – Low Voltage Switchboards.
 - xv. UL1008. The transfer switch shall be UL listed and labeled.
2. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.5. ACCEPTABLE MANUFACTURERS

1. Only approved manufacturers shall supply equipment provided under this contract. Equipment specifications for this project are based on microprocessor-based transfer switches manufactured by Cummins or Kohler. Unit shall be of same manufacturer as Generator. Equipment by other suppliers that meets the requirement of this specification are acceptable, if approved not less than ten (10) days before scheduled bid date. Proposals must include a line by line compliance statement based on this specification. Approval of substitute manufacturers will be announced by addendum.

1.6. SERVICE AND SUPPORT

1. The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.
2. The transfer switch shall be serviced by a local service organization that is trained and factory certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

1.7. WARRANTY

1. The Automatic Transfer Switch and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.
2. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

1.8. LITERATURE

1. The manufacturer shall have printed literature and brochures describing the standard series specified (not a one of a kind fabrication). Unless specified otherwise herein, all performance data and other information shall be as on the manufacturer's printed literature. Performance data shall be the result of test procedures in accordance with nationally recognized standards, plus such other procedures that are judged necessary by the manufacturer to insure maximum service reliability by the Engineer upon request.

1.9. SUBMITTALS

1. Shop drawings will be required for all work covered under this specification section. Refer specifically to Section 26 04 99 for additional special shop drawing requirements.

1.10. OPERATING AND MAINTENANCE MANUALS

1. Furnish Operating and Maintenance Manuals for the Engine-generator set and each transfer switch as specified in Section 26 04 99.

1.11. AS-BUILT DRAWINGS

1. As-built drawings will be required for all work covered under this specification section. Refer specifically to Section 26 04 99 for special As-Built requirements.

PART 2 - PRODUCTS

2.1. POWER TRANSFER SWITCH

- A. Transfer switch shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
- B. Transfer Switch shall be rated 400A, 3 Pole, 480Y/277 Volts, 3 phase, 4 Wire Cummins Model OTPC. Main contacts shall be rated for 600 Volts AC minimum.
- C. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than the available fault currents shown on the drawings and at the specified voltage. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

2.02 Connections

- A. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
- B. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

2.2. TRANSFER SWITCH CONTROL

1. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.
 - A. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
 - B. High intensity LED lamps to indicate that the transfer switch is “not in auto” (due to control being disabled or due to bypass switch (when used) enabled or in operation) and “Test/Exercise Active” to indicate that the control system is testing or exercising the generator set.
 - C. “OVERRIDE” pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
 - D. “TEST” pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
 - E. “RESET/LAMP TEST” pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
 - F. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool or an operator display panel.
 - G. Security Key Switch to allow the user to inhibit adjustments, manual operation or testing of the transfer switch unless key is in place and operated.
 - H. Analog AC meter display panel, to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor. The display shall be color-coded, with green scale indicating normal or acceptable operating level,

yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.

- I. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
 1. Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
 2. Display source status, to indicate source is connected or not connected.
 3. Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
 4. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - a. Set nominal voltage and frequency for the transfer switch.
 - b. Adjust voltage and frequency sensor operation set points.
 - c. Set up time clock functions.
 - d. Set up load sequence functions.
 - e. Enable or disable control functions in the transfer switch, including program transition.
 - f. Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
 5. Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.

6. Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
7. Display information for other transfer switches in the system, including transfer switch name, real time load in KW on the transfer switch, current source condition, and current operating mode.
8. Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.

2. Internal Controls

- A. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
- B. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 1. Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
 2. Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
 3. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
 4. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.

5. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
 6. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
 7. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
 8. Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.
- C. All transfer switch sensing shall be configurable from a Windows 7 PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED lamps.
- D. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
- E. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).

- F. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service. The control system shall be designed and prototype tested for operation in ambient temperatures from -40°C to $+70^{\circ}\text{C}$. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
- G. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

3. Control Interface

- A. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
- B. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
- C. The transfer switch shall provide relay contacts to indicate the following conditions: source 1 available, load connected to source 1, source 2 available, source 2 connected to load.

2.3. ENCLOSURE

- 1. Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70. The cabinet door shall include permanently mounted key type latches.
- 2. Transfer switch equipment shall be provided in a NEMA 1R or better enclosure.

2.4 TIMING SETTINGS

- 1. The following settings shall be programmed into the controls of the transfer switch:
 - A. Generator Start upon loss of Utility Power: 3 second delay.
 - B. Generator Transfer to Emergency Source: 0 second delay.
 - C. Generator retransfer to utility after restoration of utility source: 15 minutes.
 - D. Generator Cooldown: 15 minutes
 - E. Weekly exercise: No load test for 30 minutes. Day and time to be identified by the owner during startup.

2. The load must be transferred and on the emergency source within 10 seconds after the loss of normal utility source.

PART 3 - EXECUTION

3.1. OPEN TRANSITION SEQUENCE OF OPERATION

1. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.
2. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
 - A. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - B. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - C. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 - D. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - E. The transfer switch shall operate the generator set unloaded for a cooldown period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.
3. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

- A. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
- B. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
- C. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3.2. FACTORY TESTING

- 1. The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be available on request. Test process shall include calibration of voltage sensors.

3.3. ON-SITE ACCEPTANCE TEST

- 1. Site Tests: An installation check and building load test shall be performed by the manufacturer's local representative. The Engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include automatic start-up by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination.

END OF SECTION 26 36 00

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Interior & Exterior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for control of lighting fixtures.

C. DEFINITIONS

1. CCT: Correlated color temperature.
2. CRI: Color Rendering Index.
3. Fixture: See "Luminaire."
4. IP: International Protection or Ingress Protection Rating.
5. LED: Light-emitting diode.
6. Lumen: Measured output of lamp and luminaire, or both.
7. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation/by fixture type.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.7 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Recessed Fixtures: Comply with NEMA LE 4.
- E. Bulb shape complying with ANSI C79.1.
- F. CRI of 80. CCT of 3500 K.
- G. Rated lamp life of 50,000 hours.
- H. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- I. Internal driver.
- J. Nominal Operating Voltage: 120 V ac.
 - 1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.2 METAL PARTS

- 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- A. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
 - B. Diffusers and Globes:
 - 1. Prismatic acrylic
 - 2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 3. Glass: Annealed crystal glass unless otherwise indicated.
 - 4. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.3 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, [12 gage] <Insert size>.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.
- F. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.

- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 1. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 2. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

**MONARCH SUBDIVISION
PUMP STATION
NEW CASTLE COUNTY, DELAWARE**

SECTION 26 70 00 - PUMP CONTROL PANEL

PART 1 – GENERAL

1.01 GENERAL PROVISIONS

- A. Applicable provisions of the entire Project Manual, including Addenda, shall govern this section as fully as if repeated herein.
- B. Refer specifically to the technical provisions of Section 26 04 99, "COMMON WORK REQUIREMENTS FOR ELECTRICAL”.
- C. Refer to NEW CASTLE COUNTY DEPARTMENT OF SPECIAL SERVICES SEWER DESIGN POLICY; POLICY #SS7 for additional requirements. In the case of conflict or inconsistency, the NEW CASTLE COUNTY Standards shall prevail.

1.02 DESCRIPTION

- A. The Pump Control Panel shall control the duplex sewage pumps and monitoring station operation. The work includes all labor, materials, equipment and services necessary for, and incidental to, the complete and satisfactory installation.
- B. Abbreviations:
 - 1. HMI Human Machine Interface
 - 2. I/O Input / Output
 - 3. OIT Operator Interface Terminal
 - 4. PLC Programmable Logic Controller
 - 5. SCADA Supervisory Control and Data Acquisition
 - 6. UPS Uninterruptible Power Supply

1.03 SCOPE

- A. The work includes all providing labor, materials, equipment and services necessary for and incidental to the complete and satisfactory installation of the Pump Control PLC, OIT, HMI SCADA interface and supervisory control and data acquisition system components including but not limited to radio transceiver, modems, antenna, etc. This system provides alarm annunciation, system monitoring, data collection, historical trending and remote Automatic Mode override control of pumping station equipment. The Contractors scope under this project shall include integrating the controls at the station, and programming pump control and SCADA function. Updating the process screens, alarms, reports, etc.
- B. Systems Integrator will be responsible for assisting in integrating the controls, status, alarms, etc. into the SCADA system on the pumping station side as required for complete and satisfactory installation as determined by the Engineer and Owner. The Contractor will work with the County to integrate information from the PLC into the SCADA system.
- C. One (1) Pump Control Panel shall be provided.

1.04 SYSTEMS INTEGRATOR

The Contractor shall utilize a Systems Integrator as a subcontractor for this work, experienced in integrating PLC systems for pump control and SCADA. This integrator must be listed on the subcontractors list on the bid form. The County reserves the right to accept or reject the integrator listed and request additional information, if necessary, to determine the acceptability of the integrator.

1.05 DESCRIPTION OF WORK

A. In general, the following general scope of work will be included:

1. Provide a complete and packaged Pump Control Panel as manufactured by Gorman/Rupp, Inc and as further described in this specification. **THERE ARE NO EQUALS.** The System Integrator shall be responsible for all PLC pump control programming.
2. Provide PLC and operator interface with OIT software as specified herein. Screen development for the pumping station OIT will be the responsibility of the System Integrator.
3. Provide function programming in the Pump Control PLC. Integrate the pumping station side of the controls into the overall system. The System Integrator shall consolidate and configure memory assignments in accordance with a listing of PLC register assignments to be provided by the County.
4. Provide controls components for radio communications, backup power, etc., as specified. All communications equipment shall be installed and certified by the manufacturer's authorized communication technician. All control panels shall be fabricated, certified, and bears the serialized UL 508a label or UL 698A label for circuits extending into Hazardous Locations.
5. Install Pump Control panel, operator interface, radio components, etc., in enclosures as shown on the contract drawings and integrate with station equipment. All control panels shall be fabricated and certified in accordance with U.L. 698A certification guidelines.
6. Perform signal strength testing to finalize antenna pole height. The transmit site for testing is existing. All communications test results shall be submitted for review with shop drawings.
7. UPS, surge protection, etc., and all of the incidental equipment.
8. Provide operation and maintenance manuals, training, spare parts, etc. per Specification Section 26 04 99.

1.06 WARRANTY

A. The warranty shall provide (a) a minimum of next-day, on-site service for emergency failures, and (b) replacement of the defective component within one week, if repairs cannot be implemented within that time. A five-day response time, on-site service, is required for non-critical failures. The Systems Integrator responsible for the system installation shall provide service work under this warranty. This warranty shall cover a period of two years from the date of Substantial Completion.

1.07 SYSTEMS INTEGRATOR

- A. It shall be the System Integrator's responsibility to furnish a complete and functional, fully integrated package as described in this bid package. This includes all hardware devices necessary to interface the components of the various systems.
- B. System Integration responsibility shall include review of drawings and specifications sections for this entire project. This shall include review of specifications for all equipment, electrical contract drawings and specifications, and any other equipment interfacing to the control panel systems, as required to provide necessary point-to-point wiring schematics and compliance with the functional requirements of these specifications.
- C. All special cables, such as fiber patch cables, or sensor/transmitter specialty interconnection wiring, shall be furnished.
- D. The system integrator shall be responsible for the detailed design, installation and the proper functioning and performance of both the controls system and controllers, the preparation of the required submittal data, conducting all tests and operational demonstrations, and providing technical supervision for the installation and connections to equipment. The system supplier shall not necessarily be the manufacturer of the equipment to be furnished.
- E. The system integrator shall, for the duration of this contract and the guarantee period, provide next day, on-site service for all control panel problems as discussed in other areas of this specification.
- F. The system integrator shall provide all miscellaneous components such as isolation relay modules, interface relay modules; digital output control, etc. shall be provided as required for a complete operational system.
- G. Provide integrated operation and maintenance manuals and operation training.

1.08 DUPLEX PUMP CONTROL

- A. In general, the control system shall provide the following control features:
 - 1. Pump 1 Run indicator
 - 2. Pump 2 Run indicator
 - 3. Pump 1 Motor Overload indicator
 - 4. Pump 2 Motor Overload indicator
 - 5. Pump 1 Motor Over-temperature indicator
 - 6. Pump 2 Motor Over-temperature indicator
 - 7. Pump 1 Leak Detection
 - 8. Pump 2 Leak Detection
 - 9. Pump 1 Elapsed Time meter
 - 10. Pump 2 Elapsed Time meter
 - 11. Wet Well High Level alarm
 - 12. Manual/Off/Automatic Operation (each pump)
 - 13. Fault Reset
 - 14. Alarm Reset
 - 15. Alternation Mode (fixed sequence or alternating lead)
- B. The Pump Control Panel Trouble alarm will be a summary alarm point covering the following conditions:

1. Pump 1 Leak Detection
 2. Pump 2 Leak Detection
 3. Pump Control Panel Loss of Power
 4. Analog Signal Failure
- C. The keypad shall also provide access to set or change the following parameters:
1. Level settings of “Pump Run” and “Pump Stop”
 2. Time delays for “Pump Run” and “Pump Stop”
 3. Time delays for Delay Fault operation
- D. Pump Controller Description
1. The pump controller shall normally operate the duplex pump system based on a 4-20mA analog Wet Well level signal. The level shall be displayed on the indicator panel, calibrated to show Wet Well level in feet. Operating set-points on this signal shall pilot the pump motor controllers On and Off. The controller shall alternate the Lead Pump after each Stop signal. The operating set-points shall be as follows:
 - a. Lag Pump Run
 - b. Lead Pump Run
 - c. Both Pumps Stop
 2. High and Low Level ball floats are to be provided as backup to the analog signal and microprocessor controller. The ball float circuit shall be powered separately from the microprocessor controller. Failure of the analog controls, causing the Wet Well level to reach the High Level ball float shall cause both pumps to run at full speed. Failure causing the Wet Well level to fall to the Low Level ball float shall cause both pumps to stop running. Control shall return to the microprocessor controller after restoration of the analog signal.
 3. The pump controller shall provide isolated (dry contact) relay outputs for the following conditions:
Dry Contacts for connection to the county’s SCADA RTU as follows:
 - a. Power Fail
 - b. High Level
 - c. Low Level
 - d. Backup Float Enabled
 - e. Pump #1 Running
 - f. Pump #2 Running
 - g. Two Pumps Running
 - h. Thermal Pump #1
 - i. Thermal Pump #2
 - j. Moisture Detection Pump #1
 - k. Moisture Detection Pump #2
 4. A parallel 4-20 mA signal so they can monitor the bubbler system level in the RTU.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The Pump Control/SCADA PLC system shall be configured as shown on the Contract Drawings and as specified herein.
- B. All system software, including the HMI software package for the Operator Interface Terminal and PLC shall be standard for use in water and wastewater applications.
- C. All components of the SCADA system shall be supplied as a complete, fully integrated package by the same system integrator responsible for system installation. Control Panels shall be fabricated and certified by a UL certified Industrial Control panel fabricator, and in accordance to U.L. 698A certification standards for industrial control panels.

2.02 PUMP CONTROL PANEL

- A. Pump Control Panel shall be designed specifically for use in New Castle County System projects and as manufactured by Gorman/Rupp, Inc. NO EQUALS.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. The Systems Integrator shall install the Pump Control/system and all appurtenances in conjunction with pump controller and in accordance with the manufacturer's recommendations, U.L. guidelines and local code requirements.
- B. Routine preventative maintenance that is suggested or required by the manufacturer for the Pump Control system shall be performed by the Systems Integrator until the satisfactory completion of the final operational demonstration test as has been completed.

3.02 INPUT/OUTPUT SIGNALS – Refer to Drawings for I/O information

3.03 TESTING

- A. Site Acceptance Testing
 - 1. All functions are to be tested and proved before the scheduled Site Acceptance Test. Upon installation, the systems shall be tested at each site as detailed in the submitted site acceptance test plan. Deficiencies shall be resolved and retested as required to satisfactorily demonstrate the following:
 - a. Test the communications system between the controller and HMI. Verify proper functioning of the communication network and immunity to outside electrical noise interference.
 - b. Test all controller input devices to verify operability and calibration.
 - c. Test controller (automatic and manual) to verify proper operation, including the battery backup and UPS system in the event of loss of power, and the push-button activated self-test program.
 - B. A test procedure shall be developed by the System Integrator and transmitted to the County for approval no later than 14 days prior to the test date. The factory test shall be performed at the System Integrator's facility and witnessed by the Engineer and the Owner's representative(s).

- C. Upon installation of the Pump Control, the system shall be tested, deficiencies resolved and retested as required to satisfactorily demonstrating the following:
1. Test the communications between the PLC and Radio, PLC and I/O modules and PLC and Operator Interface. Verify proper functioning of the communication network and immunity to outside electrical noise interference.
 2. Test all PLC input devices to verify operability and calibration.
 3. Test all PLC pump controls (automatic and manual) to verify proper operation, including automatic and simulation modes, PLC battery backup and UPS system in the event of loss of power and the push-button activated self-test program.
 4. Test the communications system between the PLC and the County's portable HMI laptop for proper transmission/reception, signal strength and data errors.
 5. Perform RF signal strength test for system at installation height.
 6. Test SCADA function of the PLC and interface with the Inland Bays Landfill including alarm output, remote automatic mode control and equipment status. Assist County in coordinating tests from the pumping station to next point (Master Station). This will be a requirement for substantial completion.

3.04 TRAINING

The Pump Control PLC system supplier shall provide and/or arrange for training of personnel at the job site. Training shall be for a minimum of one 8 hour day at each station. The training shall occur after successful startup of the system. As described in Manufacturer's certification & start up, the training program shall include operator training, programming and maintenance courses in conjunction with pump station definition.

END OF SECTION 26 70 00