**SECTION 4.3**

**TECHNICAL SPECIFICATION FOR**

**ELECTRICAL CONTINUITY TESTING OF WATER MAINS**

**PART 1: GENERAL**

**1.1 Scope of Work**

Work performed under this specification shall consist of providing all supervision, labor, equipment and materials as well as providing all operations necessary to perform electrical continuity testing of water mains as shown on the drawing and specified herein.

**1.2 Purpose and Schedule of Testing:**

The purpose of the electrical continuity testing is to verify and document effective electrical conductance.

**Part 2: Quality Assurance**

* 1. **Reference Standards**

Unless otherwise stated, the latest editions of the following documents are applicable

for this specification:

AWWA M9 Manual - Concrete Pressure Pipe

NEC 70 National Electrical Code

NACE SP-0169 Recommended Practice, Control of External Corrosion on

Underground or Submerged Metallic Piping Systems

UL 467 Bonding and Grounding Equipment

UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

**2.2 Requirements**

* The testing company, or agency, proposed by the Contractor must be a firm regularly engaged in the field of corrosion control testing. The employees assigned to the project are to be personnel familiar with corrosion control electrical testing procedures, electrical instrumentation and general electrical networks. Personnel must be capable of modifying procedures to suit actual field conditions should such modifications become necessary.
* The number of readings taken to determine an electrical constant or property must be sufficient to assure that random factors due to human error in reading the instruments and transient disturbances in the electrical network have negligible influence on the final results. The adequacy of the data can generally be established by the tester and is subject to review and approval by Owner.
* Testing results shall be provided confirming all electrical discontinuities have been located and repaired.
* All continuity testing results and bonding is subject to inspection and testing by the Owner.

**2.3 Submittals**

The Contractor shall furnish following documents made in a timely manner so that project schedule can be met:

* + 1. Testing Group:

The contractor shall submit the name of the testing agency to be employed on the project as a subcontractor, if applicable. This submittal shall include:

* Full background data of the testing agency
* References to prior work or projects having similar requirements and/or complexities with this project.
  + 1. Testing Methods:

Prior to the start of the field work, the contractor shall submit a detailed written description of the proposed testing procedures to verify electrical continuity, for review and approval by the Owner. This should include:

* Step by Step Testing Procedures, including schematics showing typical electrical

instrumentation hook-ups and data reporting form(s)

* Maximum pipeline lengths to be used for testing
* Criteria to determine continuity
* References for Testing Procedures
* Materials and methods for attaching joint bonding cables to joint rings and configuring the cables so they are not exposed within the pipe bore after concrete/mortar repairs
  + 1. Instrumentation:

The contractor shall submit a list of instruments to be used for the electrical testing. The list shall include manufacturer’s name, model number, and serial number. All instrumentation shall bear evidence of certified calibration within

the prior year.

* + 1. Report:

The contractor shall submit a report including, but not limited to the following:

* Testing spans start station number and end station number
* Electrical measurements before and after any repairs
* Tabular documentation identifying each joint found to be electrically

discontinuous and each joint bonded

* All calculations and collected data, including raw data using approved data

reporting forms

* Photographic documentation shall be provided to illustrate testing procedures, and

record of every joint repaired. The photos shall be referenced to the tabular

documentation as furnished.

* + 1. Safety:

The contractor shall be responsible for personnel performing work in

compliance with all applicable OSHA and Owner’s safety requirements and

procedures, for all persons entering the pipelines.

**PART 3: EXECUTION**

Owner shall be present to observe all testing, joint bonding, and concrete/mortar repair work performed by the contractor. This observation shall in no way relieve the contractor from fully complying with the work set forth in these specifications.

**3.1** **Locating Discontinuous Joints**

* Testing shall not begin until testing methods have been submitted and approved by the Dallas Water Utilities or its designated representative.
* Testing Electrical Contact Points: Use only pipe contact points (i.e. test stations), including temporary vault connections, which have been demonstrated to provide a reliable, low resistance, electrical connection to the pipe.
* Pipe Dewatering: The dewatering of the pipe shall be performed by the Dallas Water Utilities Distribution Department, or approved contractor.
* Concrete/Mortar Removal & Repair: The contractor shall be responsible for all concrete/mortar removal and repair at joint rings necessary to facilitate the electrical testing and bonding of electrically discontinuous joints.
  + - The contractor shall remove a window at each joint suitable to perform electrical testing and bonding, if necessary.
    - The contractor shall perform pipe joint repairs including attaching bonding straps and replacing mortar.
  1. **Discontinuous Joint Bonding**
* The Contractor shall be responsible for the electrical bonding of each discontinuous joint, including the documentation of same per Section 2.3 of this specification.
* Bonding:
  + - If a discontinuity is found, two bond cables will be installed across the joint, one in the 3 to 5 O’clock position and the second in the 7 to 9 O’clock position.
    - The window created for bonding will extend across the joint, exposing the joint ring on the bell and spigot sides.
    - A #4 AWG stranded copper wire with THHN insulation shall be used to make each bond. The cable length shall be kept to the minimum necessary.
    - The contractor will submit connection techniques (e.g. Arc Welding, Pin Brazing) for approval. Means and methods shall be such that an effective electrical bond is maintained once the pipe is returned to service and so no metallic connection or cable remains exposed and extents into the pipe bore.
  1. **Post Joint Bonding Electrical Continuity Testing**
* All discontinuous joint locating and bonding must take place before this testing begins. This testing shall take place before the pipe is refilled with water.
* For a given section between manholes the Contractor shall determine and record the longitudinal resistance of the pipe for the entire section.
  + The resistance shall be determined using Ohm’s Law by impressing a direct test current across individual pipe spans of no longer than 1,000 feet and measuring the resultant voltage drop across the same span.
  + Test lengths (not exceeding 1,000 feet) shall be such that there are at least two spans tested between consecutive manholes.
  + Test connections can be test wires previously installed and determined to provide a reliable, low resistance, electrical contact to the pipe or temporary connections made internally to a joint ring.
  + For temporary connections to the joint rings, current injection points shall be at least 5 pipe diameters “outside” the corresponding voltage measuring points.
  + Contractor shall repair all pipe damaged to make temporary connections.
* The contractor shall compare the calculated longitudinal resistance with a theoretically derived resistance using procedures and formulae in AWWA M9 (Chapter 12, Design Considerations for Corrosive Environments). The theoretical resistance shall account for the resistance of the pipe cylinder, the resistance of the joint bonding, and electrical fringing effects.
* Calculated resistances that are greater than 120% of the corresponding theoretical resistance shall be evaluated further by the Contractor and DWU to determine if additional pipe joint bonding within the particular span is warranted.
* If additional pipe joint bonding is deemed necessary, the resistance tests shall be repeated after completion of the work until accepted by DWU or its designated representative
* The Contractor’s data submittal shall include raw data sheets for each pipe span along with an Excel spreadsheet showing the field measured values (voltage and current), and comparing the calculated span resistance with the corresponding theoretically derived resistance. The submittal shall include an electronic version of the spreadsheet (excel) with no hidden formulae, constants, etc.

**PART 4: METHOD OF MEASUREMENT AND PAYMENT**

Method of Measurement and Payment for providing the Electrical Continuity Testing of Water Mains as specified in this section shall be incidental and inclusive in the applicable unit price bid item.

**\*\*END OF SECTION\*\***