APPENDIX B

PUMP STATION CHECKLIST AND
TEST PROCEDURES
APPENDIX B

APPENDIX B PUMP STATION CHECKLIST AND TEST PROCEDURES

APPENDIX B.1 ACCEPTANCE PERFORMANCE TESTING REQUIREMENTS FOR NEW WATER, WASTEWATER AND PUMP STATION FACILITIES

APPENDIX B.2 PUMP PERFORMANCE TESTING

APPENDIX B.2 RECORD OF PUMP PERFORMANCE TEST

APPENDIX B.3 SURGE PROTECTION DEVICE AND CHECK VALVE TESTING

APPENDIX B.4 AUTOMATIC TRANSFER SWITCH TESTING

APPENDIX B.5 GENERAL INSTRUMENTATION AND PUMP CONTROLS TESTING REQUIREMENTS
PUMP STATION CHECKLIST AND
TEST PROCEDURES

DATE CHECKED

1. ____ Review inspector's checklist and recheck items that are not marked completed.

2. **SITE**
   ____ Fence, gate, lock as specified (Black vinyl with mowing strip and correct expansion joints at 10 foot maximum)
   ____ Paving as specified, no birdbaths
   ____ Storm drain grates clean and open
   ____ Site graded to prevent ponding and flooding
   ____ All grass areas growing and as specified; four inches of topsoil required
   ____ All shrubbery alive and as specified
   ____ Fire hydrant as specified and operating (if applicable)
   ____ Stone provided over vinyl cloth weed barrier as specified

3. **BUILDING**
   ____ Good appearance/quality workmanship
   ____ Doors keyed to A.A. County System (10 Keys)
   ____ Combination door closures with hold open device.
   ____ Weatherstripping on exterior door(s) (sponge neoprene)
   ____ Aluminum fascia and downspouts (one piece gutter)
   ____ Fire extinguisher with gauge - (20 lb.) - securely mounted as specified
   ____ Building water service gives full pressure (if applicable)
   ____ All rooms painted as specified
   ____ All floors broom clean, all hatches and equipment clean
   ____ Lighting level sufficient in all rooms
APPENDIX B

_____ Automatic transfer switch operable and as specified

_____ Check condition and operation of all louvers, exhaust fans and damper controls

_____ Check doors, lock, closers

_____ A.A. County Electrical Inspection Certificate received

_____ Check all lights (including photo electric cells). Check all receptacles

4. **HATCHES**

_____ 1/4" aluminum 300 lb./sq. ft. with corrosion resistant hardware and fasteners

_____ Bituminous coating on frame areas in contact with concrete

_____ Automatic hold open device(s).

_____ Slam latch with removable key, spare keys furnished

_____ Flush handle

5. **WET WELL LANDING**

_____ Aluminum grating (Sectional to be easily removable) and aluminum supports (bituminous coated in contact with concrete)

_____ All connections and anchors stainless steel fasteners

_____ Bar rack, removable debris basket and rake assembly as specified

6. **WET WELL**

_____ Diameter precast concrete (as specified)

_____ Exterior coating in place per specifications (refer to previous inspection reports)

_____ Joints sealed/good workmanship

_____ No infiltration or inflow observed

_____ Two _____watt explosion proof lights with heavy-duty guards

_____ Interior epoxy coating per specification

_____ Removable auxiliary float staff with standard Consolidated Electric Company 9G float switches

Published: 01/01    Revised:
7. **DRY WELL**

- Check electrical connections for adequacy for seals for location and gas tightness
- Bubbler tube (bell on bottom end) easily accessible for maintenance
- Float mast and floats properly located (easily accessible, proper elevation, will not foul)
- Soil odor filter (if specified)

8. **VALVE VAULT**

- Pump around connections and valving as specified
- Part D couplings with dust plugs on brass chain in place
- Sump pits with floor sloped to drain (test with water)
- Exercise all valves from full open to full closed (control flow to prevent spills)
- Valve operator extensions in roadway boxes within one foot of grade and aligned with boxes
9. **LADDERS**

- Aluminum construction
- Rungs 1-inch square
- Maximum run spacing 12 inches on center
- Non-skid grooves in rungs
- Minimum dimension from wall to centerline of rung seven inches
- No toe interference behind rungs at any location (no pipes, conduits, etc.)
- Ladder properly secured to structure
- Locking extension poles, grab bars or equal on hatches as specified
- Safety climbing devices (if required)

10. **PUMP**

- Pump service record card completed
- Manufacturer's certifications at site
- Factory certification that pumps will perform satisfactorily at each design condition
- Pressure gauges as specified with snubber, shut-off cock, diaphragm seal and glycerin filled
- Packing and/or mechanical seals as specified

11. **PUMP MOTORS**

- 3 phase, 60 cycle, _____ (specified) volts
- _____ efficiency, _____ power factor at full load
- Vertical squirrel cage, cast iron body
- Class F insulation
- 1.15 service factor
- Starters balance w/capacitors to give _____ power factor
12. SUBMERSIBLE PUMPS (IF APPLICABLE)

- Pull and reset each pump
- Check guide rails & pump connection seats
- Check electrical connections for adequacy and seals for gas tightness
- Check amp draw: Pump #1 _____ Pump #2 _____

13. BUBBLER SYSTEM

- Compressors (as required)

  NOTE: Some pump stations will have Gorman-Rupp diaphragm type air compressors for differential pressure level control system.

- _____ gallon air receiver ASME (as specified)
- Receiver condensate bleed valve accessible
- Delivery rate. 1.0 cfm @ 100 psi (or as specified)
- _____ hp, 115 volt, 60 hertz, single phase motor (or as specified)
- Compressor starters and manual alternator (as specified)
- Capable of individual compressor operation (including valving) or as specified
- Pressure relief valves certified and undamaged
- On/off pressure switch operation (or as specified)

14. BUBBLER CONTROLS

- Level gauge calibrated (see item #24)
- Manual high pressure purge
- Alarm level indicator lights
- Air flow rotameter
15. ELECTRIC UNIT HEATER

_____ Propeller type
_____ _____KW, _____HP, _____ cfm, ____ phase as specified
_____ Individual adjustable louvers
_____ UL approved
_____ Automatic reset
_____ Thermostat operational
_____ Fan guard/motor support

16. WET WELL BLOWER

_____ Capacity _____cfm
_____ _____ HP, _____ RPM
_____ Spark-proof weatherproof construction
_____ Automatically on continuously with wet well hatch switch, intermittent timer
operation all other times
_____ 60 minute cycle timer (10 on - 50 off)
_____ Duct work correct and sealed

17. PACKAGE PUMP STATION (IF APPLICABLE)

_____ Certification
_____ Installation plumb
_____ Preservation
_____ Base meets specifications (refer to previous inspection reports)

18. ______ Check safety equipment - safety climbing devices - rotating equipment guards -ground system

19. ______ Check heater operations
20. _____ Check blowers & fans - insure proper operation and rotation - timers on exhaust fans, switches, etc.

21. _____ Check operation of odor control system, including controls and grid condition

22. _____ Operate each pump through one complete cycle in bubbler system control and float system control modes. Check list level vs. gauge level.

<table>
<thead>
<tr>
<th>Wet Well</th>
<th>Bubbler Elevation</th>
<th>Wetwell Depth</th>
<th>Float Elevation</th>
<th>Wetwell Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sys. High Level Alarm</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag pump on</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lead pump on</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag pump stop</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low level alarm and pump stop</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

23. _____ Check that pumps alternate - lead/lag on both bubbler and float systems

24. _____ Check that back up float system cuts in automatically at bubbler system high level alarm and locks out bubbler system controls

25. _____ Check operating condition of pumps at shut-off head

26. _____ Check Q vs. TDH for each pump:

<table>
<thead>
<tr>
<th>Pump #1</th>
<th>Q</th>
<th>TDH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump #2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

27. _____ Check pump controls to insure H/O/A modes

28. _____ Check alarm signals

29. _____ Check fuel tank - proper connections - leaks - full fuel level - certify type of fuel

30. _____ Simulate power failure

_____ Check generator operation

_____ Operate both pumps simultaneously through total cycle _____ volts _____ amps

_____ Lighting available

_____ Alarm signal to panel

Published: 01/01   Revised:
____ Check exerciser for timing
____ Power transfers in specified times
____ Exhaust system operates properly

31. _____ FLOWMETER (If specified)
____ Totalizer installed
____ Chart installed, operational and calibration certification
____ Spare charts and pens (as specified)

32. _____ AIR RELEASE VALVES AND BLOWOFFS
____ All valves operational and secure and accessible for maintenance.
____ Line dewatered

33. _____ SPARE PARTS
____ Number required (attach required list - indicate parts provided)
____ Condition/preservation (list discrepancies)
____ Released to Operations

34. OPERATOR TRAINING
____ Tour and familiarization
____ Pumps and motors
____ Odor control system
____ Motor control center

35. OPERATION AND MAINTENANCE MANUAL
____ _____ copies delivered
____ Detail information
____ equipment file maintenance sheets filled out (See Appendix C)
____ trouble shooting diagrams
APPENDIX B

_____ well organized

_____ No extraneous material

36. AS-BUILT DRAWINGS

_____ Copies provided and filed

37. TESTING/ACCEPTANCE

_____ Testing/acceptance per Appendix B thru G of Specifications

cc: (When completed:)

Contractor
Design
Construction management
State OEP
Operation O & M Manua
ACCEPTANCE PERFORMANCE TESTING REQUIREMENTS
FOR NEW WATER, WASTEWATER AND PUMP STATION FACILITIES

The purpose of these requirements is to provide, prior to acceptance, an additional means to ensure that actual on-site performance of installed equipment is in compliance with design and will perform effectively, reliably and efficiently to preclude any other operational testing which may be required by contract specifications, County Design Standards or Technical Guidelines. The Engineer and/or contractor shall keep himself familiar with such.

These performance requirements include guidelines and tolerances in the following areas:

* Vibration testing of motors, electric motor driven equipment, engine driven equipment and standby generator sets
* Infrared testing
* Standby generator load bank testing and engine testing requirements
* Pump hydraulic and motor testing
* Testing of hydraulic surge protection devices
* Automatic transfer switch testing
* Instrumentation and controls. This section applies to flowmeters, motor and pump controls.

General Requirements
A. Testing Plan

1) Develop a testing plan that can be executed by the contractor in accordance with the testing requirements in the construction contract documents and the standard specifications. The plan shall address isolated operational testing of major equipment, as well as facility testing of the entire system. The testing plan shall consider all operational constraints while testing the equipment, materials required, performance criteria, physical constraints (valve and piping arrangements, fluid needs, equipment interlocks, power requirements, etc.) and provide step-by-step procedures to follow.

2) Submit the test plan for review and approval by the County. Incorporate all comments, revise the plan and submit the final testing plan thirty (30) days before the initial test phase.

3) Direct the execution of said testing plan, coordinate all activities between the contractor and County personnel. Within five (5) calendar days following the test, submit a letter report outlining the test results to the County which clearly indicates test results not in compliance with those required by the contract specifications. Meet and discuss the test results between the engineer, contractor, equipment supplier and County as necessary to resolve the identified performance problems.
4) If the performance does not meet the standards, develop the corrective actions necessary to bring the plant into full compliance. This should indicate the cause(s) of failure, changes and cost of same to meet the standards and an estimated schedule when performance problems can be resolved.

5) Meet with the County as necessary to present the performance report and discuss the implementation of changes to correct the performance problems.

B. Operations and Maintenance Manuals

1) Work with the County to outline the content, schedule and level of detail required for the Operations and Maintenance (O&M) manuals within sixty (60) days after notice to proceed.

2) The O&M manuals shall be prepared in accordance with the format and chapter outline shown in Appendix A of the County standards.

3) Prepare a draft O&M manual and submit to Anne Arundel County for approval prior to fifty percent (50%) completion of the construction phase of the project. Six (6) copies of the draft manual shall be provided. Revise the draft manual as required by the Maryland Department of the Environment (MDE), the EPA and the County.

4) Prepare a final draft O&M manual and submit for approval before ninety percent (90%) construction completion. Six (6) copies of the final draft O&M manual shall be provided. Incorporate all comments returned from the County's review, revise the manual and submit the final O&M manual, six (6) copies to the County.

C. Review equipment for proper installation before initial operation checking proper rotation (both normal power and emergency power), oil levels, lubrication, related punch list items, equipment readiness log, etc.

D. Equipment shall be checked-out and certified by the equipment manufacturer before start-up. All certificates, factory test certifications, shop drawings, etc., must be submitted.

E. Pump station final inspection and service checklist shall be completed and submitted at final acceptance.

END OF SECTION
PUMP PERFORMANCE TESTING

PART 1 - General

All pumps shall have a completed operational performance test as installed on site. This performance test is to ascertain that the pumps and motors are actually operating as designed and that specifications have been met. Each pump shall be tested to show that it operates quietly without heavy vibration, cavitation, bearing overheating, etc., under operation conditions. (Also, see vibration performance testing, Section 15990).

Pump testing should be carried out by personnel qualified to measure pump performance and shall be done in the presence of the manufacturer's representative. An authorized representative of the County shall also witness the tests.

PART 2 - Equipment to be Tested:

Pumps
Pump motors

PART 3 - Testing Prerequisites:

PART 4 - A schedule should be agreed upon by all parties in advance of the test. The schedule should be as complete a program as possible and give particulars on the range of hydraulic conditions to be tested.

Flow path established for pump tests (i.e. recirculation to wet well or pumping through force main).

PART 5 - All measuring devices and instrumentation should be calibrated and adjusted prior to testing. Calibrated pressure test gauges shall be used for head measurements.

PART 6 - On coupled motor/pump arrangements shafts shall be checked and verified for proper alignment, coupling gap settings and lubricated if necessary.

PART 7 - All pump clearances shall be properly set as recommended by the manufacturer to suit anticipated operating conditions. These shall be recorded and included in the final test report and also included in Operations and Maintenance (O&M) manuals.

PART 8 - Prior to testing, pump bearings, motor bearings, and splines and steady bearings shall be checked for proper lubrication.

PART 9 - Proper impeller rotation shall be verified for each pump under normal power and emergency power. Phase of 3-phase power shall be checked for both conditions.
PART 10 - On satisfactory completion of preliminary inspections the pumps can be lined-up, primed and seal water made available, and then started. The pumps, motors and instruments should be checked for proper operation, scale readings, evidence of malfunction or obvious mechanical problems. When equipment is determined to be functioning properly the tests shall then be conducted.

PART 11 - Test Parameters

As a minimum, the following values are to be measured on-site and compared against design conditions/values:

PART 12 - Capacity vs. head for each pump. As a minimum this will include readings as near normal operating conditions as possible and at shut-off head (except positive displacement pumps) and marked on shop drawing/performance curves.

PART 13 - Net positive suction head (NPSH) available over entire normal operation range to ensure that proper suction conditions are being met and marked on performance curves. The NPSH available at installation shall exceed the NPSH required over the normal full operating range. This will require use of suction pressure gauges installed with equipment and/or portable gauges.

PART 14 - Pump speed (not required on submersible style pumps).

PART 15 - Motor voltage between each phase and ampere draw on each phase at normal operation conditions. Voltage unbalance between phases shall not exceed 2%. Maximum current unbalance not to exceed 5%.

PART 16 - Motor and pump bearing temperature rise. Note any deficiencies and actions to be taken to correct.

PART 17 - Motors shall be megger tested on each phase and results recorded and included in O&M manuals. Megger testing is to be performed from MCC terminals on load side of starter. Readings of less than 1 megohm must be investigated and corrective actions taken. Submersible pumps and cable shall be megger tested as follows:

1. Each pump and power cable shall be meggered dry (each phase) before they have been submerged for the first time on-site.

2. Pumps will then be submerged to the normal working level. After a minimum of two (2) hours submergence the pumps and cable shall be meggered again and results recorded.
PART 18 - Pump and motor vibration (see section on vibration testing, Section 15990 and Appendix F).

PART 19 - Documentation

PART 20 - Factory certification that pumps will perform at each design condition.

.1 Motor certifications.

.2 Pump installation certificates.

.3 Pump service card submitted.

.4 Shaft alignment certification.

.5 Shop drawings with performance curves.

.6 A final performance and inspection report shall be submitted containing complete records, including any notes or comments on inspection, readings, observations and other information relative to the testing of the pumps. Sample forms for field acceptance tests is shown at the end of this section and may be used as a guide for inclusion into the O&M manuals. All actual operating conditions tested are to be compared against design and summarized in the report. All problems, findings or corrective actions necessary to bring equipment into compliance shall also be well documented.

END OF SECTION
# RECORD OF PUMP PERFORMANCE TEST

| STATION NAME | ___________________________ |
| MOTOR/PUMP # | ________________ |
| GPM | ____________________________ |
| RPM | ________________ |
| VAR/CONST. | ________________ |
| MOTOR HP | ____________________________ |
| MGFR | ________________ |
| DESCRIPTION/CONDITION: | _____________________________________________________ |
| | _____________________________________________________ |
| | _____________________________________________________ |
| SHAFT ASSEMBLY | |
| DESCRIPTION/CONDITION | ______________________________________________________ |
| | ______________________________________________________ |
| | ______________________________________________________ |
| PUMP | |
| SIZE | ____________ |
| CAPACITY | ____________ |
| MANUFACTURER | ____________ |
| IMPELLER | ____________ |
| ROTATION | ____________________________ |
| PACKING/SEALS | ____________ |
| INSPECTION PLUG | ____________________________ |
| BASE & FOUNDATION: | |
| DESCRIPTION | _____________________________________________________ |
| CONDITION | _____________________________________________________ |
| OBSERVE OPERATION | |
| VIBRATION | _____________________________________________________ |
| CAVITATION | _____________________________________________________ |
| NOISE | _____________________________________________________ |
| HEAT | _____________________________________________________ |
| VIBRATION DATA AVAILABLE | (yes) (no) |
SURGE PROTECTION DEVICE AND CHECK VALVE TESTING

PART 1 - Tests

1.1 Check valves - Test for proper closures without slamming. Proper weight, spring (lever) and dashpot adjustments shall be made, documented and included in Operations and Maintenance (O&M) manual.

1.2 Automatic Discharge/Check Valve Systems

1. Test for proper pump starting/discharge valve opening times and discharge valve closure/pump shutdown times to limit pressure rise/surges in the discharge line to acceptable ratings in accordance with surge analysis results. Optimum closure rates shall be evaluated for various combinations of pumps which might be in operation at the time of a power failure. Record final settings.

2. Test for proper operation of pump controls and alarms as a result of simulated malfunction of automatic discharge valve or limit switch failures (i.e. improper valve positions on startup, etc.) Record results.

3. Test emergency closure of automatic discharge valves on power failure. Record results.

1.3 Automatic Surge Suppressor/Spring Loaded Surge Relief Valves - Check for proper sizing to handle expected transient conditions and properly field adjusted for opening/closing times and spring and dashpot settings, if applicable. Record all information.

1.4 Test proper setting and operation of backspin/automatic pump restart protection for sewage pumps. Record setting.

PART 2 - Documentation

In addition to water hammer/surge analyses required by design standards, all final field timing settings, valve adjustments and test results of surge protection devices shall be summarized and included as part of O&M manuals.

END OF SECTION
AUTOMATIC TRANSFER SWITCH TESTING

Test for proper operation of Automatic Transfer Switch in accordance with the following:

PART 1 - Performance Criteria

1.1 Operation. The transfer switches shall close the pilot contact for remote starting of the diesel generator, after a time delay of 5 seconds, adjustable from 0 to 2 minutes, after power failure which causes voltage drop in any phase to 70 percent of line voltage. During the delay period, the load circuits shall not be disconnected from the normal service lines.

1.2 When the generator is delivering rated voltage and frequency, the load circuits shall be transferred. Retransfer to normal service shall be automatic when full line voltage and phase are restored after a time delay of 0 to 5 minutes, set for 3 minutes.

1.3 After retransfer to normal source, the diesel generator shall continue to run for 5 minutes (adjustable 0 to 25 minutes) unloaded, shall shut down and shall be ready to start-up on the next failure of the normal source or for manual start-up.

1.4 If the diesel generator set should fail while carrying the load, retransfer to the normal source shall be made instantaneously upon restoration of the normal power. The pick-up and drop-out settings of the phase voltage-sensing relays shall be completely adjustable in the field from 70 percent to 100 percent pick-up and drop-out.

1.5 Operating current for transfer shall be obtained from the source to which the load is to be transferred.

1.6 Check exerciser block for automatic routine exercising of generator set. Length of exercise shall be fully adjustable and capable of exercising the generator with or without assuming the load.

1.7 Check that if normal power interrupts while generator is exercising at no load, the load immediately transfers to the generator set.

1.8 The transfer switch shall be equipped with test button, auxiliary contacts as required for indicating lights to show that the switch is in the normal or emergency supply position, and remote starting of the diesel engine. These shall be checked for proper operation.

PART 2 - Required Documentation:

2.1 Descriptive Data

2.2 Parts List
2.3 Shop Drawings

2.4 O & M Manual

2.5 Contract as-builts

2.6 Final Field test and Performance Report - Compare switch performance in accordance with above criteria and manufacturers recommendations. Make all corrections and document final field test results and settings. Include with final O&M Manuals.

END OF SECTION
GENERAL INSTRUMENTATION AND PUMP CONTROLS
TESTING REQUIREMENTS

PART 1 - GENERAL

1.1 Description

Provide all materials and labor to perform on-site tests of instrumentation, pump controls and monitoring (ICM) systems complete in every detail. The tests include validation, start-up, and operational testing of a complete and operable instrumentation and control system as shown on the plans and as specified.

1.2 System Responsibility

A. Contractor's attention is directed to the fact that the ICM system as specified is an integrated system. The entire system installation including calibration, validation, start-up, operational testing, and training shall be performed by qualified personnel, possessing necessary equipment and experience in using the latest, most modern proven design and shall, as far as practical, be of one manufacturer. Overall system performance shall be guaranteed by the contractor.

B. The contractor shall be responsible to see that components of the instrumentation and pump controls system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, and alarming devices and appurtenances, are completely compatible and shall function as outlined and shall furnish and install such additional equipment and accessories to meet these objectives at no cost to the County.

PART 2 - WORKING REQUIREMENTS

2.1 Equipment Operating Conditions

All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:

A. Power

1. Electrical: 120 VAC ± 0 percent, 60 Hz except where specifically stated otherwise on the drawings or in the specifications.

2. Air: 20 psig ± 1 psig.
B. Field Instruments

1. Outdoor Areas:
   a. Ambient Temperature: 0 to +120 degrees Fahrenheit.
   b. Ambient Relative Humidity: 5 to 100 percent.
   c. Weather: Rain, sleet, snow, ice, condensing fog, wind, and sun.
   d. Provide, as necessary, enclosures, sun shields, and thermostatically controlled heaters to assure normal operations under these conditions.

2.2 **Signal Isolators, Converters and Conditioners**

Ensure that input-output signals of all instruments and control devices are compatible. Unless otherwise specified signals between field and panels shall be 4 to 20 mA DC unless specifically approved otherwise. Granting approval does not relieve the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application.

**PART 3 - EXECUTION**

3.1 **Inspection**

Inspect each control panel, instrument and piece of equipment for damage, defects, completeness, and correct operation before installation. Inspect previously installed related work and verify that it is ready for installation of instruments and pump control equipment.

3.2 **Contractor's Certified Reports**

The contractor shall submit a certified report for each control panel and associated field instruments certifying that the equipment:

1. Has been promptly installed under his supervision;
2. Is in accurate calibration;
3. Was placed in operation in his presence;
4. Has been checked, inspected, calibrated, and adjusted as necessary;
5. Has been operated under maximum power variation conditions and has operated satisfactorily; and
6. Is fully covered under the terms of the guarantee.

3.3 Demonstration and Final Operating Test Plans and Results

Submit for approval a written plan for demonstrating that each system of equipment provided meets the specified operational requirements. The plan shall include procedures to be used in final operation testing of entire system including a description for each system of test methods and materials, testing instruments and recorders, a list of the equipment involved with the functional parameters to be recorded on each item, and shop drawings of required temporary bypasses and like facilities. Submit eight (8) copies of test results and records of final operation tests.

3.4 Factory Testing of Control Panels

Verify, at the factory, wiring continuity and verify panel operation by simulated inputs and outputs. Provide a report certifying the control panels are operable and meet the specifications.

3.5 Manufacturer's Installation and Supervision

Furnish the services of authorized factory personnel especially trained and experienced in the installation of the equipment to:

1. Supervise the installation in accordance with the approved Instruction Manual;

2. Be present when the instruments and equipment are first put into operation;

3. Inspect, check, adjust as necessary, and approve the installation;

4. Calibrate the instruments, in accordance with the specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable; and

5. Prepare and submit the specified Manufacturers' Certified Report. Include all costs for representative's services in the contract price.

3.6 Instrument Calibration

Provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration. Each instrument shall be calibrated at 10 percent, 50 percent, and 90 percent of span using test instruments to simulate inputs and read outputs that are rated to an
accuracy of at least five (5) times greater than the specified accuracy of the instrument being calibrated. Such test instruments shall have accuracies traceable to the National Institute of Standards and Technology, as applicable.

Provide a list and basic specifications for instruments used. Provide a written report to the Engineer on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include applicable data as listed below plus any defects noted, correction action required, and correction made. Data shall be recorded on prepared forms and shall include not less than the following items.

1. Facility identification (name, location).
2. Loop identification (name or function).
3. Equipment tag and serial numbers.
4. Scale ranges and units.
5. Test mode or type of test.
6. Input values or setting.
7. Expected outputs and tolerances.
8. Date of actual calibration.
10. Explanations or special notes as applicable.
11. Tester's certification with name and signature.

### 3.7 System Validation

A. Provide the services of a factory trained and field experienced instrumentation engineer(s) to validate that each system is operational and performing its intended function without system tolerance. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output. Validate each system by simulating inputs at the first element in loop (i.e., recorder, indicator, alarm, etc. except controller). During system validation, make provisional settings of levels, and alarms. Verify controllers by observing that the final control element moves in the proper
direction to correct the process variable as compared to the set point. Verify that alarms and logic sequences operate in accordance with the specifications.

B. Cause malfunction to sound alarms or switch to standby to check system operation. Check all systems thoroughly for correct operation.

C. Immediately correct defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest. Provide a report certifying completion of validation of each instrument system. This report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices. Data sheets shall be similar to those used for calibration.

3.8 Final Operational Testing and Acceptance

A. Upon completion of instrument calibration and system validation, test system under process conditions. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation and pump control systems. This testing shall include, but not be limited to, specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failure interlocks, and operational interlocks between systems and mechanical equipment.

B. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the test results. Upon completion of final operational testing, submit certified report, with substantiating data sheets, indicating that total ICM System meets the functional requirements specified herein.

B. Testing shall be observed by the Engineer. Notify the Engineer in writing a minimum of 48 hours prior to the proposed date for commencing the test. Upon completion of this test the Contractor shall begin or have begun system start-up. Anne Arundel County reserves the right to set the testing schedule.

3.10 Start-Up Assistance

Provide the services of a factory-trained and field-experienced instrumentation engineer for a minimum of two (2) working days to assist the County's personnel during start-up of the system. The purpose of this assistance is to support in making final adjustment of settings on the instrument systems.
3.11 Instruction of County's Personnel

Provide the services of a factory-trained and field-experienced instrumentation engineer for a minimum of two (2) working days to conduct group training of the County's designated personnel in the operation of each instrument system. Include instruction covering basic system theory, operating principles, and adjustments, routine maintenance and repair, and "hands-on" operation.

3.12 Coordination

Work shall be coordinated with other trades involved in the construction project. Work shall be carefully laid out in advance so that architectural, structural, mechanical, electrical, and instrumentation features of construction will be coordinated.

END OF SECTION