
Task 4.1—Troubleshoot Rectifier

1.0 Task Description

This task consists of checking rectifier components.

This task begins when a rectifier is found inoperable. This task ends when the faulty rectifier component is identified for replacement and documentation is completed.

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

- Repair or Replace Defective Rectifier Components (Reference Task 4.2).
- Adjust Rectifier (Reference Task 4.3).

2.0 Knowledge Component

The purpose of this task is to identify faulty rectifier components.

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

- Troubleshooting a rectifier and components comparable to AMPP Certification Level CP1.
- Basic electricity, electrical circuits, and electrical schematics.
- The operation of rectifiers and the principles of converting AC to DC.
- Component operation such as AC supply, circuit breakers or fuse, transformers, rectifier elements (selenium stack or diode array), shunts, adjustment links, DC output terminals, remote monitoring units (RMUs), and surge protection.

Terms applicable to this task:

rectifier

A device used to convert alternating current (AC) to direct current (DC).

remote monitoring unit

RMU

A device that transmits rectifier readings to a remote site via wireless media.

transformer

A device used to change available voltage or current levels to desired power needs. Adjustment links (taps) are used as connectors on the secondary side of the transformer to allow different voltage settings to be selected for a desired output.

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 remote monitoring unit (RMU) is not communicating.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.

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3.0 Skill Component

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

Step	Action	Explanation
1	Check for proper operation of components to determine faulty component.	Proper operation of components is necessary for rectifier operation. Consult or refer to manufacturer's manual for detailed information.
2	Check the AC voltage input to confirm it is adequate for proper operation.	This verifies there is power to the transformer input. If AC voltage input is inadequate, check circuit breaker or fuse. If the circuit breaker or fuse is faulty, identify it for replacement. This may include checking connections to lightning arrestors and surge protection.
3	Check AC voltage output from the transformer.	If there is no AC voltage output, then the transformer is identified for replacement.
4	Check the DC voltage output at the rectifying element (selenium stack or diode array).	If no DC voltage output is present, then the rectifying element (selenium stack or diode array) is faulty and identified for replacement.
5	Check the DC voltage output to confirm it is adequate for proper operation.	If the DC voltage output is inadequate, check the circuit breaker or fuse. If the circuit breaker or fuse is faulty, identify it for replacement.
6	Check all cables, wires, and wiring connections.	Identify any bad cables, wires, or connections as faulty so they can be replaced.
7	Document faulty components according to Operator's procedures.	Documentation is critical to future analysis and identification of problem areas.

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Task 4.1—Troubleshoot Rectifier

1.0 Task Description

This task consists of checking rectifier components.

This task begins when a rectifier is found inoperable. This task and ends when the faulty rectifier component is identified for replacement and documentation is completed.

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

- Repair or Replace Defective Rectifier Components (reference Reference Task 4.2).
- Adjust Rectifier (reference Reference Task 4.3).

2.0 Knowledge Component

The purpose of this task is to identify faulty rectifier components.

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

- Troubleshooting a rectifier and components comparable to NACE-AMPP Certification Level CP1-2.
- Basic electricity, electrical circuits, and electrical schematics.
- The operation of rectifiers and the principles of converting AC to DC.
- Component operation such as AC supply, circuit breakers or fuse, transformers, rectifier elements (selenium stack or diode array), shunts, adjustment links, DC output terminals, remote monitoring units (RMUs), and surge protection.

Terms applicable to this task are as follows:

rectifier

A device used to convert alternating current (AC) to direct current (DC).

remote monitoring unit

RMU

A device that transmits rectifier readings to a remote site via wireless media.

transformer

A device used to change available voltage or current levels to desired power needs. Adjustment links (taps) are used as connectors on the secondary side of the transformer to allow different voltage settings to be selected for a desired output.

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

AOC Recognition	AOC Reaction
<i>This section intentionally left blank.</i> <u>A component is found in an inoperable condition.</u>	<u>Notify the appropriate personnel to take actions as specified by the Operator's procedures.</u>
<u>A remote monitoring unit (RMU) is not communicating.</u>	<u>Notify the appropriate personnel to take actions as specified by the Operator's procedures.</u>

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3.0 Skill Component

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

Step	Action	Explanation
1	Check for proper operation of components to determine faulty component. Consult or refer to manufacturer's manual for detailed information.	Proper operation of components is necessary for rectifier operation. Consult or refer to manufacturer's manual for detailed information.
2a	Check the AC voltage input <u>to confirm it is adequate for proper operation</u> . If none, check circuit breaker or fuse.	<u>This verifies there is power to the transformer input. If AC voltage input is inadequate, check circuit breaker or fuse. If the circuit breaker or fuse is faulty, identify it for replacement.</u> <u>This may include checking connections to lightning arrestors and surge protection.</u>
2b3	Verify power to the transformer, and c Check AC voltage <u>from the output of</u> the transformer.	If there is no AC voltage from the output , then the transformer is identified for replacement.
2c4	If the transformer output is present, then c Check the DC voltage <u>output</u> at the rectifying element (selenium stack or diode array) output.	If no DC voltage <u>output</u> is present, then the rectifier-rectifying element (selenium stack or diode array) is identified as faulty and identified for replacement.
2d5	Check the DC voltage output <u>to confirm it is adequate for proper operation</u> . If none, check the circuit breaker or fuse.	<u>If the DC voltage output is inadequate, check the circuit breaker or fuse. If the circuit breaker or fuse is faulty, identify it for replacement.</u>
2e6	If no components are found at fault, c Check all cables, wires, and wiring connections, including lightning arrestors and surge protection.	Identify any bad cables, wires, or connections as faulty <u>so they can be replaced</u> .
37	Document faulty components according to operator's <u>Operator's procedures</u> .	<u>Documentation is critical to future analysis and identification of problem areas.</u>

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Task 4.2—Repair or Replace Defective Rectifier Components

1.0 Task Description

This task consists of repairing or replacing defective rectifier components.

This task begins after a faulty component has been identified. The task ends when the rectifier is operational and documentation is complete.

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

- Troubleshoot Rectifier (Reference Task 4.1).

2.0 Knowledge Component

The purpose of this task is to repair defective rectifiers and return them to operational service. An individual performing this task must have knowledge of the following.

- Rectifier components such as AC supply, circuit breakers, transformers, rectifier elements (stack), shunts, display meters, adjustment links, DC output terminals, remote monitoring units (RMUs), and surge protection.
- Rectifier operation and the principles of converting AC to DC. Terms applicable to this task:

rectifier elements or stacks

Devices designed to allow current flow in one direction only. These stacks are used to convert AC to DC.

remote monitoring unit RMU

A device that transmits rectifier readings to a remote site via wireless media.

shunts

Calibrated resistor links that allow current measurement in a rectifier.

transformer

A device used to change available voltage or current levels to desired power needs. Adjustment links (taps) are used as connectors on the secondary side of the transformer to allow different voltage settings to be selected for a desired output.

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 remote monitoring unit (RMU) is not communicating.	Notify the appropriate personnel to take actions as specified by the Operator's procedures.

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3.0 Skill Component

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

Step	Action	Explanation
1	De-energize, install lockout/tagout, and verify the external AC supply to the rectifier is off.	Lockout/tagout devices prevent electrical current during repair. Failure to install these devices may lead to electrical shock and personnel injury.
2a	If the AC breaker is at fault, complete the repair according to manufacturer/Operator's procedures.	<p>Proper operation of the rectifier's AC breaker is essential to protect the rectifier components during power surges, electrical shorts, or component failures.</p> <p>General repair procedures may include:</p> <ul style="list-style-type: none"> — Disconnect wires from the supply to the breaker. — Disconnect wires from the breaker to the rectifier. — Replace the defective breaker with a new breaker, if necessary. — Connect wires from the breaker to the rectifier. — Connect wires from the AC supply to the breaker.
2b	If AC fuses are faulty, complete the repair according to manufacturer/Operator's procedures	<p>Proper operation of the rectifier's AC fuses is essential to protect the rectifier components during power surges, electrical shorts, or component failures.</p> <p>General repair procedures may include:</p> <ul style="list-style-type: none"> — Remove the fuse or fuses. — Replace the defective fuse or fuses with a correct size fuse.
2c	If the transformer is faulty, complete the repair according to manufacturer/Operator's procedures.	<p>Transformers are required to reduce the primary AC voltage to a lower adjustable AC voltage.</p> <p>General repair procedures may include:</p> <ul style="list-style-type: none"> — Disconnect wires from the rectifier AC breaker to the transformer. — Disconnect wires from the transformer to the coarse and fine tap panels. — Replace the defective transformer with a new transformer. — Connect wires from the transformer to the coarse and fine tap panel. — Connect wires from the transformer to the AC rectifier breaker.

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2d	If the rectifying element is faulty, complete the repair according to manufacturer/Operator's procedures.	<p>Rectifier stacks are required to change AC to DC.</p> <p>General repair procedures may include:</p> <ul style="list-style-type: none"> — Disconnect wires from the fine and coarse tap panel to the stack. — Disconnect wires from the rectifier element to the positive and negative DC output terminals. — If the stack is selenium, remove the stack and replace it with a new stack. — If the stack is silicon, remove the defective diodes and replace with new diodes. — Connect wires from the stack to the positive and negative DC output terminals. — Connect wires from the fine and coarse tap panel to the stack.
2e	If the DC fuses are faulty, complete the repair according to manufacturer/Operator's procedures.	<p>Proper operation of the rectifier's DC fuses is essential to protect rectifier components during power surges, electrical shorts, or component failure.</p> <p>General repair procedures may include:</p> <ul style="list-style-type: none"> — Remove the fuse or fuses. — Replace the defective fuse or fuses with a correct size fuse.
3	Verify that all replaced components are operational.	If replaced components are inoperable, make appropriate notifications.
4	Complete all required documentation according to Operator's procedures.	Up-to-date records are essential to maintaining a corrosion control system.

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Task 4.2—Repair or Replace Defective Rectifier Components

1.0 Task Description

This task consists of repairing or replacing defective rectifier components.

This task begins after a faulty component has been identified. The task ends when the rectifier is operational and documentation is complete.

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

- Troubleshoot Rectifier (~~reference~~ Reference Task 4.1).

2.0 Knowledge Component

The purpose of this task is to repair defective rectifiers and return them to operational service. An individual performing this task must have knowledge of the following.

- Rectifier components such as AC supply, circuit breakers, transformers, rectifier elements (stack), shunts, display meters, adjustment links, DC output terminals, ~~remote monitoring units (RMUs)~~ RMUs, and surge protection.
- Rectifier operation and the principles of converting AC to DC. Terms applicable to this task: ~~are as follows.~~

rectifier elements or stacks

Devices designed to allow current flow in one direction only. These stacks are used to convert AC to DC.

remote monitoring unit RMU

A device that transmits rectifier readings to a remote site via wireless media.

shunts

Calibrated resistor links that allow current measurement in a rectifier.

transformer

A device used to change available voltage or current levels to desired power needs. Adjustment links (taps) are used as connectors on the secondary side of the transformer to allow different voltage settings to be selected for a desired output.

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

AOC Recognition	AOC Reaction
<u>A component is found in an inoperable condition.</u>	<u>Notify the appropriate personnel to take actions as specified by the Operator's procedures.</u>
<u>A remote monitoring unit (RMU) is not communicating. This section intentionally left blank.</u>	<u>Notify the appropriate personnel to take actions as specified by the Operator's procedures.</u>

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3.0 Skill Component

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

Step	Action	Explanation
1	De-energize, <u>install lockout/tagout</u> , and verify the external AC supply to the rectifier is off.	<u>Lockout/tagout devices prevent electrical current during repair. Failure to install these devices may lead to electrical shock and personnel injury.</u>
2a	If the AC breaker is at fault, complete the <u>repair according to manufacturer/Operator's procedures</u> following on the primary AC breaker. Disconnect wires from the supply to the breaker. Disconnect wires from the breaker to the rectifier. Replace the defective breaker with a new breaker, if necessary. Connect wires from the breaker to the rectifier. Connect wires from the AC supply to the breaker.	Proper operation of the rectifier's AC breaker is essential to protect the rectifier components during power surges, electrical shorts, or component failures. <u>General repair procedures may include:</u> — <u>Disconnect wires from the supply to the breaker.</u> — <u>Disconnect wires from the breaker to the rectifier.</u> — <u>Replace the defective breaker with a new breaker, if necessary.</u> — <u>Connect wires from the breaker to the rectifier.</u> — <u>Connect wires from the AC supply to the breaker.</u>
2b	If AC fuses are faulty, complete the <u>repair according to manufacturer/Operator's procedures</u> following on the primary AC fuses. Remove the fuse or fuses. Replace the defective fuse or fuses with a correct size fuse.	Proper operation of the rectifier's AC fuses is essential to protect the rectifier components during power surges, electrical shorts, or component failures. <u>General repair procedures may include:</u> — <u>Remove the fuse or fuses.</u> — <u>Replace the defective fuse or fuses with a correct size fuse.</u>
2c	If the transformer is faulty, complete the <u>repair according to manufacturer/Operator's procedures</u> following on the transformer. Disconnect wires from the rectifier AC breaker to the transformer. Disconnect wires from the transformer to the coarse and fine tap panels. Replace the defective transformer with a new transformer. Connect wires from the transformer to the coarse and fine tap panel. Connect wires from the transformer to the AC rectifier breaker.	Transformers are required to reduce the primary AC voltage to a lower adjustable AC voltage. <u>General repair procedures may include:</u> — <u>Disconnect wires from the rectifier AC breaker to the transformer.</u> — <u>Disconnect wires from the transformer to the coarse and fine tap panels.</u> — <u>Replace the defective transformer with a new transformer.</u> — <u>Connect wires from the transformer to the coarse and fine tap panel.</u> — <u>Connect wires from the transformer to the AC rectifier breaker.</u>

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2d	<p>If the rectifier-rectifying element is faulty, complete the <u>repair according to manufacturer/Operator's procedures following on the rectifier element (stack).</u></p> <p>Disconnect wires from the fine and coarse tap panel to the stack.</p> <p>Disconnect wires from the rectifier element to the positive and negative DC output terminals.</p> <p>If the stack is selenium, remove the stack and replace it with a new stack.</p> <p>If the stack is silicon, remove the defective diodes and replace with new diodes.</p> <p>Connect wires from the stack to the positive and negative DC output terminals.</p> <p>Connect wires from the fine and coarse tap panel to the stack.</p>	<p>Rectifier stacks are required to change AC to DC.</p> <p><u>General repair procedures may include:</u></p> <ul style="list-style-type: none"> — <u>Disconnect wires from the fine and coarse tap panel to the stack.</u> — <u>Disconnect wires from the rectifier element to the positive and negative DC output terminals.</u> — <u>If the stack is selenium, remove the stack and replace it with a new stack.</u> — <u>If the stack is silicon, remove the defective diodes and replace with new diodes.</u> — <u>Connect wires from the stack to the positive and negative DC output terminals.</u> — <u>Connect wires from the fine and coarse tap panel to the stack.</u>
2e	<p>If the DC fuses are faulty, complete the <u>repair according to manufacturer/Operator's procedures following on DC fuses.</u></p> <p>Remove the fuse or fuses.</p> <p>Replace the defective fuse or fuses with a correct size fuse.</p>	<p>Proper operation of the rectifier's DC fuses is essential to protect rectifier components during power surges, electrical shorts, or component failure.</p> <p><u>General repair procedures may include:</u></p> <ul style="list-style-type: none"> — <u>Remove the fuse or fuses.</u> — <u>Replace the defective fuse or fuses with a correct size fuse.</u>
3	<p><u>Verify that all replaced components are operational.</u></p>	<p><u>If replaced components are inoperable, make appropriate notifications.</u></p>
34	<p><u>Record-Complete all required information documentation according to operator's Operator's procedures.</u></p>	<p>Up-to-date records are essential to maintaining a corrosion control system.</p>

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Task 4.3—Adjust Rectifier

1.0 Task Description

This task consists of making rectifier adjustments.

This task begins with the identification of the rectifier in need of adjustment. The task ends with proper adjustment of the rectifier and completion of documentation.

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).
- Obtain a Voltage and Current Output Reading from a Rectifier to Verify Proper Performance (Reference Task 3).

2.0 Knowledge Component

The purpose of this task is to adjust the rectifier to maintain the CP system. An individual performing this task must have knowledge of the following.

- CP systems and components comparable to AMPP Certification Level CP 2.
- Basic electricity, electrical circuits, and electrical schematics.
- Rectifier operation and adjustment methods (typically a mechanical adjustment link on the transformer output).
- Use of voltmeter and electrical measurements.
- Measuring the structure-to-soil potential (DC and AC) (Task 1.1). These measurements are used to determine CP and necessary current adjustments to the rectifier.

Terms applicable to this task:

This section intentionally left blank.

AOCs associated with the performance of this task include:

AOC Recognition	AOC Reaction
Inability to achieve target output.	Notify appropriate personnel for CP system analysis.

Task 4.3—Adjust Rectifier

1.0 Task Description

This task consists of making rectifier adjustments.

This task begins with the identification of the rectifier in need of adjustment. The task ends with proper adjustment of the rectifier and completion of documentation.

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).
- Obtain a Voltage and Current Output Reading from a Rectifier to Verify Proper Performance (~~reference~~ Reference Task 3).

2.0 Knowledge Component

The purpose of this task is to adjust the rectifier to maintain the 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.
- Basic electricity, electrical circuits, and electrical schematics.
- Rectifier operation and adjustment methods (typically a mechanical adjustment link on the transformer output).
- Use of voltmeter and electrical measurements.
- Measuring the structure-to-soil potential (DC and AC) (Task 1.1). These measurements are used to determine CP and necessary current adjustments to the rectifier.

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
Inability to achieve target output.	Notify appropriate personnel for CP system analysis.

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3.0 Skill Component

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

Step	Action	Explanation
1	Identify rectifier needing adjustment.	
2	Determine the action to be taken. Either increase or decrease the output current with consideration of the entire system components, such as pipe-to-soil readings, bonds, etc.	<u>Rectifiers are part of an overall CP system and must be adjusted based on system requirements. Adjustments (increases/decreases) made to one rectifier may impact other system components.</u> <u>Adjustments should be based on indicators such as pipe-to-soil readings, historical data, or design criteria.</u>
3	Increase/decrease <u>Adjust</u> the fine tap setting in progressive steps until the desired settings have been achieved. NOTE—Power should be off before making these adjustments. Tap settings are current-carrying connections and should be tightened prior to re-energizing the rectifier.	When the required output current is obtained, the adjustment is complete. <u>NOTE—Power should be off before making these adjustments.</u> <u>Tap settings are current-carrying connections and should be tightened prior to re-energizing the rectifier.</u>
4	If the fine tap setting reaches its limit, set adjust the fine tap to the lowest appropriate setting, and increase or decrease adjust the coarse tap setting by 1 tap. NOTE—Power should be off before making these adjustments. Tap settings are current-carrying connections and should be tightened prior to re-energizing the rectifier.	Incremental adjustments will prevent the current from exceeding design limits. <u>NOTE—Power should be off before making these adjustments.</u> <u>Tap settings are current-carrying connections and should be tightened prior to re-energizing the rectifier.</u> <u>Repeat step until desired settings have been achieved.</u>
5	Adjustments should be based on indicators such as pipe-to-soil readings, historical data, or design criteria.	Rectifiers are part of an overall CP system and must be adjusted based on system requirements.
6	Record-Complete all required information documentation per operator's-Operator's procedures.	Up-to-date records are essential to maintaining a corrosion control system.

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3.0 Skill Component

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

Step	Action	Explanation
1	Identify rectifier needing adjustment.	
2	Determine the action to be taken.	<p>Rectifiers are part of an overall CP system and must be adjusted based on system requirements. Adjustments (increases/decreases) made to one rectifier may impact other system components.</p> <p>Adjustments should be based on indicators such as pipe-to-soil readings, historical data, or design criteria.</p>
3	Adjust the fine tap setting in progressive steps until the desired settings have been achieved.	<p>When the required output current is obtained, the adjustment is complete.</p> <p>NOTE Power should be off before making these adjustments.</p> <p>Tap settings are current-carrying connections and should be tightened prior to re-energizing the rectifier.</p>
4	If the fine tap setting reaches its limit, adjust the fine tap to the appropriate setting, and adjust the coarse tap setting by 1 tap.	<p>Incremental adjustments will prevent the current from exceeding design limits.</p> <p>NOTE Power should be off before making these adjustments.</p> <p>Tap settings are current-carrying connections and should be tightened prior to re-energizing the rectifier.</p> <p>Repeat step until desired settings have been achieved.</p>
6	Complete all required documentation per Operator's procedures.	Up-to-date records are essential to maintaining a corrosion control system.

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