Task 9.1—Install Bonds

1.0 Task Description

This task consists of installing a CP bond.

This task begins with identifying the structures to be connected. This task ends with validating the effectiveness of the bond and documenting the readings.

This task does not include but may lead to the performance of other covered tasks such as:

— Test to Detect Interference (Reference Task 1.3).

— Install Test Leads by Non-exothermic Welding Methods (Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (Reference Task 2.4).

2.0 Knowledge Component

The purpose of this task is to electrically connect two or more structures to improve CP systems and prevent possible structure damage caused by interference.

An individual performing this task must have knowledge of the following.

— CP systems and components comparable to AMPP Certification Level CP 2.

— Types of bonds, including critical and noncritical.

— Installing interference bond facilities at the location of current discharge, if possible.

— Shunts Blocking diodes

Terms applicable to this task:

blocking diodes
These may be necessary to prevent current flow in the opposite direction, such as when bonding to DC traction systems.

bonds
Electrical connections between structures. Exothermic (thermite) welding, pin brazing, or other mechanical connections may be used to connect bond wires/cables and test leads to the structures. Bond leads and test leads are terminated in a test station to allow inspection.

critical bonds
These are determined by an Operator's procedures and are defined as bonds that, if disconnected, may be detrimental to one or more structures.

shunts
Commonly used between the structures to determine the current amplitude and polarity between the structures.

AOCs associated with the performance of this task include:

AOC Recognition	AOC Reaction
Inability to achieve target polarity and/or current.	Notify appropriate personnel for CP system analysis.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Identify the structures to be connected.	Structures to be bonded must be properly identified and marked for connections.
2	Install the test leads and bond cables/wires on both structures at the location of current discharge.	Test leads are not used for current-carrying connections. In addition to bond cables/wires being installed, test lead wires may also be installed on both structures to avoid taking potentials on a current-carrying connection.
3	Attach the test leads and bond cables/wires by exothermic (thermite) weld, pin brazing, or other method, which will yield a permanent, low-resistance connection.	A very low resistance path for current return is required for optimal current transfer.
4	Terminate the test leads and bond cables/wires inside of the test box/station that is accessible to both structures.	Affected parties need to be able to monitor the bond.
5	Install shunts for measurement of current flow and resistors (as required to limit current interchange) inside of the test box/station.	It is important to monitor the magnitude and direction of current flow.
6	Install blocking diodes, as required.	Occasionally it becomes necessary to prevent current flow in the opposite direction, such as when bonding to DC transit systems.
7	Conduct tests to determine the effectiveness of the installed interference bond.	It is important to determine that all negative effects of the interference have been mitigated.
8	Document readings as required by the Operator's procedures.	Documentation and communication of the bond installation is critical to future testing.

Task 9.1—Install Bonds

1.0 Task Description

This task consists of installing a CP bond.

This task begins with identifying the structures to be connected. This task ends with validating the effectiveness of the bond and documenting the readings.

This task does not include but may lead to the performance of other covered tasks such as: ~~the following.~~

— Test to Detect Interference (~~reference~~ Reference Task 1.3).

— Install Test Leads by Non-exothermic Welding Methods (~~reference~~ Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (~~reference~~ Reference Task 2.4).

2.0 Knowledge Component

The purpose of this task is to electrically connect two or more structures to improve CP systems and prevent possible structure damage caused by interference.

An individual performing this task must have knowledge of the following.

— CP systems and components comparable to ~~NACE~~ AMPP Certification Level CP 2.

— Types of bonds, including critical and noncritical ~~(critical bonds are determined by an operator's procedures and are defined as bonds that, if disconnected, may be detrimental to one or more structures)~~.

— Installing interference bond facilities at the location of current discharge, if possible.

— Shunts ~~(commonly used between the structures to determine the current amplitude and polarity between the structures).~~

— Blocking diodes ~~(may be necessary to prevent current flow in the opposite direction, such as when bonding to DC traction systems).~~

Terms applicable to this task: ~~are as follows.~~

blocking diodes
These may be necessary to prevent current flow in the opposite direction, such as when bonding to DC traction systems.

bonds
Electrical connections between structures. Exothermic (thermite) welding, pin brazing, or ~~bolt-on~~other mechanical connections may be used to connect bond wires/cables and test leads to the structures. Bond leads and test leads are terminated in a test station to allow inspection.

critical bonds
These are determined by an Operator's procedures and are defined as bonds that, if disconnected, may be detrimental to one or more structures.

shunts
Commonly used between the structures to determine the current amplitude and polarity between the structures.

AOCs associated with the performance of this task include: ~~the following.~~

AOC Recognition	AOC Reaction
Inability to achieve target polarity and/or current. ~~*This section intentionally left blank.*~~	Notify appropriate personnel for CP system analysis.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Identify the structures to be connected.	Structures to be bonded must be properly identified and marked for connections.
2	Install the test leads and bond cables/wires on both structures at the location of current discharge.	Test leads are not used for current-carrying connections. In addition to bond cables/wires being installed, test lead wires may also be installed on both structures to avoid taking potentials on a current-carrying connection.
3	Attach the test leads and bond cables/wires by exothermic (thermite) weld, pin brazing, or other method, which will yield a permanent, low-resistance connection.	A very low resistance path for current return is required for optimal current transfer.
4	Terminate the test leads and bond cables/wires inside of the test box/station that is accessible to both structures.	Affected parties need to be able to monitor the bond.
5	Install shunts for measurement of current flow and ~~resistance~~ resistors (as required to limit current interchange) inside of the test box/station.	It is important to monitor the magnitude and direction of current flow.
6	Install blocking diodes, as required.	Occasionally it becomes necessary to prevent current flow in the opposite direction, such as when bonding to DC transit systems.
7	Conduct tests to determine the effectiveness of the installed interference bond.	It is important to determine that all negative effects of the interference have been mitigated.
8	Document readings as required by the ~~operator's~~ Operator's procedures.	Documentation and communication of the bond installation is critical to future testing.

Task 9.2—Install Galvanic Anodes

1.0 Task Description

This task consists of installing galvanic anodes that provide CP for buried or submerged metallic structures.

This task begins with determining the most suitable locations for the galvanic anodes within design considerations. The task ends when installation documentation is complete.

The performance of this covered task may require the performance of other covered tasks such as:

— Observe Excavation Activities (Reference Task 32).

— Perform Backfilling (Reference Task 39).

This task does not include but may lead to the performance of other covered tasks such as:

— Install Test Leads by Non-exothermic Welding Methods (Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (Reference Task 2.4).

2.0 Knowledge Component

The purpose of this task is to provide a galvanic anode to operate with a CP system. An individual performing this task must have knowledge of the following.

— CP systems and components comparable to AMPP Certification Level CP 2.

— Connection methods (connections are made in a test station with a lead connected to the structure being protected and across a shunt for measurement and testing; isolation of galvanic anodes may be necessary for additional testing of the structure).

— Galvanic anodes and their applications (galvanic anodes may be used for direct CP, shielding of electrical interference, spot protection, or AC mitigation; applications may be in various soil conditions, underwater or offshore, or where power for impressed systems is unavailable).

Terms applicable to this task:

This section intentionally left blank.

AOCs associated with the performance of this task include:

AOC Recognition	AOC Reaction
Indications of a leak (e.g., soil discoloration, smell, dead vegetation) when installing the anode bed.	Stop all activity related to this task and notify Operator personnel, as required.
A component is found in an inoperable condition.	Notify the appropriate personnel to take actions as specified by the Operator’s procedures.

Task 9.2—Install Galvanic Anodes

1.0 Task Description

This task consists of installing galvanic anodes that provide CP for buried or submerged metallic structures.

This task begins with determining the most suitable locations for the galvanic anodes within design considerations. The task ends when installation documentation is complete.

The performance of this covered task may require the performance of other covered tasks such as:

— Observe Excavation Activities (Reference Task 32).

— Perform Backfilling (Reference Task 39).

This task does not include but may lead to the performance of other covered tasks such as: ~~the following.~~

— Install Test Leads by Non-exothermic Welding Methods (~~reference~~ Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (~~reference~~ Reference Task 2.4).

2.0 Knowledge Component

The purpose of this task is to provide a galvanic anode to operate with a CP system. An individual performing this task must have knowledge of the following.

— CP systems and components comparable to ~~NACE~~ AMPP Certification Level CP 2.

— Connection methods (connections are made in a test station with a lead connected to the structure being protected and across a shunt for measurement and testing; isolation of galvanic anodes may be necessary for additional testing of the structure).

— Galvanic anodes and their applications (galvanic anodes may be used for direct CP, shielding of electrical interference, spot protection, or AC mitigation; applications may be in various soil conditions, underwater or offshore, or where power for ~~implied~~ impressed systems is unavailable).

Terms applicable to this task: ~~are as follows.~~

This section intentionally left blank.

AOCs associated with the performance of this task include: ~~the following.~~

AOC Recognition	AOC Reaction
Indications of a leak (e.g., soil discoloration, smell, dead vegetation) when installing the anode bed.	Stop all activity related to this task and notify ~~operator~~ Operator personnel, as required.
A component is found in an inoperable condition.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	~~Galvanic anodes —~~Determine the most suitable location along the pipeline within design considerations.	A location that has high sub-surface moisture content is preferred. Moisture in the electrolyte is essential for proper operation of the anode.
~~2~~	~~Place the anode in an electrolytic environment that is moist.~~	~~Vertical anodes can be located in augered holes while horizontal anodes may require backhoe excavation. Excavations should be sufficiently deep so that ground water levels will not dry out. Anode holes should be at least as deep as the pipeline.~~
~~3~~2	Install the anode by placing in an augered hole or horizontal excavation. ~~NOTE Anodes must be removed from the manufacturer's protective packaging before installation.~~	Vertical anodes can be located in augered holes while horizontal anodes may require backhoe excavation. Excavations should be sufficiently deep so that ground water levels will not dry out. Anode holes should be at least as deep as the pipeline. Care needs to be exercised to minimize damage to the anode or its prepackaged backfill. NOTE Manufacturer/Operator procedures may require the anode to be soaked or wetted prior to installation. NOTE Anodes must be removed from the manufacturer's protective packaging before installation.
~~4~~3	Wet ~~down~~ the anode prior to backfilling ~~or prior to installation in the ground~~.	Galvanic anodes are typically supplied in special backfill (hydrated gypsum, bentonite clay, and sodium sulfate). This backfill must be wet for the anodes to start discharging current.
~~5~~4	Uncoil the anode ~~pigtail~~ lead wire and extend fully, being careful not to damage or kink wire.	The anode lead wire (pigtail) comes coiled at one end of the anode bag. Care must be taken to ensure that this lead wire is not damaged. ~~This will prevent premature failure.~~
~~6~~5	~~If the design is for direct connection, then~~Connect the anode ~~test lead~~ lead wire ~~is connected~~ directly to the pipe for a direct connection, and ~~. I~~install shunt, and a resistor (if necessary),~~s for measurement of current flow and resistance (as required to limit current interchange)~~ inside of the test stations.	Connection to the pipe is necessary for anode operation; connection to the pipe via a shunt is important to monitor the magnitude of current flow.
~~7~~6	Backfill carefully with native soil backfill. Use rock-free backfill to pad the anode and the anode lead wire.	Care must be taken in the backfill process to ensure that the anode and its lead wire are not damaged.
~~8~~7	Document installation as required by ~~operator's~~ Operator's procedures.	Documentation is necessary to maintain record of installed anode locations.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Determine the most suitable location along the pipeline within design considerations.	A location that has high sub-surface moisture content is preferred. Moisture in the electrolyte is essential for proper operation of the anode.
2	Install the anode by placing in an augered hole or horizontal excavation.	Vertical anodes can be located in augered holes while horizontal anodes may require backhoe excavation. Excavations should be sufficiently deep so that ground water levels will not dry out. Anode holes should be at least as deep as the pipeline. Care needs to be exercised to minimize damage to the anode or its prepackaged backfill. NOTE Manufacturer/Operator procedures may require the anode to be soaked or wetted prior to installation. NOTE Anodes must be removed from the manufacturer's protective packaging before installation.
3	Wet the anode prior to backfilling.	Galvanic anodes are typically supplied in special backfill (hydrated gypsum, bentonite clay, and sodium sulfate). This backfill must be wet for the anodes to start discharging current.
4	Uncoil the anode lead wire and extend fully, being careful not to damage or kink wire.	The anode lead wire (pigtail) comes coiled at one end of the anode bag. Care must be taken to ensure that this lead wire is not damaged.
5	Connect the anode lead wire directly to the pipe for a direct connection, and install shunt, and a resistor (if necessary), inside of the test stations.	Connection to the pipe is necessary for anode operation; connection to the pipe via a shunt is important to monitor the magnitude of current flow.
6	Backfill carefully with native soil backfill. Use rock-free backfill to pad the anode and the anode lead wire.	Care must be taken in the backfill process to ensure that the anode and its lead wire are not damaged.
7	Document installation as required by Operator's procedures.	Documentation is necessary to maintain record of installed anode locations.

Task 9.3—Install Rectifiers

1.0 Task Description

This task consists of installation of impressed current CP rectifiers.

This task begins with verifying the rectifier is appropriate for the location and service. This task ends with documentation of the installation.

This task does not include but may lead to the performance of other covered tasks such as:

— Adjust Rectifier (Reference Task 4.3).

— Install Test Leads by Non-exothermic Welding Methods (Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (Reference Task 2.4).

— Install Impressed Current Groundbeds (Reference Task 9.4).

2.0 Knowledge Component

The purpose of this task is to install CP rectifiers to protect facilities against external corrosion. An individual performing this task must have knowledge of the following.

— CP systems and components comparable to AMPP Certification Level CP 2.

— Basic electricity and electrical circuits.

— Rectifier types, including: air cooled, oil cooled, explosion proof, solar powered, etc.

— Mounting requirements (pole mount and rack mount).

— Positive and negative terminal termination requirements.

Terms applicable to this task:

This section left intentionally blank.

AOCs associated with the performance of this task include the following.

AOC Recognition	AOC Reaction
A component is found in an inoperable condition.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.
A rectifier housing is energized.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Verify the rectifier is appropriate for the location and service.	Rectifiers are available for nonhazardous and for hazardous locations. They can be air cooled, oil cooled, or explosion proof. They can be supplied for either single phase or three-phase service with input voltages as high as 480 volts AC. Rectifiers can be designed for a myriad of DC output voltage and current configurations.
2	Mount the rectifier securely at the designated location.	Rectifiers may be mounted on poles, posts, walls, panels, concrete pads, etc., and must be mounted securely using appropriately sized fasteners. Insecure fastening could lead to damage and bodily injury. NOTE Installation must meet all applicable building and electrical codes.
3	Connect the AC power feed wires through an appropriately sized conduit or approved armored cable in accordance with the applicable sections of the *National Electric Code*, the *National Electric Safety Code*, and local electric and building codes.	The AC supply to a rectifier is usually made through a safety switch or circuit breaker panel. It is important to consult the applicable codes and requirements to prevent electrical shock. The AC conduit is usually connected to the "knockout" supplied for that purpose.
4	Terminate the AC feed wires at terminals on circuit breaker or AC input connection wires.	Refer to the installation portion of the rectifier manual for AC termination.
5	Connect the DC conduits to the rectifier.	DC conduits are used to house the DC output cables from their termination at the DC output terminals to a point underground from which the cables usually run directly buried to the groundbed (positive) and structure (negative). NOTE In hazardous areas, seal conduits may be required below the rectifier.
6	Install the DC cables from the anode groundbed and the structure in their respective conduits, and terminate on their respective terminals.	It is imperative that care be taken during this phase of the installation. Termination at the proper terminal is essential. Crossing the wires (connecting the anode groundbed to the negative and the structure to the positive) can have disastrous consequences. NOTE The positive cable is connected to the anodes and the negative is connected to the structure.
7	Test and verify that cables are correctly installed.	Use the appropriate test meter (e.g., multimeter) to confirm proper polarity connections. Incorrect cable connections will cause the pipeline or structure that is intended to be protected to become an anode causing it to rapidly corrode.
8	Document installation as required by operator's procedures.	Documentation is necessary to maintain record of rectifier installation.

Task 9.3—Install Rectifiers

1.0 Task Description

This task consists of installation of impressed current CP rectifiers.

This task begins with verifying the rectifier is appropriate for the location and service. This task ends with documentation of the installation.

This task does not include but may lead to the performance of other covered tasks such as: ~~the following.~~

— Adjust Rectifier (~~reference~~ Reference Task 4.3).

— Install Test Leads by Non-exothermic Welding Methods (~~reference~~ Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (Reference Task 2.4).

— Install Impressed Current Groundbeds (~~reference~~ Reference Task 9.4).

2.0 Knowledge Component

~~This~~ The purpose of this task is to install CP rectifiers to protect facilities against external corrosion. An individual performing this task must have knowledge of the following.

— CP systems and components comparable to ~~NACE~~ AMPP Certification Level CP 2.

— Basic electricity and electrical circuits.

— Rectifier types, including: air cooled, oil cooled, explosion proof, solar powered, etc.

— Mounting requirements (pole mount and rack mount).

— Positive and negative ~~T~~terminal termination requirements.

Terms applicable to this task: ~~are as follows.~~

This section left intentionally blank.

AOCs associated with the performance of this task include the following.

AOC Recognition	AOC Reaction
A component is found in an inoperable condition. ~~*This section intentionally left blank.*~~	Notify the appropriate personnel to take actions as specified by the Operator's procedures.
A rectifier housing is energized.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Verify the rectifier is appropriate for the location and service.	Rectifiers are available for nonhazardous and for hazardous locations. They can be air cooled, oil cooled, or explosion proof. They can be supplied for either single phase or three-phase service with input voltages as high as 480 volts AC. Rectifiers can be designed for a myriad of DC output voltage and current configurations.
2	Mount the rectifier securely at the designated location.	Rectifiers may be mounted on poles, posts, walls, panels, concrete pads, etc., and must be mounted securely using appropriately sized fasteners. Insecure fastening could lead to damage and bodily injury. NOTE Installation must meet all applicable building and electrical codes.
3	Connect the AC power feed wires through an appropriately sized conduit or approved armored cable in accordance with the applicable sections of the *National Electric Code*, the *National Electric Safety Code*, and local electric and building codes.	The AC supply to a rectifier is usually made through a safety switch or circuit breaker panel. It is important to consult the applicable codes and requirements to prevent electrical shock. The AC conduit is usually connected to the "knockout" supplied for that purpose.
4	Terminate the AC feed wires at terminals on circuit breaker or AC input connection wires.	Refer to the installation portion of the rectifier manual for AC termination.
5	Connect the DC conduits to the rectifier.	DC conduits are used to house the DC output cables from their termination at the DC output terminals to a point underground from which the cables usually run directly buried to the groundbed (positive) and structure (negative). NOTE In hazardous areas, seal conduits may be required below the rectifier.
6	Install the DC cables from the anode groundbed and the structure in their respective conduits, and terminate on their respective terminals.<br~~NOTE The positive cable is connected to the anodes and the negative is connected to the structure.~~	It is imperative that care be taken during this phase of the installation. Termination at the proper terminal is essential. Crossing the wires (connecting the anode groundbed to the negative and the structure to the positive) can have disastrous consequences. NOTE The positive cable is connected to the anodes and the negative is connected to the structure.
7	Test and verify that cables are correctly installed.	Use the appropriate test meter (e.g., multimeter) to confirm proper polarity connections. Incorrect cable connections will cause the pipeline or structure that is intended to be protected to become an anode causing it to rapidly corrode.
8	Document installation as required by operator's procedures.	Documentation is necessary to maintain record of rectifier installation.

Task 9.4—Install Impressed Current Groundbeds

1.0 Task Description

This task consists of installing impressed current groundbeds.

This task begins with verification that site location, material, and method of installation all comply with design requirements. The task ends when the impressed current anodes are installed and documentation has been completed as required.

The performance of this covered task may require the performance of other covered tasks such as:

— Observe Excavation Activities (Reference Task 32).

— Perform Backfilling (Reference Task 39).

The performance of this covered task may require the performance of other covered tasks such as:

— Adjust Rectifier (Reference Task 4.3).

— Install Rectifiers (Reference Task 9.3).

2.0 Knowledge Component

The purpose of this task is to provide CP for buried or submerged metallic structures. An individual performing this task must have knowledge of the following.

— CP systems and components comparable to AMPP Certification Level CP 2

— Connection methods

— Impressed current anodes are connected together to form an anode bed. Connections are made based on configuration and design of the bed, which may include a termination box with a lead connected to the positive lead of the rectifier. Shunts may be used for measurement and testing of individual anodes. Isolation of individual anodes may be necessary for additional testing of the anodes.

— Impressed current anodes (which are installed in special backfill, such as coke breeze or other fill material)

— Header cables (which is a cable or wire to which the anode lead wires are connected)

— Splice connections (which is the electrical connection between the anode lead wire and the header cable/wire or between anodes; these splice connections must be carefully insulated to protect the connection from oxidation)

— Rectifier adjustment (which is performed after the anode system is energized to set CP levels)

Terms applicable to this task:

This section intentionally left blank.

AOCs associated with the performance of this task include the following.

AOC Recognition	AOC Reaction
Anode lead cable/wire is damaged.	Notify the appropriate personnel to take actions as specified by the Operator’s procedures.
Unexpected production of water in anode installation.	Notify the appropriate personnel to take actions as specified by the Operator’s procedures.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Verify that the location and materials are in accordance with design criteria.	Impressed current anodes are usually installed in a right-of-way that is separated from the pipeline. Locations are selected using criteria such as soil resistivity, topography, proximity to other structures, and geography.
2	Lay out the number, spacing, and configuration of the anodes at a selected location in accordance with design criteria (i.e., remote vs. distributed).	Remote (deep well or conventional): installed vertically or horizontally as designed for the location and typically more than a hundred feet away from pipeline. Distributed: located in close proximity to the structure and typically installed a minimum of 10 ft from the structure.
3	Excavate a vertical hole or horizontal ditch for anode installation.	Excavation techniques may include ditching, augering, drilling, etc. Anodes are also installed as a replacement for expended anodes. Anodes must be installed in the soil or submerged in water that is electrically continuous with the pipeline backfill (common electrolyte.) NOTE If coke breeze or other fill material is required by design to enhance current flow, it must be installed during the installation of the anodes.
4	Carefully install anode in the excavated hole, and confirm that anodes are placed flat in horizontal installations or centered in the bore for vertical installations.	Anodes should be lowered carefully into the excavations, being careful not to damage the anode, its lead wire, or the lead wire to anode connection. Any damage will result in premature failure. NOTE To prevent damage to the anode, do not lift or lower the anode by its lead wire.
5	Install the anode header cable between the groundbed and the rectifier.	Care must be observed during this process, as any damage to the cable insulation will lead to premature failure of the groundbed. DC will be discharged at any breaks in the cable insulation.
6	Backfill the vertical hole or horizontal ditch.	Anodes must be installed in the soil or submerged. Backfill material must be free of rocks and debris to prevent damage to cable insulation.
7	Document installation as required by Operator's procedures.	Documentation is necessary to maintain record of groundbed installation. Documentation must include the number of anodes and the manner or spacing of installation.

Task 9.4—Install Impressed Current Groundbeds

1.0 Task Description

This task consists of installing impressed current groundbeds.

This task begins with verification that site location, material, and method of installation all comply with design requirements. The task ends when the impressed current anodes are installed and documentation has been completed as required.

The performance of this covered task may require the performance of other covered tasks such as:

— Observe Excavation Activities (Reference Task 32).

— Perform Backfilling (Reference Task 39).

The performance of this covered task may require the performance of other covered tasks such as~~:~~ ~~the following.~~

— Adjust Rectifier (~~reference~~ Reference Task 4.3).

— Install Rectifiers (~~reference~~ Reference Task 9.3).

2.0 Knowledge Component

The purpose of this task is to provide CP for buried or submerged metallic structures. An individual performing this task must have knowledge of the following.

— CP systems and components comparable to ~~NACE~~ AMPP Certification Level CP 2~~.~~

— Connection methods~~.~~

— Impressed current anodes are connected together to form an anode bed. Connections are made based on configuration and design of the bed, which may include a termination box with a lead connected to the positive lead of the rectifier. Shunts may be used for measurement and testing of individual anodes. Isolation of individual anodes may be necessary for additional testing of the anodes.

— Impressed current anodes (which are installed in special backfill, such as coke breeze or other fill material)~~.~~

— Header cables (which is a cable or wire to which the anode lead wires are connected)~~.~~

— Splice connections (which is the electrical connection between the anode lead wire and the header cable/wire or between anodes; these splice connections must be carefully insulated to protect the connection from oxidation)~~.~~

— Rectifier adjustment (which is performed after the anode system is energized to set CP levels)~~.~~ Terms applicable to this task~~:~~ ~~are as follows.~~

This section intentionally left blank.

AOCs associated with the performance of this task include the following.

AOC Recognition	AOC Reaction
~~This section intentionally left blank.~~Anode lead cable/wire is damaged.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.
Unexpected production of water in anode installation.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Verify that the location and materials are in accordance with design criteria.	Impressed current anodes are usually installed in a right-of-way that is separated from the pipeline. Locations are selected using criteria such as soil resistivity, topography, proximity to other structures, and geography.
2	Lay out the number, spacing, and configuration of the anodes at a selected location in accordance with design criteria (i.e., remote vs. distributed).	Remote (deep well or conventional): installed vertically or horizontally as designed for the location and typically more than a hundred feet away from pipeline. Distributed: located in close proximity to the structure and typically installed a minimum of 10 ft from the structure.
3	Excavate a vertical hole or horizontal ditch for anode installation. ~~NOTE If coke breeze or other fill material is required by design to enhance current flow, it must be installed during the installation of the anodes.~~	Excavation techniques may include ditching, augering, drilling, etc. Anodes are also installed as a replacement for expended anodes. Anodes must be installed in the soil or submerged in water that is electrically continuous with the pipeline backfill (common electrolyte.) NOTE If coke breeze or other fill material is required by design to enhance current flow, it must be installed during the installation of the anodes.
4	Carefully install anode in the excavated hole, and ~~C~~confirm that anodes are placed flat in horizontal installations or centered in the bore for vertical installations. ~~NOTE Do not lift or lower the anode by its lead wire to prevent damage to the anode.~~	Anodes should be lowered carefully into the excavations, being careful not to damage the anode, its lead wire, or the lead wire to anode connection. Any damage will result in premature failure. NOTE To prevent damage to the anode, do not lift or lower the anode by its lead wire.
5	Install the anode header cable between the groundbed and the rectifier.	Care must be observed during this process, as any damage to the cable insulation will lead to premature failure of the groundbed. DC will be discharged at any breaks in the cable insulation.
6	Backfill the vertical hole or horizontal ditch.	Anodes must be installed in the soil or submerged. Backfill material must be free of rocks and debris to prevent damage to cable insulation.
7	Document installation as required by ~~operator's~~ Operator's procedures.	Documentation is necessary to maintain record of groundbed installation. Documentation must include the number of anodes and the manner or spacing of installation.

Task 9.5—Repair Shorted Casings

1.0 Task Description

This task consists of electrically isolating the pipe and pipe casing after a short is detected. An electrical short between the casing and the pipe draws protection away from the pipe and may not allow adequate protection in the cased area.

This task begins when the pipeline casing end(s) have been exposed. The task ends when the pipeline casing is tested for isolation and proper documentation is completed per the Operator's procedure.

The performance of this covered task may require the performance of other covered tasks such as:

— Measure Structure-to-Soil Potentials (Reference Task 1.1).

— Inspect the Condition of External Coating on Buried or Submerged Pipe (Reference Task 5.3).

— Install Test Leads by Non-exothermic Welding Methods (Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (Reference Task 2.4).

— Locate Line (Reference Task 14.1).

— Observe Excavation Activities (Reference Task 32).

— Perform Backfilling (Reference Task 39).

2.0 Knowledge Component

The purpose of this task is to provide CP for the pipe.

An individual performing this task must have knowledge of the following.

— Casing systems (which includes end seals, insulators, and vent connections).

— Casings are oversized pipe required in some instances to reduce external load on the pipeline, such as railroad crossings, interstate highways, etc.

— End seals are kits composed of rubber, vinyl, or other composites to seal the pipeline/casing interface to prohibit water and contaminants from infiltrating the casing.

— Isolating spacers are installed on the pipeline to prevent metallic contact with the casing. Spacers must have sufficient mechanical strength to withstand installation and to maintain isolation.

— Vent connections are made to provide an atmospheric outlet to the casing to prevent pressure buildup and access to test the casing atmosphere. One vent is attached on the bottom of the pipe and one is attached on the top to allow insertion of non-conductive material.

— Metallic shorts (which are caused by metal-to-metal contact between the pipe and casing).

— Electrolytic shorts (which are caused by material in casing that provides a current path between the pipe and casing such as water or soil).

Terms associated with this task:

This section intentionally left blank.

AOCs associated with the performance of this task include the following.

AOC Recognition	AOC Reaction
Unexplained hydrocarbon encountered.	Stop all activity related to this task and notify Operator personnel, as required.
Pipeline damage discovered while repairing shorted casings.	Take action, if qualified, and notify personnel of observed condition, as required.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Clear a workable area and support the pipeline as needed.	This provides sufficient working room for seal work, coating repair, etc. Supporting the pipeline may be necessary to prevent sagging or future damage. Factors that could affect the support could include things such as diameter, length, product, etc.
2	Remove the end seal.	This exposes the carrier pipe at the casing end.
3	Inspect the ends of the carrier pipe and casing to determine whether metallic contact is visible.	Inspect for the location of metal contact, which may be near the end seal or at another location in the casing. If no metallic contact is found, an electrolytic condition may be the cause of elevated potentials on the casing.
4	If pipe has settled, then center the carrier pipe within the casing, if possible.	This is to confirm that there is no contact between the carrier pipe and casing. If the pipe has to be lifted, then follow Operator's procedures for moving in-service pipe. On long casings, cutting off excess casing may eliminate the casing short. NOTE Pipeline/casing support must be performed in accordance with engineering procedures or work plans to prevent damage to pipeline.
5	If the pipeline is coated, confirm that the coating is bonded to carrier pipe.	Coating is necessary for good CP and isolation.
6	Install casing insulator (isolating spacers) and centering cradle while providing adequate support.	Isolating spacers are used to maintain electrical isolation of the carrier pipe from the casing. Adequate support reduces strain on a pipeline that could cause a pipeline rupture or metallic contact between the carrier pipe and casing.
7	If an electrolytic condition exists, removal of the electrolytic material in the casing may be required, if possible.	Excess material in casing should be removed (blown out) if possible while end seals are removed. Resolution of an electrolytic condition may not be necessary. If electrolytic condition exists, follow Operator's procedures.
8	Replace the end seal.	End seals prohibit water and contaminants from infiltrating the casing.

9	Install the test leads as required and conduct a pipe-to-casing potential difference test.	Test leads on both the carrier pipe and casing may be required for testing casing isolation. NOTE A pipe-to-casing potential difference test is used to determine that pipe and casing are isolated. If isolation is not achieved, follow additional remediation steps per Operator's procedures.
10	Document repair as required by Operator's procedure.	Up-to-date records are essential to maintaining corrosion control data.

Task 9.5—Repair Shorted Casings

1.0 Task Description

This task consists of electrically isolating the pipe and pipe casing after a short is detected. An electrical short between the casing and the pipe draws protection away from the pipe and may not allow adequate protection in the cased area.

This task begins when the pipeline casing end(s) have been exposed. The task ends when the pipeline casing is tested for isolation and proper documentation is completed per the ~~operator's~~ Operator's procedure.

The performance of this covered task may require the performance of other covered tasks such as~~:~~ ~~the following.~~

— Measure Structure-to-Soil Potentials (~~reference~~ Reference Task 1.1).

— Inspect the Condition of External Coating on Buried or Submerged Pipe (~~reference~~ Reference Task 5.3).

— Install Test Leads by Non-exothermic Welding Methods (Reference Task 2.3).

— Install Test Leads by Exothermic Welding Methods (~~reference~~ Reference Task 2.4).

— Locate Line (~~reference~~ Reference Task 14.1).

— Observe Excavation Activities (~~reference~~ Reference Task 32).

— Perform Backfilling (~~reference~~ Reference Task 39).

2.0 Knowledge Component

The purpose of this task is to provide CP for the pipe.

An individual performing this task must have knowledge of the following.

— Casing systems (which includes end seals, insulators, and vent connections).

— Casings are oversized pipe required in some instances to reduce external load on the pipeline, such as railroad crossings, interstate highways, etc.

— End seals are kits composed of rubber, vinyl, or other composites to seal the pipeline/casing interface to prohibit water and contaminants from infiltrating the casing.

— Isolating spacers are installed on the pipeline to prevent metallic contact with the casing. Spacers must have sufficient mechanical strength to withstand installation and to maintain isolation.

— Vent connections are made to provide an atmospheric outlet to the casing to prevent pressure buildup and access to test the casing atmosphere. One vent is attached on the bottom of the pipe and one is attached on the top to allow insertion of ~~nonmetallic~~ non-conductive material.

— Metallic shorts (which are caused by metal-to-metal contact between the pipe and casing).

— Electrolytic shorts (which are caused by material in casing that provides a current path between the pipe and casing such as water or soil).

Terms associated with this task~~:~~ ~~are as follows.~~

This section intentionally left blank.

AOCs associated with the performance of this task include the following.

AOC Recognition	AOC Reaction
Unexplained hydrocarbon encountered.	Stop all activity related to this task and notify ~~operator~~ Operator personnel, as required.
Pipeline damage discovered while repairing shorted casings.	Take action, if qualified, and notify personnel of observed condition, as required.

3.0 Skill Component

To demonstrate proficiency of this task, an individual must perform the following steps.

Step	Action	Explanation
1	Clear a workable area and support the pipeline as needed.	This provides sufficient working room for seal work, coating repair, etc. Supporting the pipeline may be necessary to prevent sagging or future damage. Factors that could affect the support could include things such as diameter, length, product, etc.
2	Remove the end seal.	This exposes the carrier pipe at the casing end.
3	Inspect the ends of the carrier pipe and casing to determine whether metallic contact is visible.	Inspect for the location of metal contact, which may be near the end seal or at another location in the casing. If no metallic contact is found, an electrolytic condition may be the cause of elevated potentials on the casing.
4	If pipe has settled, then center the carrier pipe within the casing, if possible. ~~NOTE Pipeline/casing support must be performed in accordance with engineering procedures or work plans to prevent damage to pipeline.~~	This is to confirm that there is no contact between the carrier pipe and casing. If the pipe has to be lifted, then follow Operator's procedures for moving in-service pipe. On long casings, cutting off excess casing may eliminate the casing short. NOTE Pipeline/casing support must be performed in accordance with engineering procedures or work plans to prevent damage to pipeline.
5	If the pipeline is coated, confirm that the coating is bonded to carrier pipe.	Coating is necessary for good CP and isolation.
6	Install casing insulator (isolating spacers) and centering cradle while providing adequate support.	Isolating spacers are used to maintain electrical isolation of the carrier pipe from the casing. Adequate support reduces strain on a pipeline that could cause a pipeline rupture or metallic contact between the carrier pipe and casing.
~~7~~	~~If no metallic contact is found, an electrolytic condition may be the cause of elevated potentials on the casing.~~	~~Potentials on a casing may be elevated due to an electrolytic condition.~~
~~8~~7	If an electrolytic condition exists, ~~Resolution of electrolytic condition may require~~ removal of the ~~electrolyte~~ electrolytic material in the casing may be required, if possible. ~~Resolution of an electrolytic condition may not be necessary.~~	Excess material in casing should be removed (blown out) if possible while end seals are removed. Resolution of an electrolytic condition may not be necessary. If electrolytic condition exists, follow Operator's procedures.
~~9~~8	Replace the end seal.	End seals prohibit water and contaminants from infiltrating the casing.

~~10~~9	Install the test leads as required and conduct a pipe-to-casing potential difference test.	Test leads on both the carrier pipe and casing may be required for testing casing isolation. NOTE ~~Conduct a~~A pipe-to-casing potential difference test is used to determine that pipe and casing are isolated. If isolation is not achieved, follow additional remediation steps per Operator's procedures.
~~11~~10	Document repair as required by ~~operator's~~ Operator's procedure.	Up-to-date records are essential to maintaining corrosion control data.