



Safety Measures ^{ELECTRICAL}

“Elimination is the first priority!
Ensure a risk assessment is completed before energized work tasks are completed.”

Arc Flash & Shock Hazards: EVs & Renewable Power Generation

By Terry Becker, P.Eng., CESC, IEEE Senior Member

Renewable power generation and electrical vehicles are not new technology, and have been adopted in Canada, the United States and globally for decades. With respect to wind turbine power generation Canada has a strong installed base with some accelerated development in recent years. Large scale solar power generation development (e.g. 10MW, 20MW or larger) has lagged wind turbine based power generation, but has accelerated in the last 3 to 5 years.

According to Natural Resources Canada, besides wind and solar power generation development growth, development of other renewable power generation such as hydro, solid biomass, ethanol, renewable municipal waste/landfill gas, biodiesel, and tidal has also accelerated in the last fifteen to twenty years.

Additionally, technological development and competition in electrical vehicles and battery technology has resulted in lower prices and greater range. This has resulted in accelerated growth in adoption of electrical vehicles. Continued specific technological developments in large commercial electrical vehicles has also evolved (e.g. eBus, eTruck, eHeavy Equipment Vehicles, etc.).

The CSA Z462 Workplace electrical safety Standard will publish its 5th Edition in January 2021 and has been adopted across Canada by industrial, commercial and institutional business sectors as the industry best practice for development and implementation of policies, practices and procedural requirements for electrical safety and the effective management of arc

flash and shock hazards. The CSA Z462 Workplace electrical safety Standard is work task based and risk assessment based and in the 2021 Edition will apply to electrical equipment with a voltage greater than 30V ac or 60V dc (CSA Z462, 2021 Edition, Clause 4.1.6.2.3). The adoption and application of CSA Z462 to renewable energy power generation and electric vehicles would be considered good due diligence to applicable Federal, Provincial or Territorial Occupational Health & Safety Regulations.

Renewable energy power generation is produced at both ac and dc voltages that will be greater than 30V ac or 60V dc. As defined by the Canadian Electrical Code, CE Code Part I for ac and dc both low voltage ($\leq 750V$ ac) and high voltage ($\geq 751V$ ac) power generation will occur. Solar power generation and electric vehicles will have dc voltages that will be high voltage. There is significant electric shock and arc flash hazard exposure related to isolation and any diagnostics/troubleshooting work tasks related to renewable energy power generation and electric vehicles.

As mentioned above the CSA Z462 Workplace electrical safety standard is work task based with specific defined work task descriptions in CSA Z462 Table 2 for both ac and dc electrical equipment. The table below highlights some of the work tasks that would be performed related to construction/commissioning, operation and maintenance of renewable power generation and electric vehicles.

Energized Work Tasks Applicable to Renewable Power Generation and Electric Vehicles

1	For ac systems, work on energized electrical conductors and circuit parts, including electrical testing.
2	Operation of a circuit breaker or switch that is not in a normal equipment condition.
3	For dc systems, working on energized electrical conductors and circuit parts of series-connected battery cells, including electrical testing.
4	Opening hinged door(s) or cover(s) or removal of bolted covers (to expose bare, energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.
5	Working on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V.
6	Insertion or removal (racking) of circuit breakers or starters from cubicles, doors open or closed.
7	Insertion or removal of connector covers or battery intercell connector(s).
8	For dc systems, working on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a DC source.
9	Operation of a circuit breaker, switch, contactor or starter.
10	Voltage testing on individual battery cells or individual multi-cell units.
11	Removal of battery nonconductive intercell connector covers.
12	Maintenance and testing on individual battery cells or individual multi-cell units in an open rack.
13	Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.

Note: Work tasks listed are excerpted from CSA Z462 Table 2 Estimate of the likelihood of occurrence of an arc flash incident for ac and dc systems.

For renewable energy power generation during construction related to commissioning the power distribution system and balance of plant electrical loads Qualified Electrical Workers will be exposed to the electrical hazards of arc flash & shock.

Following commissioning ongoing operation and electrical equipment maintenance may also expose both operations and maintenance employees or contractors to the electrical hazards of arc flash and shock. Renewable power generation also includes the construction of additional overhead power lines both distribution and transmission with related outdoor high voltage substations, this energized electrical equipment poses a significant shock and electrocution hazard.

Electric Vehicles

With respect to electric vehicles the initial offerings of hybrids and pure electric vehicles has also evolved and significant new technology and competitors are coming to the market. Evolution and technology development in Canada will see large commercial vehicle development as rebuilds or retrofits, for example diesel buses converted to “eBuses.” The larger commercial electric vehicle also comes with higher dc voltage electrical equipment (650V dc or higher) and larger capacity battery packs.

How Can CSA Z462 Be Applied?

As noted above the CSA Z462 Workplace electrical safety Standard is work task based. The next consideration is the voltage of the electrical equipment the work task will be completed on and the condition of maintenance of the electrical equipment. CSA Z462 requires a risk assessment procedure to be implemented for defined “Jobs” that would include the execution of a single or multiple work tasks. Two separate risk assessments are completed underneath the Job’s risk assessment procedure for each work task, a shock risk assessment and arc flash risk assessment.

Based on the work tasks listed in the table, the construction/commissioning, operation and maintenance of renewable energy power generation and electric vehicles requires effective hazard identification and risk assessments to be completed for “Jobs” that may include the work tasks listed.

In summary the requirements of the CSA Z462 Workplace electrical safety Standard do apply to energized electrical equipment related to renewable power generation and electric vehicles.



Terry Becker, P.Eng, CESC, IEEE Senior Member is the first past Vice-Chair of the CSA Z462 Workplace electrical safety Standard Technical Committee and currently a Voting Member and Working Group Leader for Clause 4.1 and the Annexes. Terry is also a Voting Member on the CSA Z463 Maintenance of electrical

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