

NATIONAL RAILROAD PASSENGER CORPORATION
ELECTRIFIED TERRITORY



Specification No. 16064
Issued December 28, 2012
Philadelphia, PA

SPECIFICATION FOR EQUIPMENT AND VEHICLE GROUNDING NEAR
ENERGIZED OVERHEAD WIRES

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including National Railroad Passenger Corporation (Amtrak) "General Provisions for Construction Contracts" (General Provisions) and Supplementary General Provisions and other Division 1 Specification Sections, apply to this Section.
- B. Amtrak Electric Traction Standard Operating Instructions/Procedures/Drawings
 - 1. AMT-2, Electrical Operating Instructions
 - 2. Standard Operating Instruction 11 - Electrical Clearance Procedures
 - 3. Standard Operating Instruction 12 - Approved Temporary Ground Clamps for Use In Electrified Territory
 - 4. Amtrak employees will utilize two different documents:
 - a. For Amtrak Electric Traction employees: Standard Operating Instruction 213 - Roadway Machinery and Construction Equipment Grounding in Electrified Territory.
 - b. For all other Amtrak employees: Engineering Practice Specification for Roadway Machinery and Construction Equipment Grounding in Electrified Territory.
 - c. Both of these documents shall be used interchangeably within this document.
 - 5. Amtrak Vehicle Grounding Drawings; AET-1001 through AET – 1010.
- C. Appendices which are included for issue to contractors and vendors:
 - 1. Annual Vehicle and Equipment Safety Grounding Evaluation Form.
 - 2. Amtrak Vehicle Grounding Drawings; AET-1001 through AET – 1010.

1.2 SUMMARY

- A. In general, Vehicle and Equipment Grounding and Bonding (G&B) systems are intended to ensure safety and to protect all personnel, overhead wires and the associated equipment in the event of accidental contact with energized overhead lines. The grounding and bonding system shall be comprised of bare or insulated (600V class) cables and associated grounding clamps and connectors that create a complete low-resistance path to ground, as required and specified on the related drawings. The resistance of the path between the potential contact area of the vehicle and return circuit shall not exceed 10 ohms.

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- B. The purpose of this document is to specify the grounding and bonding requirements and related safety requirements for Construction Machines, Mobile Vehicles and Construction Equipment utilized for maintenance and construction work near overhead energized wires.
1. This specification shall apply to any vehicle or equipment which can extend into close proximity to energized overhead electric lines.
 2. G&B components shall be permanently installed on vehicle components which can be contacted by operators and others while operating within the vicinity of energized overhead electric lines. Sections which are beyond the reach of operators and others (e.g. farthest boom sections of cranes) need not be bonded.
- C. This specification is intended to serve three functions related to vehicle and equipment Grounding and Bonding (G&B) in the vicinity of energized overhead wires:
1. Provide requirements and guidance to contractors working on Amtrak projects:
 - a. Temporary G&B connections between the equipment and the return rail (system ground when working outside electrified territory) when working in the proximity of overhead energized lines.
 - b. Permanently installed G&B measures on contractor equipment. All contractor equipment and vehicles shall be properly equipped with bonds, cables and connections as noted herein and within reference documents.
 2. Provide requirements and guidance to Amtrak employees related to:
 - a. Maintenance and periodic testing requirements for G&B components that are permanently installed on vehicles and equipment.
 - b. Temporary G&B connections between the equipment and the return rail (system ground when working outside electrified territory) when working in the proximity of overhead energized lines.
 - c. Permanently installed G&B measures on contractor equipment. All contractor equipment and vehicles shall be properly equipped with bonds, cables and connections as noted herein and within reference documents.
 3. Provide requirements and guidance to vendors supplying equipment and vehicles to Amtrak:
 - a. Vendors shall install and test G&B components, as specified herein, on all new and rental vehicles and equipment.
- D. Contractor shall follow Amtrak safety rules and policies at all times.
- E. All employees, Amtrak and contractor, shall participate in the daily safety briefing and the Contractor shall ensure the following:
1. Contractor employees participate in Amtrak Contractor Safety Training Class and wear badge while onsite.
 2. Contractor employees participate in an Employee Job briefing in association with Amtrak's authorized personnel.

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3. All worksite personnel are equipped with and wear Amtrak approved personal protective equipment (PPE).
 4. Worksite personnel shall not foul any track unless they have permission from the Authorized Amtrak employee in charge at the job site.
 5. Appropriate ET protection is in place for work in the vicinity of overhead conductors. High voltage conductors and equipment shall always be considered energized until protective grounds are installed by Amtrak authorized representative.
 6. For work which is within the vicinity of overhead lines that are not owned by Amtrak, contractors or Amtrak employees (where applicable) shall contract the local utility (or owner) and comply with local "Proximity Act" rules and requirements.
 7. Approved barriers shall be provided when the work requires the placement of material or equipment within the restricted zone.
 8. All employees are informed of hazards and associated protective measures.
- F. In the event a vehicle (equipment) comes into contact with an energized overhead wire, the equipment shall be taken out of service until a visual and resistance measurement tests are performed and performance requirements satisfied.

1.3 SUBMITTALS

- A. Shop Drawings: Submit shop drawings prepared by or under the supervision of a professional engineer for equipment and vehicle grounding systems.
1. The Contractor/Vendor shall submit details of all the grounding and bonding materials and associated components indicating their specific intent.
 2. The submittals shall also include sketches on each equipment/machine grounding and bonding detail.
 3. Written approval shall not relieve the Contractor of its complete responsibility for the adequacy and safety of the operations.
 4. Equipment suppliers shall provide cut sheets for all installed G&B materials as well as test results.
 5. Contractors, whose employees will be working in the vicinity of overhead energized lines, will provide test results for all equipment and vehicles.

PART 2 - PRODUCTS**2.1 AMTRAK OWNED AND RENTED EQUIPMENT AND VEHICLES**

- A. This section details requirements for vendors providing rental or purchased vehicles and equipment to Amtrak.

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- B. Suppliers shall provide equipment or vehicles with permanent bonds, connectors, clamps and all other materials (shown on typical drawings and related documents) sufficient to demonstrate a measured resistance path of 10 ohms or less from all components ten feet above the highest platform an operator can reach to the connection point for the grounding cable
- C. Amtrak fleet maintenance personnel shall maintain equipment and vehicle bonds, connectors, clamps and all other materials sufficiently to maintain a maximum resistance of 10 ohms across all bonded components to the return (or ground connection).
- D. Amtrak fleet maintenance personnel shall provide all labels and safety warnings for installation by vehicle and equipment suppliers.
- E. Hardware
 - 1. All materials and components shall be provided in accordance with Amtrak Standard Operating Instruction No.12, Approved Temporary Ground Clamps for use in electrified territory, and Standard Operating Instruction 213 - Roadway Machinery and Construction Equipment Grounding in Electrified Territory.
 - 2. Grounding and bonding conductors shall be of 4/0 AWG, 600V flexible copper cable (welding cable), unless otherwise indicated on the drawings. Cable assemblies shall meet ASTM F-855 –“Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment.” or an Amtrak Approved equal.
 - 3. Grounding clamps, ferrules, threaded stud type terminals, nuts and washers shall be of copper or silicon bronze to suit the cable size and specific requirement of the equipment and ground connections. The grounding clamps shall comply with ASTM F-855.
 - 4. Size and type of exothermic welds, where required, shall be per manufacturer’s recommendations.
- F. Warning Placards
 - 1. Refer to Section 3.4 for all information regarding warning labels and placards.

2.2 CONTRACTOR OWNED EQUIPMENT AND VEHICLES

- A. Contractor owned vehicles equipment shall comply with all hardware requirements of Articles 2.1.A & 2.1.B of this specification and related documents.
- B. Contractor personnel shall maintain a maximum 10 ohm path across all bonded components to the return or ground connection.
- C. Refer to Section 3.4 for all information regarding warning labels and placards.

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PART 3 - EXECUTION

3.1 GENERAL

- A. It shall be the responsibility of the equipment operator to ensure equipment is properly grounded and perform a visual inspection of all grounding equipment, bonds and connections prior to operating in the vicinity of overhead lines.
- B. The Contractors and Sub-Contractors and their personnel, shall adhere to the same Amtrak Safety requirements as the Amtrak employees when working at site.
- C. No employees or equipment shall be permitted to work within minimum approach distance of Amtrak owned overhead wires of electrified tracks except when protected by a Class "A" employee of the Railroad.
- D. Employees shall not work within the vicinity of overhead lines which are not owned by Amtrak without contacting the Owner (typically a utility) and working in compliance with local "Proximity Act" requirements.
- E. It is the intent of this specification section and the associated drawings to provide general guidelines to enable qualified workers a means to install appropriate bonding for most situations. In the event conditions are not clear and or uncertainty develops, employees must contact appropriate engineering or ET personnel for clarification.

3.2 INSTALLATION GUIDELINES

- A. General Guidelines for permanently mounted grounding equipment
 - 1. When mobile cranes, crawler cranes, power shovels, pile drivers, dump trucks, boom trucks, bucket trucks, articulated light standards, digger derricks and similar machines are used in proximity of the overhead electrification wires or equipment, the aerial devices and the support frame of the machine shall be properly grounded as follows: (Note that hot-line work is not permitted on Amtrak's overhead electrical equipment.)
 - a. Boom sections (within reach of operator and others in the vicinity) and the supporting frame shall be bonded together with a 600V insulated 4/0 AWG copper cable with suitable grounding clamps or threaded stud type terminals. The surfaces used for clamping and connections shall be cleaned thoroughly of any dirt or paint. The bonding cable shall have sufficient slack to permit necessary movement of the boom as required. The wire shall be attached to the boom with suitable clips to avoid damaging the cables.
 - b. Rail car frame and the car axle journal boxes shall also be bonded together with 600V insulated 4/0 AWG copper cables with suitable grounding

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- clamps or bolted connections at either ends. Alternatively 4/0 AWG equivalent size tinned copper flexible braids with compressed end ferrules may be used for axle journal bonding to the car frame.
2. Any vehicle or equipment which comes into contact with an energized overhead wire shall be removed from service until a visual inspection and resistance measurement test has confirmed that an appropriate low resistance path is still intact.
 3. Perform daily visual inspections on all equipment or vehicles which will be utilized in the proximity of energized overhead lines.
 4. Perform annual resistance measurements of the G&B path for all vehicles and equipment used in the vicinity of overhead lines.
 5. For all permanent mechanical grounding connections, an oxide inhibiting joint compound, such as Penetrox or an approved equivalent, should be used to produce low initial surface contact resistance and prevent oxidation or corrosion due to air and moisture.
- B. Guidelines for Field connections
1. Grounding cables shall be continuous and splicing shall not be permitted.
 2. When applying grounds, attachment shall be made to the vehicle or equipment ground point first, then to the worksite ground to prevent arcing near the vehicle or equipment. Ground points shall be cleaned with a stiff wire brush before applying grounds.
 3. In the event the construction equipment has to be carried on flat bed rail car, the equipment base shall be bonded to the flat car frame with a 600V insulated 4/0 AWG copper cable with suitable end plate at either end for connections.
 4. Multiple vehicles situated in a manner that allows a worker to contact two of them simultaneously shall be bonded together with 600V insulated 4/0 AWG copper cable.
 5. Rubber tired vehicles or construction vehicles not carried on flat bed rail car, used at construction sites in electrified territory shall be grounded to the nearest steel catenary pole, bridge structure or a non-signaled track rail in the same manner as described above.
 6. Ground cables on reels or looped on the vehicles shall be completely unwound to allow thorough inspection of the cable and laid down on the ground before use to minimize or eliminate destructive forces resulting from induction in the event of a fault at the worksite. Under no circumstances shall an installed ground cable be coiled.
 7. The rail car frame connection shall complete the return circuit through the wheels to running track connection. If rail car is to be stationary for an extended period a bonding conductor shall be bonded to the nearest steel catenary pole, bridge structure or a non- signaled track rail as applicable with a 600V insulated 4/0 AWG copper cable with suitable grounding clamps at either end. Provide sufficient slack and adjust length of the grounding cable to suit the site requirements to allow movement of the flat car within the construction area.

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8. For work in switchyards and substations having ground mats, all mobile equipment and vehicles involved at worksite within the facility shall be grounded (bonded) to the (substation or switchyard) ground mat at a visible connection point. Amtrak or utility personnel should be contacted if contractor is uncertain of connection.
9. Cranes located inside the substation/switchyard (on top of the ground grid) shall not make picks outside the perimeter fence, (off the ground mat) without being properly connected to the ground grid. Likewise, Cranes off the ground perimeter (outside the substation/ switchyard) shall not make picks in the facility or deliver material into the facility without being connected to the ground grid. Hazardous transferred touch potentials may develop at the crane hook or frame during an accidental electrical fault for these situations.

3.3 TESTING

- A. The continuity of the grounding between the equipment construction machines boom and the grounded rail structure (catenary pole, bridge or non- signaled rail or ground mat) shall be established by resistance measurements using an ohmmeter. **The measured resistance value shall be less than 10 ohms.** In the event the measured resistance is greater than 10 ohms, check bonding connections for contact and cleanliness and inspect cabling for continuity or breaks. Add additional bonds if necessary. The test form is shown on Attachment 1: Annual Vehicle and Equipment Safety Grounding Evaluation Form.
- B. Resistance measurements shall be conducted on all vehicles at Amtrak discretion. Additionally, contractors shall perform annual tests to ensure appropriate resistance values are achieved.
- C. In the event a vehicle (equipment) comes into contact with an energized overhead wire, the equipment shall be taken out of service until a visual and resistance measurement tests are performed.

3.4 WARNING LABELS AND PLACARDS

- A. Equipment and vehicles shall have warning placards as defined on reference documents.
- B. Amtrak vehicles and equipment
 1. Amtrak will provide labels to suppliers for rental equipment and new vehicle and equipment purchases. Vendors will install according to Attachment 2: Drawing AET.1010.
 2. Amtrak Employees will inspect warning labels annually and replace as needed.
- C. Contractor vehicles and equipment

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1. Contractor owned equipment and vehicles shall have adequate signage to warn operators and others of potential hazards due to energized overhead lines in accordance with OSHA requirements.
2. Contractor shall comply with article 3.4.B.1 above, but ANSI approved warning labels/placards may be installed.

3.5 GROUNDING AND BONDING DETAILS

- A. Typical arrangements of the grounding and bonding details for construction equipment at site are shown in Attachment 2: Drawings AET-1001 through AET-1009 for guidance.

3.6 PROXIMITY

- A. Minimum approach distance should be maintained to all energized lines at all times. When it becomes necessary to operate equipment within minimum approach distance of energized overhead conductors, whether on rail or roadway, grounding cable shall be attached to the rail and grounding pad of the equipment or machine before operating the boom.
- B. Amtrak Employees shall refer to AMT-2 for minimum approach distance guidelines and related information and direction.
- C. When contractors are operating equipment outside of minimum approach distance, grounding, in accordance with this specification, is required if the failure of a single component of the equipment or vehicle, could compromise the noted clearances. Typical components which could affect these clearances include bolts, booms, cables or footing(s). Amtrak shall have authority to require these grounds as they see fit.

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APPROVALS

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Director- Design & Standards- Electric Traction

REVIEWED: G. J. Nangle
G. J. Nangle
Director of Operations, Maintenance, and Compliance- Electric Traction

APPROVED: R. J. Verhelle
R. J. Verhelle
Deputy Chief Engineer- Electric Traction

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OVERHEAD WIRES

ATTACHMENT #1

ANNUAL VEHICLE EQUIPMENT SAFETY GROUNDING
EVALUATION FORM

DATE: _____

EQUIPMENT : _____	AMTRAK ID:	
	LOCATION:	
REFERENCE DRAWING:	INSPECTOR:	

INSTRUCTIONS:

- 1) VERIFY INSTALLATION OF ALL BONDS SHOWN ON REFERENCE DRAWING.
- 2) INSPECT AND INVENTORY ALL ON BOARD GROUNDING EQUIPMENT
- 3) VISUAL INSPECTION OF ALL BONDS AND DEVICES. RECORD ALL OBSERVATIONS BELOW.
- 4) ZERO RESISTANCE (CONTINUITY) METER AND RECORD ANY IMPEDANCE (LEAD LENGTH.)
- 5) MEASURE AND RECORD IMPEDANCE OF ALL BONDS
- 6) VERIFY METER ZERO.

ON-BOARD EQUIPMENT:	LOCATION	CONDITION
GROUNDING CABLE		
RUNNING RAIL CLAMP		
STRUCTURE CLAMP		
BALL SOCKET GROUND CLAMP		

BOND IMPEDANCE MEASUREMENTS:					
INITIAL METER ZERO:		OHMS		COMMENTS	
TEST POINT (TP)	to	TP	RESISTANCE (OHMS)		
			GROSS		NET *
1		2			
1		3			
1		4			
1		5			
1		6			
1		7			

* NET VALUE EQUALS GROSS (MEASURED) VALUE MINUS INITIAL METER ZERO READING

APPROVED BY:	
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VISUAL INSPECTION SHALL BE PERFORMED DAILY.
RESISTANCE MEASUREMENTS SHALL BE PERFORMED ANNUALLY.
IN THE EVENT OF CONTACT WITH AN ENERGIZED OVERHEAD LINE, REMOVE VEHICLE FROM SERVICE UNTIL A VISUAL INSPECTION AND RESISTANCE MEASUREMENT TESTS PROVIDE SATISFACTORY RESULTS.

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SPECIFICATION FOR EQUIPMENT AND VEHICLE GROUNDING NEAR ENERGIZED
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ATTACHMENT #2

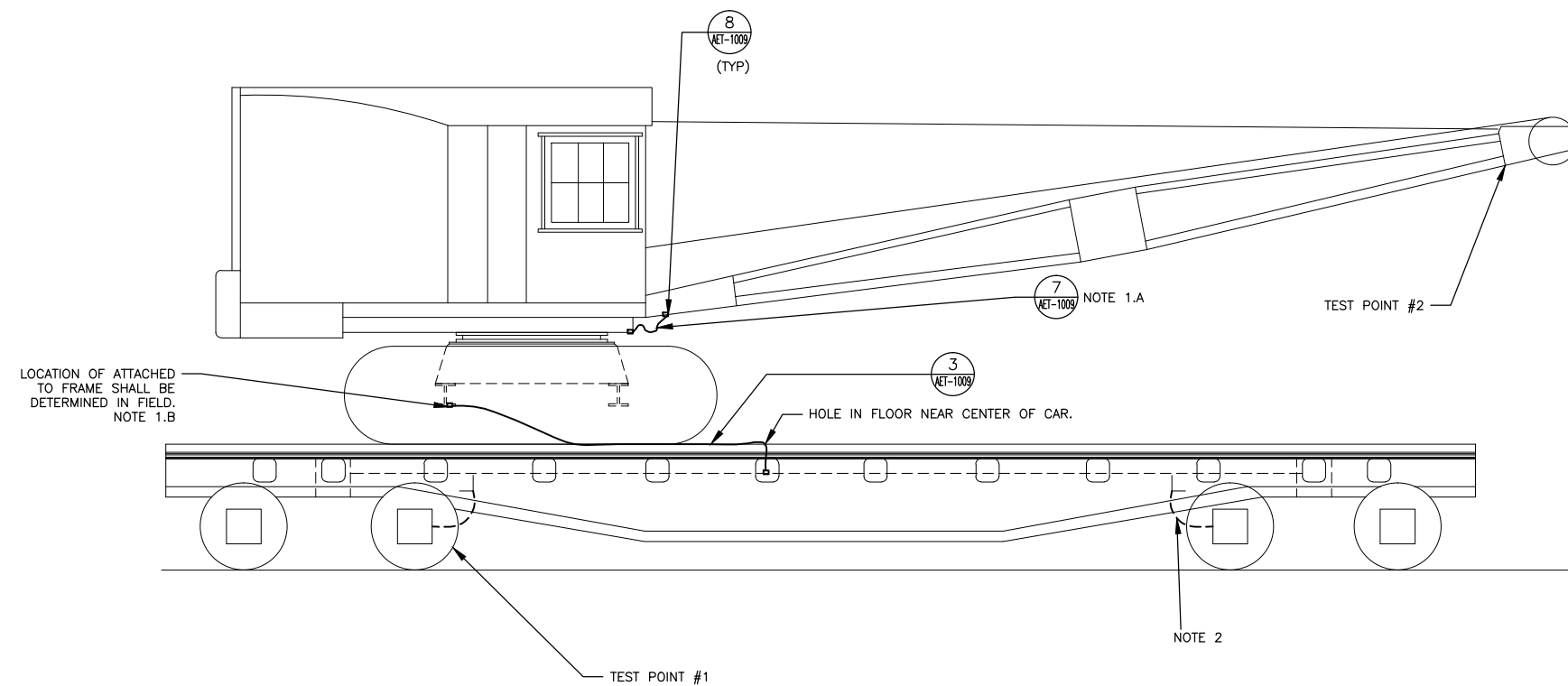
NOTES:

1. WHEN MOBILE CRANES, CRAWLER CRANES, POWER SHOVELS, PILE DRIVERS, AND SIMILAR ROADWAY MACHINES ARE USED IN PROXIMITY TO OVERHEAD ELECTRIFICATION WIRES OR ELECTRICAL APPARATUS, THE BOOM AND SUPPORTING FRAME OF THE ROADWAY MACHINE MUST BE PROPERLY GROUNDED. FOR GROUNDING PURPOSES THE FOLLOWING PROCEDURE SHALL APPLY:

ALL BONDING SHALL BE IN PLACE PRIOR RAISING BOOM FROM TRAVEL POSITION.

- A. ATTACH BOND TO BOOM AND TO SUPPORTING FRAME. CABLE SHALL HAVE ENOUGH SLACK TO PERMIT NECESSARY MOVEMENT OF BOOM.
- B. ATTACH ONE END OF BONDING CABLE TO MAIN SUPPORTING FRAME.

2. JOURNAL BEARING ENCLOSURES ARE BONDED TO CAR FRAME.



1 ELECTRICAL TERRITORY, GROUNDING ARRANGEMENT FOR CRAWLER CRANE MOUNTED ON FLAT CAR
SCALE: NONE

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No.	Revisions	Date	By



Office of Engineering
Engineering Design
National Railroad Passenger Corporation
30TH Street Station, Philadelphia, Pennsylvania 19104

Approved	Date
Deputy Chief Engineer Electric Traction	
Sig: _____	
Director Electric Traction & Standards	
Sig: _____	
Sig: _____	

ELECTRIC TRACTION DEPT.
30 TH. & MARKET STR.
PHILADELPHIA, PA

ELECTRIFICATION STANDARDS

ROADWAY MACHINE MAINTENANCE

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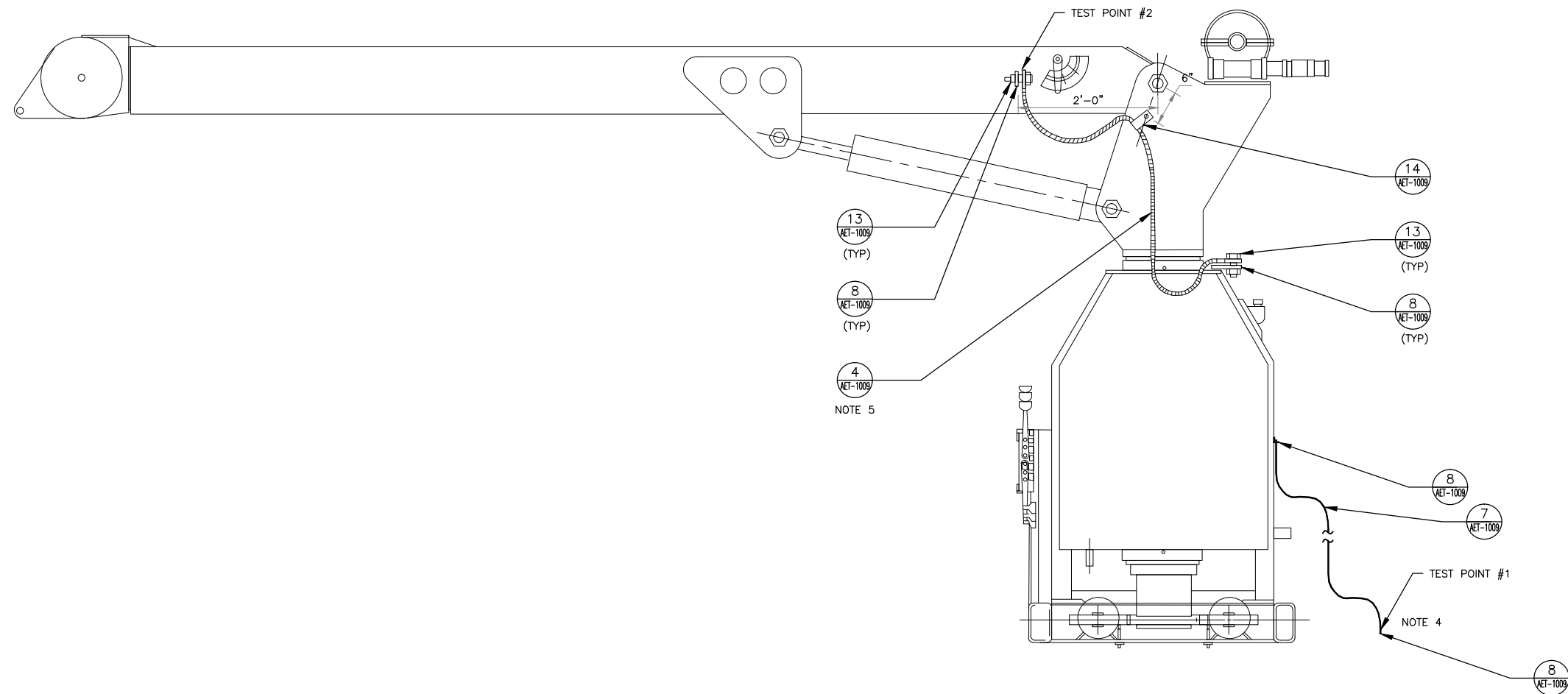
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NOTES:

1. ALL BONDS MUST ALLOW FOR FULL EXTENSION OF EQUIPMENT AND SHALL NOT PINCH OR OTHERWISE INTERFERE.
2. BONDS REQUIRED FOR ALL EXTENSIONS CAPABLE OF HEIGHTS OF 12' OR MORE.
3. GROUNDING CONDUCTOR SHALL BE ATTACHED TO FRAME.
4. CABLE SHALL BE BONDED TO TRUCK BODY WITH A WELDED ANGLE.
5. CABLE SHALL HAVE ENOUGH SLACK TO PERMIT NECESSARY MOVEMENT OF BOOM.

PROCEDURE:

1. WHEN WORKING IN PROXIMITY TO ENERGIZED CONDUCTORS, WHETHER ON RAIL OR ROADWAY, GROUNDING CABLE MUST BE ATTACHED TO RAIL AND GROUNDING PAD OF TRUCK BEFORE OPERATING BOOM.
2. THREE FOOT CLEARANCE TO ENERGIZED CATENARY AND SIGNAL POWER AND FIFTEEN FOOT CLEARANCE TO TRANSMISSION MUST BE MAINTAINED AT ALL TIMES.



1 TYPICAL BOOM GROUNDING DETAIL
 - SCALE: NONE

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 Engineering Design
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 30TH Street Station, Philadelphia, Pennsylvania 19104

Approved	Date
Deputy Chief Engineer Electric Traction	
Sig: _____	
Director Electric Traction & Standards	
Sig: _____	
Sig: _____	

ELECTRIC TRACTION DEPT.
 30 TH. & MARKET STR.
 PHILADELPHIA, PA

ELECTRIFICATION STANDARDS
 GROUNDING ARRANGEMENT FOR BOOM TRUCKS

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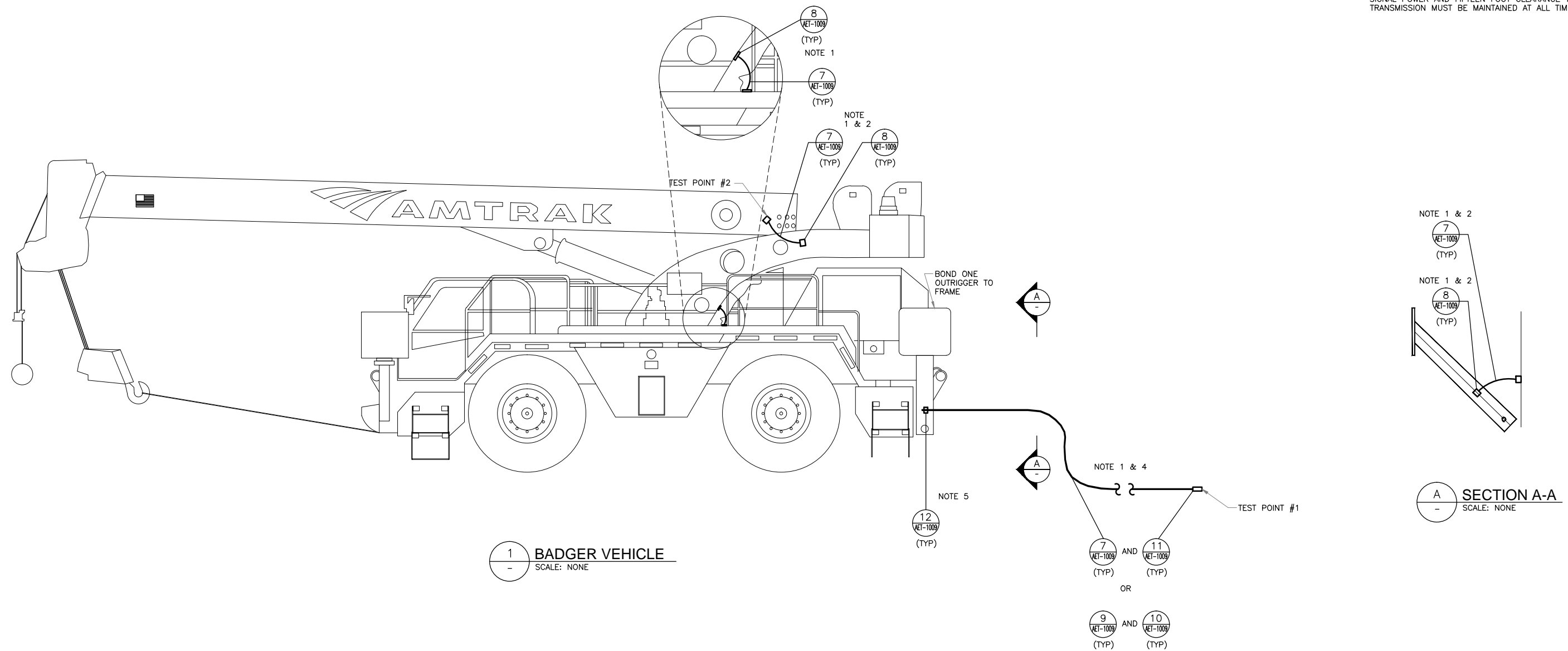
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Drawn By:	AET-1002

NOTES:

1. ALL BONDS MUST ALLOW FOR FULL EXTENSION OF EQUIPMENT AND SHALL NOT PINCH OR OTHERWISE INTERFERE.
2. BONDS REQUIRED FOR ALL EXTENSIONS CAPABLE OF HEIGHTS OF 12' OR MORE.
3. GROUNDING CONDUCTOR SHALL BE ATTACHED TO FRAME.
4. THE GROUNDING CABLE USED DEPENDS ON WHETHER IT IS CLAMPED TO THE RAIL OR A STRUCTURE.
5. IF CONNECTION NOT POSSIBLE, USE WELDED ANGLE CONNECTION (DETAIL #8, AET-1009.)

PROCEDURE:

1. WHEN WORKING IN PROXIMITY TO ENERGIZED CONDUCTORS, WHETHER ON RAIL OR ROADWAY, GROUNDING CABLE MUST BE ATTACHED TO RAIL AND GROUNDING PAD OF TRUCK BEFORE OPERATING BOOM.
2. THREE FOOT CLEARANCE TO ENERGIZED CATENARY AND SIGNAL POWER AND FIFTEEN FOOT CLEARANCE TO TRANSMISSION MUST BE MAINTAINED AT ALL TIMES.



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Approved	Date
Deputy Chief Engineer Electric Traction	
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Director Electric Traction & Standards	
Sig: _____	
Sig: _____	

ELECTRIC TRACTION DEPT.
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ELECTRIFICATION STANDARDS

VEHICLE GROUNDING
BADGER VEHICLE

Scale: NTS Drawn: CBS Checked: - Date: 3/20/13

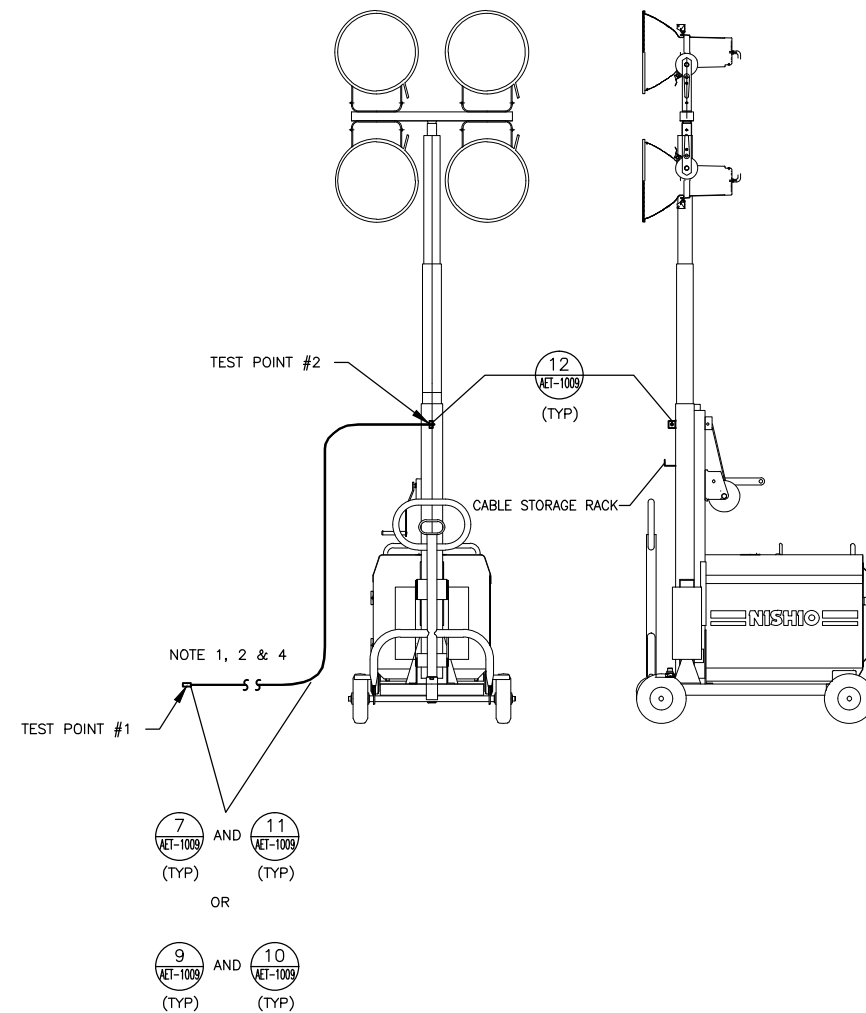
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Sheet No:	
Drawn:	AET-1003

NOTES:

1. ALL BONDS MUST ALLOW FOR FULL EXTENSION OF EQUIPMENT AND SHALL NOT PINCH OR OTHERWISE INTERFERE.
2. BONDS REQUIRED FOR ALL EXTENSIONS CAPABLE OF HEIGHTS OF 12' OR MORE.
3. GROUNDING CONDUCTOR SHALL BE ATTACHED TO FRAME.
4. THE GROUNDING CABLE USED DEPENDS ON WHETHER IT IS CLAMPED TO THE RAIL OR A STRUCTURE.

PROCEDURE:

1. WHEN WORKING IN PROXIMITY TO ENERGIZED CONDUCTORS, WHETHER ON RAIL OR ROADWAY, GROUNDING CABLE MUST BE ATTACHED TO RAIL AND GROUNDING PAD OF TRUCK BEFORE OPERATING BOOM.
2. THREE FOOT CLEARANCE TO ENERGIZED CATENARY AND SIGNAL POWER AND FIFTEEN FOOT CLEARANCE TO TRANSMISSION MUST BE MAINTAINED AT ALL TIMES.



1 TYPICAL PORTABLE LIGHT
SCALE: NONE

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Engineering Design
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Approved	Date
Deputy Chief Engineer Electric Traction	
Sig: _____	
Director Electric Traction & Standards	
Sig: _____	
Sig: _____	

ELECTRIC TRACTION DEPT.
30 TH. & MARKET STR.
PHILADELPHIA, PA

ELECTRIFICATION STANDARDS

**VEHICLE GROUNDING
PORTABLE LIGHT & WIRE TRAILER**

Scale: NTS Drawn: CBS Checked: - Date: 3/20/13

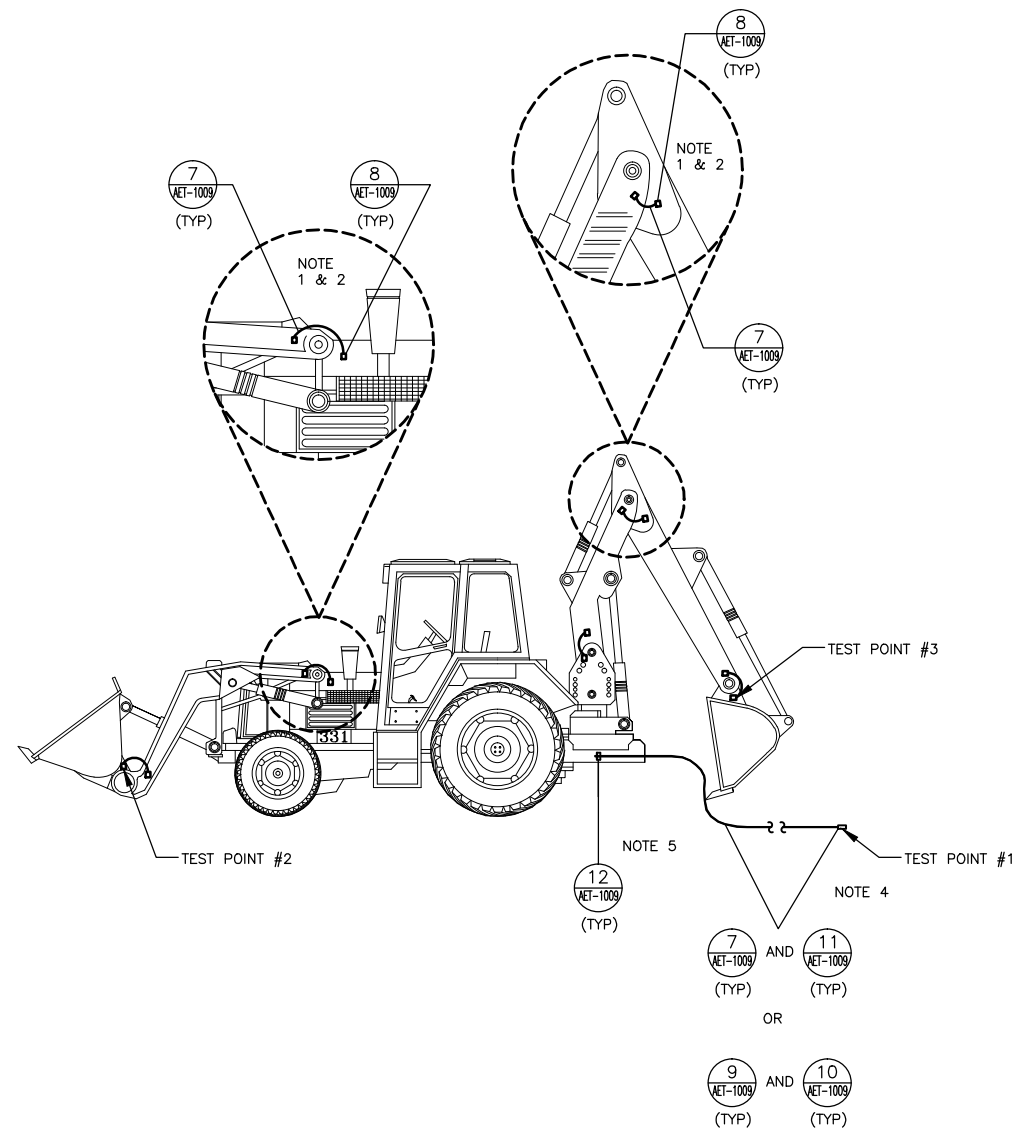
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NOTES:

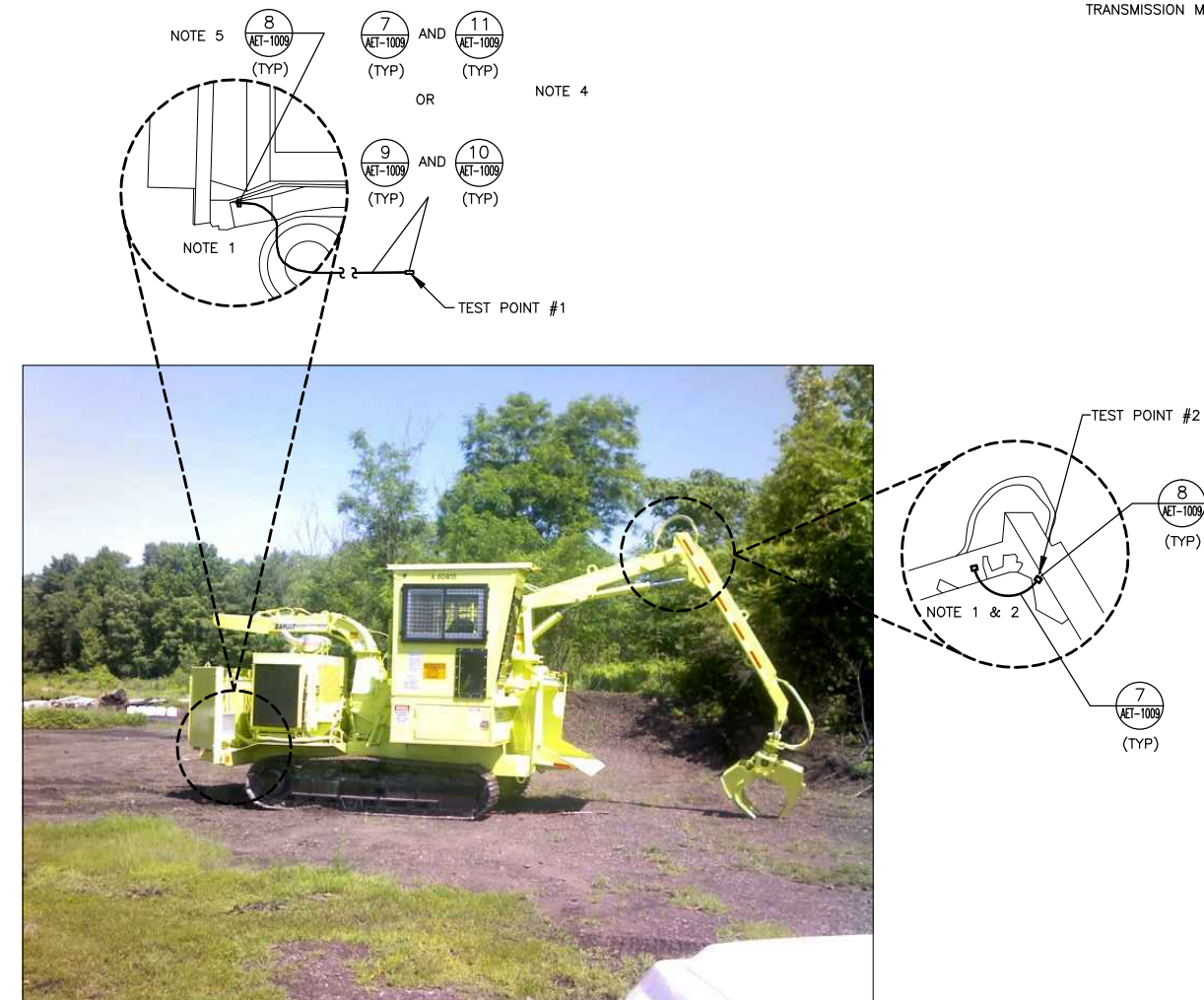
1. ALL BONDS MUST ALLOW FOR FULL EXTENSION OF EQUIPMENT AND SHALL NOT PINCH OR OTHERWISE INTERFERE.
2. BONDS REQUIRED FOR ALL EXTENSIONS CAPABLE OF HEIGHTS OF 12' OR MORE.
3. GROUNDING CONDUCTOR SHALL BE ATTACHED TO FRAME.
4. THE GROUNDING CABLE USED DEPENDS ON WHETHER IT IS CLAMPED TO THE RAIL OR A STRUCTURE.
5. IF CONNECTION NOT POSSIBLE, USE WELDED ANGLE CONNECTION (DETAIL #8, AET-1009.)

PROCEDURE:

1. WHEN WORKING IN PROXIMITY TO ENERGIZED CONDUCTORS, WHETHER ON RAIL OR ROADWAY, GROUNDING CABLE MUST BE ATTACHED TO RAIL AND GROUNDING PAD OF TRUCK BEFORE OPERATING BOOM.
2. THREE FOOT CLEARANCE TO ENERGIZED CATENARY AND SIGNAL POWER AND FIFTEEN FOOT CLEARANCE TO TRANSMISSION MUST BE MAINTAINED AT ALL TIMES.



1 TYPICAL BACKHOE GROUNDING
SCALE: NONE



2 TYPICAL TREE GRINDER (BANDIT)
SCALE: NONE

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National Railroad Passenger Corporation
30TH Street Station, Philadelphia, Pennsylvania 19104

Approved	Date
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Director Electric Traction & Standards	
Sig: _____	
Sig: _____	

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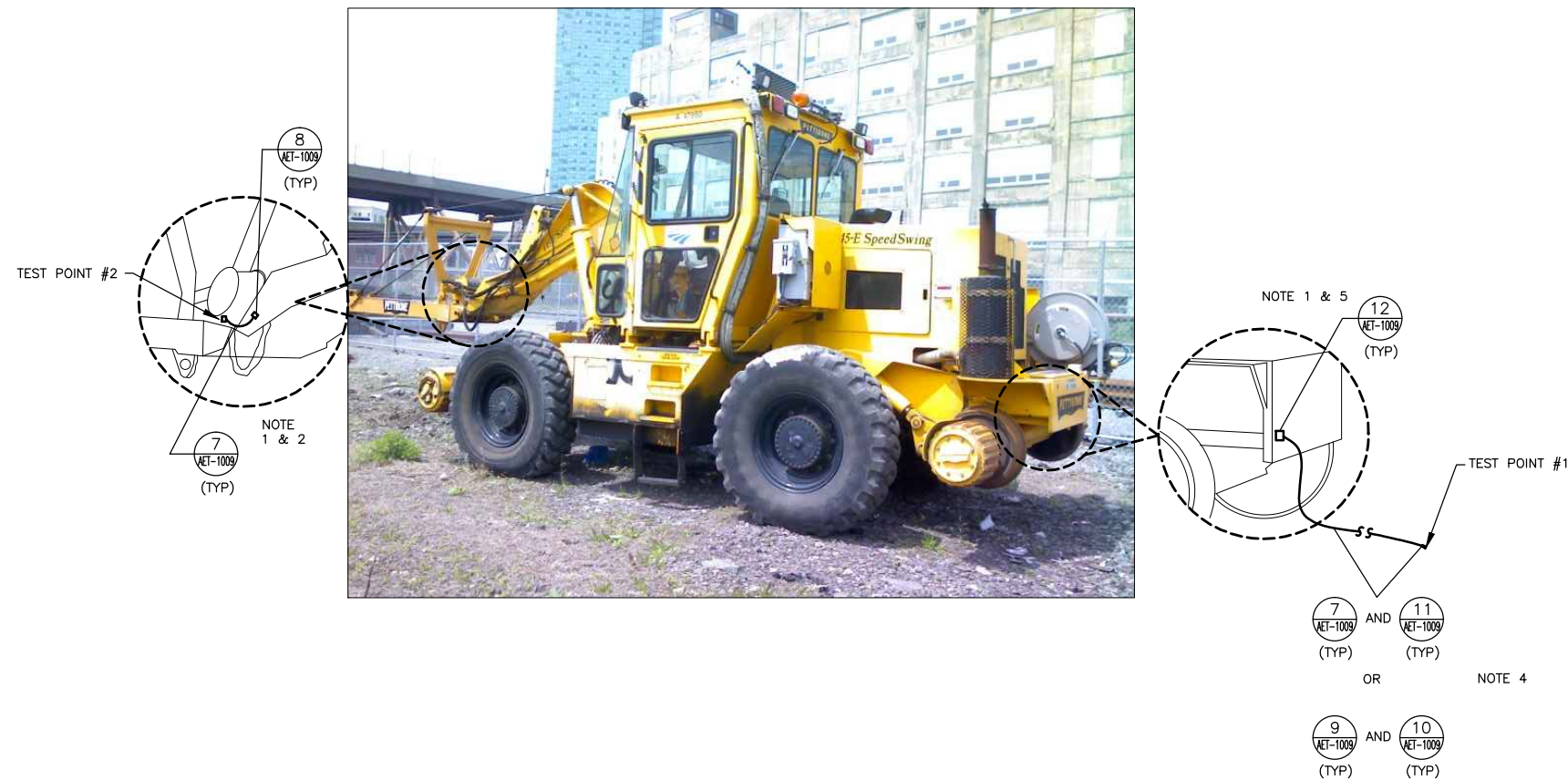
ELECTRIFICATION STANDARDS			
VEHICLE GROUNDING BACKHOE & TREE GRINDER (BANDIT)			
Scale: NTS	Drawn: CBS	Checked: -	Date: 3/20/13
File No:	Design No:	Sheet No:	Dwg. No. AET-1005

NOTES:

1. ALL BONDS MUST ALLOW FOR FULL EXTENSION OF EQUIPMENT AND SHALL NOT PINCH OR OTHERWISE INTERFERE.
2. BONDS REQUIRED FOR ALL EXTENSIONS CAPABLE OF HEIGHTS OF 12' OR MORE.
3. GROUNDING CONDUCTOR SHALL BE ATTACHED TO FRAME.
4. THE GROUNDING CABLE USED DEPENDS ON WHETHER IT IS CLAMPED TO THE RAIL OR A STRUCTURE.
5. IF CONNECTION NOT POSSIBLE, USE WELDED ANGLE CONNECTION (DETAIL #8, AET-1009.)

PROCEDURE:

1. WHEN WORKING IN PROXIMITY TO ENERGIZED CONDUCTORS, WHETHER ON RAIL OR ROADWAY, GROUNDING CABLE MUST BE ATTACHED TO RAIL AND GROUNDING PAD OF TRUCK BEFORE OPERATING BOOM.
2. THREE FOOT CLEARANCE TO ENERGIZED CATENARY AND SIGNAL POWER AND FIFTEEN FOOT CLEARANCE TO TRANSMISSION MUST BE MAINTAINED AT ALL TIMES.



1 TYPICAL SPEED SWING
SCALE: NONE

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ELECTRIFICATION STANDARDS

**VEHICLE GROUNDING
SPEED SWING**

Scale: NTS Drawn: CBS Checked: - Date: 3/20/13

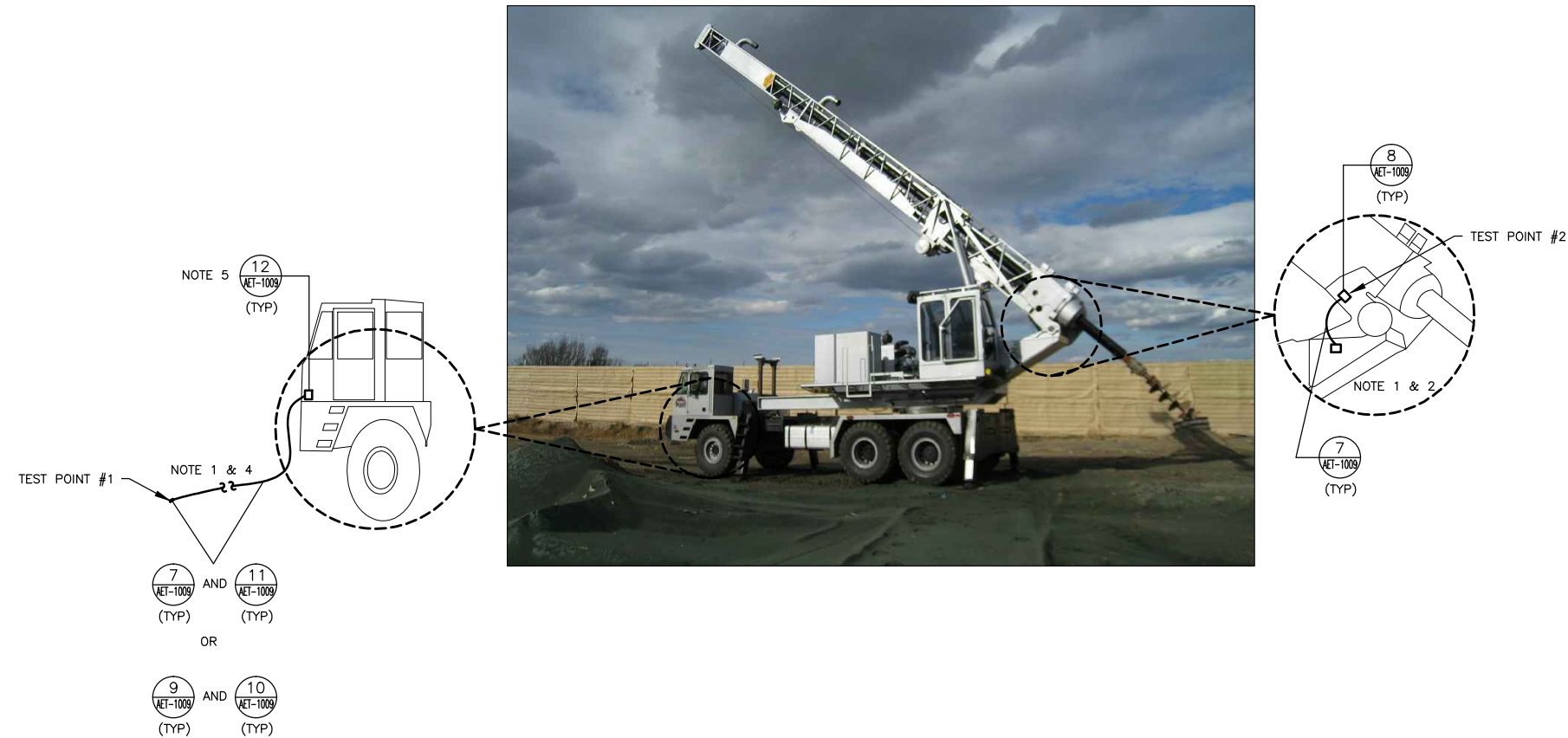
File No:	
Design No:	
Sheet No.:	
Drawn:	AET-1006

NOTES:

1. ALL BONDS MUST ALLOW FOR FULL EXTENSION OF EQUIPMENT AND SHALL NOT PINCH OR OTHERWISE INTERFERE.
2. BONDS REQUIRED FOR ALL EXTENSIONS CAPABLE OF HEIGHTS OF 12' OR MORE.
3. GROUNDING CONDUCTOR SHALL BE ATTACHED TO FRAME.
4. THE GROUNDING CABLE USED DEPENDS ON WHETHER IT IS CLAMPED TO THE RAIL OR A STRUCTURE.
5. IF CONNECTION NOT POSSIBLE, USE WELDED ANGLE CONNECTION (DETAIL #8, AET-1009.)

PROCEDURE:

1. WHEN WORKING IN PROXIMITY TO ENERGIZED CONDUCTORS, WHETHER ON RAIL OR ROADWAY, GROUNDING CABLE MUST BE ATTACHED TO RAIL AND GROUNDING PAD OF TRUCK BEFORE OPERATING BOOM.
2. THREE FOOT CLEARANCE TO ENERGIZED CATENARY AND SIGNAL POWER AND FIFTEEN FOOT CLEARANCE TO TRANSMISSION MUST BE MAINTAINED AT ALL TIMES.



1 TYPICAL DRILL RIG/CANISTER INSTALLATION
SCALE: NONE

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ELECTRIFICATION STANDARDS
VEHICLE GROUNDING
DRILL RIG/CANISTER INSTALLATION

Scale: NTS Drawn: CBS Checked: - Date: 3/20/13

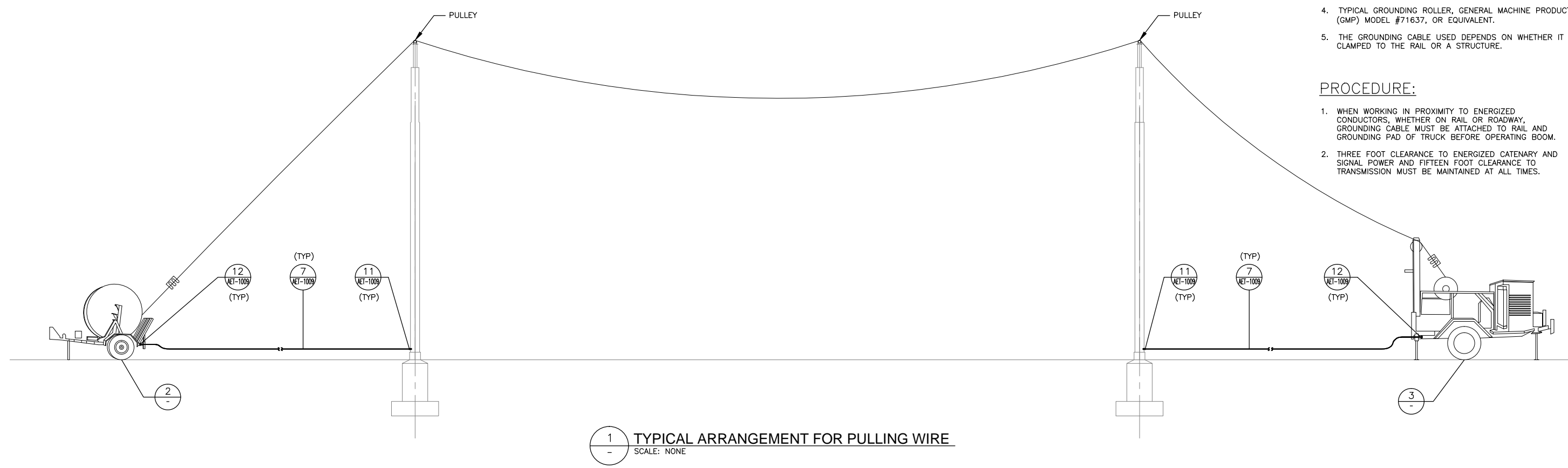
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Sheet No.:	
Drawn:	AET-1007

NOTES:

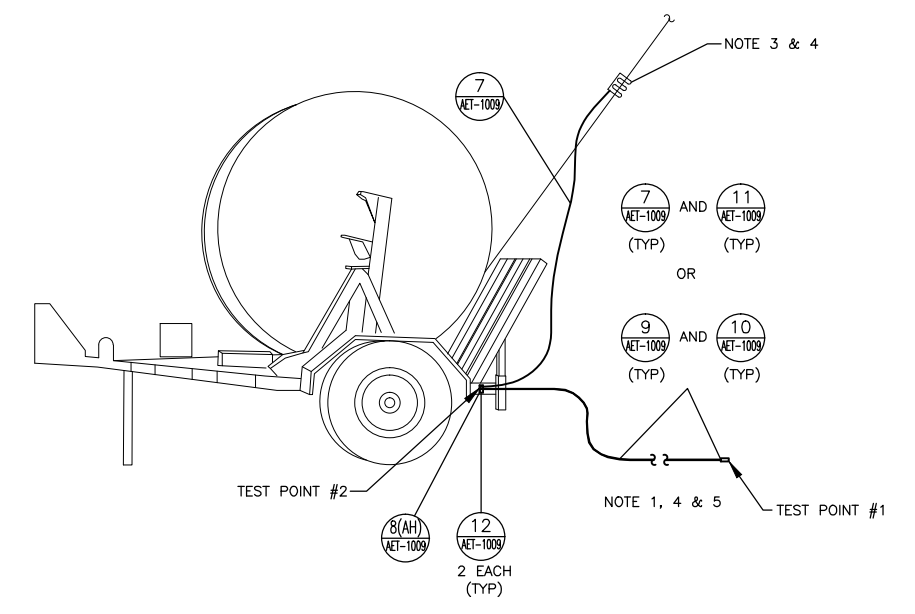
1. ALL BONDS MUST ALLOW FOR FULL EXTENSION OF EQUIPMENT AND SHALL NOT PINCH OR OTHERWISE INTERFERE.
2. BONDS REQUIRED FOR ALL EXTENSIONS CAPABLE OF HEIGHTS OF 12' OR MORE.
3. ROLLING GROUND NEEDED FOR STEEL PULL LINE & BARE CONDUCTORS ONLY. NOT NEEDED FOR NYLON PULL LINE.
4. TYPICAL GROUNDING ROLLER, GENERAL MACHINE PRODUCTS (GMP) MODEL #71637, OR EQUIVALENT.
5. THE GROUNDING CABLE USED DEPENDS ON WHETHER IT IS CLAMPED TO THE RAIL OR A STRUCTURE.

PROCEDURE:

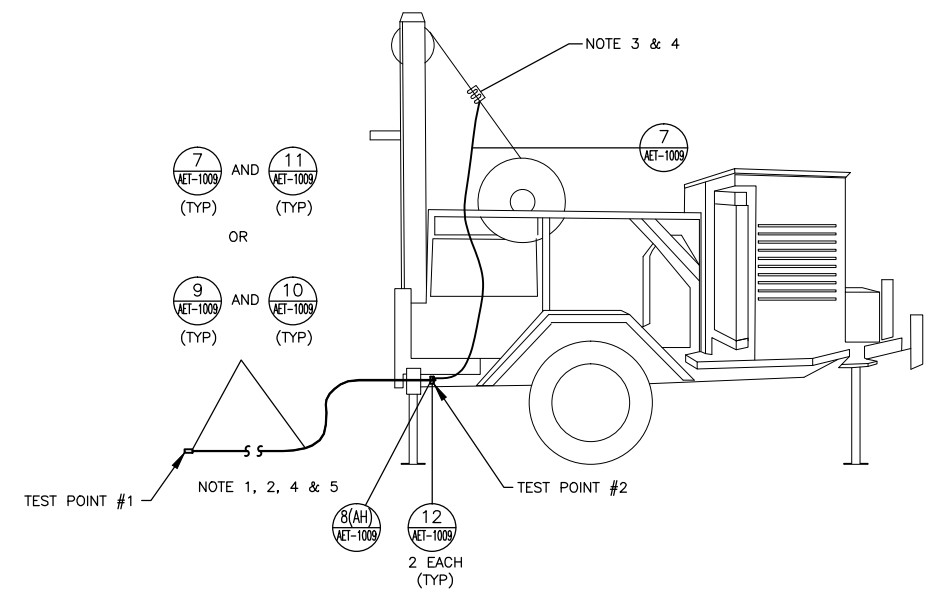
1. WHEN WORKING IN PROXIMITY TO ENERGIZED CONDUCTORS, WHETHER ON RAIL OR ROADWAY, GROUNDING CABLE MUST BE ATTACHED TO RAIL AND GROUNDING PAD OF TRUCK BEFORE OPERATING BOOM.
2. THREE FOOT CLEARANCE TO ENERGIZED CATENARY AND SIGNAL POWER AND FIFTEEN FOOT CLEARANCE TO TRANSMISSION MUST BE MAINTAINED AT ALL TIMES.



1 TYPICAL ARRANGEMENT FOR PULLING WIRE
SCALE: NONE



2 TYPICAL WIRE TRAILER
SCALE: NONE



3 TYPICAL PULLING TRAILER
SCALE: NONE

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ELECTRIFICATION STANDARDS			
VEHICLE GROUNDING WIRE TRAILER & GROUND WHEN PULLING WIRE			
Scale: NTS	Drawn: CBS	Checked: -	Date: 3/20/13
File No:	Design No:	Sheet No:	Drawn: AET-1008

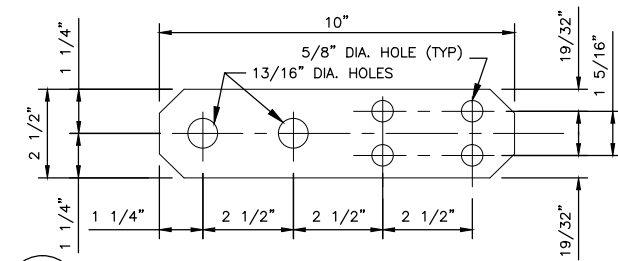
NOTES:

1. REEL SYSTEM MAY BE USED, CABLE MUST BE FULLY EXTENDED PRIOR TO MAKING CONNECTIONS.
2. SEE TYPICAL CONNECTIONS ON THIS SHEET.

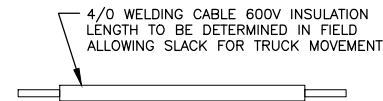
APPLICATION	PERMANENT OR TEMPORARY	TYPICAL GROUNDING EQUIPMENT APPLICATION			COMMENTS
		RETURN	VEHICLES	CABLES	
CRANE - FRAME TO FLAT CAR	P	#13	#13	#4	25'
CRANE - BOOM TO FRAME	P	#8	#8	#7	5'
ELECTRIFIED TERRITORY:					
VEHICLE TO OCS STRUCTURE	T	#11	#8 OR #12	#7	50', NOTE 1
VEHICLE TO RUNNING RAIL	T	#10	#8 OR #12	#9	50', NOTE 1
NON ELECTRIFIED TERRITORY:					
VEHICLE TO RUNNING RAIL	T	#10	#12	#9	50', NOTE 1

NOTES:

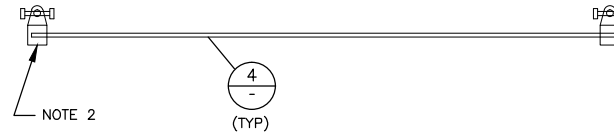
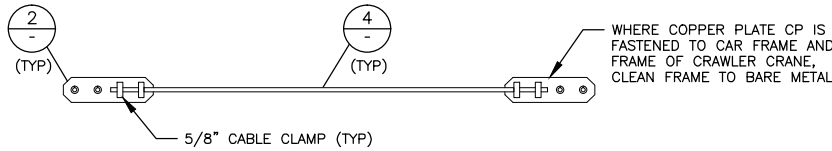
- 1) IN ELECTRIFIED TERRITORY, CABLE CANNOT EXCEED 175'. IN NON-ELECTRIFIED TERRITORY CABLE LENGTH CANNOT EXCEED 200'. TYPICAL LENGTH IS 50'.
- 2) ALL CABLE LENGTHS SUBJECT TO SPECIFIC EQUIPMENT ADJUSTMENTS.



2 - **DETAIL OF CABLE END PLATE**
2 1/2" x 1 1/2" x 10" H.D. COPPER - TINNED



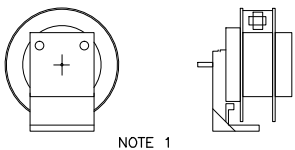
4 - **CABLE FOR GROUNDING DETAIL**
1 - 4/0 GROUNDING CABLE - HASTINGS CAT #9228, AMT #4401520003



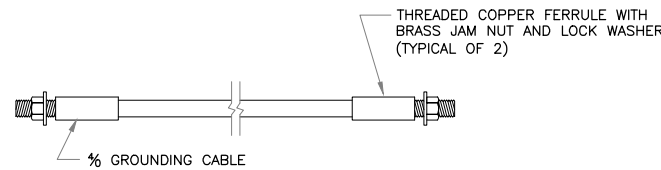
3 - **CABLES FOR GROUNDING CRAWLER CRANE MOUNTED ON FLAT CAR**

5 - **CABLES FOR GROUNDING ROADWAY MACHINES**

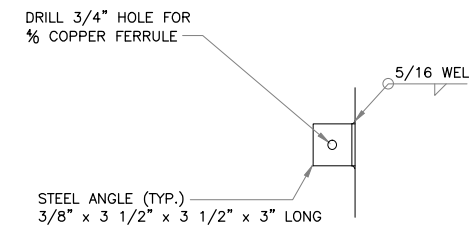
1 - **TYPICAL GROUNDING EQUIPMENT APPLICATION CHART**



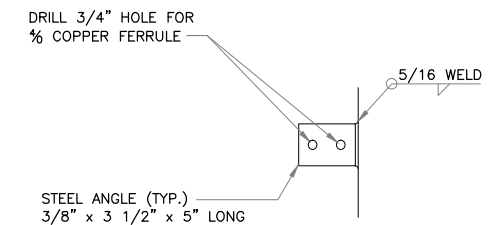
6 - **REEL ASSEMBLY DETAIL**
1 - REEL ASSEMBLY - HASTINGS #21366, SAP#500002735
1 - RAIL GROUND CLAMP - SAFETY LINE, INC #75675475, AMT #44015520013
1 - COPPER FERRULE (THREADED) - HASTINGS #13001, P50349, AMT #4444457053



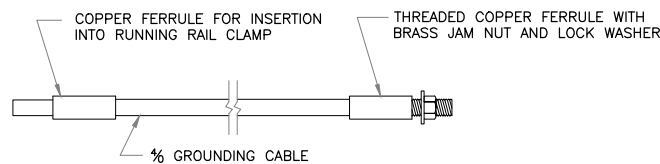
7 - **GROUNDING CABLE DETAIL**
2 - COPPER FERRULE (THREADED) - HASTINGS #13001, P50349, AMT #4444457053
1 - 1/2" GROUNDING CABLE (LENGTH AS NEEDED)



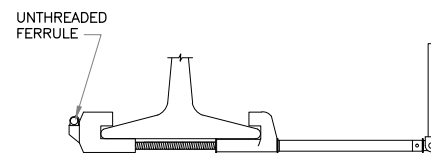
8 - **TYPICAL WELDED CONNECTION DETAILS**



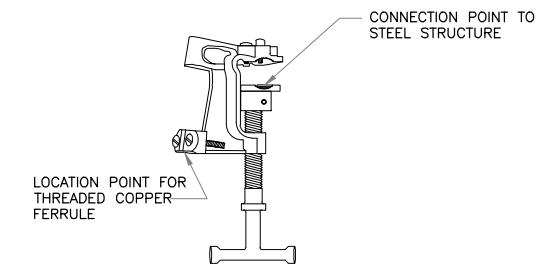
8(AH) - **TYPICAL WELDED CONNECTION DETAILS**



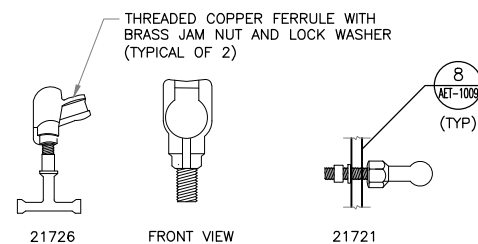
9 - **GROUNDING CABLE DETAIL**
1 - COPPER FERRULE (BOLTED) - HASTINGS #P30247, P50349, AMT #4444457054
1 - COPPER FERRULE (THREADED) - HASTINGS #13001, P50349, AMT #4444457053
50' - 1/2" GROUNDING CABLE (APPLICATION TABLE NOTE 1)



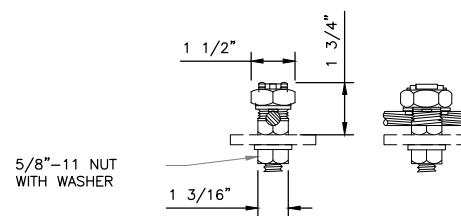
10 - **RUNNING RAIL CLAMP DETAIL**
1 - RAIL TYPE GROUND CLAMP - SAFETY LINE, INC #75675475, AMT #4401520013
1 - COPPER FERRULE (BOLTED) - HASTINGS #P30247, P50349, AMT #4444457054



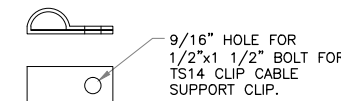
11 - **STRUCTURE CLAMP WITH TEE HANDLE DETAIL**
1 - FLAT FACE GROUND CLAMP - WHITE RUBBER #760CM3ET, AMT #4401520024
1 - COPPER FERRULE (THREADED) - HASTINGS #13001, P50349, AMT #4444457053



12 - **BALL SOCKET GROUND CLAMP & BALL STUD DETAILS**
1 - BALL SOCKET GROUND CLAMP - HASTINGS 21726, SAP#500002736
1 - BALL STUD - HASTINGS 21721, SAP#500002734
1 - COPPER FERRULE (THREADED) - HASTINGS #13001, P50349, AMT #4444457053



13 - **MECHANICAL GROUNDING CONNECTOR**
1 - MECHANICAL GROUNDING CONNECTOR - BURNDY KC28, AMT #4445405201



14 - **TYPICAL GROUNDING CLIP**

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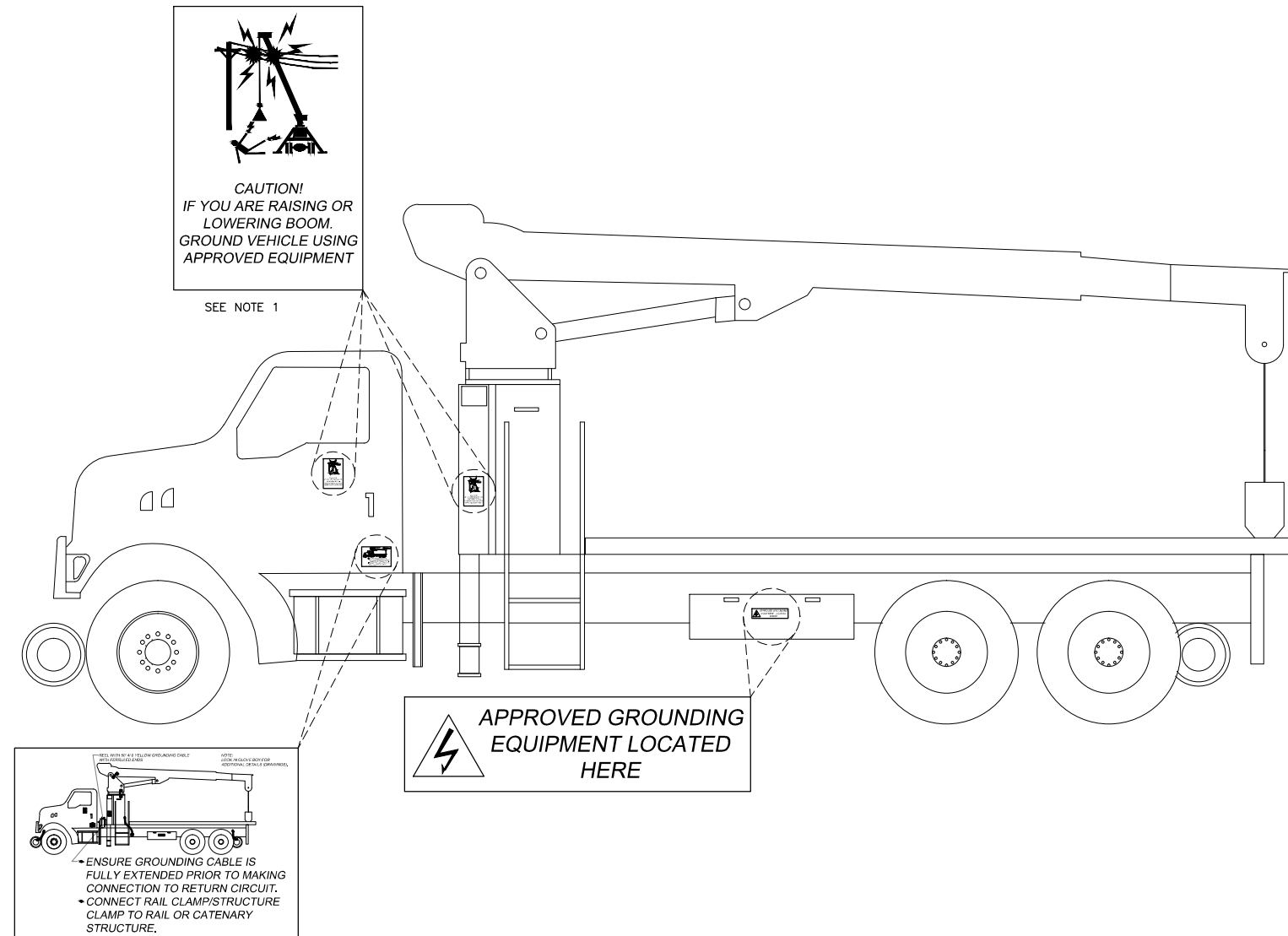
TYPICAL CONNECTION DETAILS

Scale: NTS Drawn: CBS Checked: - Date: 3/20/13

File No:	
Design No:	
Sheet No:	
Drawn:	AET-1009

GENERAL NOTES:

1. PROVIDE ANSI GREEN AND BLACK SIGNS ON DRIVER AND PASSENGER DOORS OF VEHICLE AND BOTH SIDES OF VEHICLE EQUIPMENT.



1 TYPICAL VEHICLE SIGNAGE

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VEHICLE GROUNDING
TYPICAL SIGNAGE

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Sheet No.:	
Dwg. No.:	AET-1010