Product Manual

Sensor

255-100

Novalynx Analog Output Evaporation Gage

Revision: 8/18

RELIABLE SINCE 1974 MONITORING

CAMPBELL SCIENTIFIC

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- 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.

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CRBasic Examples

255-100 Novalynx Analog Output Evaporation Gage

1. Introduction

The 255-100 determines evaporation rate by measuring the changing water level in an evaporation pan. The evaporation gage produces a resistance output that our dataloggers can monitor. The 255-200 or another standard National Weather Service Class A evaporation pan must be purchased separately.

NOTE This manual provides information only for CRBasic dataloggers. For Edlog datalogger support, see an older manual at *www.campbellsci.com/old-manuals*.

2. Precautions

- READ AND UNDERSTAND the *Safety* section at the front of this manual.
- When unpacking the 255-100, use caution when removing packing materials and parts from inside the gage and avoid hitting the potentiometer sprocket wheel.
- Install a fence or another deterrent to prevent animals from using the evaporation pan as a watering trough.
- Keep the evaporation pan free of algae and dirt (Section 8, *Maintenance (p. 12)*).
- During the winter months when the water may freeze, drain the pan and store both the pan and evaporation gage indoors (Section 8, *Maintenance (p. 12)*).

3. Initial Inspection

- Upon receipt of the equipment, inspect the packaging and contents for damage. File damage claims with the shipping company.

4. Overview

Novalynx Corporation manufacturers the 255-100 Analog Output Evaporation Gage (FIGURE 4-1) and the 255-200 Class A Evaporation Pan (FIGURE 4-2). The 255-100 consists of a stilling well and potentiometer based shaft encoder. It is a low-power option for reading the water level of an evaporation pan such as the 255-200.

FIGURE 4-1. 255-100 Novalynx Analog Output Evaporation Gage

FIGURE 4-2. 255-200 Novalynx Class A Evaporation Pan

The 255-100 uses a chain-mounted float and counter weight that turns a sprocket attached to a precision 1000 Ω potentiometer. When provided with a precision excitation from the datalogger, the 255-100 Evaporation Gage produces a dc voltage that changes proportionally to the change in water depth of the evaporation pan. The datalogger measures the voltage to determine water level and, consequently, evaporation and rainfall.

Novalynx Corporation manufacturers the 255-100P/F Steel Pipe and Fittings (FIGURE 4-3) for connecting the evaporation gage to the evaporation pan. The 255-100P/F allows the gage to be installed outside of, but hydraulically connected to the pan. This configuration will prevent the gage from interfering with the wind flow over the pan or from altering the solar loading on the pan. A pipe connects the pan to the gage keeping both at the same head.

FIGURE 4-3. 255-100P/F Novalynx Stainless Steel Pipe and Fittings for Evaporation Pan

A flexible hose may be used instead of the stainless-steel pipe, provided it does not deteriorate in outdoor weather conditions. You'll need 0.5 inch polybraid (fiber-reinforced) flexible hose, nylon fittings (0.5 inch NPT Hose Bar), and small stainless-steel hose clamps. This equipment is available at most local hardware stores.

NOTE International customers should use the 255-100P/F instead of purchasing the equipment separately since pipes with the correct diameter may be difficult to locate in their country.

Evaporation pans need to be periodically refilled. Depending on the local rainfall, the pan should be filled to about 2 to 3 inches below the top. The evaporation pan can be refilled automatically with the 255-620A Automatic Refill Kit. More precise refill control can be done by programming the datalogger to control a solenoid valve. Programming the datalogger for partially draining the evaporation pan, using a second solenoid valve, may be desirable if the site regularly experiences heavy rainstorms. Refer to Section 7.2, *Automatically Refilling the Evaporation Pan* *(p. 10)*, for more information.

5. Specifications

5.1 255-100 Analog Output Evaporation Gage

Features:

- Low-power device for reading the water level of an evaporation pan such as the 255-200
- Compatible with Campbell Scientific CRBasic Dataloggers: CR200(X) series, CR300 series, CR6, CR800 series, CR1000, CR1000X, CR3000, CR5000, and CR9000(X)

Height:	700 mm (27.5 in)
Diameter:	203 mm (8 in)
Weight:	3.4 kg (7.5 lb)
Shipping weight:	6.8 kg (15 lb)
Cable description:	3-conductor, 24 AWG, shielded
Cable length:	15.2 m (50 ft)
Float:	10.2 cm (4 in) diameter, plastic
Counter weight:	114 g (4 oz), stainless steel
Water input port:	0.5 inch NPT coupling, female
Base dimensions:	40.6 cm (16 in) triangle with leveling screws
Total resolution:	0.76 mm (0.03 in)
Potentiometer accuracy:	0.25%

Rotation:	360° continuous
Electrical angle:	340°, ±1° (20° gap)
Resistance:	1000 Ω, ±10%
Operating temperature:	–40 to 60 °C (evaporation is normally not measured at temperatures below freezing)
Linearity:	0.25%
Mechanical range:	0 to 254 mm (0 to 10 in)
Electrical range:	0 to 240 mm (0 to 9.44 in)

5.2 255-200 Class A Evaporation Pan

Material:	Low carbon stainless steel, type 304, 18 gage
Construction:	Heliarc welded, 0.5 inch drain plug NPT female coupling
Inside depth:	25 cm (10 in)
Inside diameter:	120.6 cm (47.5 in)
Wall thickness:	1.2 mm (0.047 in)
Volume:	~77 gallons (291 liters); adding 7.7 gallons will raise water level in pan by 1 inch
Weight:	22 kg (48 lb)
Shipping weight:	26.8 kg (59 lb)

5.3 255-100P/F Stainless-Steel Pipe and Fittings for Evaporation Pan

Material:	304 stainless steel
Weight:	5.4 kg (12 lb)
Pipe diameter:	0.5 inch with NPT fitting
Pipe length:	152.4 cm (60 in)

6. Installation

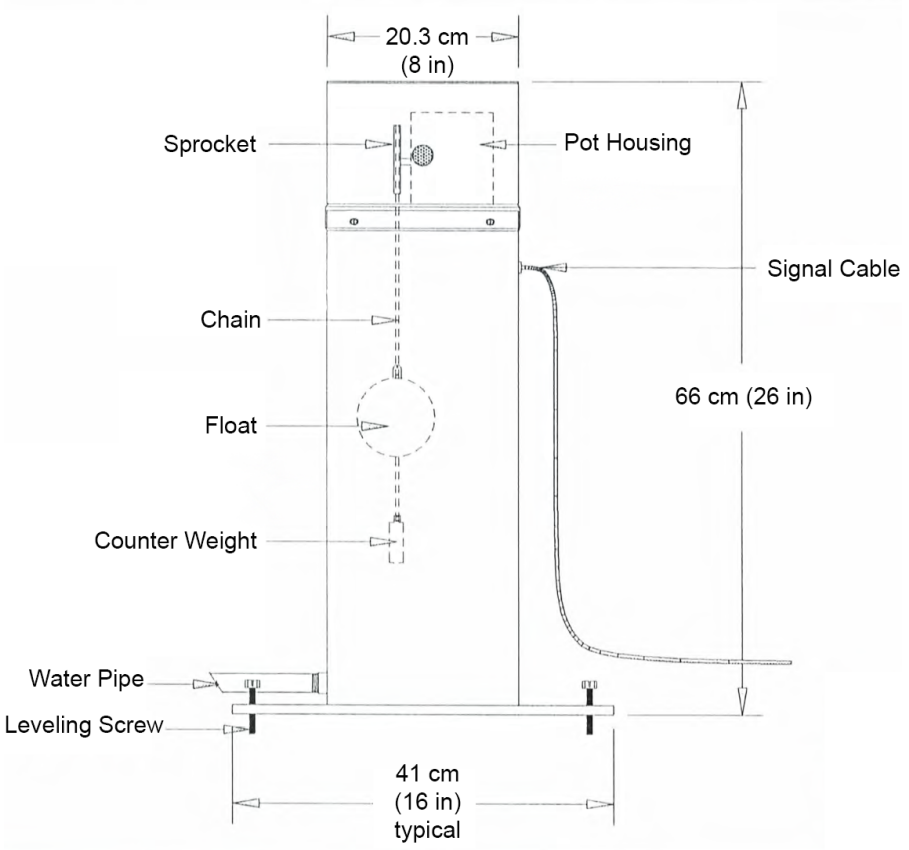

FIGURE 6-1. Components of the 255-100 Evaporation Gage

6.1 Unpacking

Carefully unpack all of the evaporation gage. Remove the top cover. The float with chain and counter-weight are shipped inside the bottom of the gage housing. Remove packing material from inside the housing. The float cannot be removed without removing the pot/gear assembly housing.

CAUTION Carefully remove the packing materials and parts from inside the gage, and avoid hitting the potentiometer sprocket wheel.

6.2 Siting

The site should be level and free of nearby obstructions that can cast shadows or reflect sunlight onto the evaporation pan. To avoid shadows or reflection, the evaporation gage should be north of the evaporation pan. Placing the gage away from the pan also helps reduce shadows and reflections.

The evaporation pan should sit upon a level wooden platform that is placed over soil typical of the area. Dimensions of the platform need to be 127 x 127 x

25.4 cm (50 x 50 x 10 inch). This platform can be made of wood pallets. You can also use the 255-250 Evaporation Pan Support Platform (available by special order).

Fences or other deterrents may be required to prevent animals from using the evaporation pan as a watering trough. Locate the fence so that it does not cast shadows or reflect sunlight onto the evaporation pan.

6.3 Field Installation Procedure

1. Level the wooden platform.
2. Place the evaporation pan on the level wooden platform so that the water pipe fitting faces the evaporation gage.
3. Mount the evaporation gage so that the bottom of the gage is at the same elevation as the pan. This may require a platform for the evaporation gage.
4. Level the gage by adjusting the three leveling screws located on the triangular base.
5. Remove the top cover and place a bubble level across the opening.
6. Adjust the leveling screws until the bubble in the level is centered.
7. Ensure that the float and chain inside the stilling well hang down straight and are centered in the gage. The float must be free to move up and down without touching the sides of the gage.
8. Connect the evaporation gage to the datalogger (Section 6.4, *Wiring* *(p. 7)*).
9. Attach the evaporation gage to the evaporation pan (FIGURE 6-2).

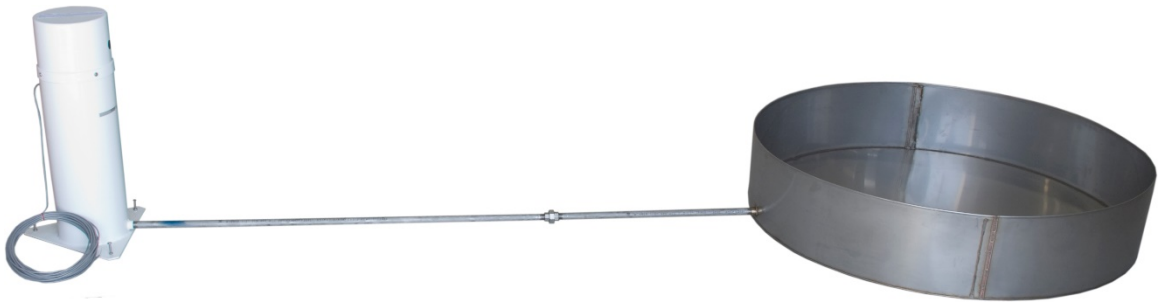

FIGURE 6-2. 255-100 Attached to the 255-200 by Using the 255-100P/F

10. Fill the evaporation pan with water. Depending on the local rainfall, the pan should be filled to about 2 to 3 inches below the top of the pan.
11. Carefully check the joints for leaks. Using Teflon® tape or plumbers pipe joint compound at each threaded coupling will help prevent leaks.

6.4 Wiring

TABLE 6-1 and FIGURE 6-3 show the datalogger connections. FIGURE 6-4 provides a close-up of the evaporation gage terminal.

TABLE 6-1. Wire Color, Function, and Datalogger Connection

Wire Color	Wire Function	Datalogger Connection Terminal
Red	Voltage-excitation input	**U** configured for voltage excitation[1], **EX**, **VX** (voltage excitation)
White	Analog-voltage output	**U** configured for single-ended analog input[1], **SE** (single-ended, analog-voltage input)
Black	Negative Signal	⏚ (analog ground)
Clear	Shield	⏚ (analog ground)

[1]**U** terminals are automatically configured by the measurement instruction.

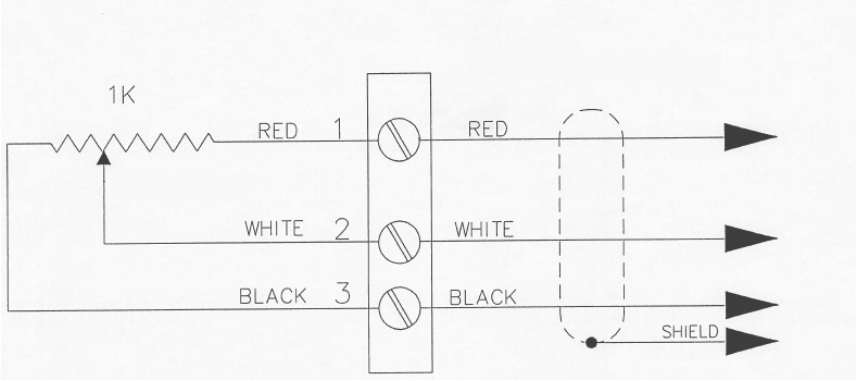

FIGURE 6-3. 255-100 Schematic

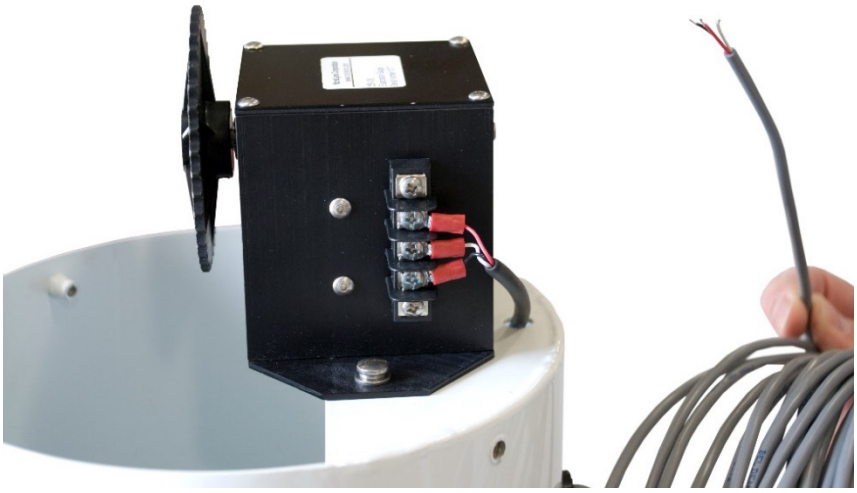

FIGURE 6-4. Close-up of Terminal Strip on 255-100

6.5 Programming

Programming basics for CRBasic dataloggers are provided in the following sections. Complete program examples for select CRBasic dataloggers can be found in Appendix A, *Example Programs* (p. A-1). Programming basics and programming examples for Edlog dataloggers are provided at www.campbellsci.com\old-manuals.

6.5.1 BrHalf Instruction

CRBasic dataloggers (except the CR200(X) series) use the **BrHalf()** instruction, which has the following structure:

BrHalf(*Dest, Reps, Range, SEChan, ExChan, MeasPEx, ExmV, RevEx, SettlingTime, fN1/Integ, Mult, Offset***)**

TABLE 6-2 shows the excitation and voltage ranges used for this instruction. Refer to Section 7.1, *Calibration* (p. 9), to determine the multiplier and offset. The multiplier and offset are unique for individual evaporation gages.

TABLE 6-2. Excitation and Voltage Ranges

Datalogger	mV excitation	Full Scale Range
CR300 Series	2500	± 2500 mV
CR6	2500	± 5000 mV
CR800 Series	2500	± 2500 mV
CR1000	2500	± 2500 mV
CR1000X	2500	± 5000 mV
CR3000	5000	± 5000 mV
CR5000	5000	± 5000 mV

You can average the readings to reduce error from ripples in the water by using the **AvgSpa()** instruction. An example of doing this is shown in Appendix A.1, *CR1000X Program* (p. A-1).

6.5.2 ExDelSE Instruction

CR200(X)-series dataloggers use the **ExDelSE()** instruction, which has the following structure:

ExDelSE(*Dest, Reps, SEChan, ExChan, ExmV, Delay, Mult, Offset***)**

Use *mV2500* for the *ExChan* parameter. Refer to Section 7.1, *Calibration* (p. 9), to determine the multiplier and offset. The multiplier and offset are unique for individual evaporation gages.

You can average the readings to reduce error from ripples in the water by using the **AvgSpa()** instruction.

7. Operation

7.1 Calibration

All 255-100 gages need to be field calibrated by the user. Field calibration will provide the multiplier and offset for use in the datalogger program to provide data in units of inches or centimeters. The **FieldCal()** instruction may be used to perform the calculations automatically and preserve the results in the datalogger. Refer to the **FieldCal()** help in *CRBasic Editor* for more information on its use. The following provides instructions on performing a manual field calibration.

Calibration Procedure:

1. Partially fill the evaporation pan. Measure the depth with a ruler.

2. Measure the voltage using the gage and the **BrHalf()** or **ExDelSE()** instruction with a multiplier of 1.0 and an offset of 0.0.

3. Add more water to the evaporation pan and measure the depth in the pan using the ruler.

4. Measure the voltage at that depth using the gage and the **BrHalf()** or **ExDelSE()** instruction with a multiplier of 1.0 and an offset of 0.0.

5. Calculate the multiplier using the following equation:

$$m = (D_2 - D_1) / (V_2 - V_1)$$

   Where,
   m = multiplier
   D_1 = initial depth measurement (inches or cm)
   D_2 = second depth measurement (inches or cm)
   V_1 = initial voltage measurement (mV)
   V_2 = second voltage measurement (mV)

6. Calculate the offset using the following equation:

$$b = D_1 - m \cdot V_1$$

   Where,
   b = offset
   m = multiplier
   D_1 = initial depth measurement (inches or cm)
   V_1 = initial voltage measurement (millivolts)

Example

This example calculates the multiplier (m) and offset (b) for a specific evaporation gage. Because the multiplier and offset vary with each gage, your numbers will be different than this example.

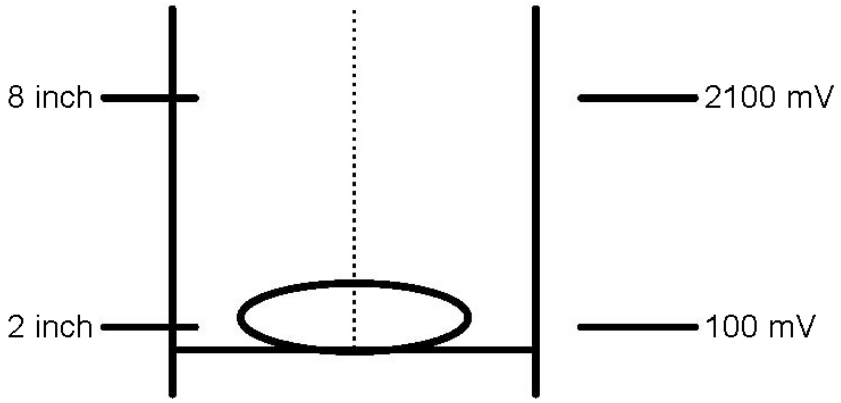

FIGURE 7-1. Multiplier and Offset Calculation Example

In this example, the pan is filled to a depth of 2 inches and the datalogger reads 100 mV on the gage. The pan is then filled to a depth of 8 inches and the datalogger reads 2100 mV. This provides data for a two point calibration (FIGURE 7-1).

Therefore the multiplier is:

$$m = (8 \text{ in} - 2 \text{ in}) / (2100 \text{ mV} - 100 \text{ mV}) = 0.003 \text{ in/mv}$$

The offset is:

$$b = 2 \text{ in} - (0.003 \text{ in/mV} \bullet 100 \text{ mV}) = 1.7 \text{ in}$$

7.2 Automatically Refilling the Evaporation Pan

A simple solution for automatic refilling of the evaporation pan is provided by the 255-620A Evaporation Pan Automatic Refill System. The 255-620A consists of an electronic water timer powered by 2 AAA batteries and an automatic float valve. The 255-620A must be connected to a user-provided water supply. The water supply can be a pressurized system or a storage tank that sits higher than the evaporation pan. The automatic float valve will stop tank filling between 21.6 cm (8.5 in) and 24.1 cm (9.5 in), depending on water pressure. The electronic water timer will enable tank filling at a user-set time and interval.

If more precise fill control is wanted, program the datalogger to control a solenoid valve in a fill line that's connected to a water supply. A second solenoid may be used for draining the pan in areas of high rainfall. Power requirements need to be taken into consideration when using a solenoid valve.

TABLE 7-1 provides the recommended solenoids for the different water types

TABLE 7-1. Recommended Solenoids

Water Type	Part Number	Description
Clean water only	ASCO pn 8210G94	0.5 inch, 12 Vdc
Acidic water	ASCO pn SC827012E	0.5 inch, 12 Vdc solenoid with a plastic valve that can handle up to 40% sulfuric acid. Acidic water also requires plastic pipes.

Use NPT fittings with a 0.5 inch inside diameter. Mount the solenoid next to the tank (0 psi) or next to the pan (1 psi). Use a solenoid that requires 0 psi differential pressure.

CAUTION Do not use the datalogger switched 12 V terminal to power the solenoid. Campbell Scientific offers an SPST single-channel solid-state relay for this purpose. Mount the relay in the enclosure and run the control voltages and lines (+12 V and ground) to the solenoid. Refer to *www.campbellsci.com/p7321* for more information.

CAUTION Campbell Scientific recommends that the solenoid valves have a power supply independent of the weather station. If the fill tank runs dry, the solenoid could remain open for an extended period, draining the battery.

7.3 Storage Tank Size

If a storage tank is used, you need to determine the best size of tank for your application. You determine this by estimating the amount of water you'll use and deciding the number of trips to refill the tank you're willing to make. You can estimate the amount of water you'll use by multiplying the pan's surface area by the evaporation rate of the worst case condition (hot dry summer day).

Example

If you're using a 48 inch diameter evaporation pan, the surface area is:

$\pi R^2 = \pi(24 \text{ in})^2$

$= 1{,}809.56 \text{ in}^2$ or $11{,}674.56 \text{ cm}^2$

Assuming you refill the pan once a day and the evaporation rate is 10 mm (1 cm) per day, the amount of water you'll use is:

$(1 \text{ cm/day})(11{,}674.56 \text{ cm}^2) = 11{,}674.56 \text{ cm}^3\text{/day}$ or

11.675 liters/day or 3.1 gallons/day

If you use a 125 gallon tank, you will need to refill the tank in approximately:

(125 gallons)/(3.1 gallons/day) » 40 days

8. Maintenance

Prevent algae from growing in the pan by adding 5 to 10 mg/liter of copper sulphate to the water. Copper sulphate is available at many farm and garden supply stores. If algae is already in the pan, the pan will need to be thoroughly cleaned.

NOTE In severe situations, spa chemicals may be used, but they may influence the evaporation process.

Keep plants from growing over the edges of the pan.

Regularly rinse the pan to prevent dirt and debris from accumulating in the pan.

During the winter months when the water may freeze, drain and clean the pan and then store both the pan and evaporation gage indoors. If the evaporation pan must be left outside, turn it upside down and secure it to the platform using a stout rope.

9. Attributions and References

For details on site selection, installation, and maintenance refer to the Cooperative Station Observations section of the National Weather Service Observing Handbook No. 2 currently available at:

www.nws.noaa.gov/om/coop/Publications/coophandbook2.pdf

Troubleshooting and other information is also available in the Novalynx Manual available at:

www.novalynx.com

Appendix A. Example Programs

A.1 CR1000X Program

This CR1000X program makes five measurements then averages the readings to reduce error from ripples in the water.

CRBasic Example A-1. CR1000X Program for the 255-100 Novalynx Evaporation Gage

```
'CR1000X Series Datalogger
'Example program for 255-100 Novalynx evaporation gage
Public PTemp, batt_volt
Public PanLevel
Dim  Leveltemp(5)
Const PanMultiplier = 1  'Adjust Pan Multiplier and PanOffset
Const PanOffset = 0  'according to sensor calibration

Units PanLevel = Inches

DataTable (Hourly,1,-1)
  DataInterval (0,60,min,10)
  Sample (1,PanLevel,FP2)
  Minimum (1,batt_volt,FP2,0,False)
  Sample (1,PTemp,FP2)
EndTable

BeginProg
  Scan (60,Sec,0,0)
    PanelTemp (PTemp,60)
    Battery (Batt_volt)
    'Make five measurements then average the readings to reduce error from ripples in the water
    'The SE Chan parameter uses a negative sign "-1" to force all 5 reps to be read on channel 1.
    BrHalf (Leveltemp(),5,mV5000,-1,Vx1,5,2500,True ,20000,60,PanMultiplier,PanOffset)
    AvgSpa (PanLevel,5,Leveltemp(1))
    'Call data tables
    CallTable Hourly
  NextScan
EndProg
```

A.2 CR200(X)-Series Program

CRBasic Example A-2. CR200X Program to Measure the 255-100 Evaporation Gage

```
'CR200X Program to measure 255-100 Evaporation Gage
Public Batt_volt
Public PanLevel
Const PanMultiplier = 1  'Adjust Pan Multiplier and PanOffset
Const PanOffset = 0  'according to sensor calibration

DataTable (Hourly,1,-1)
  DataInterval (0,60,min)
  Sample (1,PanLevel)
  Minimum (1,Batt_volt,0,0)
EndTable

BeginProg
  Scan (60,Sec)
    Battery (Batt_volt)
    ExDelSE (PanLevel,1,1,Ex1,mV2500,0,PanMultiplier,PanOffset)
    CallTable Hourly
  NextScan
EndProg
```

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