

	GROUNDING AND BONDING FOR OIL & GAS DRILLING OR SERVICING OPERATIONS ALL-HSE-PRC-633	Retention Code: CG01 - CA
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Owner: WCBU Electrical Engineer	Approved By: HSE Manager, Capital Projects	Review Frequency: Five years or less
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1.0 Purpose

This document applies to the selection and installation of grounding and bonding equipment used within the ConocoPhillips Canada business unit for drilling and well servicing operations.

The objective of this procedure is to:

- Inform the user of standards and regulations impacting grounding and bonding for drilling or well servicing operations.
- Provide practical design considerations when applying grounding and bonding for drilling or well servicing operations.

2.0 Hazards to Mitigate

Hazards include, but are not limited to:

- Shock/electrocution.
- Arc flash/extreme heat.

3.0 Procedure-Specific Roles and Responsibilities

3.1. Well Site Supervisor

- Ensure grounding of all structures, tanks and other equipment in accordance with this document.

3.2. Contractors

- Ground all structures, tanks and other equipment in accordance with this document.
- Conduct resistance testing on flexible braided hoses and retain records at each field site.

4.0 Procedure

Grounding and bonding are used to mitigate the potential of static or stray current in hazardous locations such as drilling, completions or well servicing operations. Grounding and bonding function by providing a low impedance path for current to flow in the event of abnormal conditions or dissipation of static electricity.

4.1. General

For this to operate correctly, all structures, tanks, vehicles, power swivels, and other equipment must be interconnected via dedicated low impedance structures or bonding conductors.

The following interpretations apply:

- Follow requirements in the Electrical STANDATA CEC-10 (revision 8).
 - Found at <http://www.municipalaffairs.alberta.ca/documents/ss/STANDATA/electrical/454-CEC-10-rev8.pdf>.
- The grounding electrode must consist of either:
 - two (2) ground rods $\frac{3}{4}$ " x 10' spaced 3 m apart and driven to a minimum depth of 8', or
 - two (2) commercially manufactured ground plates spaced 3 m apart and buried to a depth of 600 mm, or

- as identified in sections 4.2 to 4.5 for specific operations.
- All equipment and structures on site must be interconnected by an approved bonding conductor minimum #4 American Wire Gauge (AWG).
- The grounding conductor (see Typical Layout #1 or Typical Layout #2 in STANDATA CEC-10 Rev 8) must be sized per rules 10-204 to 10-206 (see Table 16 and Rule 204(2)(b)) in the Canadian Electrical Code (CEC) but in no case be smaller than #2 AWG for mechanical protection.
- Light Plants/Towers must be connected into any ground system based on which system is close by. If no ground system is close by then a ground rod must be driven for the light plant. The ground rod must be $\frac{3}{4}$ " x 10' and driven to minimum 8' depth.
- Flexible braided hose may be used in lieu of a dedicated bonding conductor in certain circumstances. As there is no Canadian Standards Association (CSA) standard available which deals with the bonding properties of these braided hoses, this low impedance path must be verified by measurement after installation at location.
 - Ground resistance testing must be completed on these braided hoses via the Werner method and have a resistance of less than 1 ohm to the wellhead or rig anchor. This must be documented at each location.
- Grounding connections used to connect to the ground electrode (e.g. wellhead casing, conductor barrel, or rig anchor) must be in good condition and attach tightly to the ground electrode.
- Spring-type clamps are not-acceptable; screw-type connections are required on ConocoPhillips locations. Connections to the ground electrode must be clean and free of paint, dirt and grease.
- Spring enabled cable clamps may only be used for truck loading and unloading operations and only when clean and in good repair.
- Grounding and bonding conductors must be copper.

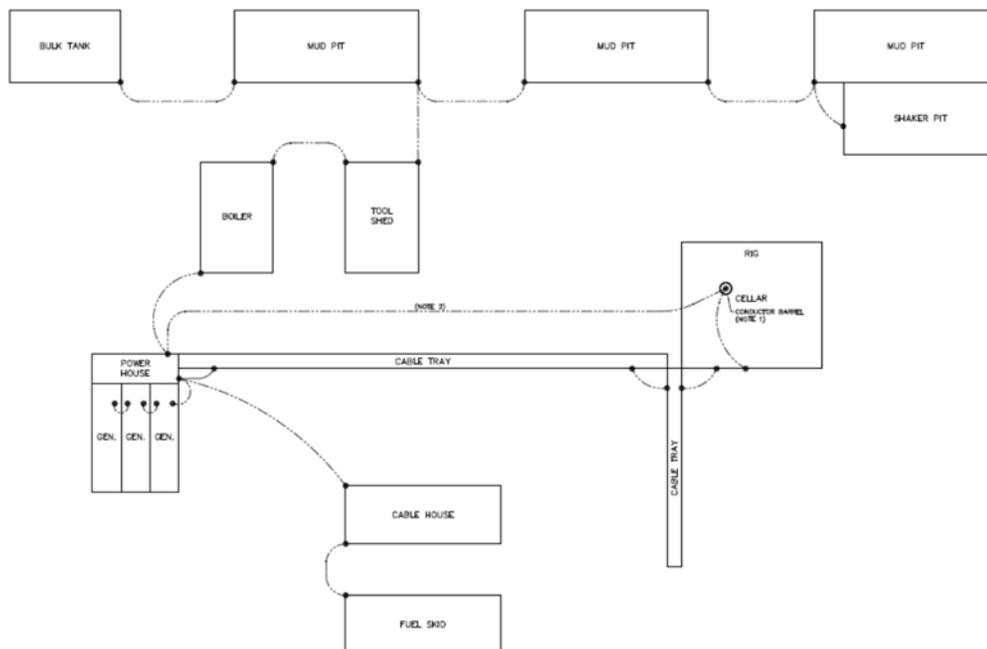
4.2. Drilling Operations – Specific Interpretations

All interpretations under 4.1 above, apply to drilling operations. The following are additional clarifications required for drilling operations:

- Ground electrodes for drilling operations can be either as identified in section 4.1 or in lieu of those requirements; the conductor barrel may be utilized. If the conductor barrel is to be utilized, ensure the cellar steel is also connected. Consider using a 2-hole lug to connect the ground cable to the conductor barrel.



- All conductive equipment such as skids, sheds, boilers, tanks, pits, catwalks, etc., must be bonded together with a #4 AWG insulated conductor.



Note 1: Sketch shows conductor barrel as ground electrode, refer to 7.1 (b) above for other suitable ground electrodes.

Note 2: Ground conductor sized per CEC 10-204

4.3. Completions Operations – Specific Interpretations

All interpretations under 4.1 above, apply to completions operations. The following are additional clarifications required for completions operations:

- If the conductor barrel has been used as the ground electrode for the drilling operations and is available to the completions operation, the conductor barrel may be utilized. Alternatively, the wellhead casing may be used as the ground electrode.

- All conductive equipment such as skids, sheds, boilers, flow back tanks, pumping units, pits, catwalks, etc., must be bonded together with a #4 AWG insulated conductor.
- 'C' ring water storage is considered inherently grounded via the water pumping goose neck which is located in the lowest section of the 'C' ring.
- Based on a 2015 risk assessment, HP pumping units with non-flammable fluids are considered grounded against static via the hammer unions which connect the units to the wellhead.
 - Refer to the study for full details.
- Completions operations use a large number of fresh water tanks for some completions operations. Best practice is to connect these to the ground system. If this is not possible due to tank loading traffic and routing of the ground conductors it is possible to not interconnect these fresh water tanks to the ground system under the following conditions:
 - There can be no situations where flow back can occur to the fresh water tank system,
 - The freshwater tank system must be 7.5 m away from any hydrocarbon source.

4.4. Well Servicing Operations – Specific Interpretations

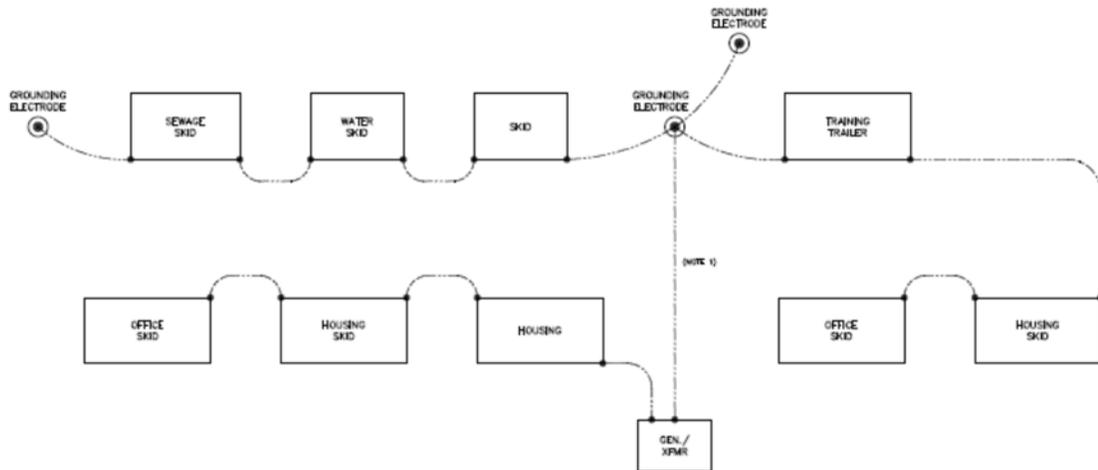
All interpretations under 4.1 apply to completions operations. The following are additional clarifications required for completions operations:

- If the conductor barrel has been used as the ground electrode for the drilling operations and is available to the well servicing operation, the conductor barrel may be utilized. Alternatively, the wellhead casing may be used as the ground electrode.
- Wellhead casings of adjacent wells on multi-well pads may be used as a ground electrode. Care must be taken to ensure all equipment is bonded to the same wellhead casing.

4.5. Camp & Consultant Trailers – Specific Interpretations

Grounding of camp/consultant trailers can be accomplished via 4.1 above or interconnected to the rig/completions ground point.

- All trailers are to be connected together by a #4 AWG green insulated bonding conductor to form an equipotential (everything interconnected) plane. Conductors to be routed to minimize interference with personnel.
 - Exception: RV towable consultant trailers (fiberglass) are considered bonded by the bonding conductor supplied with the RV power system.



Note 1: Ground conductor sized per CEC 10-204.

5.0 References

- Alberta Occupational Health & Safety Code Part 10
- Saskatchewan Occupational Health & Safety Regulations
- British Columbia Occupational Health & Safety Regulations
- Canadian Electrical Code – Latest Edition

6.0 Document Retention

Records must be retained in accordance with ConocoPhillips' Document Retention Schedule.

Record	Owner	Classification	Retention
Ground resistance testing results	Contractor	N/A	As per contractor's requirements

Appendix A – Definitions

Terms that are important to understanding this procedure are defined below:

Bonding	A low impedance path obtained by permanently joining all non-current-carrying metal parts to ensure electrical continuity and having the capacity to conduct safely any current likely to be imposed on it.
Drilling Operations	Drilling operations are used to construct a well bore. Major components of a drilling operation include the drilling rig, mud tanks, draw works, rotary table, drill string, boiler and power generators.
Grounding	A permanent and continuous conductive path to the earth with sufficient ampacity to carry any fault current liable to be imposed on it, and of a sufficiently low impedance to limit the voltage rise above ground and to facilitate the operation of the protective devices in the circuit.
Static and Stray Current Discharge	A release of static electricity in the form of a spark, corona discharge, brush discharge, or propagating brush discharge that might be capable of causing ignition under appropriate circumstances.
Well Servicing Operations	Well servicing operations are any operations which utilize equipment to enter a well bore. General equipment utilized are service rigs and equipment for rigless operations (slickline, swabbing, well testing, fracing, etc.).

Appendix B – Revision Record

Page#	December 21, 2015	Previous Information	Change Assessment
4	Addition of Specific Interpretations for completions	None	Based on 2015 Risk Assessment conducted. Low – Clarifies specific requirements. 'C' ring grounding requirements and HP Non Flammable Frac grounding requirements.