GUIDE SPECIFICATION FOR

ELECTRO OSMOTIC PULSE TECHNOLOGY TO CONTROL WATER SEEPAGE INTO CONCRETE STRUCTURES
(July 2004 Draft)

PART 1 GENERAL

1.1 REFERENCES

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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TC 2	(1990) Electrical Polyvinyl Chloride (PVC) Tubing (EPT) and Conduit (EPC-40 and EPC-80)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(1996) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6	(1993) Rigid Metal Conduit

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1248	(1984; 1989) Polyethylene Plastics Molding and Extrusion Materials

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with SECTION 01330 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

QA/QC Plan; G, [____]

A quality assurance plan for installation of the EOP system to include personnel safety issues, installer certification, application and inspection of the EOP system, location and placement of splices, grout curing provisions, means to assure dry interior surfaces, quality assurance sampling and cleanup. Indicate the testing that will be performed and identify the party or parties responsible for this testing.

SD-02

Provide drawings that document the as-built installation of the system. Include system layout and wiring diagrams.

SD-03 Product Data

Materials

Manufacturer's product data sheets indicating physical, mechanical, and chemical characteristics of all materials used in the EOP system.

Delivery Inspections

Material Safety Data Sheets (MSDS) for all materials to be used at the job site in accordance with OSHA and 29 CFR 1910.1200.

SD-06 Test Reports

Field Test Data
Pre-installation photographs
Post-installation photographs

SD-07 Certificates

Contractor Qualifications; G, [____]

A list of a minimum of five (5) completed EOP projects performed by the contractor in the last 4 years for the U. S. Government. Include summaries for each of the related projects. Include for each project: project title, the U. S. Government agency for which the work was performed, a short description of the work and supporting documentation including names and telephone numbers of persons who have knowledge of the completed project.

Personnel: Submit a roster of technical and support personnel who would be available for assignment to the work. These rosters shall include the names, positions and qualifications of all potential participants.

SD-08 Manufacturer's Instructions

EOP System; G, [____]

Submit one copy of the user's guide and operating manual for the EOP control unit to be installed.

SD-10 Operation and Maintenance Data

EOP maintenance; G, [____]

Provide written procedures to properly maintain the installed EOP system as well as written manufacturer recommended repair procedures for damage to the in-place EOP system.

1.3 GENERAL REQUIREMENTS

A complete, operating electro-osmotic water seepage protection system in accordance with applicable federal, state and local regulations, NFPA 70 (National Electrical Code), and the requirements of this contract shall be provided. The project shall include pre-installation inspection of the site, development of site specific plans and specifications, installation of the EOP system, and adjustment and testing of the protection system. Buy American Act provisions must be followed as well as conforming to applicable standards (e.g. ASTM, NFPA, and UL) and regulations.

1.4 QUALIFICATIONS

Provide all professional staff, support staff, and specialists necessary to plan, supervise and perform the required work. Provide adequate professional supervision to assure the accuracy, quality and completeness of all work required. Additionally, provide a person who is qualified and competent as defined in Section 01 of Engineering Manual (EM) 385-1-1 for all job sites. The U.S. Army Corps of Engineers Safety and Health Requirements Manual, EM 385-1-1 may be accessed at: http://www.hq.usace.army.mil/soh/hqusace_soh.htm.

TECHNICIAN

This position requires a minimum of 3 years experience in control of water intrusion in below-grade structures. The technician is directly responsible for the installation of the system and will be instrumental in services such as cutting and drilling, cable assembly, electrode wiring, epoxy and grout placement, etc.

INSTALLER

This is an entry level position that requires a minimum of one (1) year experience in assisting technicians and engineers. Performs tasks which require mainly physical abilities and effort involving a limited amount of specialized skill or prior experience. Works directly with the technician and assists in the installation of the system.

1.5 WORK SITE SAFETY

Workers having access to the work area shall be informed of the contents of the applicable material safety data sheets (MSDS) and of potential health and safety hazards associated with it's application as well as protective controls associated with materials used on the project. Personnel having a need to use hearing protection, respirators and masks shall be instructed in the use and maintenance of such equipment.

1.6 PREINSTALLATION CONFERENCE

Participate in a meeting between the Contracting Officer, Contractor, the Contracting Officer's Representative and other interestedc parties to discuss the project requirements. Review and discuss all aspects of the project including Specifications, environmental control, surface preparation, EOP system application, quality assurance, schedule requirements, and safety. Request clarification of any ambiguities, and advise the Contracting Officer and the Contracting Officer's Representative of any potential conflicts and/or any technical requirements that appear improper or inappropriate.

1.7 PROJECT/SITE CONDITIONS

Conduct site assessment and structure testing to determine the feasibility of EOP installation. This assessment shall include the following:

(1) The conductivity of the structural material and the backfill material including soil and/or water conductivity. This testing shall be done by using either a standard 4-probe conductivity/resitivity tester; a 2-probe method that utilizes the EOP Control Unit as the power source; or a 2-probe method that uses a "Protimeter", or similar instrument, to measure the relative moisture content. When the EOP Power Supply is used as the power source, one (1) anode and cathode are temporarily installed and connected to the unit. The power supply voltage and current are then used to determine the conductivity.

(2) Document the site using a variety of methods, including but not limited to, photographs, physical measurements, drawings, and verbal descriptions of the site and relevant features and information.

1.10 WARRANTY

Provide a standard warranty that may be used at the option of the Government. Under the terms and conditions of the warranty, the EOP Water Control System and its components shall be warranted against defects for a period of a minimum of two years after the installation is complete. Any problems with the EOP System shall be corrected at no expense to the government or building occupants during this period.

PART 2 PRODUCTS

2.1 ANODES

2.1.1 Ceramic Anodes

The anode (positive electrode) consists of electro-catalytic coatings applied by thermal decomposition to specially prepared titanium substrates. The electro-catalytic coatings are formulated primarily of platinum group metals and appropriate binders. The coatings are applied by spraying or dip coating aqueous salts of the metals onto an acid etch-cleaned titanium substrate and heating to several hundred degrees Celsius. Multiple layers of coating may be applied by this process to provide the desired final coating thickness. The resulting mixed metal oxide coating shall be:

Highly conductive (10-3 Ω-cm to 10-6 Ω-cm resistivity).
Crystalline (anhydrous).
Corrosion and acid resistant.
Very hard (hardness of 60).
Highly abrasion resistant.

The nickel metal oxide (ceramic) coated titanium or niobium wire anode material is available in a variety of configurations for optimization of specific current density and current distribution requirements. It is a ceramic-metal multi-layer composite that is ductile, rugged, and easy to use. It consists of an ultra thin layer of an iridium-tantalum-titanium, mixed metal oxide ceramic deposited onto either a solid titanium core (STI version), a copper cored titanium interface (CTC) or a copper cored niobium-titanium interface (CNC version). The latter has a niobium interface for other applications requiring the added high voltage capacity of niobium with respect to breakdown voltage characteristics that are not of concern in these applications.

The nickel metal oxide anode coating is exceptionally durable in combination with the ductile commercially pure titanium substrate. It has been tested at current densities over 2000 amperes per square foot of anodic current discharge. It is fabricated primarily from precious metal and refractory metal oxides in sufficient quantities and ratios to provide a defined life expectancy.

2.2 CATHODES

Cathodes (negative electrodes) are copper clad steel rods which meet the minimum requirements for grounding of electrical systems per NFPA 70. The cathode normally receives electric current from positive ceramic coated titanium wire electrodes. This action normally provides corrosion mitigation for the negative electrode and therefore common metal materials can be used for this purpose. A commonly used electrode is the common copper clad steel electrical ground rod, typically 5/8-in. diameter by 6-ft long (minimum), which can be driven through a purposely made hole in either the structure wall or slab into the surrounding earth.

2.3 EOP CONTROL UNIT

2.3.1 Control Unit

The EOP control unit supplies a dc voltage with alternating polarity to the anodes and the cathodes. Control units shall have a programmable output pulse pattern. The dc power delivered by the unit shall be within manufacturers specifications and shall meet the system designer's specifications.

The unit uses a standard 120 Volt ac power source. An external ac power switch must be provided and appropriately labeled. The labeling for this switch must clearly identify which position is off. The control unit can be either hard-wired or plugged into a 120 Volt outlet. If metal, the outlet box is required to be grounded.

All electrical connections must be enclosed, either within the control unit itself or within a separate enclosure.

2.1.3.2 Circuit Protection

Overcurrent protection of the ac input shall be fully contained within the unit itself. The output of each unit shall have short circuit protection.

2.3.3 Wiring

AC supply wiring shall be installed in accordance with NFPA 70.

2.3.4 Wiring Diagram

A complete electrical connection diagram showing both the ac and the dc connections to the power supply shall be posted on the inside cover of the unit or its enclosure.

2.3.5 Control Unit Panel Cover

The control panel of the EOP control unit shall have a lockable cover which will also allow viewing of the panel display. If a cover is not available on the unit itself then a separate enclosure to house the entire unit shall be provided. The enclosure shall have a lockable hinged door which will permit viewing of the control panel display when closed. The enclosure shall not interfere with the cooling requirements of the unit. Holes, conduit knockouts, or threaded hubs of sufficient size and number shall be conveniently located in the enclosure.

2.4 ELECTRODE WIRING

All interior and exterior wiring shall be enclosed in either conduit, raceways or tubing and shall be installed in accordance with NFPA 70. Conduit shall be securely fastened at 2.4 m (8 foot) intervals or less. Splices shall be made inside outlet fittings only. Conductors shall be color coded and labeled for easy identification.

Anode supply wires shall have insulation UL rated for at least 600 Volts. Wires from the power supply to the anode junction boxes shall be at least 12 AWG and have red insulation. No more than 20 amps should be handled by the 12 AWG wire. The wire from the junction box to the anode string shall be at least 14 AWG and have blue insulation. Wire enclosures, including raceways, conduits, and junction boxes, within the anode system shall be nonmetallic. The wire from the junction box to the anode shall be connected to the anode with an in-line crimp type splice connector. The connector shall be protected with thermal heat shrink insulated tubing containing a sealant to provide an air tight seal for the connection. The wires in the junction boxes shall have markers designating the circuit letter and anode number permanently attached to facilitate testing and repair.

Wires from the power supply to the cathodes shall be at least 10 AWG with type RHH or RHW insulation. Wires shall be connected to the cathodes using exothermic welds: brazing, "Cadweld", or Burndy "Thermo-Weld" or approved equal. Use of these materials shall be in accordance with the manufacturer's recommendations. The welded area shall be suitably protected so that only the ground rod and insulated wire is exposed. Buried cathode wires shall be encased in rigid nonmetallic conduit suitable for burial. Wiring used for the cathodes shall have black colored insulation.

All exposed wiring and conduits shall be clearly marked as an EOP System. Label spacing is up to the judgment of the installer, but at least one label per room. All labeling shall be in English.

2.5 CONDUIT

Rigid galvanized steel conduit and accessories shall conform to UL 6. Nonmetallic conduit shall conform to NEMA TC 2.

PART 3 EXECUTION

3.1 SYSTEM INSTALLATION

3.1.1 Repair of Cracks or Voids

Any cracks or voids where obvious water penetration is occurring shall be repaired. This is done with either mortar, foams or epoxies depending upon conditions. All materials will be compatible with the EOP system.

3.1.2 Concrete and Soil Conductivity

A test of the concrete and soil conductivity is done to verify both the amount and location of the anodes and cathodes. This testing is done by using a temporary power source to an EOP Control Unit. One anode and cathode are hooked up to the unit and used for testing conductivity.

3.1.3 Anodes

Anodes shall be located no closer than 5 cm (2 inches) to any rebar embedded in the structure. The electrical connection between the anode lead wire and the anode feed wire shall be sealed and shall extend to the insulated portion of the feed wire

3.1.3.2 Ceramic anodes

Grooves are chipped or cut into the floor at the floor-wall juncture using a pattern which is determined from conductivity testing. The groove depth shall allow for sufficient filler material to protect the wire from external damage. After all wiring is placed in the grooves, a mortar compatible with the EOP system is used to fill the grooves. The grooves are filled with mortar and finished providing a 45-degree coving against the wall.

3.1.4 Cathodes

Cathodes are installed adjacent to the structure. They may be installed through the structure walls or through the floor. Installation is accomplished by drilling a hole through the structure, inserting the cathode into the hole, and then driving it into the exterior soil. For optimum system operation, electrical isolation must be maintained between the structure material and the cathode. The lead and supply wires will be protected by enclosing them in a plastic raceway or flexible nonmetallic conduit.

3.1.5 EOP Control Unit

The EOP Control Unit is mounted in an area that is suitable to both the user and the installer. Wiring is run from the unit to both the anodes and cathodes. This wire may be mounted using any of the following methods: surface mount with plastic wire mold; conduit and junction boxes; or by embedding within the wall and encasing with mortar, which results in a flush to

surface condition. After the unit is turned on, it is adjusted and calibrated. The system is now operational.

3.2 OPERATION

The following tasks shall be evaluated and reported:

3.2.1 EOP Control Unit Output Voltage

The EOP Control Unit output voltage shall be monitored. The normal operating output voltage is ± 30 VDC. The output voltage shall never exceed ± 50 VDC. Due to the fact that every installation will be different, and load current is dependent on the number of anodes, or the total length of wire, and the moisture content of the structural material, only qualitative performance criteria can be given. When the moisture level reaches its nominal EOP operating level, the load current will become nearly constant.

3.2.2 EOP Control Unit Output Current

The EOP Control Unit output current shall be monitored. Due to the fact that every installation will be different, and load current is dependent on the number of anodes, or the total length of wire, and the moisture content of the structural material, only qualitative performance criteria can be given. At start up, current shall be greater for high moisture conditions than for low moisture conditions. A properly operating system shall show a significant drop in current during the first few months of operation as the moisture is slowly driven out of the structure material. When the moisture level reaches its nominal EOP operating level, the load current will become nearly constant.

3.2.3 EOP Current Density

The EOP Current density shall be evaluated and reported as milliamps per linear foot of anode installed in the loop. At start-up this value should not exceed 6.5 mA/LF. If the current is greater, selected cathodes should be taken off line.

3.2.4 EOP Current Waveform

The EOP dc current wave form pattern shall correspond to Figure [___].

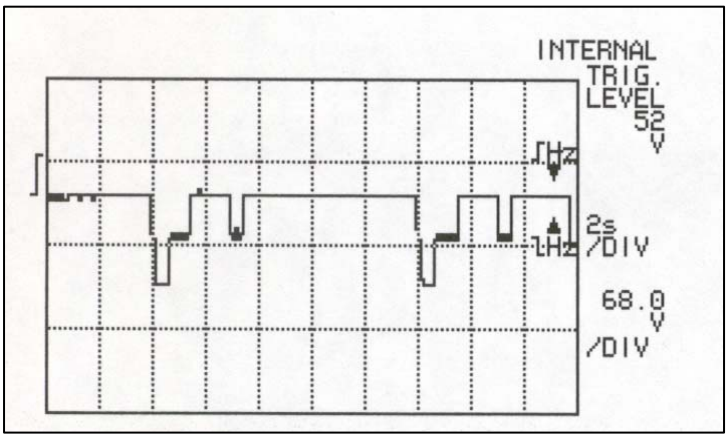

Figure [___]

3.2.5 Relative Humidity Monitoring

Record substrate moisture readings at several locations along the structure perimeter before, during, and after EOP installation. These readings should be taken at the same locations at various time intervals to check for trends.

3.3 FINISH

Where installation of the EOP system has damaged wall or floor finishes, restore the damaged surfaces to the same appearance that was before the commencement of work.

3.4 DOCUMENTATION

3.4.1 Moisture

Document the amount of water seepage existing in the affected areas, prior to installation of EOP systems. The visual documentation shall consist of still photographs or video. The surface moisture content of the structure material and the relative humidity of the interior space shall be documented prior to installation of the EOP system.

3.4.2 Mold and Other Biological Growth

Document the presence and location of mold or other biological growth in the work area. The visual documentation shall consist of still photographs or video. Obtain samples of mold for analysis.

3.4.3 Operating Parameters

Document operating parameters of EOP system at time of EOP system commissioning. This documentation shall include ac voltage and current (power input), dc voltage and current, and waveform analysis.

3.4.5 User's Guide

Provide a user's guide and operating manual for the EOP control unit shall be provided. Drawings of the design and drawings that document the as-built installation of the system shall be included.

3.5 CLEAN UP

Store all materials in a place and manner which protects them from damage or contamination. Regularly inspect all materials to identify damage or deteriorating items. The Government will not be liable for the security of any equipment or materials left on site.

Provide protection to all Government and occupant's property. The Contractor shall be responsible and liable for all damages to the Government or other property due to any negligence on the part of himself or his workers in the orderly prosecution and sequence of his work. Take appropriate steps to safeguard the contents of the facilities while the Contractor and/or any of the employees are working. Contractor personnel are not permitted to use any Government supplies or equipment unless specific authorization is obtained from the Contracting Officer or his/her representative.

After each work day and upon completion of all work, clean the area of all dirt and debris generated as a result of this operation and dispose of in accordance with installation policy and Federal, State and Local regulations.