Health and Safety

Health and safety around solar photovoltaic systems is very important. In the DC circuit you will find up to 600 volts in residential and commercial systems. In utility systems you may find systems operating at close to 1,000 volts DC!

DC is very unforgiving and if you short the circuit, you may well start a fire. Most firefighting departments will not fight a solar photovoltaic fire until after sunset, due to these high voltages that are present on the system.

The DC circuit will keep producing power while it is exposed to sunlight and it is this attribute that makes the solar photovoltaic circuit a particular risk to personnel. You should be aware that the string fuses in the DC circuit will not blow under a short condition after the combiner box, due to the solar DC circuit being current limited. The fuses are there to protect against reverse current flow into the string circuit that could damage the solar modules.

You will commonly find yourself working on live systems and you should be taking the following precautions:

The top hazards in solar photovoltaics are:

- Falls.
Use of undersized and incorrect electrical equipment.
- Shocks and electrocution.
- Fire and arc flash.
- Excessive electromagnetic interference (EMI) exposure.

Regarding electromagnetic interference (EMI) exposure, this can cause Radio Wave Sickness (RWS) or Electromagnetic Hypersensitivity (EHS). The symptoms to look for are:

- Forgetfulness.
- Irregular heartbeats.
- Fatigue.
- Intoxication symptoms.
- Aggression.
- Anxiety.
- Seemingly random aches and pains.
- Arthritis symptoms, particularly in knees.
- Intestinal pains.
- Diarrhea.
- Headaches.
- Increased sexual desire.

If you start to show these symptoms, you should remove yourself from the solar field. You should attempt to
identify the equipment that is causing the human health problems and establish if it is faulty. As equipment ages, the electromagnetic interference may increase from it. A Trifield meter and an AM radio that is tuned to static can be useful in detecting these problems.

You should be wary of using metal buildings and containers to house equipment in. These can cause very high electromagnetic interference (EMI) environments to occur and may make the personnel ill. Instead, mount all solar equipment outdoors using concrete pads and shade canopies. Try and use natural materials to construct the shade canopies. Metal roofing materials should be avoided as they act like reflectors to EMI and may increase the magnitude of it.

Do not cluster inverters together in groups, it is better to spread them out over the site on large installations. Leave at least three feet of clearance around each piece of electrical equipment for maintenance purposes.

Residential solar equipment should be mounted away from the human environment. It is preferable for electrical equipment to be mounted to the garage rather than the home. It is wise to keep the inverter out of the human environment and most definitely do not mount it on bedroom walls. If there is no suitable wall to mount it onto, then consider using micro-inverters or AC solar modules.

For roof mounted solar modules you should mount them near to the apex on a pitched roof to keep the EMI fields low in the human environment below. EMI decays with
distance. For flat roofs, consider mounting them with a few feet between the lowest edge of the module and the roof surface.

Cleaning solar modules should not be done on a system that is producing power. The EMI effects and the risk of electrocution is at its greatest during cleaning operations with water. Instead, clean systems during the night time.

The diagrams on the following pages show the EMI fields being emitted by the inverter system.
Inverter Systems and Human Health

Extended exposure to inverter systems may be harmful to human health.

Many inverters create electromagnetic fields around them. You should be wary about entering these fields.

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INVERTER ELECTROMAGNETIC INTERFERENCE (EMI)

Inverter EMI fields may be large.

Inverters produce magnetic and radio wave fields.

Electromagnetic field weakens with distance.

You should not install inverter systems in human environments.

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If you have overhead power lines, then these should be kept clear of tree growth. Arrange tree trimming in the fall, after the tree growth period ends. If growth is rapid, then you may have to trim more often. Trees growing into your power lines may lead to failures on the power system and fires.

Tree trimming is shown on the next page.
Tree Trimming

Specialized equipment is needed to trim the trees around aerial power lines. Test the lines for EMI before trimming and turn the power lines off if they are emitting significant EMI. Fix the EMI problems at the same time as trimming the trees.
You should have the following safety equipment:

- Insulated gloves.
- Insulated shoes.
- Insulated mats.
- Insulated tools.
- Hard hats.
- Eye protection (DC fuses can explode).
- Fall protection when working above 6 feet.
- Arc flash protective clothing.
- Reflective vests.
- Powder (ABC) fire extinguishers.
- First aid kit with burn treatments.
- Oscilloscope with a Fast Fourier Transform (FFT) function.
- Trifield meter.
- AM Radio.

Always tie off your ladders. Make sure that you know the layout of the roof and where weak spots such as roof skylights are. Do not step on roof skylights and roof vents and consider roping them off. Use cones and reflective tapes to mark out roof hazards that are to be avoided.

OSHA has a solar safety website at:
The following picture shows the correct site dress code.
Safety Clothing and Tools

Safety clothing and the correct tools are needed around solar photovoltaic systems. These people were trimming trees around power lines and should probably be wearing long sleeve arc flash shirts.
You should not spend time directly under power lines, as this will put you into the plasma field. Plasma is the fourth state of matter and under the power lines is an invisible flow of electrons from the lines into the ground below through capacitive coupling. It is the reason why florescent tubes will light there.

During my research into power lines producing AM radio frequencies, I noticed the reflection effect. The cell phone tower microwave signals seem to be interacting with the power lines and may be producing pockets of AM radio frequencies that can be picked up on a standard AM radio tuned to static. If you were in one of these pockets for an extended time period, you may develop Radio Wave Sickness (RWS) or Electromagnetic Hypersensitivity (EHS).

When working around power generation, distribution and transmission systems it is wise to establish the presence of the various fields and to exercise caution around them. Stay out of strong electromagnetic interference (EMI) fields as they may eventually make you sick.

The following pages demonstrate the various effects of power lines.
Power lines and poles can have many types of large fields around them. "Dirty electricity" effects may cause extensive radio wave fields.
Power Pole Metal Work

Induction effects in power pole metal work may cause sparks to jump between it which will cause radio wave emissions to occur. Defective insulators do the same.
Power lines and poles can emit plasma and ions. The high voltage causes the electrostatic attraction effect. Power lines and poles have fields that extend out from the area that set backs should be applied to, to protect human health.
Power Line and Pole Solar Interference

The power poles and lines can interfere with the solar radiation transmission when in front of the Sun.
Power Line Reflections

Power lines may cause radio and microwave reflections and interference effects to occur.
Dr. Phillip Stoddard, Professor of Biological Sciences at Florida International University, has done extensive research on power lines. He has found very significant health risks from their presence:

- The closer you live to a power line, the more likely you are to develop leukemia.
- Living in a magnetic field of 3.5 milli-gauss doubles the leukemia risk.
- Living within 0-50 meters of a power line doubles the risk of Alzheimer's Disease and presents a 1.5 increased risk of developing senile dementia.
- Burying the power lines brings the magnetic fields closer.

A common problem on buried power lines is the corrosion of the concentric neutral. The concentric neutral is the wire that you see wrapped around the outside of the utility cable that comes down the power pole. If this corrodes, then the neutral starts to become high resistance and this will cause current to increase though the ground. Basically, corrosion of the concentric neutral will electrify the surrounding ground and is clearly a human health hazard. Faulty insulation on the live conductor that causes leakage currents will have a similar effect. You should be aware of these effects when working around electrical systems and take the appropriate precautions.
In particular you should limit your time in these environments:

- Power lines.
- Power poles.
- Transformers.
- Substations.
- Switch yards.
- Power generation plants.

The areas in the vicinity of these may have large amounts of stray voltages and currents in the ground.

It is important when designing power systems that you use setbacks to prevent the electrical system from impacting both the health of the electrical workers and the people who may be around the system daily. You should consider fencing the setbacks to prevent people from inadvertently entering them.