

OWNER

Cathodic Protection Design

Calculation



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Project: [REDACTED] [REDACTED]



TORUS

[REDACTED], [REDACTED] County, [REDACTED]

ISSUE SUMMARY AND APPROVAL

This page records each issue of CP-CAL-001. The preparer, reviewer and approver sign for each revision.

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1. OBJECTIVE

This calculation defines the external corrosion control system for all buried steel at the [REDACTED] and on its outlet lateral to the receiving pipeline operator's tap. It establishes the current requirement, selects between galvanic and impressed current protection, sizes the anodes and the rectifier for a 30-year life, and sets the electrical isolation, surge protection and test facilities that 49 CFR 192 Subpart I requires. The test stations are scheduled in [REDACTED] CP-LST-001, Cathodic Protection Test Station Schedule.

2. METHODOLOGY

TORUS took the buried steel from the station piping model behind [REDACTED] MEC-DWG-001, Plot Plan, rather than from the preliminary plot coordinates. A pipe leg was counted as buried where its centerline lies below finished grade. The inventory was then divided into three electrical zones by the two insulating joints: the outlet lateral beyond IJ-102, which is welded to the receiving pipeline and shares its cathodic protection; the Owner's upstream lateral beyond IJ-101; and the station piping between the joints.

The station zone governs the design. Every motor, actuator and transmitter mounted on the piping carries an equipment grounding conductor back to the copper grounding system, so the buried station steel cannot be separated from the copper in the soil. The current requirement for that zone therefore includes the bare copper of the grounding system described in [REDACTED] ELE-CAL-005, Grounding, as well as the coated steel.

Current requirements follow the bare-area method of AMPP SP0169: the bare-equivalent area is the surface area times the fraction of coating that has failed, and the current is that area times a current density for the soil. Anode resistances use the Dwight equation for a single vertical anode and the Sunde equation for a line of anodes. Galvanic anode life follows from the anode mass, the electrochemical capacity of magnesium, its current efficiency and a utilization factor. The impressed current system was sized on circuit resistance, with rectifier margin for the uncertainty in the copper current density and in the resistivity at depth. Interference from the anode bed was screened with the surface potential of a buried line current source. AC corrosion was screened with the AC current density criterion of AMPP SP21424.

3. DESIGN INPUTS

The inputs in Table 3-1 govern the calculation. Values taken from other project documents name that document.

Table 3-1: Design Inputs

Input	Value	Source
Soil resistivity	1,500 ohm-cm (15 ohm-m), corrosive	GEN-DB-001, Basis of Design (HOLD H-08)
Buried external coating	Fusion-bonded epoxy 14 to 16 mils, abrasion-resistant overlay at bores	GEN-DB-001
Outlet lateral 12"-G-1042	100 ft buried, NPS 12, 0.500 in wall X52, 3R riser bends	MEC-DWG-001 and MEC-CAL-001
Fuel gas line 2"-F-1051	212 ft buried at 4 ft cover	MEC-DWG-001
Fuel gas line 1"-F-1052	118 ft buried at 4 ft cover	MEC-DWG-001
Grounding copper in soil	2,684 ft 4/0, 537 ft 2/0 and 520 ft #2 bare copper; 49 rods 5/8 in x 10 ft	ELE-CAL-005, Grounding
Protection criterion	-850 mV CSE polarized, or 100 mV of polarization	49 CFR 192 Appendix D; AMPP SP0169
Receiving pipeline CP levels and bond requirements	Not available	HOLD H-01, H-04
Power line proximity and AC data	Not available	HOLD H-08

4. ASSUMPTIONS

1. The soil is uniform at 1,500 ohm-cm to the depth of the anode bed. The rectifier voltage covers a resistivity at depth up to 3 times the surface value. *Verification required (HOLD H-08, Wenner survey and deep resistivity log).*
2. Fusion-bonded epoxy coating efficiency is 99 % when new and 90 % at the end of the 30-year design life.
3. Bare steel requires 2.0 mA/ft² in this soil. Bare copper requires 2.0 mA/ft² to reach the steel protection potential. *Verification required by a current requirement test at commissioning.*
4. A contingency of 25 % is added to every current requirement.
5. Finished grade at the buried runs is elevation 1150.5 ft, set by the 48 in cover on the outlet lateral.
6. Magnesium anodes are high-potential alloy, -1.75 V CSE open circuit, 1,000 A-h/lb theoretical capacity, 50 % current efficiency and 85 % utilization. Mixed metal oxide (MMO) anode ratings are typical values. *Verification required (HOLD H-15).*
7. Liquids tank T-101 stands on a concrete slab inside its containment and has no soil contact. Pipe support posts and anchor bolts are encased in concrete and draw negligible current.
8. The Owner's upstream lateral is protected by its own system under the separate lateral project (HOLD H-16).

5. REFERENCES

1. AMPP SP0169-2013 (formerly NACE SP0169), Control of External Corrosion on Underground or Submerged Metallic Piping Systems. The edition in force at the date of design review shall be confirmed.
2. AMPP SP0572-2020, Design, Installation, Operation, and Maintenance of Impressed Current Deep Anode Beds.
3. AMPP SP0286-2021, Electrical Isolation of Cathodically Protected Pipelines.
4. AMPP SP0177-2019, Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems.
5. AMPP SP21424-2018, Alternating Current Corrosion on Cathodically Protected Pipelines: Risk Assessment, Mitigation, and Monitoring.
6. 49 CFR Part 192, Subpart I, Requirements for Corrosion Control (192.451 to 192.491) and Appendix D, as amended through the 2022 gas transmission safety rule, and 192.319(d) to (f) for coating surveys after backfill.
7. Administrative Code Title 165, Chapter 20, Gas and Hazardous Liquid Pipeline Safety.
8. NFPA 70-2023, National Electrical Code.
9. A. W. Peabody, Control of Pipeline Corrosion, 2nd Edition (NACE, 2001), for the Dwight and Sunde resistance equations.
10. GEN-DB-001, Basis of Design.
11. MEC-DWG-001, Plot Plan; MEC-CAL-001, Pipe Wall Thickness.
12. ELE-CAL-005, Grounding; ELE-RPT-001, Hazardous Area Classification.
13. CP-LST-001, Cathodic Protection Test Station Schedule.
14. CP-DWG-001, Cathodic Protection Layout Plan; CP-DWG-002, Cathodic Protection Details (Appendix A).

6. CALCULATION

6.1. BURIED STEEL INVENTORY

Table 6-1 lists the buried steel and its current requirement when new and at the end of the design life. Only two lines inside the insulating joints are buried: the two fuel gas lines, which run below grade from FG-101 to the heater burner train and to the standby generator. The process piping, the V-101 bypass and the liquid drain lines to T-101 are all above grade, and the vent stack base drain line to T-101 has been deleted from the design, so none of them needs cathodic protection. Above-grade steel is protected by its three-coat paint system.

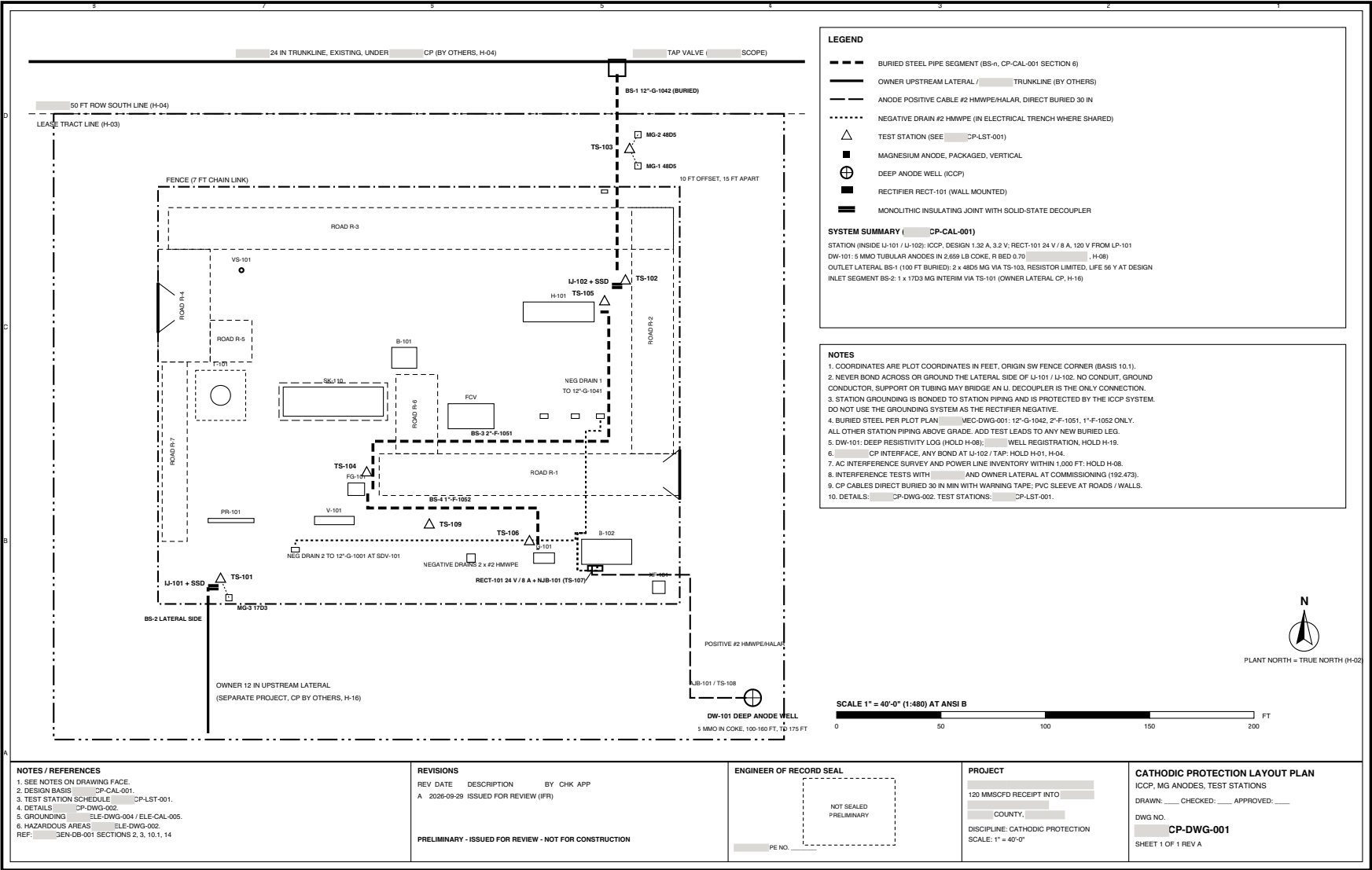
Table 6-1: Buried Steel Inventory and Current Requirement

ID	Line	Zone	Buried length, ft	Surface area, ft ²	Current new, mA	Current at 30 years, mA
BS-1	12"-G-1042-A6	Outside IJ-102	100	334	6.7	66.8
BS-2	12 in Owner upstream lateral, in-tract segment	Outside IJ-101	13	43	0.9	8.7
BS-3	2"-F-1051-A1	Inside IJs	212	132	2.6	26.4
BS-4	1"-F-1052-A1	Inside IJs	118	40	0.8	8.1

Note 1: Currents are before the contingency. The outlet lateral crosses the north road and the north fence below grade.

Figure 6-1 shows the buried segments, the anode locations, the rectifier and every test station. The deep anode well sits in the southeast corner of the lease, as far as the tract allows from both the Owner's lateral and the receiving pipeline.

Figure 6-1. Cathodic Protection Layout



6.2. CURRENT REQUIREMENT

The copper in soil comprises the 4/0 grid and loops, the 2/0 and #2 equipment taps below grade, and 49 ground rods. Its surface area is $A_{Cu} = 439.0 + 72.2 = 511.2 \text{ ft}^2$. The steel inside the joints has a surface area of 172.3 ft^2 . At the end of the design life the station requirement is:

AMPP SP0169, current requirement by bare-equivalent area

$$I_{req} = [A_{st}(1 - \eta_c) i_{st} + A_{Cu} i_{Cu}] F_c = [172.3(1 - 0.90)(2.0) + 511.2(2.0)](1.25) = 1,321 \text{ mA}$$

Copper accounts for 97 % of this requirement. The coated steel alone would need only 43 mA.

The station zone requires 1.32 A at the end of the 30-year life (1.28 A when new).

6.3. SELECTION OF THE PROTECTION SYSTEM

6.3.1. Galvanic Magnesium Anodes

TORUS first evaluated galvanic protection with 48 lb high-potential magnesium anodes in a prepared backfill package (8 in x 38 in). The resistance of one vertical anode to earth is:

Dwight, single vertical anode; Peabody

$$R_a = \frac{\rho}{2\pi L} \left[\ln \frac{8L}{d} - 1 \right] = \frac{1,500}{2\pi(96.5)} \left[\ln \frac{8(96.5)}{20.3} - 1 \right] = 6.52 \text{ } \Omega$$

With the anode at -1.75 V and the structure at the design polarized potential of -1.00 V, the driving voltage is 0.75 V and each anode delivers:

Ohm's law; AMPP SP0169 galvanic anode design

$$I_a = \frac{\Delta E}{R_a} = \frac{0.75}{6.52} = 115 \text{ mA}$$

Faraday's law, galvanic anode life

$$Y = \frac{W Q E U}{8760 I_a} = \frac{48(1000)(0.50)(0.85)}{8760(0.115)} = 20.3 \text{ years}$$

Protecting 1.32 A would take 12 anodes, each lasting about 20 years, so 24 anodes over the 30-year life. They would have to be spread across the station, through classified areas and under roads, because most of their output would go to the copper grounding rather than to the fuel lines. Galvanic protection of the station zone was rejected on anode count, replacement and current distribution.

6.3.2. Isolating the Buried Segments

The alternative of isolating the two buried fuel lines from the grounded piping was also considered. It would need 4 insulating flange kits at the soil-to-air transitions at FG-101, the heater burner train and the generator inlet, each in or near a Class I Division 2 area and each needing a surge-protective

decoupler. Every added isolation point is a place where a support, conduit or tube can short the isolation. Isolation would also leave the copper grounding without cathodic protection, and copper bonded to any holiday in the station steel makes that holiday anodic. The option was rejected.

6.3.3. Impressed Current (Selected)

TORUS selected an impressed current system with a single deep anode well, DW-101. One well protects the fuel lines and the copper together, its output can be adjusted after the commissioning current test, and at 1.32 A the anodes are far from their rating. A deep bed was chosen over a shallow one because the tract is too small for a remote surface bed: the active anodes 100 ft down give the station structure an even current distribution, as the interference screening below shows. The well may require registration with the Water Resources Board (HOLD H-19).

6.4. DEEP ANODE WELL DW-101

The well is a 10 in hole drilled to 175 ft, with a 20 ft PVC surface casing, a perforated vent pipe for the full depth, and a column of calcined petroleum coke from 90 to 165 ft. The 5 MMO tubular anodes are spaced evenly through the active length $L = 60$ ft, from 100 to 160 ft. Treating the coke column as the electrode:

Dwight, single vertical anode; AMPP SP0572

$$R_{bed} = \frac{1,500}{2\pi(1,829)} \left[\ln \frac{8(1,829)}{25.4} - 1 \right] = 0.699 \, \Omega$$

If the resistivity at depth is 3 times the surface value, $R_{bed} = 2.10 \, \Omega$. The grounding system, a 52,736 ft² area with 2,611 ft of grid conductor, has a resistance to remote earth of:

IEEE 80, simplified grid resistance

$$R_s = \frac{\rho}{4} \sqrt{\frac{\pi}{A}} + \frac{\rho}{L_T} = \frac{15}{4} \sqrt{\frac{\pi}{4,899}} + \frac{15}{796} = 0.114 \, \Omega$$

Table 6-2 builds up the circuit resistance.

Table 6-2: Impressed Current Circuit Resistance

Element	Basis	Resistance, Ω
Anode bed	Dwight, 60 ft x 10 in coke column	0.699
Structure to earth	Grounding system and bonded steel	0.114
Positive header	#2 AWG, 147 ft	0.029
Negative drains	Two #2 AWG in parallel, 105 and 188 ft	0.013
Anode leads	5 x #8 AWG in parallel	0.021
Total, design resistivity		0.876
Total, deep resistivity x 3		2.27

With a back voltage of 2.0 V between the anodes and the structure, the rectifier output at the design current is:

Impressed current circuit

$$V = IR_c + E_b = 1.32(0.876) + 2.0 = 3.16 \text{ V}$$

The rectifier current rating is set at three times the design current, with a 4 A floor, because the copper current density is not known until it is measured: the rating must be at least 4.0 A. At the next standard rating of 8 A and the high resistivity case, the voltage needed is:

$$V_r = 8(2.27) + 2.0 = 20.2 \text{ V}$$

The anodes are 1 in x 39 in MMO tubes, each rated 4 A for 20 years in coke, or 2.67 A for 30 years. 3 anodes would carry the full rectifier rating; 5 are installed so that the loss of one anode does not reduce the output and the current spreads over the active length.

Anode life at rated capacity

$$Y_{MMO} = \frac{I_{20}(20)n}{I} = \frac{4.0(20)(5)}{8} = 50 \text{ years at full rating}$$

At the design current the anode life exceeds 303 years. The coke column holds 40.9 ft³, or about 2,660 lb at 65 lb/ft³. At a consumption of 2.2 lb per ampere-year it loses 87 lb in 30 years at the design current and 528 lb at full rating, so the backfill does not limit the life.

RECT-101 is rated 24 V and 8 A DC, air cooled, with an interrupter and remote monitoring. It draws 0.30 kW at 120 V single phase at full output and about 39 W at the design point. DW-101 holds 5 MMO anodes in 2,660 lb of coke.

RECT-101 is mounted on the south wall of the control building B-102, outside all classified areas, with negative junction box NJB-101 beside it. The negative connects to the station piping through two drains, one to 12"-G-1041 at SDV-103 and one to 12"-G-1001 at SDV-101, so that the loss of one connection cannot reverse the system. The grounding system is never used as the negative return.

6.5. INTERFERENCE SCREENING

A current discharged from the anode bed raises the potential of the surrounding earth, and a foreign pipeline in that zone can pick up current near the bed and discharge it elsewhere. Table 6-3 gives the earth potential rise at each structure for the design current and for the full rectifier rating, calculated for a line source in the active column:

Surface potential of a buried vertical line current source

$$V(r) = \frac{I\rho}{2\pi L} \ln \frac{z_2 + \sqrt{z_2^2 + r^2}}{z_1 + \sqrt{z_1^2 + r^2}}$$

Table 6-3: Earth Potential Rise from DW-101

Structure	Distance, ft	Design current, mV	Full rating, mV	Shallow bed, design, mV
trunkline (Y = 260), nearest point	305	31	189	34
Upstream Owner lateral (X = 24, south of IJ-101)	261	35	215	40
Outlet lateral at riser (220, 160)	215	41	249	48
Station grounding perimeter (253, -3)	53	75	452	187

Note 1: The shallow bed column is for comparison: the same current discharged 6 to 26 ft below grade at the same location.

At the receiving pipeline and the Owner's lateral the rise is about 31 and 35 mV at the design current, and a shallow bed would give nearly the same. The deep bed's benefit is at the station itself, where it gives 75 mV at the nearest grounding against 187 mV for a shallow bed. Because the rise scales with current, the rectifier shall be set at the current found by the commissioning current requirement test, not at its rating. Interference tests with the receiving pipeline operator and the Owner's lateral are required at commissioning; any anodic shift on a foreign line will be corrected by a resistance bond agreed with its operator (HOLD H-01) or a lower rectifier setting.

6.6. OUTLET LATERAL 12"-G-1042

The outlet lateral is welded to the receiving pipeline's tap, so it is electrically continuous with that pipeline and its cathodic protection. TORUS designed it to be protected by its own anodes, so that its condition does not depend on the receiving pipeline's system. Any bond to that system is an open item with the operator (HOLD H-01, H-04).

AMPP SP0169, current requirement by bare-equivalent area

$$I_{1042} = \pi \frac{12.75}{12} (100)(1 - 0.90)(2.0)(1.25) = 83.4 \text{ mA}$$

Two 48 lb anodes are installed 10 ft east of the lateral and 15 ft apart, between the north fence and the operator's right-of-way. Each has $R_a = 6.52 \Omega$ (the pair, by the Sunde equation, 3.40Ω) and carries 41.7 mA at the design current, a life of:

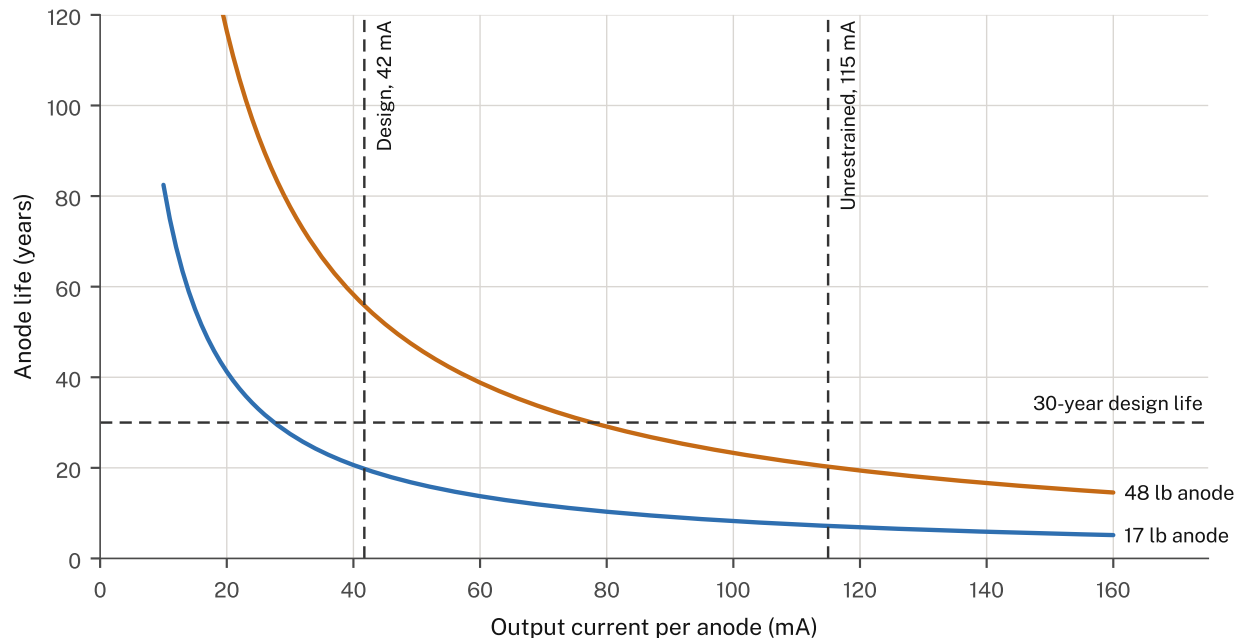
Faraday's law, galvanic anode life

$$Y = \frac{48(1000)(0.50)(0.85)}{8760(0.0417)} = 56 \text{ years}$$

Because the lateral is continuous with the receiving pipeline, an unrestrained anode would discharge as much as the circuit allows, 115 mA with the lateral held at -1.00 V, and would last only 20.3 years. Figure 6-2 shows the anode life against its output. The anodes are therefore connected through an adjustable resistor in test station TS-103, which holds each anode near the design current:

$$R_{lim} = \frac{0.75}{0.0417} - 6.52 = 11.5 \, \Omega$$

Figure 6-2. Magnesium Anode Life Against Output Current



The outlet lateral is protected by two 48 lb high-potential magnesium anodes through a 0 to 25 Ω adjustable resistor in TS-103, giving 56 years at the design current.

6.7. OWNER'S UPSTREAM LATERAL AT IJ-101

About 13 ft of the Owner's upstream lateral lies inside the tract, from the south fence to the riser at IJ-101. It is part of the lateral and is protected by the lateral's own system (HOLD H-16). Because that system may not be energized when the station is commissioned, one 17 lb magnesium anode ($R_a = 9.04 \, \Omega$) is connected through TS-101 as an interim measure. Continuous with the whole lateral, it will run near its unrestrained output of 83 mA and last about 10 years, which is accepted for an interim anode. It shall be disconnected at TS-101 once the lateral system is in service.

6.8. ELECTRICAL ISOLATION AND SURGE PROTECTION

IJ-101 and IJ-102 are monolithic, factory-tested insulating joints. Each is bridged by a solid-state decoupler, listed for Class I Division 2, connected with #6 copper leads no longer than 3 ft. The decoupler blocks DC between -2 V and +2 V, so the cathodic protection systems on each side stay separate, while it passes AC fault current (typically 3.7 kA for 30 cycles) and lightning current (typically 100 kA, 8 x 20 μ s) that would otherwise arc across the joint (HOLD H-15). The decoupler is

the only connection across a joint. No conduit, grounding conductor, pipe support, handrail or instrument tube may bridge a joint; the first support on the lateral side is fitted with an insulating pad and sleeves. The station side of each joint is bonded to the grounding system and the lateral side is not.

6.9. AC INTERFERENCE SCREENING

For a 1 cm² coating holiday ($d = 0.0113$ m) in 15 ohm-m soil, the AC current density at an induced voltage V_{ac} is:

AMPP SP21424, AC current density

$$J_{ac} = \frac{8 V_{ac}}{\rho \pi d} = \frac{8(15)}{15 \pi (0.0113)} = 225 \text{ A/m}^2 \quad \text{at the 15 V touch limit}$$

The low-risk limit of 30 A/m² is reached at only 2.0 V, because the soil is conductive. The station piping is held near earth potential by the grounding system and is not at risk. The outlet lateral is short, but it is continuous with the receiving pipeline, whose induced voltage depends on any power lines along its route. An AC survey and a power line inventory within 1,000 ft are required (HOLD H-08), and an AC coupon at TS-103 will be read at commissioning. If the induced voltage exceeds the limit, gradient control mats or zinc ribbon connected through decouplers will be designed with the operator per AMPP SP0177.

6.10. TEST STATIONS AND MONITORING

Nine test points are provided: four-wire insulating joint stations at IJ-101 and IJ-102, an anode and coupon station on the outlet lateral, a station at each end of the 2 in fuel line and one on the 1 in fuel line, the negative and anode junction boxes, and a coupon and reference electrode station in the middle of the station, remote from the anode bed. Their locations, leads and purposes are given in CP-LST-001. Test leads are #12 AWG minimum, current-span leads #8 AWG, exothermically welded to the pipe and coated.

6.11. COMPLIANCE WITH 49 CFR 192 SUBPART I

Table 6-4 shows how the design meets each requirement of Subpart I that applies to new construction.

Table 6-4: Compliance with 49 CFR 192 Subpart I

Section	Requirement	How the design complies
192.455	New buried steel coated and cathodically protected within one year	FBE coating; ICCP and anodes energized at commissioning
192.461	External coating properties and inspection before backfill	FBE per SPC-SPC-009; holiday detection before lowering in
192.319(d) to (f), 192.461(f)	Above-ground coating survey after backfill for transmission lines of 1,000 ft or more	All buried segments are under 1,000 ft; confirm with the transmission determination (HOLD H-18)

Section	Requirement	How the design complies
192.463, App. D	Criteria for cathodic protection	-850 mV polarized or 100 mV polarization; coupons give IR-free readings
192.465(a)	Pipe-to-soil survey each calendar year, 15 months maximum	Test stations TS-101 to TS-109
192.465(b)	Rectifier inspection six times each year, 2.5 months maximum	RECT-101 remote monitoring plus site checks
192.465(c)	Interference bonds and decouplers checked	Decouplers and any future bond checked each year
192.467	Electrical isolation, inspection of isolation, protection against fault current and lightning	IJ-101 and IJ-102 with decouplers; no bridging
192.469	Sufficient test stations	Nine test points (CP-LST-001)
192.471	Test leads mechanically secure and coated	Exothermic weld and epoxy patch (Appendix A, Detail 7)
192.473	Interference minimized; interference surveillance program for transmission lines	Deep bed; interference tests at commissioning
192.479, 192.481	Atmospheric corrosion protection and inspection every three years (39 months)	Three-coat paint system; Owner's inspection program
192.491	Records of cathodic protection	This calculation, CP-LST-001, as-built layout, commissioning survey

Note 1: The adopts 49 CFR 192 in 165:20.

7. RESULTS AND CONCLUSIONS

Table 7-1 summarizes the cathodic protection system.

Table 7-1: Cathodic Protection System Summary

Item	Selection	Key value
Station zone, inside the joints	Impressed current, deep well DW-101	1.32 A design, 3.2 V
Rectifier RECT-101	24 V, 8 A, air cooled, on B-102	0.30 kW at 120 V, 1 phase
Deep bed anodes	5 MMO tubes in coke, 100 to 160 ft	50 years at full rating
Outlet lateral 12"-G-1042	Two 48 lb magnesium anodes, resistor limited	56 years at design current
Owner's lateral at IJ-101	One 17 lb magnesium anode, interim	Removed when the lateral system is energized
Insulating joints	Solid-state decouplers at IJ-101 and IJ-102	Class I Division 2 listed

Item	Selection	Key value
Test points	Nine (two are junction boxes)	CP-LST-001

TORUS draws the following conclusions:

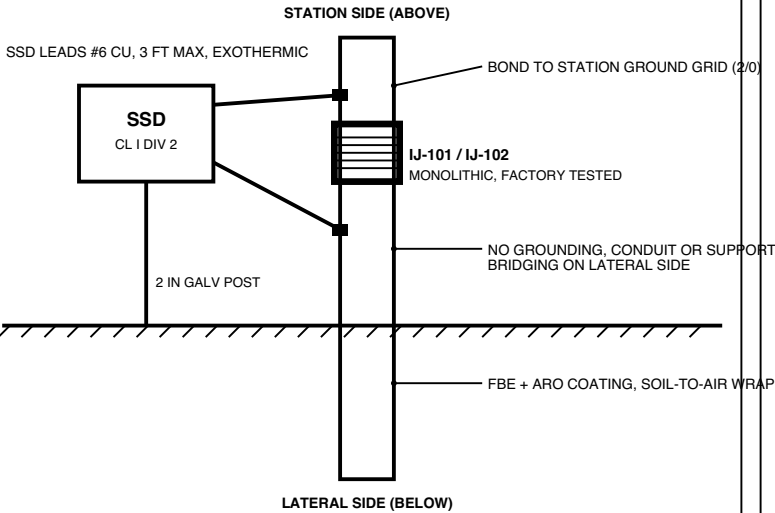
1. The copper grounding bonded to the station piping sets the station current requirement (97 % of 1.32 A). An impressed current system with one deep anode well is the practical way to protect it together with the buried fuel lines.
2. The 24 V, 8 A rectifier has enough margin for a copper current density up to about six times the value assumed and for a resistivity at depth three times the surface value.
3. The outlet lateral shall carry its own magnesium anodes, and their output shall be limited by the resistor in TS-103, or they will be consumed in about 20 years feeding the receiving pipeline.
4. Nothing shall bridge IJ-101 or IJ-102 except the decouplers.
5. Before the next issue: a Wenner soil survey and a deep resistivity log at DW-101, an AC interference survey, the receiving pipeline operator's CP data and bond requirements, and the well registration determination.
6. At commissioning: record native potentials before energizing, run the current requirement test, test both joints, run interference tests with the receiving pipeline operator and the Owner's lateral, and set the rectifier and the TS-103 resistors.

The following items remain open: soil resistivity and AC interference data (HOLD H-08), the receiving pipeline operator's CP interface (HOLD H-01, H-04), the Owner's lateral CP (HOLD H-16), the transmission determination (HOLD H-18), well registration (HOLD H-19) and vendor data for the anodes, rectifier and decouplers (HOLD H-15).

APPENDIX A. CATHODIC PROTECTION DETAILS

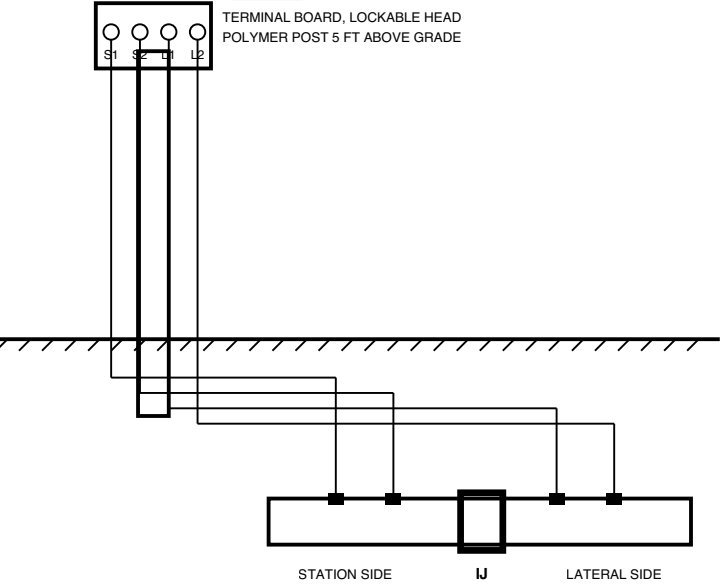


DECOUPLER: -2/+2 V DC BLOCKING, 3.7 kA 30 CYCLE AC FAULT, 100 kA 8x20 LIGHTNING (TYPICAL, HOLD H-15). FIRST SUPPORT ON LATERAL SIDE INSULATED (PAD + SLEEVES).



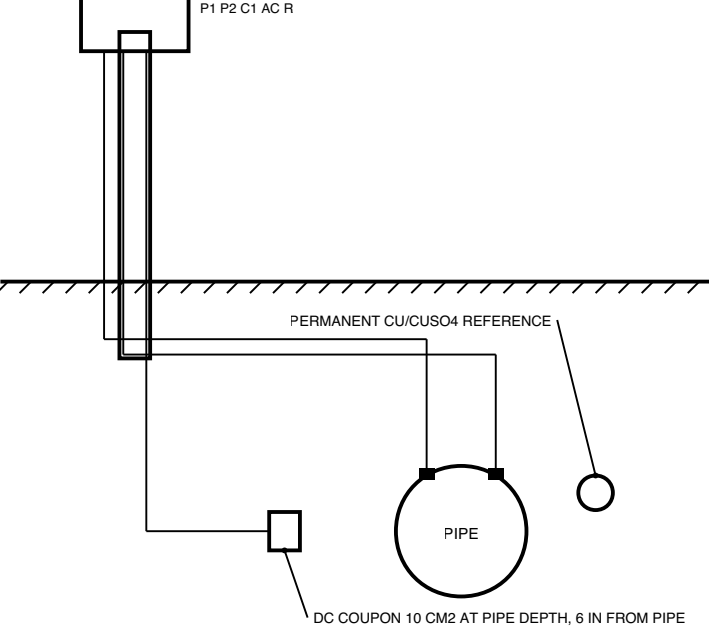
1 INSULATING JOINT WITH DECOUPLER
NOT TO SCALE

S1 #8 BLACK (CURRENT), S2 #12 BLACK (POTENTIAL) STATION SIDE
L1 #8 WHITE (CURRENT), L2 #12 WHITE (POTENTIAL) LATERAL SIDE
18 IN SLACK COIL AT POST; LEADS 30 IN MIN COVER
TS-102: SPARE TERMINALS FOR BOND (HOLD H-01)



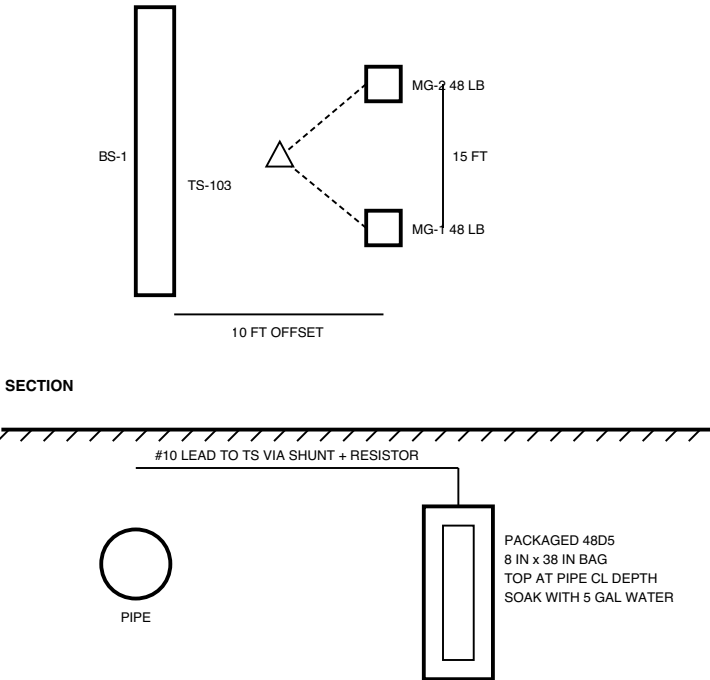
2 4-WIRE IJ TEST STATION (TS-101, TS-102)
NOT TO SCALE

P1 / P2 #12 BLACK TO PIPE; C1 #12 BLUE COUPON;
AC COUPON 1 CM2 #12 BLUE (TS-103); R #14 YELLOW.
COUPON SHORTING LINK C1-P1 FOR ON / INSTANT-OFF.

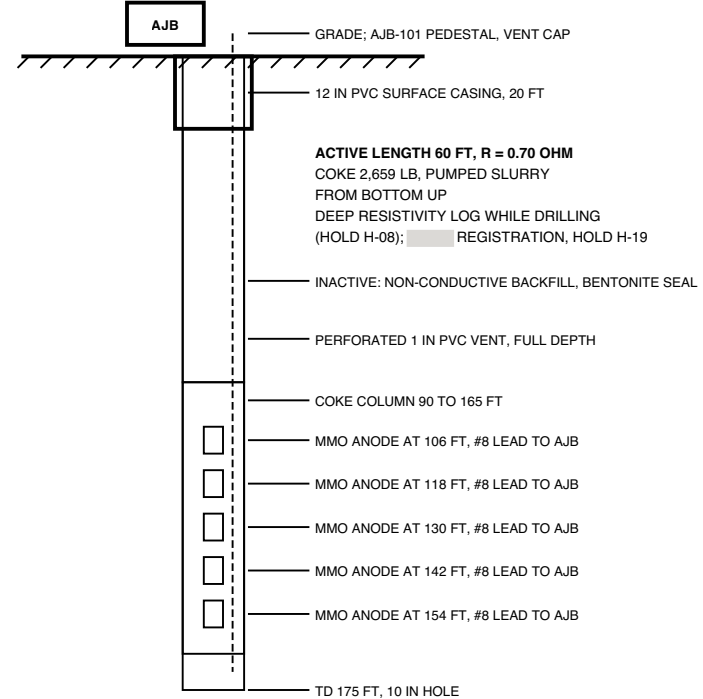


3 2-WIRE / COUPON TEST STATION
NOT TO SCALE

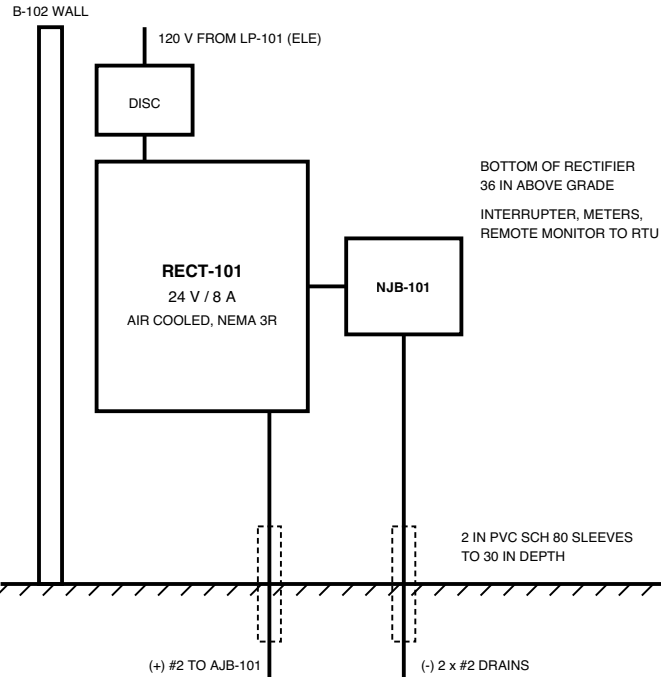
PLAN (MG-1 / MG-2 ON 12"-G-1042)



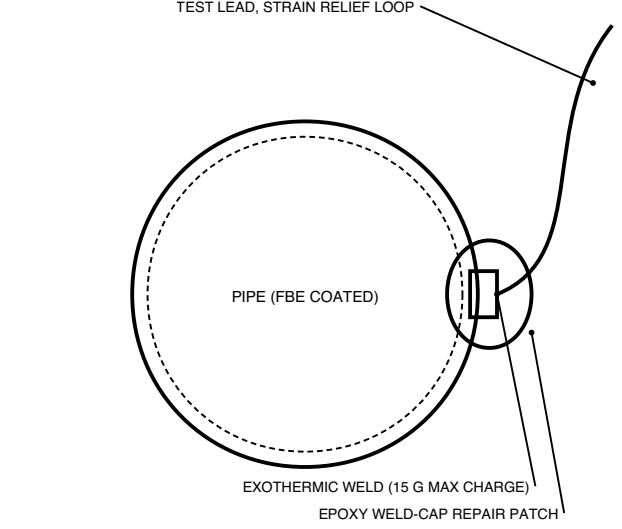
4 MAGNESIUM ANODE INSTALLATION
NOT TO SCALE



5 DEEP ANODE WELL DW-101 SECTION
NOT TO SCALE



6 RECTIFIER MOUNTING, B-102 SOUTH WALL
NOT TO SCALE



7 TEST LEAD CONNECTION TO PIPE
NOT TO SCALE

GENERAL NOTES

- DESIGN: CP-CAL-001; LAYOUT CP-DWG-001; SCHEDULE CP-LST-001.
- CABLE: HMWPE 600 V; ANODE HEADER AND ANODE LEADS HMWPE/HALAR DUAL INSULATION.
- DIRECT BURIAL 30 IN MIN, SAND BEDDING, WARNING TAPE 12 IN ABOVE.
- NO SPLICES IN POSITIVE CABLE EXCEPT AT AJB; ANY DAMAGED ANODE CABLE IS REPLACED (A NICK CORRODES THROUGH).
- DECOUPLER AND EQUIPMENT IN CLASS I DIV 2 AREAS LISTED FOR THE LOCATION (ELE-RPT-001).
- MG ANODES: REMOVE PLASTIC WRAP, SET BAG ON UNDISTURBED SOIL, NATIVE BACKFILL TAMPED IN 6 IN LIFTS.
- RECORD NATIVE POTENTIALS BEFORE ENERGIZING; SET RECTIFIER AND MG RESISTORS AT COMMISSIONING.
- VENDOR DATA HOLD H-15; INTERFACE HOLD H-01 / H-04.
- LEAD COLOURS: BLACK STATION, WHITE LATERAL, RED ANODE, BLUE COUPON, YELLOW REFERENCE.

NOTES / REFERENCES
1. ALL DETAILS NOT TO SCALE.
2. DESIGN BASIS CP-CAL-001.
3. LAYOUT CP-DWG-001.
4. TEST STATIONS CP-LST-001.
REF: AMPP SP0169, SP0572, SP0286; 49 CFR 192.467, .469, .471

REVISIONS
REV DATE DESCRIPTION BY CHK APP
A 2026-09-29 ISSUED FOR REVIEW (IFR)

PRELIMINARY - ISSUED FOR REVIEW - NOT FOR CONSTRUCTION

ENGINEER OF RECORD SEAL

NOT SEALED
PRELIMINARY
PE NO. _____

PROJECT

120 MMSCFD RECEIPT INTO _____
COUNTY, _____
DISCIPLINE: CATHODIC PROTECTION
SCALE: NTS

CATHODIC PROTECTION DETAILS

IJ, TEST STATIONS, ANODES, RECTIFIER
DRAWN: _____ CHECKED: _____ APPROVED: _____
DWG NO. CP-DWG-002
SHEET 1 OF 1 REV A