Product Manual

Sensor

MS-80M

Secondary Standard Pyranometer with RS-485 Modbus Communication

Revision: 05/2020

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

Table of contents

1. MS-80M introduction

The MS-80M, manufactured by EKO Instruments, is an innovative, next-generation secondary standard pyranometer inspired by the combination of latest technologies and state-of-the-art thermopile sensor with an unprecedented, low zero-offset behavior; fast sensor response; Modbus RTU 485 output; and a five-year warranty and recalibration interval.

The MS-80M features a compact design with internal desiccation, single dome, isolated thermopile detector, quartz diffusor, immunity to offsets, ultra-low temperature dependency, and exceptional non-linearity characteristics. EKO instruments is the only ISO 17025 accredited pyranometer manufacturer in the world, enabling highest-quality calibration, compliant to international standards (ISO/IEC 17025/9847).

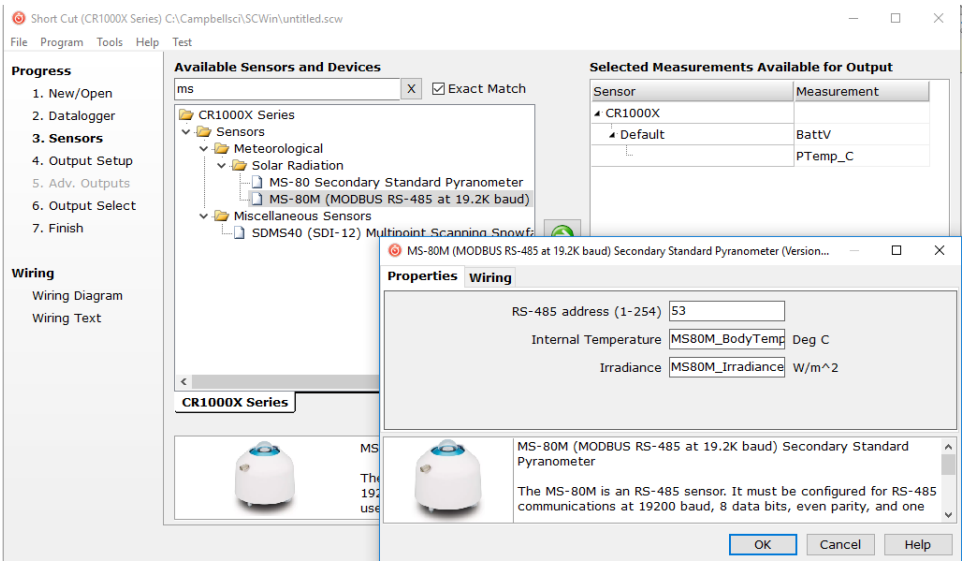
2. QuickStart

A video that describes data logger programming using Short Cut is available at: www.campbellsci.com/videos/cr1000x-datalogger-getting-started-program-part-3. Short Cut is an easy way to program your data logger to measure the sensor and assign data logger wiring terminals. Short Cut is available as a download on www.campbellsci.com. It is included in installations of LoggerNet, RTDAQ, PC400, or PC200W.

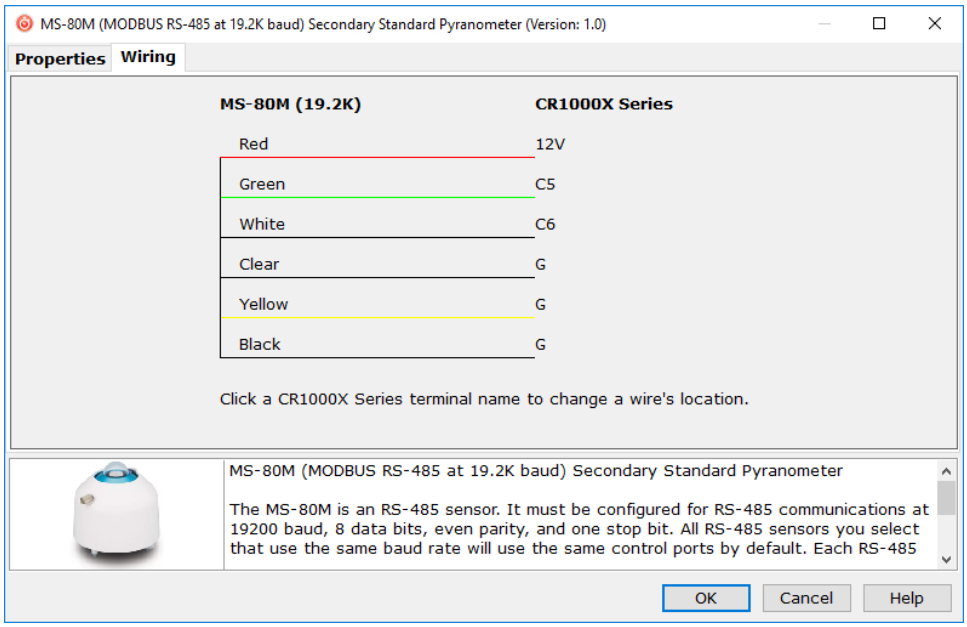
The following procedure also shows using Short Cut to program the sensor.

1. Open Short Cut and click **Create New Program**.
2. Double-click the data logger model.

3. In the **Available Sensors and Devices** box, type MS-80M or locate the sensor in the **Sensors > Meteorological > Solar Radiation** folder. Double-click the MS-80M. Type the **RS-485 address**. Default value is 53.

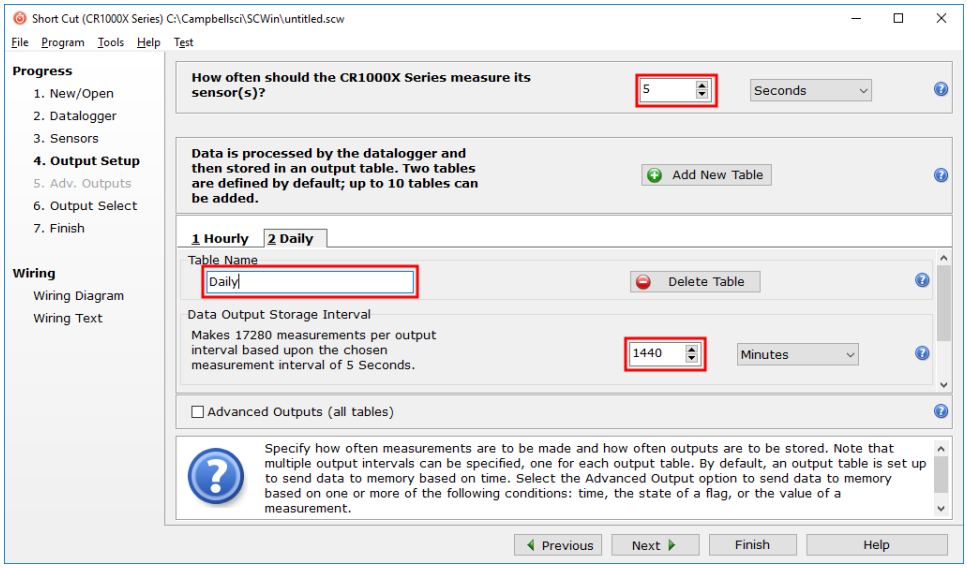


4. Click the **Wiring** tab to see how the sensor is to be wired to the data logger. Click **OK** after wiring the sensor.

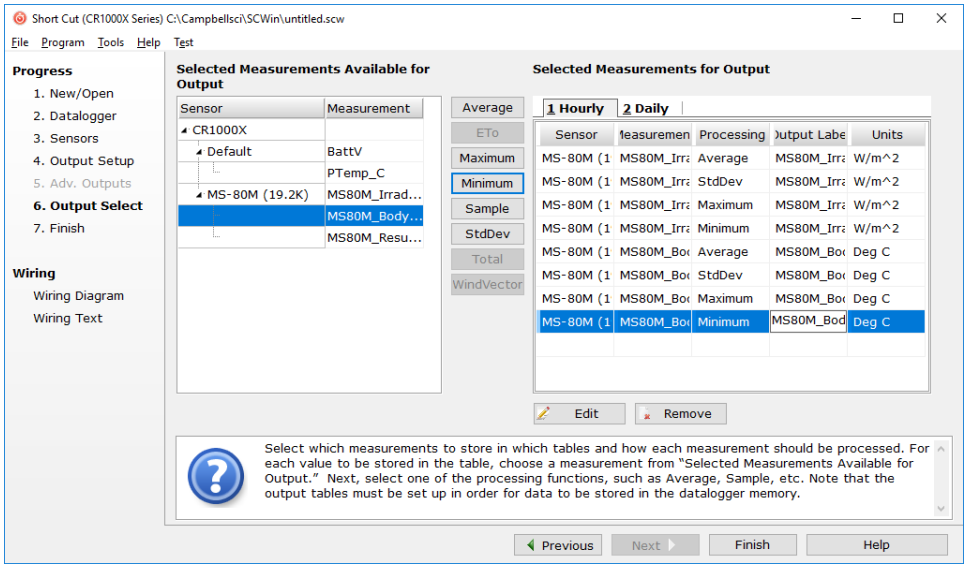


5. Repeat steps three and four for other sensors.

6. In **Output Setup**, type the scan rate, meaningful table names, and **Data Output Storage Interval**.



7. Select the measurement and its associated output option.



8. Click **Finish** and save the program. Send the program to the data logger if the data logger is connected to the computer.
9. If the sensor is connected to the data logger, check the output of the sensor in the data logger support software data display in LoggerNet, PC400, RTDAQ, or PC200W to make sure it is making reasonable measurements.

3. MS-80M specifications

ISO 9060:classification:	Secondary standard
Output:	Modbus RS-485
Default Modbus address:	53
Response time 95%:	1 s
Zero offset A:	< 1 W/m^2 (response to 200 W/m^2 net thermal radiation)
Zero offset B:	±1 W/m^2 (5 K/hr)
Non-stability:	±0.5% change in 5 years
Non-linearity:	±0.2% (1000 W/m^2)
Directional response:	±10 W/m^2 (1000 W/m^2)
Spectral selectivity:	±3% (0.35 to 1.5 µm)
Spectral range:	285 to 3000 nm
Operating temperature range:	–40 to 80 °C
Temperature response:	< 0.4% (–10 to 40 °C), < 0.5% (–20 to 50 °C)
Tilt response:	±0.2% (1000 W/m^2)
Irradiance range:	0 to 4000 W/m^2
Operating voltage range:	12 to 24 VDC
Power consumption:	0.2 to 0.3 W
Compliance documents:	View at: www.campbellsci.com/ms-80m-l

4. Siting

The solar radiation sensor is usually installed horizontally, but can also be installed at any angle including an inverted position. Site the sensor to allow easy access for maintenance while ideally avoiding any obstructions or reflections above the plane of the sensing element. It is important to mount the sensor such that a shadow or a reflection will not be cast on it at any time. If this is not possible, try to choose a site where any obstruction over the azimuth range between earliest sunrise and latest sunset has an elevation not exceeding 5°. Diffuse solar radiation is less influenced by obstructions near the horizon. The sensor should be mounted with the cable

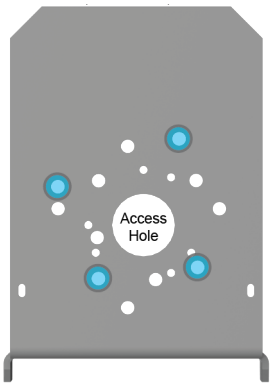
pointing towards the nearest magnetic pole. For example, in the northern hemisphere, point the cable toward the North Pole.

5. Mounting procedure

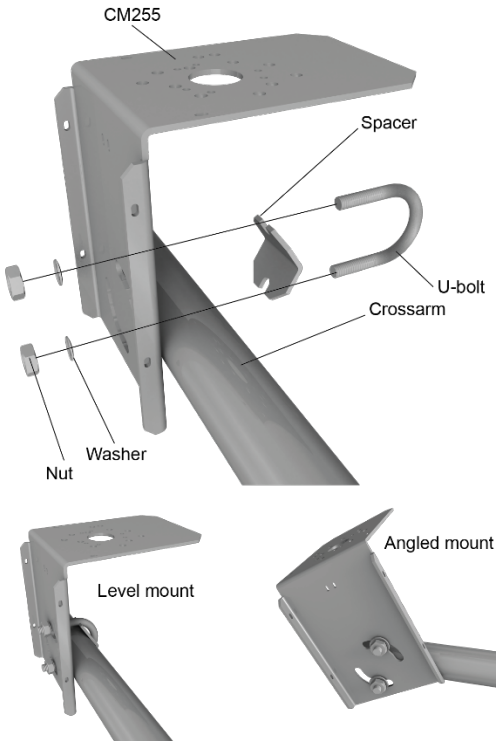
Required tools:

- Diopter
- Solar compass
- 8 mm (5/16-inch) open-end wrench for U-bolt nuts

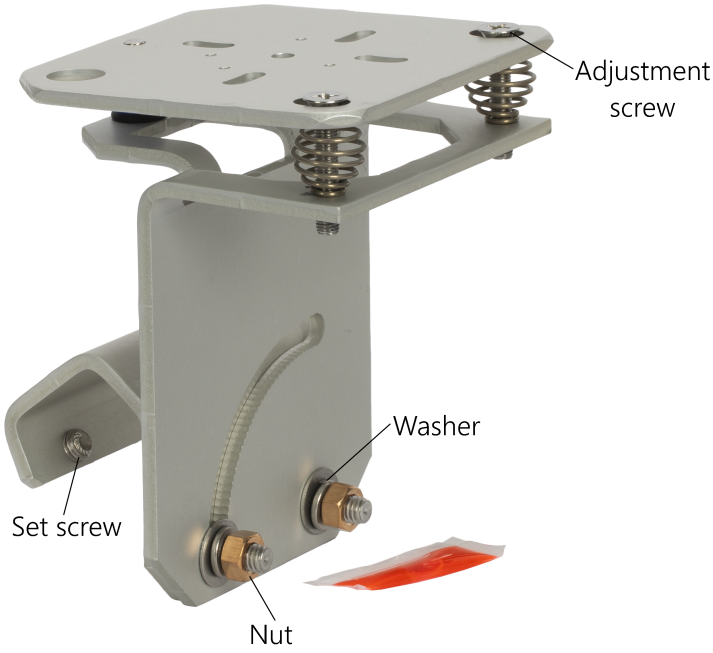
1. On a level surface, level the solar radiation sensor using the leveling feet on the sensor. Alternatively, remove the sensor leveling feet to allow it to be mounted directly to the mounting bracket.
2. Secure the solar radiation sensor to the mounting bracket. The blue dots in the following figure indicate the mounting holes used for this pyranometer.



3. Using a diopter in combination with a solar compass, install and orient the crossarm on the tripod or the mast. If installing the mounting bracket on a vertical pole, ensure the pole is truly vertical.
4. Secure the mounting bracket to the crossarm or vertical pole using the hardware included with the mounting bracket. The CM255 uses one U-bolt, nuts, flat washers, and lock washers to mount the bracket, as shown in the following figure.



5. For the CM256 bracket, use the two set screws to secure the bracket to the crossarm or pole as shown in the following figure. For pyranometers mounted horizontally, ensure the mounting bracket is horizontal in two dimensions. For pyranometers mounted at an angle, set the mounting bracket angle to the desired angle prior to tightening the mounting hardware.



6. Verify mounting hardware is firmly tightened, and that the mounting bracket is at the desired angle.

6. MS-80M wiring

Table 6-1: Pin-out, wire color, function, and data logger connection

Wire color	Pin-out	Function	Data logger connection[1]
Green	4	RS-485A	A–, C (odd)
White	3	RS-485B	B+, C (even)
Red	1	Power in (12 V)	12V
Black	2	Power ground	G
Yellow	5	RS-485 ground	G
Clear	N/C	Shield	⏚ (analog ground)

[1] Assumes the sensor directly connects to the data logger.

7. RS-485 default configuration

The default RS-485 settings are: 19200 baud rate, 8 data bits, even parity, one stop bit. This configuration is used for most Modbus networks.

8. MS-80M register map

Table 8-1 (p. 8) provides the register map for the most commonly used values. A comprehensive register map is available in the EKO manual.

Table 8-1: RS-485 register map

Starting register number	Register count	Data format	Units	Description
14	1	16 bit integer	W/m²	Irradiance minimum output
15	1	16 bit integer	W/m²	Irradiance maximum output
17	2	Float	µV/W/m²	Pyranometer sensitivity
19	1	16 bit integer		Temperature units 1 = °C, 2 = K, 3 = °F
20	2	Float	mV	Sensor voltage output with three decimals
22	2	Float	W/m²	Irradiance
24	2	Float	°C	Internal temperature
26	1	16 bit integer		Password (required for setting the temperature and linearity corrections)
27	2	Float		Temperature response correction factor[1] a
29	2	Float		Temperature response correction factor[1] b
31	2	Float		Temperature response correction factor[1] c
33	2	Float		Temperature response correction factor[1] d

[1] If temperature correction is required, the following formula is used:
$ETC(E,T) = E/TC1(T)$; $TC1(T)=a + b + T + cT^2 + dT^3$

Where,
ETC(E,T): Measurement voltage with temperature correction (mV)
E: Measurement voltage (mV)
TC1(T): Correction coefficient
T: Internal temperature (°C)
a, b, c, d: Correction coefficients

9. RS-485 programming

The RS-485 output can be directly read by a MeteoPV, CR6-series, CR1000X-series, or Modbus RTU RS-485 network. Other Campbell Scientific data loggers can use an MD485 multidrop interface to read the RS-485 output (refer to the MD485 manual).

A CR6 or CR1000X data logger programmed as a Modbus Master can retrieve the values stored in the Input Registers. To do this, the CRBasic program requires a `SerialOpen()` instruction followed by the `ModbusMaster()` instruction.

The `SerialOpen` instruction has the following syntax:

```
SerialOpen (ComPort, Baud, Format, TXDelay, BufferSize, Mode)
```

The `Format` is typically set to logic 1 low; even parity, one stop bit, 8 data bits. The `Mode` parameter should configure the ComPort as RS-485 half-duplex, transparent. The `ModbusMaster()` instruction has the following syntax:

```
ModbusMaster (Result, ComPort, Baud, Addr, Function, Variable, Start, Length,
Tries, TimeOut, [ModbusOption])
```

The `Addr` parameter must match the sensor Modbus address. To collect all of the values, the `Start` parameter needs to be 1 and the `Length` parameter needs to correspond with the register count (see MS-80M register map (p. 7)). `ModbusOption` is an optional parameter described in the CRBasic Editor Help. Refer to MS-80M example program (p. 12) for more information.

10. Maintenance and troubleshooting

The MS-80M has no service items requiring scheduled replacement. There is no accessible desiccant cartridge to maintain. Use pure alcohol or distilled water and a lint-free cloth to clean the dome, removing smears and deposits. Local conditions and application dictate cleaning interval. Sophisticated research applications require daily cleaning. For typical PV applications, clean once per week, bi-monthly, or monthly. The MS-80M should be recalibrated following industry standard best practices such as ASTM G167, ISO 9846, ASTM E824 or ASTM G207 by an accredited lab. The recommended recalibration interval is two years. Contact Campbell Scientific for more information.

Unexpected results typically occur because of improper wiring or programming, electromagnetic radiation, or damaged cables. Ensure that the data logger program includes the correct parameters for the measurement instructions. Check for the presence of strong sources of electromagnetic radiation and use the 50 or 60 Hz integration option in the data logger program

if electromagnetic radiation can be a problem. Check the cable for damage and ensure that it is properly connected to the data logger.

Appendix A. Importing Short Cut code into CRBasic Editor

Short Cut creates a .DEF file that contains wiring information and a program file that can be imported into the CRBasic Editor. By default, these files reside in the C:\campbellsci\SCWin folder.

Import Short Cut program file and wiring information into CRBasic Editor:

1. Create the Short Cut program. After saving the Short Cut program, click the **Advanced** tab then the **CRBasic Editor** button. A program file with a generic name will open in CRBasic. Provide a meaningful name and save the CRBasic program. This program can now be edited for additional refinement.

   > NOTE:
   > Once the file is edited with CRBasic Editor, Short Cut can no longer be used to edit the program it created.

2. To add the Short Cut wiring information into the new CRBasic program, open the .DEF file located in the C:\campbellsci\SCWin folder, and copy the wiring information, which is at the beginning of the .DEF file.
3. Go into the CRBasic program and paste the wiring information into it.
4. In the CRBasic program, highlight the wiring information, right-click, and select **Comment Block**. This adds an apostrophe (') to the beginning of each of the highlighted lines, which instructs the data logger compiler to ignore those lines when compiling. The **Comment Block** feature is demonstrated at about 5:10 in the CRBasic | Features video.

Appendix B. MS-80M example program

Table B-1 (p. 12) provides wiring for the example program. Although, this program is for the CR1000X, other CRBasic data loggers are programmed similarly.

Table B-1: Wiring for example program

Wire Color	Function	CR1000X
Green	RS-485A	C5
White	RS-485B	C6
Red	Power in (12 V)	12V
Black	Power ground	G
Yellow	RS-485 G	G
Clear	Shield	⏚ (analog ground)

CRBasic Example 1: CR1000X program that measures the MS-80M

```
' Variables associated with Pyranometer 1 (MS-80M)
Dim ModbusMS80_1(2) As Float
Public ModbusResult_1
Public MS80M_Irradiance As Float
Units MS80M_Irradiance=W/m²
Public MS80M_InternalTemp As Float
Units MS80M_InternalTemp = DegC
DataTable (OneMin,True,-1 )
  Datainterval (0,1,Min,10)
  Average (1,MS80M_Irradiance,IEEE4,False)
  StdDev (1,MS80M_Irradiance,IEEE4,False)
  Maximum (1,MS80M_Irradiance,IEEE4,False,False)
  Minimum (1,MS80M_Irradiance,IEEE4,False,False)
  Average (1,MS80M_InternalTemp,IEEE4,False)
  StdDev (1,MS80M_InternalTemp,IEEE4,False)
  Maximum (1,MS80M_InternalTemp,IEEE4,False,False)
  Minimum (1,MS80M_InternalTemp,IEEE4,False,False)
EndTable
BeginProg
```

CRBasic Example 1: CR1000X program that measures the MS-80M

```
  SerialOpen (ComC5,19200,2,0,50,4)
  Scan(1, Sec, 0, 0)
    'MS-80M
    ModbusMaster (ModbusResult_1,ComC5,19200,65,3,ModbusMS80_1,22,2,1,100,0)
    MS80M_Irradiance = ModbusMS80_1(1)
    MS80M_InternalTemp = ModbusMS80_1(2)
    CallTable OneMin
  NextScan
EndProg
```

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DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND **TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.** FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com. You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a **hardhat** and **eye protection**, and take **other appropriate safety precautions** while working on or around tripods and towers.
- **Do not climb** tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- **You can be killed** or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in **contact with overhead or underground utility lines**.
- Maintain a distance of at least one-and-one-half times structure height, 20 feet, or the distance required by applicable law, **whichever is greater**, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.
- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

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