Note to Specifier: This document is intended to provide assistance in developing a specification for the use of embedded zinc anodes and should be modified as appropriate to accommodate project specific conditions and applications. For additional information, contact Vector Corrosion Technologies.

Galvashield® Fusion T2 - Anode Type 2A, Class C – powered galvanic anodes embedded within drilled holes to extend the life of existing reinforced concrete structures.

SECTION 03700 – EMBEDDED ANODES

PART 1 GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes furnishing all labor, tools, materials, equipment and services necessary to properly install embedded anodes.

B. Powered galvanic anodes are designed to mitigate corrosion in chloride-contaminated or carbonated concrete. When placed in drilled holes at the appropriate spacing, the anodes will extend the service life of the concrete structure.

C. The two-stage anode system shall be installed by a cathodic protection specialist with three years of experience in two-stage anode installation on similar projects. Training and technical oversight will be provided by a certified corrosion technician supplied by the anode manufacturer.

1.3 References

A. ACI/ICRI Concrete Repair Manual

B. ACI Guideline No. 222 – Corrosion of Metals in Concrete

C. ACI Repair Application Procedure (RAP) Bulletin 8 – Installation of Embedded Galvanic Anodes (2010)

D. ICRI Guideline 310.1R Guide for Surface Preparation for the Repair of Deteriorated Concrete resulting from Reinforcing Steel Corrosion

E. ASTM B418 – Standard Specification for Cast and Wrought Galvanic Zinc Anodes

F. ASTM C 309 Curing Compounds for Concrete

G. ISO 12696 - Cathodic protection of steel in concrete

H. NACE SP0290 - Impressed Current Cathodic Protection of Reinforcing Steel in Atmospherically Exposed Concrete Structures

*Note to Specifier: Vector provides a standard limited warranty against defects in materials and workmanship of the manufactured product. This is included in the standard terms of sale and can be downloaded from the Vector website at* [*www.vector-corrosion.com/warranty.pdf*](http://www.vector-corrosion.com/warranty.pdf)*.*

*An extended limited project-specific warranty is also available that covers anode activity over a ten-year period. Eligible projects shall be professionally designed by a licensed architect or engineer and include manufacturer supplied site training.*

*If a project is to require an extended limited warranty, contact Vector’s Business Development Manager prior to final design and include the information in Section 1.4 and Section 3.5.*

1.4 Manufacturer Extended Limited Warranty

A. Contractor shall provide a Limited Warranty with a notarized signature from a corporate officer of the anode manufacturer.

B. The Limited Warranty shall state the following:

*Note to Specifier: Note to Specifier: The typical Galvashield Fusion T2 system has an estimated design life of 30 years however this can be adjusted as required. Enter the actual design life used in the system design in 1.4.B.1.*

1. The design guidelines for anode size and spacing are based on an estimated *[X]*-year anode service life.

2. The Stage 1 phase has sufficient capacity to passivate active corrosion based on typical design guidelines.

3. The Stage 2 galvanic phase will remain electrochemically active and produce galvanic current in relation to the environment in which it is installed for a minimum of 10 years from the date of anode installation.

4. The galvanic anode does not include intentionally added substances that will cause adverse effects to concrete or reinforcing steel and will not contribute to reinforcing steel corrosion damage over the life of the structure.

5. The anodes meet all building and repair code requirements.

PART 2 PRODUCTS

2.1 Embedded Anodes

1. Embedded anodes shall be GalvashieldFusion T2 *[-Standard or -Slim],* a Type 2A Class C anode with the following nominal dimensions: *[add anode dimensions]* available from Vector Corrosion Technologies (www.vector-corrosion.com).

*Note to Specifier:*

*Galvashield Fusion T2 anodes are available in 2 standard configurations (T2-Standard, and T2-Slim). Custom sizes are also available for specific projects. Anode selection should be based on factors such as steel density and concrete thickness. Specify the required anode size in 2.1.*

*Anode Size Dimensions*

*T2-Standard 46 x 105 mm (1 3/4 x 4 1/8 in.)*

*T2-Slim 29 x 135 mm (1 1/8 x 5 3/8 in.)*

*Type: Anode Type is a two-character code*

*The first character indicates where the anode is installed:*

*1 - Embedded in concrete repairs, or*

*2 - Embedded into sound concrete.*

*The second character denotes the type of zinc activation utilized:*

*A - Alkali-activated using high pH, or*

*H - Halide-activated using corrosive salts.*

*Class: This indicates the intended use of the anode.*

*C – Corrosion control (reducing existing active corrosion) and corrosion prevention (preventing the initiation of corrosion), or*

*P - Corrosion prevention only.*

1. The anode unit shall be a single, pre-manufactured unit, capable of providing 2-stage protection without the need for external power or manual switching. Stage 1 shall be characterised by a period of self-powered Impressed Current Cathodic Protection (ICCP). Stage 2 shall be delivered by an alkali-activated galvanic anode capable of providing Cathodic Prevention for the design life of the system.
2. Each anode shall operate independently in Stage 1 and be able to deliver a similar charge, irrespective of the variability in concrete resistance.

Note to Specifier: The charge density range is based upon the chloride content at the surface of the steel. A typical range is between 75kC/m2 – 300kC/m2, contact Vector Corrosion Technologies for design assistance.

1. All steel within the treatment area shall receive a minimum charge of *[X]* kC/m2 of steel surface area during Stage 1.
2. During Stage 1 the galvanic element shall remain electrically isolated so that charge is not distributed from the zinc surface.
3. Each anode shall operate independently in Stage 1 and be able to deliver a total charge of 50kC, irrespective of the variability in concrete resistance.
4. The impressed current treatment shall last for a minimum period of 50 days to maximize the durability of the passive film.
5. The current provided by the galvanic anode shall meet or exceed the cathodic prevention requirements of ISO 12696 (0.2-2mA/m2) for the design life of the system.
6. The zinc core of the galvanic anode shall be in compliance with ASTM B418 Type II and be encased in an activating cementitious mortar with a pH of 14 or greater. The activating mortar shall contain no intentionally added chloride, bromide, sulphate, or other constituents that are corrosive to reinforcing steel as per ACI document 222R.
7. Both stages of the treatment shall be conformant to the performance characteristics as outlined in NACE SP0290 and ISO 12696 for cathodic protection and cathodic prevention.
8. All anodes shall be installed such that the resistance between the first and last anode of a zone is 1 Ohm or less.
9. An anode to steel connection ratio of 20:2 shall be used to maximize redundancy such that the failure of any one connection shall not impair the performance of the system.

*Note to Specifier:*

*Galvashield Fusion T2 Anodes have the capability to be installed such that Stage 1 can be repeated at a later time. This feature would need to be incorporated into the design. For more information, contact Vector.*

1. The anode unit shall have the capability to be installed so that stage 1 can be repeated once the galvanic anode has reached the end of its design life.

Approved equals shall be requested in writing two weeks before submission of project bids. The application shall include verification of the following:

1. A single, pre-manufacture anode capable of delivering 2-stage protection
2. ICCP anode capable of delivering a steel charge density of between 75-300kC/m2 during Stage 1 without the need for external power.
3. Stage 2 shall be a solid zinc core (ASTM B418) surrounded by a highly alkaline cementitious shell with a pH of 14 or greater with a proven activation track record showing a minimum of 20 years of field performance.
4. Contain no added constituent’s corrosive to reinforcing steel or detrimental to concrete, e.g. chloride, bromide, sulphates, etc.
5. Cathodic Prevention anode capable of delivering a continuous current density of between 0.2-2mA/m2 for the design life of the system (Stage 2)
6. Autonomous switching between stages 1 and 2
7. Single wire installation
8. Provide warranty indicating galvanic stage will provide cathodic prevention level of current for a minimum of 10 years from the date of anode installation independent of the level of chloride in the concrete
9. A highly alkaline cementitious shell with a pH of 14 or greater
10. 30 years or more designed service life
11. Assured charge density per square foot or square meter of concrete

2.2 Grout

A. Grouting material shall be Vector Galvashield Embedding Mortar from Vector Corrosion Technologies or approved equal.

2.3 Anode Connections

A. For individual anode connections, use Vector Rebar Connection Kit and Vector Setting Tool from Vector Corrosion Technologies or approved equal.

B. To connect anodes in series, use Vector Anode Connection Kit from Vector Corrosion Technologies or approved equal.

2.4 Storage

Deliver, store, and handle all materials in accordance with manufacturer’s instructions. Anode units shall be stored in dry conditions in the original unopened containers in a manner to avoid exposure to extremes of temperature and humidity.

PART 3 EXECUTION

3.1 Anode Layout

1. Using a suitable rebar locator, the location of the reinforcing grid should be determined and marked out in areas where anodes are to be installed.

*Note to Specifier: Specify maximum grid dimensions in 3.1.B. Contact Vector for design assistance if required.*

1. Mark out locations for anode installation. The anodes shall be installed in a grid pattern with a maximum spacing of *[enter maximum grid dimension]* on center, in each direction. When possible, anodes shall be installed in the center of the reinforcing grid.
2. Mark out location of rebar connections. If the anodes are to be individually connected, one rebar connection per anode is required. If the anodes are to be installed to a common header wire, two rebar connections per string of anodes are required with a maximum of 20 anodes per string.

3.2 Drill Holes and Saw Cuts

1. Rebar Connection – Electrical connections shall be established using a Vector Rebar Connection Kit. At the location of the rebar connections, drill ½ inch (12 mm) diameter holes from the concrete surface until contact is established with the top surface of the rebar. Let the drill bit spin on top of the bar to provide a clean contact area.

*Note to Specifier: Refer to Galvashield Fusion T2 product data sheet for appropriate anode hole dimensions and specify on 3.2.B appropriate for the selected anode.*

B. Anode Location - Drill a hole *[enter the appropriate anode hole dimensions]* in close proximity to marked out location to accommodate the anode. Do not damage rebar when drilling holes.

C. Saw cuts – All saw cuts into the concrete surface between the anode installation holes and the rebar connection holes shall be approximately ¼ inch (6 mm) wide by ½ inch (12.5 mm) deep.

1. If anodes are to be individually connected, saw cut grooves between the anode installation hole and the rebar connection hole for each anode location.

2. If anodes are to be installed in series, saw cut a single continuous groove between the anode installation holes and the rebar connection holes.

1. All holes and saw cuts shall be cleaned of debris and concrete dust.

3.3 Rebar Connections

A. Option 1 - Vector Rebar Connection Kit

1. Using one Vector Rebar Connector per rebar connection hole, place the weighted end of the connector into the drilled hole until the steel coil contacts the top of the steel.
2. Feed the steel connector wire through the Vector Setting Tool and set into place by striking with a hammer.
3. Option 2 – Rivet Connection Kit
   1. 2 in (50 mm) diameter holes shall be cored to the reinforcing steel taking care to avoid cutting steel.
   2. Electrical connection to the steel can shall be established by drilling a 5-7mm deep hole using the 3.5mm drill bit provided.
   3. 3.2mm stainless steel pop rivet are used to connect the connecting wire to the steel.
   4. The connection shall be insulated by a neutral cure sealant or epoxy.
4. Proper connection and rebar continuity for each rebar connection shall be verified between two installed rebar connectors using a multi-meter. Maximum resistance between the two locations shall be less than 1 ohm.

3.4 Anode Installation

1. Prewet the holes and anodes to a saturated-surface dry condition prior to anode placement. Do not let the anodes soak for longer than 20 minutes in a shallow water bath.
2. Mix one 44 lb. (20 kg) bag of embedding mortar with 3.2 to 3.7 liters of potable water using a slow speed drill and paddle 3 minutes until a smooth consistency is achieved.
3. After removing any excess water from the presoaked holes, fill each anode installation hole approximately 2/3 full with mixed embedding mortar.
4. Insert an anode into each hole, forcing the embedding mortar to fill the annular space from the bottom up.
5. Clean out excess mortar from the top of the anode leaving the wire fully exposed.
6. Complete wiring between the anodes and the rebar connections.

1. If anodes are to be connected individually, insert the end of the rebar connection wire though the open side of the button-type wire connectors and the steel anode wire into the terminated side. Crimp the button connector until it is flush with its casing and cut off the excess rebar connection wire. (Test connection as per 2.b.)

2. If anodes are to be installed in series,

a. Insert the interconnecting coated wire though the open side of the button-type wire connectors supplied in the Vector Anode Connection Kit and the coated anode wire into the terminated side. With the anode alongside of the installation hole, crimp the button connector to cut through the wire coating until the connector is flush with its casing.

b. After all anodes along the string are connected to the interconnecting cable, verify continuity between anodes and rebar connections with a multi-meter. Testing is carried out using a portable copper/copper sulfate reference electrode once the anodes have been connected to the steel. Connect the DC Volt port of the multi-meter to the steel. Connect the portable reference cell to the COM port. With the reference cell on top of each anode within the string record the individual readings at each anode. A reading more negative than -2.5V indicates a positive connection.

1. Top off the hole with embedding mortar or other approved mortar and strike off excess flush with the concrete surface. Minimum cover over the top of the anode shall be 1 in. (25 mm).
2. Bury all wiring into the saw cuts and drilled holes with embedding mortar or other material approved by the owner *[owner’s representative]* and strike off flush with the concrete surface.

*Note to Specifier: It is important that the Galvashield Fusion T2 anodes be grouted into place with the specially formulated Galvashield Embedding Mortar. Saw cuts and rebar connection holes can be backfilled with the Galvashield Embedding Mortar or other cementitious or polymer-based materials.*

1. Wet cure cement-based mortar or cure with two coats of a membrane-forming concrete curing compound meeting the requirements of ASTM C309.
2. Protect area from traffic for 24 hours.

*Note to Specifier: If the project designer or owner requires that the anode manufacturer provides an experienced corrosion technician for on-site contractor training, or if an extended warranty will be required (per Section 1.4) include the language in Section 3.5.*

3.5 Manufacturer Corrosion Technician

A. The contractor will enlist and pay for a technical representative employed by the galvanic anode manufacturer to provide training and on-site technical assistance during the initial installation of the galvanic anodes. The technical representative shall be a NACE-qualified corrosion technician (Cathodic Protection Technician–CP2 or higher).

B. The qualified corrosion technician shall have verifiable experience in the installation and testing of embedded galvanic protection systems for reinforced concrete structures.

C. The contractor shall coordinate its work with the designated corrosion technician to allow for site support during project startup and initial anode installation. The corrosion technician shall provide contractor training and support for development of application procedures, verification of electrical continuity, and project documentation.

END OF SECTION