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Preparing Activity: USACE Superseding
UFGS-43 31 14 (April 2006)

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated July 2023**
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**05/18**

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**USACE / NAVFAC / AFCEC / NASA** **UFGS-46 53 22 (May 2018)**

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**Preparing Activity: USACE** **Superseding**
**UFGS-43 31 14 (April 2006)**

**UNIFIED FACILITIES GUIDE SPECIFICATIONS**

**References are in agreement with UMRL dated July 2023**

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SECTION 46 53 22

TRICKLING FILTER
**05/18**

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**NOTE: This guide specification covers the requirements for a trickling filter for use in sewage treatment plants normally handling domestic sewage.**

**Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insertappropriate information.**

**Remove information and requirements not required in respective project, whether or not brackets are present.**

**Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).**

**********

PART 1 GENERAL

**********

**NOTE: Special consideration must be given to sewage carrying industrial wastes containing components detrimental to biodegrading microorganisms. Show the following information on the project drawings or provided by the project designer:**

**a. Dimensions of filter tank and elevation of base slab.**

**b. Design flows and loading rate.**

**c. Available head.**

**d. Depth of filter bed.**

**e. Size of inlet piping.**

**f. Location of vent stack pipes.**

**g. Design loads for wind and ice where applicable.**

**h. Clearance of arms above filter surface.**

**i. Number of distribution arms.**

**j. Type(s) of filter media to be allowed.**

**k. Type of filter blocks.**

**********

## 1.1 REFERENCES

**********

**NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.**

**Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.**

**References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.**

**********

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)

| | |
|---|---|
| ABMA 9 | (2015) Load Ratings and Fatigue Life for Ball Bearings |
| ABMA 11 | (2014) Load Ratings and Fatigue Life for Roller Bearings |

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

| | |
|---|---|
| AISC 360 | (2016) Specification for Structural Steel Buildings |

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C151/A21.51 | (2017) Ductile-Iron Pipe, Centrifugally Cast |

ASTM INTERNATIONAL (ASTM)

| | |
|---|---|
| ASTM A36/A36M | (2019) Standard Specification for Carbon Structural Steel |
| ASTM A48/A48M | (2003; R 2021) Standard Specification for Gray Iron Castings |
| ASTM A53/A53M | (2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless |
| ASTM A123/A123M | (2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A153/A153M | (2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A475 | (2022) Standard Specification for Metallic-Coated Steel Wire Strand |
| ASTM B209 | (2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate |
| ASTM B241/B241M | (2022) Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube |
| ASTM B429/B429M | (2010; E 2012) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube |
| ASTM C88 | (2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate |
| ASTM C144 | (2018) Standard Specification for Aggregate for Masonry Mortar |
| ASTM C150/C150M | (2022) Standard Specification for Portland Cement |
| ASTM C159 | (2006; R 2021) Standard Specification for Vitrified Clay Filter Blocks |
| ASTM C700 | (2018; R 2022) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated |
| ASTM C1107/C1107M | (2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) |

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 8 (1982; E 2004) Pickling

1.2 SUBMITTALS

**********
**NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.**

**For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.**

**The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.**

**Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.**
**********

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Rotary Distributor; G[, [_____]]

SD-03 Product Data

Rotary Distributor; G[, [_____]]

Spare Parts

Submit spare parts data after approval of the detail drawings and not later than [_____] months prior to the date of beneficial occupancy.

Plastic Media; G[, [_____]]Filter Media

SD-07 Certificates

Size And Grading

Layout Of Filter Block Units

SD-10 Operation and Maintenance Data

Operating and Maintenance Manuals

## 1.3 EXTRA MATERIALS

Provide spare nozzles, seals, and all other standard spare parts as recommended in the manufacturer's instruction manuals for each component of the equipment. Include a complete list of parts and supplies, with current unit prices and source of supply.

# PART 2 PRODUCTS

## 2.1 SYSTEM DESCRIPTION

A trickling filter includes a rotary distributor, reinforced concrete walls and base, filter media, filter block underdrainage system, and all other components indicated or necessary for proper operation.

## 2.2 MATERIALS

**********
**NOTE: Delete materials that are not used.**
**********

### 2.2.1 Standard Products

Unless otherwise specified, provide standard commercial products in regular production by the manufacturer and suitable for the required service. [Provide ASTM A36/A36M structural steel.] [Provide ASTM A53/A53M steel pipe for structural members and distributor arms.] [Provide steel members with a minimum thickness of 6 mm 1/4 inch when members will be in contact with sewage, completely or intermittently, during normal operation of the equipment.] [Provide ASTM A48/A48M, Class 30 cast iron.] [Provide ASTM B209 (3003-H14)aluminum alloy for structural members, and provide ASTM B429/B429M (6063-T6) aluminum alloy for pipe.]

### 2.2.2 Materials Protection

Provide ferrous metal surfaces that can be pickled in accordance with SSPC SP 8. Provide ferrous metal surfaces, including rotating assembly, distributor arms, supports, and attachments that are zinc coated in accordance with ASTM A123/A123M or ASTM A153/A153M, as applicable. Pickle and galvanize the interior and exterior of all fabricated ferrous metal components after fabrication. Insulate components such as gaskets, couplings, or bushings, of a dielectric-type To prevent corrosive action

of bimetallic-type contacts, at connections between dissimilar metals.

2.2.3 FILTER MEDIA

2.2.3.1 Quality

**********
**NOTE: When plastic media is to be used exclusively, delete all requirements for and reference to other materials. Consider economic and geographic influences when deciding the filter media type. When trickling filters will be used in cold weather conditions, covers, hydraulic controls, and ventilation should be considered to ensure the optimum trickling filter biological performance.**
**********

[Provide [crushed stone or crushed slag][ or ][random-dumped or stacked modular plastic] media. Ensure the top 460 mm 18 inches of media has a loss by the 20-cycle sodium sulfate soundness test of ASTM C88 of not more than 10 percent by weight; the balance of the media must pass a 10-cycle test using the same criteria.] [Provide plastic media that is random-dumped ring type or stacked modular type. Provide random-dumped ring type media of long term heat aging, rigid polypropylene plastic specially manufactured as trickling filter media, with a minimum void volume of 90 percent, and a minimum surface area of 82 square meters per cubic meter 25 square feet per cubic foot.] [Provide plastic stacked modular type [vertical or crossflow] media of saran, polyvinyl chloride (PVC), fiberglass reinforced resins, or plastic equally resistant to oxidation, ozone aging or effects of ultraviolet exposure, and a minimum void volume and surface area per cubic meters feet volume as required for random-dumped ring type media.] Provide media with a minimum projected life of 25 years in the intended service. Base projected life on case history or simulated aging tests as performed by an independent testing laboratory acceptable to the Contracting Officer. Substantiate such tests by certified test reports. Provide installed media that can provide support for the weight of two workmen working together on any part of the surface of the filter without damage or displacement of the media.

2.2.3.2 Size and Grading

[Conform stone or slag media to the following size distribution and grading and mechanical graded over a vibrating screen with square opening: 100 percent passing 5.0 inch sieve; 95-100 percent by weight retained on 3.0 inch sieve; 2 percent by weight passing the 2.0 inch sieve; and 1 percent by weight passing the 1.0 inch sieve.] [Provide plastic media in accordance with the manufacturer's standard as approved by the Contracting Officer. Provide random-dumped media with a specific gravity between 0.90-0.97 grams per cubic centimeter, a minimum tensile strength of 4500 pounds per square inch, and a minimum modulus of elasticity of 200000 pounds per square inch. Provide stacked modular media with a specific gravity between 1.39-1.50 grams per cubic cemtimeter, a minimum tensile strength of 6000 pounds per square inch, and a minimum modulus of elasticity of 325000 pounds per square inch. Evaluate the module's bearing capacity in the top layer, intermediate layers, and bottom layers.]

## 2.3 EQUIPMENT

### 2.3.1 Standard Products

Unless otherwise specified, provide standard commercial products in regular production by the manufacturer and suitable for the required service.

### 2.3.2 Rotary Distributor

Provide a rotary distributor suitable for the uniform distribution of sewage over the filter bed at the rates of flow and operating conditions specified herein. Provide a rotary distributor including distributor arms, center column, and other appurtenances necessary for proper operation. Provide a rotary distributor that rotates solely from the reaction of sewage flowing through jets or nozzles in the distributor arms and operates freely and effectively over the entire range of operation. Submit detail rotary distributor drawings and installation instructions. Include detail drawings containing equipment layout and anchorage, and sufficient details to demonstrate that the rotary distributor will properly function as a unit.

#### 2.3.2.1 Operating Requirements

**********

**NOTE: Delete ice coating requirements in warm climates.**

**********

Provide a rotary distributor designed for a filter bed of [_____] mm feet inside diameter. Provide design flows that range from a minimum of [_____] L/second gpm to a maximum of [_____] L/second gpm and with average design loading of [_____] L/second gpm. Provide an available total head at the inlet (above the media surface) of [_____] at the maximum rate of flow. Ensure the maximum velocity in the arms does not exceed 1.22 m/second 4.0 fps. Provide a rotary distributor and each of its component parts that are designed to withstand all structural and mechanical stresses brought about by the following loadings: weight of equipment plus liquid; wind loading; and a live load of [_____] N pounds at any point on the arm; and an ice coating of [_____] mm inch thick. Provide a minimum safety factor of 1.6 based on the yield point of the steel. Provide anchorage of the concrete center pier that is designed to resist, with a 2.0 minimum safety factor, a maximum overturning moment brought about when arms on one side of the distributor are filled with water and those on the other side are empty. Ensure vertical deflections at the end of the distributor arms do not exceed 100 mm 4 inches. Provide arms that have a clearance above the surface of filter bed as indicated. Provide a rotary distributor designed for continuous 24-hour service under the design load without excessive wear, damage, or failure. Ensure stresses developed under the aforementioned operating conditions and loads do not exceed the stresses allowed under AISC 360.

#### 2.3.2.2 Center Column

**********

**NOTE: Delete bracketed wording pertaining to weirs or dependent on the provisions of weirs when distributors have less than four arms, except when two-compartment arms are used.**

**The trickling filter tank should be constructed in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Walls should have standard finish. Horizontal surfaces should have screed finish. Insert the following requirements in the appropriate place: "Construct the hollow concrete center pier, including installation of anchor bolts, in accordance with the recommendations of the manufacturer of the rotary distributor, as approved by the Contracting Officer."**

**Type IIA cement normally will be specified, but Type V cement will be specified when the soils contain in excess of 0.2 percent water soluble sulfate as SO(4), or waste water contains in excess of 1,000 parts per million sulfates. Alkali reactive aggregates require use of a cement containing less than 0.60 percent alkalis. Type I cement may be permitted when it can be assured that the water soluble sulfates in the soil will be less than 0.1 percent and the waste water will contain less than 150 parts per million sulfates over the design life of the project. Air entrainment admixtures will be used in all types of concrete.**

**********

Provide a mast-type or turntable-type center column including a stationary assembly, rotating assembly, seal, bearing assembly, lubricating fittings, and anchor bolts. Provide port areas or openings to permit unrestricted flow of sewage from inlet in stationary assembly through rotating assembly into distributor arms.

a. Stationary Assembly: Fabricate elements of the stationary assembly from cast iron, structural steel, steel pipe, or aluminum alloy. Provide a stationary assembly with a [_____] mm inch diameter inlet, and designed for anchorage to the hollow concrete center pier by anchor bolts.

b. Rotating Assembly: Fabricate elements of the rotating assembly from cast iron, structural steel, or aluminum alloy, except as otherwise specified herein. Select cast iron turntables only, when provided. Provide steel for nonstructural applications with a minimum yield point of 207 MPa 30,000 psi. [Provide an adjustable weir to divide the flow between the primary and secondary arms so that only primary arms will operate at minimum flow and that all arms will discharge uniformly at maximum flow. Provide a weir that is accessible for adjustment without dismantling the equipment. Provide a weir in the rotating assembly, unless provided in each secondary arm as specified hereinafter.] Provide a rotating assembly with machined surfaces suitable for installation of distributor arms and a height that provides suitable anchorage for the distributor arm supports.

c. Seal: Provide a mechanical seal or an air gap to prevent the leakage of water between the stationary and rotating assemblies at the maximum hydraulic head. Any type of seal employing mercury as the sealing element is not allowed.

(1) Mechanical Seal: Design the mechanical seal, to withstand the

full hydraulic head in the rotating assembly. Provide seals having an annular ring of replaceable grease-resistant neoprene or tetrafluoroethylene with a low coefficient of friction. Provide seals between horizontal surfaces that are maintained against the seal plate by annular steel weight strips and steel seal clamps. Provide seals between vertical surfaces that are spring loaded in steel retainer rings attached to the rotating assembly.

(2) Air Gap: Provide an air gap, to prevent the liquid from entering the rotor bearing and that requires no auxiliary equipment to maintain the air gap between the fixed feeder pipe or column and the rotating sleeve and/or drum. Provide means to prevent the liquid level in the rotating equipment from rising positively to the elevation of the air gap. Provide a relief device to prevent this that is constructed to force any overflow to discharge on the surface of the filter, visible to the operator and at a point above or apart from normal distribution outlets.

d. Bearings: Ensure radial and axial loads of the rotating assembly and distributor arms are transmitted to the stationary assembly by an anti-friction thrust bearing of the ball or roller type. Provide guide or steady bearings where necessary to maintain alignment. Design bearing so that the rotating assembly maintains its alignment, starts freely, and operates satisfactorily at the minimum head at all conditions of wind and temperature. Ensure bearings are designed for the vertical thrust of the machine full of water and the horizontal thrust due to eccentric loads on the arms. Provide bearings that have a minimum rated life expectancy of 100,000 hours (L-10). When the equipment is operating continuously under specified loading conditions, the load rating and the fatigue life is based on ABMA 9 and ABMA 11, as applicable.

e. Lubrication Fittings: Provide all moving parts subject to wear and all bearings with adequate means for lubrication. Lubrication is by grease or oil, as suitable. Provide greased bearings with fittings for grease gun service. If not easily accessible, provide a bearing lubrication with grease tubing extended to convenient locations. Provide grease fittings that prevent over-lubrication and pressure build-up injurious to bearings. Provide oil reservoirs that are liberal in size and have an opening for filling, an overflow opening at the proper location to prevent overfilling, an oil-level sight glass, and a drain at the lowest point. Provide the manufacturer's recommended lubricant sufficient for 6 months of normal operation.

f. Anchor Bolts: Provide anchor bolts, with necessary hex nuts and washers, fabricated of Type 304 stainless steel. Provide anchor bolts and accessories to secure the stationary assembly to the hollow concrete center pier.

2.3.2.3 Distributor Arms

Provide distributor arms that are attached to the rotating assembly by flanged or screwed connections. Provide arms fabricated of steel pipe, structural steel with a minimum wall thickness of 6 mm 1/4 inch, or aluminum alloy that conforms to ASTM B241/B241M. [When the adjustable flow division weir specified in paragraph Rotating Assembly is not provided in the rotating assembly, provide one adjustable, accessible overflow weir in each secondary arm to cut off flow to that arm at minimum flow and to allow uniform flow of all arms at maximum flow.] Provide the

end of each arm with a quick-opening shear gate for flushing. Support the arms from the rotating assembly by cables, steel tie rods with turnbuckles, or a steel truss. Conform wire strand for cables to ASTM A475. Provide arm supportsto support the design loads. Brace arms laterally by means of horizontal steel tie rods with turnbuckles. Provide each arm with openings spaced to distribute the flow uniformly over the filter bed. Provide nozzles and spreaders at each opening and constructed of corrosion-resistant nonferrous material. Design nozzles to provide maximum reactive force with minimum head loss. Ensure spreaders disperse the flow evenly from each opening. Provide spreaders that are easily removable for cleaning and equipped with replaceable orifices permitting variation of flow capacity with different orifices. Provide rectangular-arm distributors that have orifices in the spreaders. Provide orifices of nonclogging design.

#### 2.3.2.4 Center Pier Supply Fittings

Provide the [_____] mm inch supply inlet line junction fitting with a [base tee and riser pipe] [base-plate with short riser pipe and flange] suitable for the rotary distributor center column attachment. Construct center pier supply fittings of ductile iron, or steel conforming to AWWA C151/A21.51 or ASTM A53/A53M, respectively.

## 2.4 FILTER BLOCKS

Provide an underdrain system that includes rectangular and cut tile blocks, cover blocks for drainage channels, and vent blocks. Conform all blocks to ASTM C159, Type I-H, except provide cover blocks without apertures and provide vent blocks with openings to accommodate vent stacks. Provide cut or angle blocks that are cut on an angle to conform approximately to the wall curvature. Provide filter underdrain blocks that have semicircular inverts or equivalent sections and cover the entire floor of the filter. Provide vent stack pipes of extra strength vitrified clay pipe conforming to ASTM C700 and that are provided as indicated.

# PART 3 EXECUTION

## 3.1 INSTALLATION

### 3.1.1 Placing Rotary Distributor

**********

**NOTE: Delete bracketed wording pertaining to weirs or dependent on the provisions of weirs when distributors have less than four arms, except when two-compartment arms are used. Coordinate with paragraph CENTER COLUMN.**

**********

Provide rotary distributor that is installed in accordance with the recommendations of the manufacturer and by workmen experienced in the installation of this type of equipment. Carefully check all components with galvanized or other corrosion-protective coating and restore any damaged or abraded areas to the original or an equivalent coating. Provide proper alignment of all equipment. Set the anchor bolts in place and the nuts tightened against the shims. Securely bolt the stationary assembly in place. Further check the alignment of equipment after securing to the foundations and, after confirming all alignments, grout the stationary assembly in place using grout that conforms to

ASTM C1107/C1107M. Align equipment with associated piping and under no circumstances will "pipe springing" be allowed.[ Set the weirs in accordance with the directions of the manufacturer, based on anticipated flows.]

### 3.1.2 Placing Filter Block

Lay filter underdrain blocks in a dry mortar bed. Provide mortar thatcontain one part cement conforming to ASTM C150/C150M, Type II, and 4 parts sand conforming to ASTM C144, except a 1:3 cement-sand mortar bed for the first course of blocks where cover blocks are used. After the blocks are laid and before the stone is placed, dampen the dry mortar bed by sprinkling. Install filter blocks providing an uninterrupted flow through the drainage channels in the blocks to the effluent channel. Lay blocks in true alignment, with cross joints staggered in longitudinal rows at right angles to the center drains. Start the rows of blocks at the edge of the drainage channel and end at a sufficient distance from the filter wall to provide an air passage around the inside periphery of the filter. Provide air ducts comprised of either blocks or stacks for venting air to the atmosphere as shown on the drawings. Provide the manufacturer's plan layout of filter block units.

### 3.1.3 Placing Filter Media

[Store stone or slag media delivered to the filter site on wood planks or other clean hard surface areas. Do not dump stone and slag directly into the filter. Rescreen and fork the media at the filter site to remove all fines before placement in the filter. Place material by hand to a depth of 300 mm 12 inches above the filter blocks and place all material without damaging or displacing the underdrains. Place the remainder of the material by means of belt conveyors, wheelbarrows, or other equipment recommended by the manufacturer. Place the media in layers not exceeding 450 mm 18 inches in depth. Place filter media as near as practicable in final position to avoid excessive rehandling; take special care to avoid breakage or segregation of different size particles. Dumping the filter media directly from trucks into the filter, dropping the filter media from heights exceeding 1 m 3 feet or throwing the media into the filter is not permitted. If it is determined that an excessive amount of fractured stone or dust is passing into the underdrains, remove and rescreen the filter media at a location outside the filter walls. Walkways or runways over the filter, except for the purpose of installing materials or equipment for the filter, are not be permitted. Storing materials, such as cement or sand, or placing heavy construction equipment within the filter walls will not be permitted. Do not pass concrete, sand, dirt, or other materials deleterious to the filter over the filter by any means. Driving trucks, tractors, or other heavy equipment over the filter during or after construction is not permitted.][ Install plastic filter media in accordance with the recommendations of the media manufacturer.]

## 3.2 FIELD TESTS AND INSPECTIONS

Provide all labor, equipment, and incidentals required for the tests, except that water required for the field tests will be supplied as set forth in the CONTRACT. Notify the Contracting Officer [_____] days prior to dates and times of field tests. Perform all field tests in the presence of the Contracting Oficer. Rectify any deficiencies found and completely retest work affected by such deficiencies. Test the distributor mechanism to demonstrate correct alignment, smooth operation, and uniformity of flow distribution over the filter media.

## 3.3 CLOSEOUT ACTIVITIES

Submit operating and maintenance manuals. Provide manuals that include the manufacturer's name, model number, service manual, parts list, brief description of all equipment and their basic operating features, and simplified wiring diagrams for the system as installed.

-- End of Section --