

Belfort Instrument Company



Universal All Environment Precipitation Gauge Model AEPG 600/1000

INSTRUCTION MANUAL MK III

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1.0 INTRODUCTION

The AEPG 600/1000 series of All Environment Precipitation Gauges, introduced in 2008, are the latest in a long line of precipitation gauges manufactured by the Belfort Instrument Company. For over 60 years Belfort has manufactured automatic precipitation gauges for the professional meteorological community. The Company has sold over 7000 automatic precipitation gauges, including the Fisher Porter Series of Gauges, the Belfort Universal Weighing Precipitation Gauges and Belfort heated tipping bucket gauges using the latest technologies to provide precise measurement of precipitation events. The new AEPG (All Environment Precipitation Gauges) are designed to measure all types of precipitation in the most difficult environments using the latest in weighing transducer technology combined with on-board computer processing and wind shielding to provide accurate and reliable measurement of accumulated precipitation. Belfort has focused its design efforts on accurate measurement of precipitation events consistent with the requirements of the U.S. National Weather Service and the World Meteorological Organization.

Designed for Accuracy: Exhaustive studies sponsored by the WMO and NWS over the last 30 years have focused on the errors associated with sitting, wind, evaporation and wetting losses. Belfort has carefully considered these studies in the design of the new AEPG series of gauges.

Errors in site selection: Read section 2.0 of this manual to properly site the AEPG series gauges in order to minimize errors caused by terrain and obstacles. Errors as from 5-50% of true precipitation values can easily occur if precipitation gauges are not properly sited and the site not properly maintained.

Wind Errors: Wind can blow light snow and precipitation over and around the precipitation gauge. Vertical components of wind can be generated when it hits the side of a precipitation gauge and is deflected upward thus pushing precipitation over the catch orifice of the gauge. Horizontal components of wind can blow snow past the catch orifice only to descend on the lee side of the gauge. Ideally the gauge should be placed within several concentric rings of fence (similar to a snow fence) called a double fence inter-comparison reference (DFIR) configuration that will sufficiently interrupt laminar air flow over and around the gauge to produce more accurate precipitation measurements. The alternative to this is the Alter Shield, a moving set of vertically suspended deflectors located within a few feet of the precipitation gauge. Some double alter shield tests indicate they are nearly as effective as the DFIR shields. The Belfort Alter shield has been designed with limited angular motion to improve alter shield performance in high wind conditions. When used in conjunction with DFIR fences the AEPG series of gauges will provide the most accurate measurement of precipitation events.

The second form of wind error in weighing type of precipitation gauges is pumping errors. When wind flows over some rain gauge orifices, it can create a vacuum that lifts the internal collection device and creates error in the weight measurement. This is corrected in the Belfort AEPG gauges by leaving sufficient opening at the bottom of the gauge to minimize the vacuum created.

Evaporation Errors: In the AEPG gauges, evaporation errors are reported as negative changes in weight of accumulated precipitation. The use of surface oil to retard evaporation is recommended where possible.

Surface Wetting and Freezing Errors: In the AEPG gauges, surface wetting errors are minimized by using a proprietary fluoro-polymer coating on the collection orifice. Freezing precipitation sticking to the collection orifice is minimized by heating the orifice when temperatures and precipitation activity indicates it may be necessary.

Sensor Error Reduction: With sensors measuring to a resolution of 0.001 inches (0.025mm) with rounding set to 3 decimal digits or 0.000001 with rounding disabled and with an accuracy of 0.01 inches (0.25mm) or 0.1% of full scale (whichever is greater), the Belfort AEPG sensors are calibrated with temperature compensation models to assure accurate measurement over the broadest range of environmental conditions. Furthermore, by reporting the accumulative weight measured by three independent transducers, individual transducer errors are averaged to improve overall accuracy.

The new AEPG gauges are designed to accurately measure all forms of precipitation in all weather conditions. It is recommended that the user carefully follows the sitting and installation guidelines provided in this manual.

Designed for High Reliability and low maintenance:

Although designed for High Reliability and low maintenance, it is also critical that the AEPG gauges be properly installed, monitored and maintained in order to provide consistent and reliable precipitation information.

Sensor Reliability: Each AEPG gauge is designed with one or three field proven load sensors that weigh the accumulated precipitation and should provide years of reliable service and require no maintenance. Each strain gauge is monitored independently and its output is compared to the other two load sensors. If one load sensor differs from the other two by a predetermined amount, the on-board computer removes that gauge from the calculation of accumulated precipitation and sends out a notification that it should be replaced. An LED indicator on the inside of the gauge housing will also light up and indicate which sensor needs to be replaced. With sensor redundancy and automatic fault detection and isolation, the gauge should provide overall reliability far in excess of those measurement systems using only a single sensor.

Low Maintenance Design: All of the AEPG gauge components are housed inside of the heavy duty UV stabilized polyethylene resin housing and mounted to heavy duty aluminum forgings and machined parts that will offer years of service. Removal of the outer housing provides easy access to each component in the system. Each component is designed to be replaced at a modular level to minimize field maintenance time. Cleaning and servicing of the collection bucket is facilitated through three easy to remove snap clamps and removal of the outer housing. The bucket containing the accumulated precipitation can then be removed, cleaned, serviced with oil and de-icing components if required, and restored to its original position. The gauge may then be zeroed for continued operation.

Full digital output and connectivity to the on-board computer allows easy connection to external data transmission modules, data loggers or computers. Digital outputs are in RS-232 or RS485.

Please read this manual carefully prior to installation and operation of your new Belfort AEPG 600/1000 precipitation gauge in order to obtain the optimum performance to meet your meteorological application.

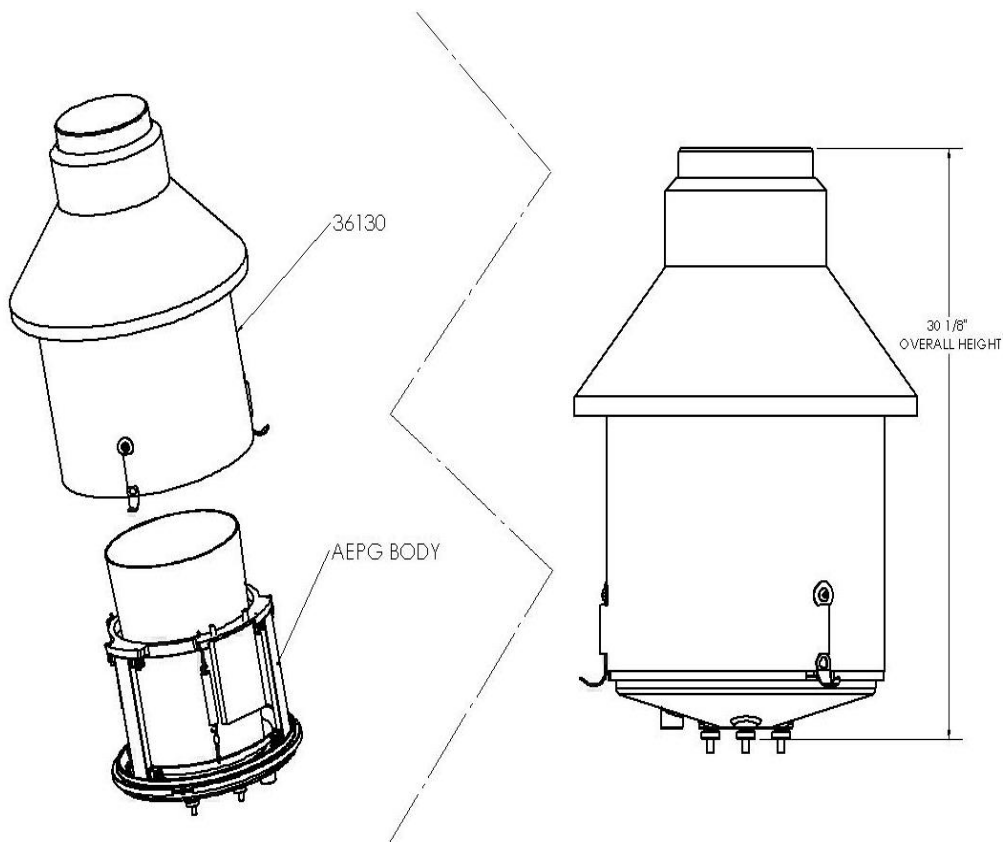


Figure 1.1 AEPG Unit assembly

1.1 Specifications

Capacity:	AEPG 600:	24 inches/ 610 mm
	AEPG 1000:	40 inches/ 1016 mm
Collection Area:	8 inch diameter/50.26 square inches area (AEPG 600)	
Metric Option:	16 cm diameter / 200 mm ² area (AEPG 600 or 1000)	
Resolution:	0.001 in. (0.025mm) with 3 digit rounding 0.000001 in. with rounding disabled	
Accuracy	0.01 in. (0.25mm) or 0.1% Full Scale, whichever is greater	
Repeatability:	+/- 0.01 in. (0.25mm)	
Operating Temp Range:	-67 ⁰ to +131 ⁰ F (-55 ⁰ to +55 ⁰ C)	
Storage Temp Range:	-75 ⁰ to +140 ⁰ F (-60 ⁰ to +60 ⁰ C)	
Input Voltage Electronics:	8-15 Volts DC	
Input Voltage Heaters:	115VAC for AC Heaters 12VDC for DC Heaters	
Input Current:	500 ma @ +12 to 15 v for electronics, 1 Amp @ 115VAC for AC heaters, 8 Amps @ 12VDC for DC heaters	
Output:	Configurable Baud Rate, 8 data bits, no parity, 1 stop bit, no handshake, RS232 on Com 0, RS232 or RS485 on Com1	
Mounting:	Standard 2 inch ID Schedule 40 steel pipe or Standard 125mm ID steel pipe	
Options:	48 Inch diameter Alter Shield	
Firmware:	Current Released Version 4.4U (10/24/12)	
	Belfort is always improving the functionality of the AEPG. The newest functions are included in this manual revision. Those functions may not be included in the version of firmware at the time your gauge was provided.	
Firmware Upgrade:	The firmware can be field upgraded, if the electronics was supplied with the boot loader. If the boot loader is not installed, then the main electronics unit will need to be returned to the factory for upgrade.	

1.2 Equipment List

BELFORT PART NUMBER	DESCRIPTION	QUANTITY
36020	Base	1
36030	Leg, Ring	3
36040	Ring, Top	1
36050	Cradle, Bucket	1
36060	Sensor, Transducer	3
36080	Swivel	3
36090	Digital Processor	1
36095	Orifice Heater Control Unit	1
*****	Preload Plate	1
36100	Adjustment Foot	3
36110	3/8-16X 2-1/2" SS SHC Screw	3
36120	6 Gallon Bucket	1
36130	Exterior Housing	1
36150	Pegasus-3001	3
36160	¼-20 X 1" SS SHC Screw	12
36250	Pipe, EMBED, Base (Customer supplied)	1
36290	Plate, Base Adaptor	1
36300	Base, Pipe Fitting	1
36310	Eyebolt	3
36320	3/8-16 X 5/8" SS SHC Screw	4
36330	3/8-16 X ½" SS SHC Screw	3

Optional Calibration Kit

36001	Calibration Kit	1
36107	Calibration Weight set	1
36108	500ml Measurement Beaker	1
36109	Level	1



Figure 1.2 Calibration Kit

2.0 Site Selection and Preparation

Site selection, wind shielding and site preparation can be the most important factor in the accuracy of precipitation measurements. Measurement errors in excess of 50% can occur if these issues are not properly addressed.

2.1 Terrain and Obstacle Considerations:

Class 1 site: The U.S. Climate Reference network recommends positioning precipitation instruments on flat ground with a slope of below $1/3$ (less than 19°) and cleared of vegetation. Any obstacle must be located at a distance of at least 4 times the height of the obstacle. That is, if a building or tree is 30 feet tall, the instrument should be located at least 4×30 feet or 120 feet from the building or tree. An obstacle is defined as an object seen from the precipitation gauge with an angular width equal to or greater than 10 degrees.

Class 2 site, (error up to 5%): Same as Class 1, except an obstacle is located at a distance of at least 2 times its height.

Class 3 site, (error 10-20%): Ground slope below $1/2$ (less than 30 degrees). Any obstacle is located at a distance of at least the height of the obstacle.

Class 4 site, (error over 20%): Ground with a slope in excess of $1/2$ (over 30 degrees). Obstacles located at a distance less than their height.

Class 5 site, (error over 50%): Obstacles overhanging the gauge.

2.2 Wind Shield Selection

The catchment orifice of the precipitation gauge offers a horizontal opening for the collection of precipitation. Wind blowing across this opening can cause catchment errors due to updrafts from wind hitting the exterior surface of the gauge, creation of a vacuum inside the gauge and or updraft from the gauge. All of these effects lead to measurement errors. These errors are worse in light precipitation events under high wind conditions.

Global studies of these phenomena have led to the design of a number of wind shielding methodologies including surrounding the gauge with vegetation of the same height as the gauge, digging pits in the ground to position the gauge orifice close to the ground surface where minimal wind speed will occur and the use of a variety of mechanical shielding devices that reduce laminar wind flow over the gauge and encourage uniform deposition of precipitation.

The most commonly used standard is called the Double-Fence Inter-comparison Reference (DFIR) shield developed in Russia in the 1960's. It consists of two concentric rings (usually octagonal) of vertical slated fence (50% density) that are 12 meters and 4 meters in diameter with the snow gauge

positioned in the center of the rings. The top of the outer ring is usually $\frac{1}{2}$ meter above the collection orifice height and the top of the inner ring level with the precipitation gauge collection orifice. This approach has yielded collection efficiencies in excess of 90% of true precipitation and is often used as a reference for "true" precipitation.

The Alter shield in some test reports, available as an option to the Belfort AEPG gauges, has shown that it will catch 13% more precipitation (Average for all types of precipitation) than the unshielded equivalent gauge although a single Alter Shielded gauge will not catch precipitation as efficiently as the DFIR shielded configuration. For rain, the Alter shielded gauge will catch within 92 to 96% as much rain as the DFIR gauge vs 88 to 92% for the unshielded gauge. The primary advantage of the Alter shield and the DFIR shield is in catching snow, where it has been shown to catch up to 50% more snow than an unshielded gauge.

Belfort Instrument Co. continues to participate in tests of improved wind shields with improved designs currently fielded.

2.3 Power and Communications Options

The AEPG series of Precipitation gauges are all weighing gauges that measure the weight of a collection bucket interior to the gauge using vibrating wire technology. The frequency of each of three vibrating wires is measured by proprietary algorithms and processed by an on board computer to calculate the average accumulated precipitation. This information is available in RS-232 format for transmission to a data collection device such as a computer or data logger. The monitoring equipment can be located up to 100 feet from the gauge or may be connected to Belfort's proprietary data transmission radio for transmission to a remote collection device within 5 miles line of sight from the gauge.

The power requirement for the sensors and the electronic processing unit is 8-14 volts DC at 500 MA. In areas where freezing precipitation may occur, AC and DC powered heaters are available to heat the collection orifice. The AC heater will require 120 volts AC at 1 amp and the DC heaters will require +12 volts DC at 8 amps, depending on the number of heaters required. The heater power duty cycle is controlled to maintain the desired collection orifice temperature. Power wires should be of adequate gauge to minimize voltage drop over the length of wire when the heater current is applied.

2.4 Placement and Installation of Mounting Pipe

The company recommends installing a standard 2 inch ID ANSI Schedule 40 steel pipe with outside diameter of 2.38 inches (60.5 mm) or equivalent (not supplied with gauge unless ordered separately) at least 3 feet into the ground with at least 12 inches exposed above ground to accommodate the rain gauge stand. The height of the steel pipe should be specified to assure the collection orifice is at least 1 foot above the level of snow accumulation anticipated for the site. The mounting pipe should either be perforated below ground (1 inch diameter holes) and cemented (Quickrete TM recommended) into a

hole (cement also poured into pipe center) that is at least 2 feet in diameter. Additional structural stability may be added by extending the Quickrete™ above ground level as shown using a cardboard concrete retainer form. Caution: Leave adequate room between top of pipe and Quickrete™ base to fit tools into position for mounting hardware as shown.

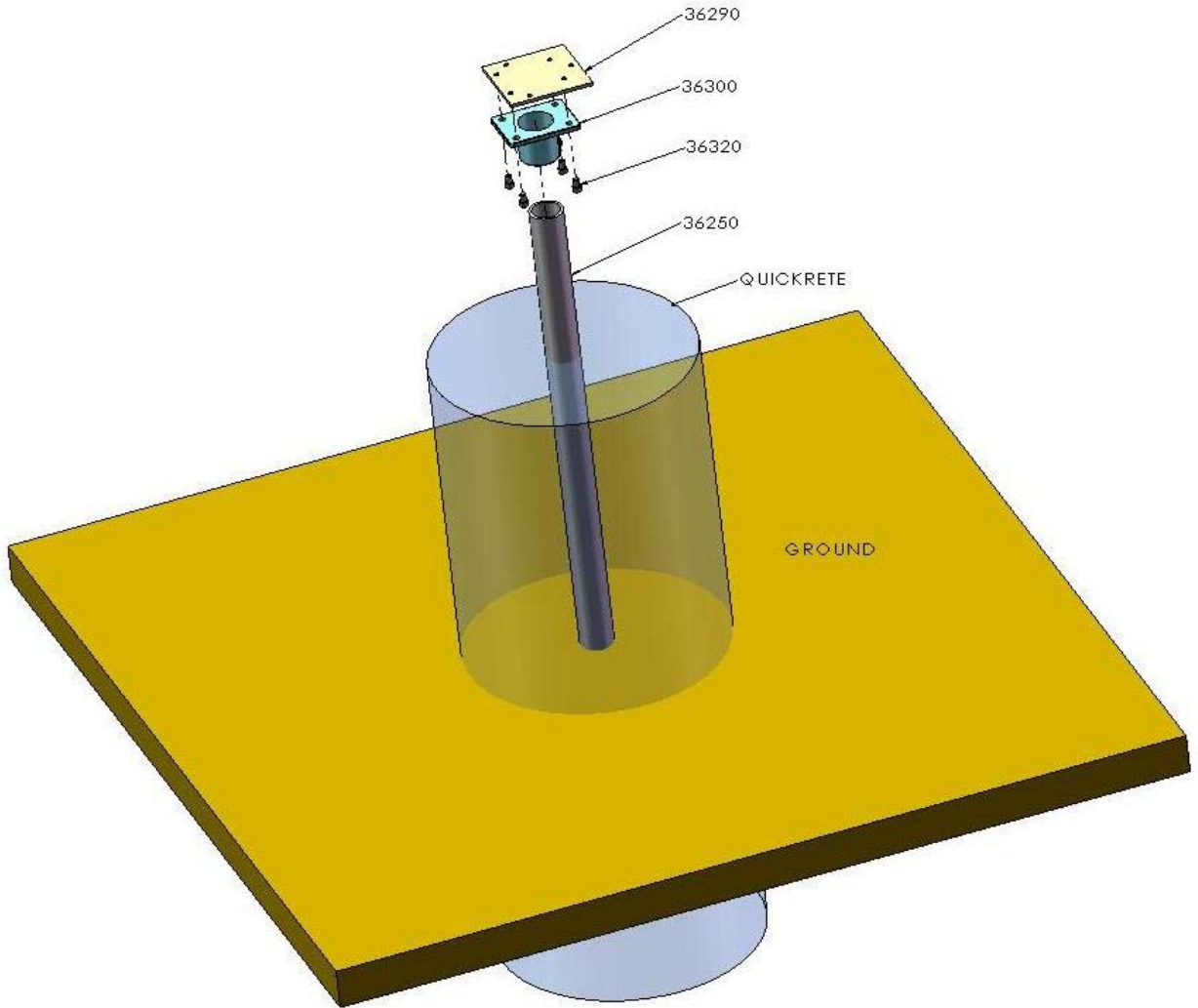


Figure 2.1 AEPG Mounting Pipe and Stand Installation

Once the Pipe (PN36250) is set in the concrete (Quickrete™™) the pipe should be adjusted to hold it vertical using bubble level supplied with equipment.

If you prefer to manufacture your own base plate and mounting hardware the base plate dimensions and hole pattern should be configured per the below drawing: An 8 inch diameter base plate with mounting holes as shown should be affixed to a pipe stand sufficient to provide a stable platform for the gauge. CAUTION: If inadequate stability is provided by the mounting base and pipe stand hardware, vibrations in the gauge caused by wind may affect gauge accuracy.

3.0 Unpacking Instructions and Mechanical Setup

The AEPG gauges are packed in a single box and must be carefully unpacked to remove all packing material prior to installation.

The following items should be removed from the packing container:

1. Rain Gauge assembly, complete with bucket,
2. Assorted mounting hardware in plastic package.

Remove the Rain Gauge Exterior Housing P/N36130 by pulling down and out on 3 latching springs at base of housing. Gently lift the outer enclosure up over the inner gauge structure.

Remove the 6 gallon bucket interior to the assembly.

Locate and unwrap the preload weight plate.

Remove all packing material on and in the gauge structure, bucket cradle ring and electronics and cables.

Note how the sensors are packed in case gauge needs to be returned for any reason.



3.1 Mechanical Setup

Carefully cut any temporary tie wraps holding transducers in place against the top ring during shipment **but not those securing the transducer cables to the gauge frame.**

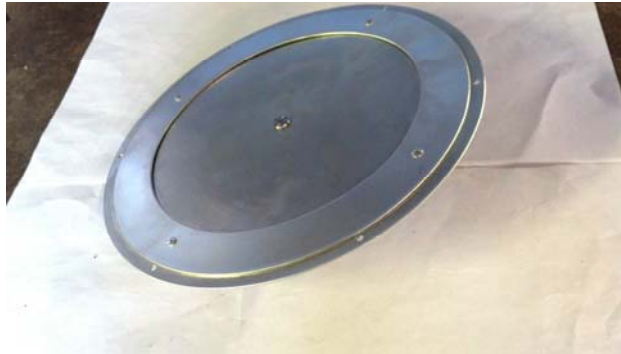
Insert the top hook of each transducer into the screw eyelets installed in the top ring of the inner structure.

Attach the three snap swivels that are already installed on the bucket support ring to the transducer bottom hooks.

Verify that the transducers hang freely and are not twisted or pushed by the transducer cables.

Make sure that the brass weights on the lower end of each sensor are concentric. This assures that the sensors are hanging straight. It should not be necessary to adjust this concentricity, but this can be done by bending the hook at the top of the sensor in such a manner as to cause the brass weights to become concentric.

Locate the Preload Weight Plate:



After the gauge is mounted onto the mounting post and leveled, carefully install the Preload Weight Plate into the bucket ring shown below.



Special care must be taken to NOT drop the Preload Plate into the ring if the sensors are attached as shown in the picture above.

4.0 INSTALLATION

Once the concrete is set, the Pipe Fitting Base (PN 36300) as shown in figure 4.1 below, can be secured to the pipe by tightening its set screws. The Base Adapter Plate PN36290 attaches using 3/8-16X5/8" SS SHC Screws (PN 36320).

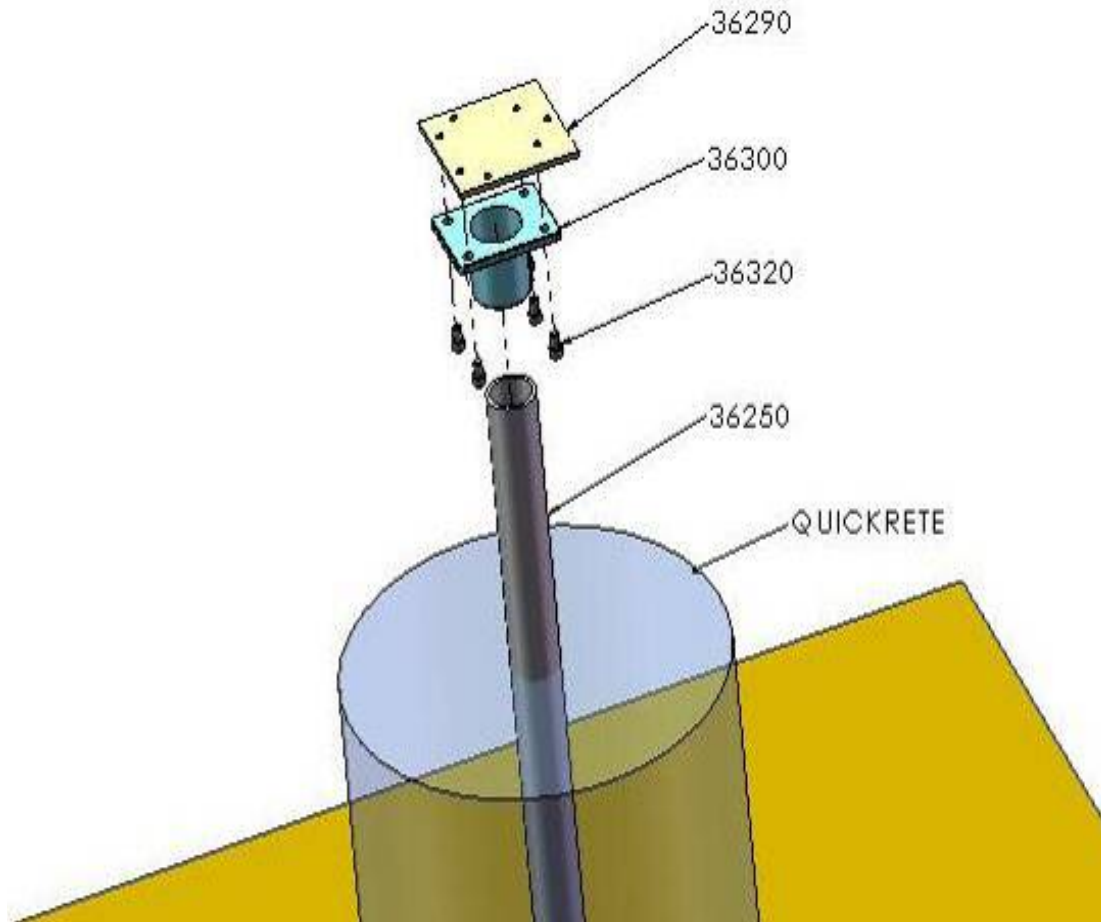


Figure 4.1 Base Mounting Assembly

The Mounting screws PN 36110 are first inserted into the base of the AEPG as shown in below Figure 4.2. The screws will pass through the adjustment feet PN 36100 shown in below figure 4.3. With the gauge assembly setting atop the Base Adapter Plate, align the screws with the screw holes in the plate. Then slightly tighten the mounting screws into the plate with the appropriate sized hex head wrench.

To level the gauge, place a level across the top ring PN 36040 of the gauge as shown in Figure 4.3 and turn the adjustment screws at the base of the unit to level the gauge in all axes. Mounting Screw 36110 is then tightened to lock down the gauge to the mounting plate.

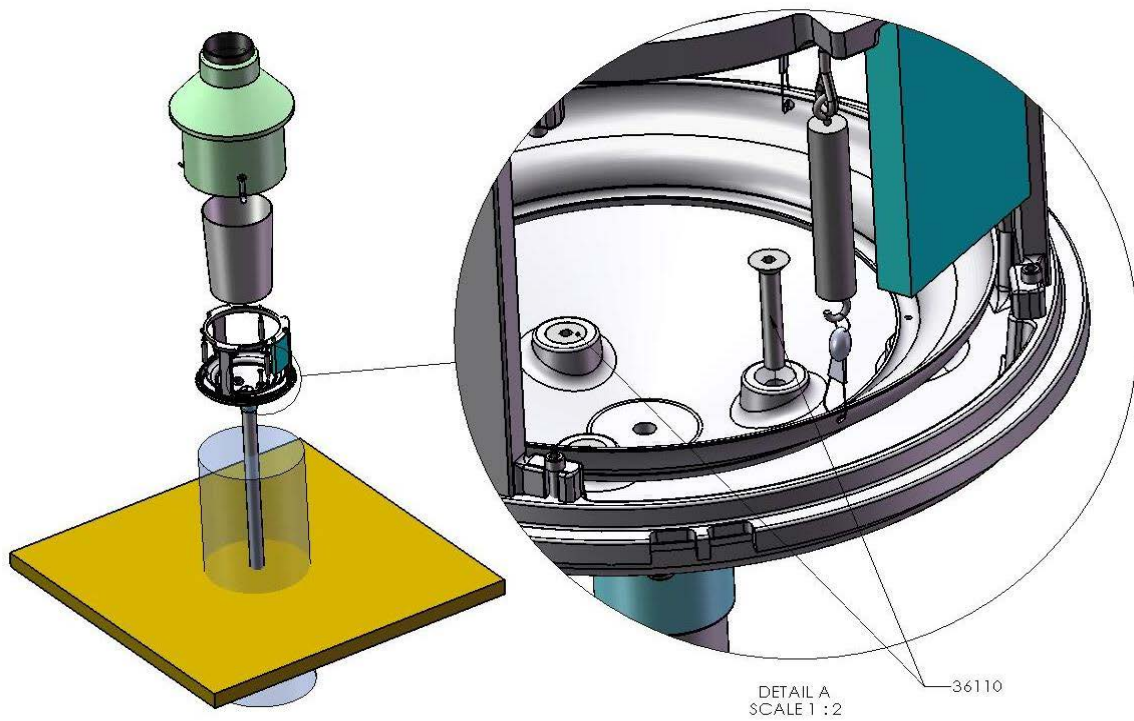


Figure 4.2 Mounting AEPG to Base

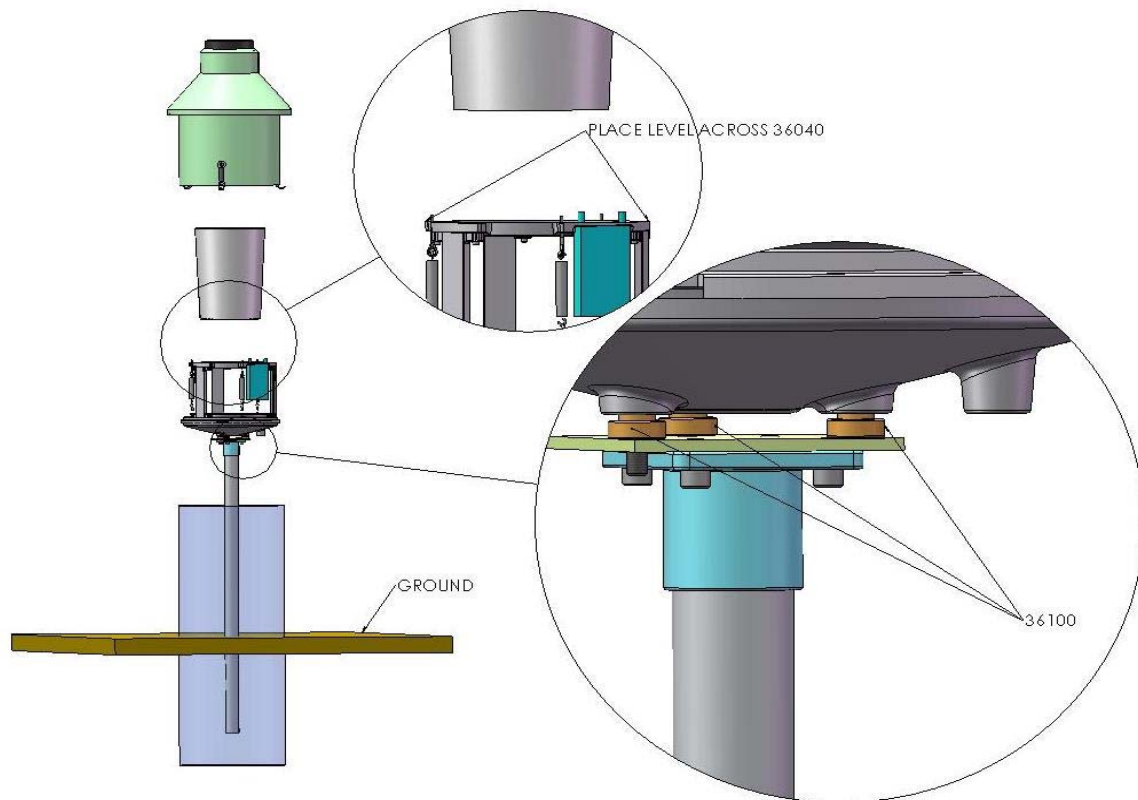


Figure 4.3 Adjustment Screw and Leveling Mechanism

Once the AEPG is mounted to the stand and leveled, insert the 6 Gallon bucket PN 36120 into the bucket cradle PN 36050. Make sure it is seated symmetrically in the bucket cradle and proceed with connections to power and monitoring equipment and then the calibration.

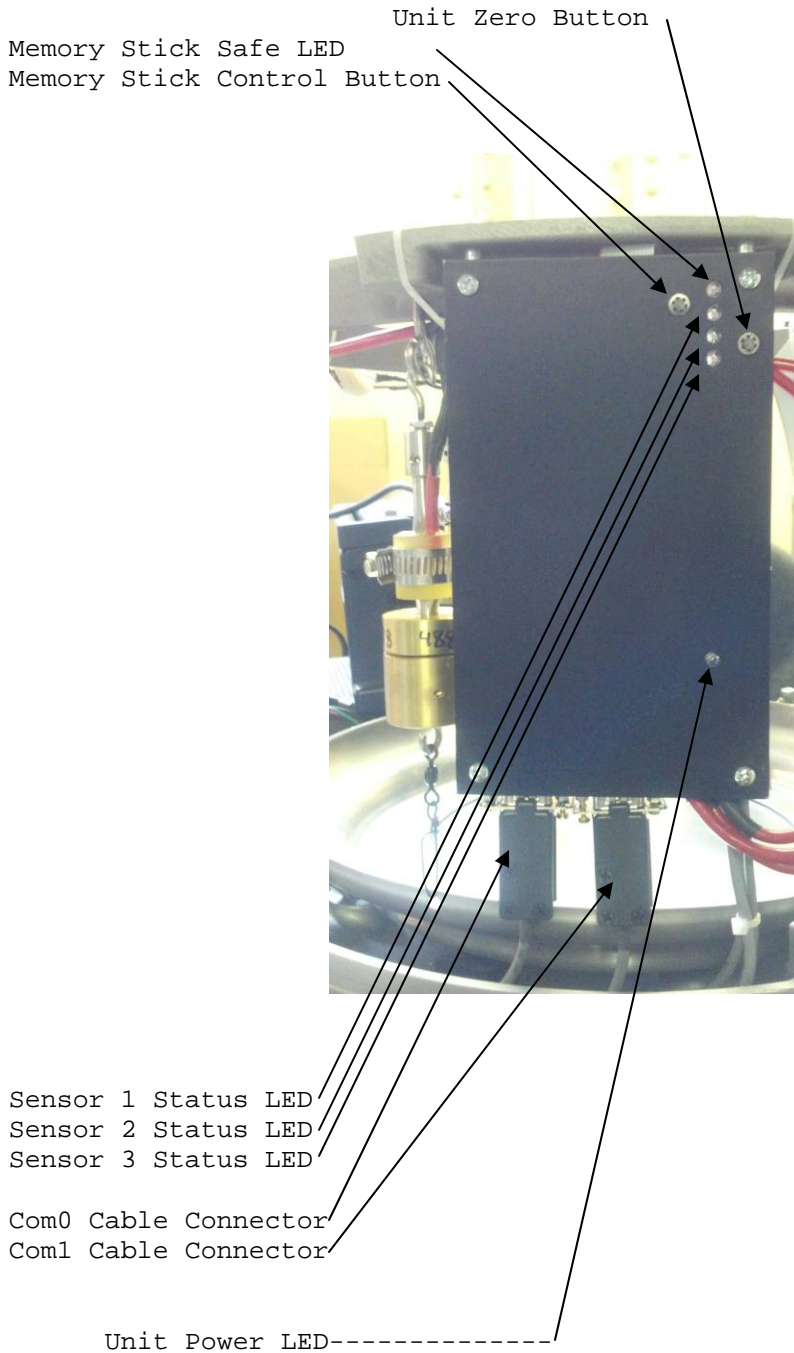
It may be necessary to place the exterior housing over the AEPG during calibration if windy conditions exist.

Once calibration is completed place, place the exterior housing over AEPG assembly so that each Pegasus 3001 locking springs PN 36150 shown above in figure 4.3, lines up with a corresponding hold down hooks. Then snap each locking spring catch over its corresponding hold down hook.

If the unit has heaters, make sure that the exterior housing alignment is such that the heater cable from the base of the gauge aligns with its mating receptacle mounted on the side of the exterior housing.

5.0 Digital Processor and Signal Conditioning Unit (P/N 36090)

The data processor and signal-conditioning unit provides excitation pulses to the vibrating wire transducers, receives and processes the vibrating wire inputs, and processes these inputs into a weight equivalent amount of precipitation collected in the collection bucket.



Connector I/O Detail:

Com 0 & Com 1-DE9S Cable connectors: This cable connection can be plugged directly into a PC Serial Port with no adapters. Com0 and Com1 cable connections are identical for RS232 connection to a PC. Com1 cable adds the capability for RS485 connection on other pins.

The cables connected to Com0 and Com1 connectors do not have conductors connected to the unused connector pins.

Com0 connector

Pin 1,4,6,7,8,9 No connection
Pin 2: RS232 TX Data Out of the gauge
Pin 3: RS232 RX Data into the gauge
Pin 5: RS232 Ground

Com1 connector

Pin 1,4,6,7 No connection
Pin 2: RS232 TX Data Out of the gauge
Pin 3: RS232 RX Data into the gauge
Pin 5: RS232/RS485 Ground
Pin 8: B (- RS485 data)
Pin 9: A (+ RS485 data)

Access to the following connectors requires removing the front panel of the unit.

Connectors J1, J7, J9 Vibrating Wire Transducer Connectors

Pin 1: Transducer I/O
Pin 2: Ground
Pin 3: Input from Temperature Transducer
Pin 4: Ground
Pin 5: Ground

J1 is the connection for transducer #1, J7 is the connection for transducer #2 and J9 is the connection for transducer #3.

Connector J5- Power Connection

Pin 1 + 12 Volt Return or Ground
Pin 2: + 12 V @ 0.5 amp input

Connector J16- Ambient Temp Transducer (if equipped with heaters)

Pin 1: Temp Transducer input
Pin 2: Temp Transducer Return or Ground

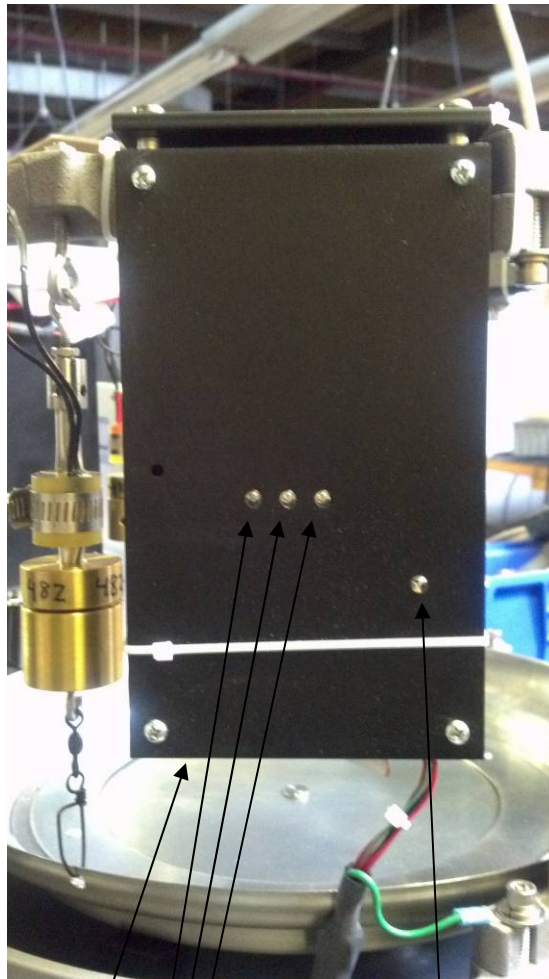
Connector J17- Orifice Temp Transducer (if equipped with heaters)

Pin 1: Temp Transducer input
Pin 2: Temp Transducer Return or Ground

6.0 Orifice Heater Control Unit (P/N 36095)

(This unit is optional. It is supplied if the rain gauge has orifice heaters or internal logging).

If orifice heating option is required, the AEPG model 600/1000 has two orifice heater options available which are determined at time of order placement. The heaters can be 12VDC powered and have a nominal capacity from 25 to 75 watts (75 watt standard) or 120vac powered with a nominal capacity of 120 watts.



USB Connector
Heater 1 Status LED
Heater 2 Status LED
Heater 3 Status LED
Orifice Heater Control Unit Power LED

The heaters are located on the orifice tube located in the top of the exterior housing. The heaters are connected to the Control unit by a cable

on the outside of the enclosure. This cable must be properly connected for the heater and orifice temperature to operate properly.



Orifice Heater Cable showed properly connected!

The on/off status of the heaters can be added to the output message string by enabling the Heater Reporting option parameter.

When the heater has been turned on, the appropriate Heater Status LED will be turned on.

The orifice heaters are controlled by the orifice heater control unit operating in one of three modes: (See Section 7.1 for access to parameters).

Mode 1 The heaters are turned off all the time by selecting 0 (zero) heaters in the "RC" configuration menu. The heaters will never come on.

Select number of inlet heaters. (0-3), 0 = None 0

Mode 2 The heaters are controlled by the orifice temperature sensor only and will be on or off based on the temperatures set in the "RC" configuration menu shown below. The heaters will be on whenever the **Heater Relay Ambient Temperature** is between the high and low limits. If the ambient temperature is above or below the limits, the heaters will never come on. If the heaters are on, the orifice temperature is maintained between the **Heater Relay Inlet Temperature** high and low limits parameter values saved in the configuration:

Select number of inlet heaters. (0-3), 0 = None 1 or 2 or 3

Heater Relay Ambient Temperature Low Limit. (F) 17.959999

Heater Relay Ambient Temperature High Limit. (F) 39.920001

Heater Relay Inlet Temperature Low Limit. (F) 35.960000

Heater Relay Inlet Temperature High Limit. (F) 37.939999

Values set in these temperature limit parameters will vary by customer requirements.

Mode 3. The heaters will be controlled as in mode 2 above EXCEPT only if precipitation has been detected by the gauge within the limits set in the "RC" configuration menu as shown below.

Enable precipitation in heater control? (Y/N) Y

Relay 'on' point, inches of precipitation 0.004000

Time period for relay 'on' point (minutes) 60

Averaging interval for relay 'on' point (minutes) 60

Relay 'off' point, inches of precipitation 0.002000

Time period for relay 'off' point (minutes) 60

7.0 User Commands

7.1 The Password and Super User Privileges

The "Super User" privileges allow the operator to modify the configuration and calibration parameters of the AEPG Gauge.

Since that affects the way the Gauge works, a Password is needed to become a "Super User".

The operator will need to communicate with the Sensor using one of the RS-232 links. The operator may become Super User at any time by typing **Ctrl-V**. That is, press AND HOLD the "Ctrl" key, then press the "V" key. The Sensor will then ask for a password.

The Password is: **thunder**

The password is not case sensitive

Password? -> *****

Password accepted, Operator is now Super User.

Figure 7.1 - Results of typing "Ctrl-V" and correctly entering the Password "thunder"

To disengage the super user status type "Ctrl-V" and then hit enter. It should be noted that if the user types "Ctrl-V" and then enters any word other than the password, the super user status is disengaged. Also, a manual or software reset will disengage the super user status.

7.2 Firmware Commands of the Model 600/1000 AEPG Sensor

The Model 600/1000 AEPG Sensor is controlled by an integral firmware program. The commands are available for use by the user. All commands begin with a command letter "R". These commands control the operation of the AEPG Sensor. All commands are in a two-character format. The first character is the letter 'R', to identify this as an AEPG Gauge command and the second character selects the desired function. The Sensor's command parser is case insensitive, (e.g. 'R' is the same as 'r'), so case doesn't matter. Each command is entered by typing only the two characters of the desired command, the ENTER key is not needed. During Sensor configuration, the ENTER key will be used.

NOTE: Set the RS232 terminal emulator to send only a carriage return for the ENTER key,
NOT carriage return / line feed.

WARNING - The calibration and performance of the instrument can be affected by operator commands via RS232. Provided with each instrument is a printout of its configuration as it left the factory. It is highly recommended that the configuration printout be duplicated and stored for later reference in case the configuration data in the sensor is corrupted or changed.

The following command should **NEVER** be used by the operator:

rI = Initialize configuration. All calibration and instrument specific parameters will be lost. Factory service is required to recover from this command.

The following list of commands can be accessed by typing "RM"

r0 = Display serial no. & firmware version.
r1 = Toggle 'report raw vs. averaged data' flag.
r2 = Toggle 'rounding enable' flag.
rC = Update configuration.
rD = Toggle 'output details' flag.
rH = Toggle state of orifice heater relay.
rI = Initialize configuration.
rJ = Toggle 'output inhibit' flag.
rL = Poll for output data.
rM = Display menu (this).
rN = Display general configuration parameters.
rR = Reset system.
rS = Start a 'span' calibration.
rV = Display calibration parameters.
rX = Abort a calibration in progress.
rZ = Start a 'zero' calibration.

Figure 6.2 - AEPG Sensor commands

The most commonly used commands are RL, RC, RZ, RS, and RR

7.2.1 The RL Command

The RL command polls the Gauge for an immediate data output message. It can be invoked by the operator through the RS232 interface or by a remote polling data logger. The RL commands works equally for the short or extended message outputs.

[R]: PPP 15.513275 4.712437

Figure 7.2.1 - Results of RL Command for Short Message

[R=Rain Gauge]: Transducer 1, 2, 3 Status Total Weight Total Inches or metric

P or Pass means the transducer is reporting a stable frequency. S or Search means the indicated transducer is not reporting a stable frequency after a step change in weight in the bucket or a mechanical perturbation of the Gauge. F or Fail means the temp thermistor is open or the sensor wire is broken. The Gauge will continue to report a reduced accuracy Weight and Inches until the faulty transducer returns to a P, indicating a stable frequency.

The following is a sample of the output message string with all output variables turned on, metric variables and displaying their individual units of measurements selected in the configuration parameters file:

[R]: PPP 24.891775 C 120.000005 C 24.777191 C 24.513214 C 24.803588 C 43070
39875 30237 1323.574543 Hz 1306.748509 Hz 1289.105053 Hz 2.039382 Kgs.
2.049951 Kgs. 2.010538 Kgs. 6.099 Kgs. 2.403 mm. Htrs= 000 0.000 mm.

[Rain Gauge]: (Pass) (Pass) (Pass) (Ambient temp) (Orifice Temp) (Sensor 1
Temp) (Sensor 2 Temp) (Sensor 3 Temp) (Sensor 1 Amp) (Sensor 2 Amp) (Sensor 3
Amp) (Sensor 1 Freq) (Sensor 2 Freq) (Sensor 3 Freq) (Sensor 1 Wt) (Sensor 2
Wt) (Sensor 3 Wt) (Total Wt) (Total Inches) (Heater Status) (Precipitation
Accumulation rate)

Note: There are no units of measurement for Sensor Amplitude. These values
are used for factoring testing and should be left disabled.

7.2.2 The R0 Command

The **R0 (R Zero)** command, reports the Gauge's serial number, Sensor serial
numbers and the firmware revisions of the 4 processors.
The first line reports the Gauge's serial number. The second line reports
the Main Processors Firmware revision number and date. Then the serial
number of the 3 sensors and the revision of the three sensor processors are
reported.
If the unit is configured with the Memory Stick Logging, the Hardware and
Firmware revisions are next, followed by the Memory Stick Status and the
logging Date and Time.

Unit serial number: 84
Firmware version: Mega-VWRG 4.21d(04/25/11)
Sensor 1: S/N 0360, firmware version: Tiny-VWRG 3.06 (07/06/10)
Sensor 2: S/N 0361, firmware version: Tiny-VWRG 3.06 (07/06/10)
Sensor 3: S/N 0359, firmware version: Tiny-VWRG 3.06 (07/06/10)

Memory Stick Hardware: C
Memory Stick Firmware: C
Memory Stick Status: Attached.
Date, mm/dd/yy: 07/11/12
Time: 13:31:04

(Memory Stick parameters will be reported if the gauge has a Heater
Controller, programmed with Memory Stick Option and after the Heater
Controller has completed initialization)

Figure 7.2.2 - Results of R0 Command

7.2.3 The R1 Command

The **R1 (R One)** command toggles between raw and averaged data. Raw data can
be viewed without changing the configuration averaging period by using this
command. RR or a power reset will return the gauge to the configured
operation.

r1Reported data is instantaneous (not averaged).

r1Reported data is averaged.

r1Reported data is instantaneous (not averaged).

Figure 7.2.3 - Results of R1 Command

7.2.4 The R2 Command

The R2 command toggles data rounding to shorten the data output string. RR or a power reset will return the gauge to the configured operation.

r2Rounding and clamping are disabled.

[R]: PPP 15.513275 4.712437

r2Rounding and clamping are enabled.

[R]: PPP 15.518 4.715

Figure 7.2.4 - Results of R2 Command

7.2.5 The RC Command

The RC command allows the operator to configure the sensor. The response will appear one line at a time. The operator will be prompted for any changes to each configuration parameter. If the operator does not wish to change a specific parameter, just press ENTER to skip to the next parameter. It is possible to "back up" in the parameter list. If the desired parameter has been passed over by accident, type ^ or shift 6 to back up one line. Repeating the command will back up as far as desired.

The old value of the parameter to be changed must be back spaced out, the new value can now be entered and a carriage return will save it and move to the next parameter.

It is also possible to avoid traversing the entire list after changing only one (or more) parameters by pressing ESC **AFTER** saving the last changed parameter (save by pressing ENTER after typing the new value).

The new values should be stored in memory for future use.

The **Bold Underlined** values should not be modified except under factory supervision. An example would be after replacing a transducer. The **Bold** values need not be entered and are automatically stored after a **RS** or **RZ** command.

Following is the response to an RC command, the configurable parameters.

***Note:** The values shown below are example values only. Some values will vary from gauge to gauge. Some options will not appear if the option is not enabled in the configuration parameters. Some newer options may appear in the list that your version of firmware does not have.

If Metric Units reporting is enabled, the values shown will be in Metric units of measurement. If Metric Units is not enabled, the values shown will be in US units of measurement.

Serial number 78

Serial number of the Gauge

Baud rate 19200

RS232 baud rate for serial communication

Enable RS-485? (Y/N) N

Enable's the RS-485 interface on Com1. Note: The RS232 will still operate on both Com 0 and Com1 connectors.

Enable Memory Stick Logging? (Y/N) Y

Enable's the memory stick logging if the option is installed on gauge.

Two Digit Year (20xx) 11

Month 4

Day of the month 12

Hour 15

Minutes past the hour 52

Used to set the clock for time stamping data saved to memory stick.

Reporting interval (seconds) 0 for no report, even values 2-3600 secs. 2
0 (zero) turns off asynchronous reporting but the gauge will respond to a polling command under either condition.

Report in Metric Units? (Y/N) N

Changes the output string data from pounds and inches to kilograms and millimeters

Enable CSV compatible option? (Y/N) N

Changes the output string to comma separated fields for easy incorporation into other data display functions. This selection will automatically disable units reporting.

Enable Units Reports? (Y/N) N

Includes the unit descriptions in the output string except when CSV mode is selected.

Averaging interval (in seconds), Zero for averaging off . . . 60

0 (zero) returns instantaneous un-averaged data.

Enable extended output message? (Y/N) Y

Adds the sensors frequency, temperatures and individual sensor weights to the output string.

Show ambient and orifice temperatures? (Y/N) Y

Adds ambient and orifice temperatures to the extended output message string if the gauge is equipped with orifice heaters.

Show ping amplitudes? (Y/N) Y

Adds the sensor signal amplitudes to the extended output message string.

Enable frequency fill function? (Y/N) N

Frequency Fill is not required and should not be enabled.

Size of history data base for Frequency Fill, 1 - 30 . . . 30
Length of measurement history used in regression analysis to calculate sensor frequency if the Frequency Fill is enabled.

Enable Precipitation Rate Calculation? (Y/N) Y
Calculates precipitation rate and adds data to the extended message output string.

Time span for Precipitation Rate (minutes) 5
Length of time used for precipitation rate calculation.

Select number of inlet heaters. (0-3), 0 = None 3
Number of orifice heaters used if heater option is included in gauge.

Relay 'on' point, inches of precipitation 0.004000
Inches of precipitation accumulated during the time period to determine presence of precipitation.

Time period for relay 'on' point (minutes) 1
Time period of precipitation accumulation for precipitation detection

Averaging interval for relay 'on' point (minutes) 1
Averaging interval applied to accumulation data for precipitation detection

Relay 'off' point, inches of precipitation 0.003000
Inches of precipitation accumulated during the time period, below which absence of precipitation is reported.

Time period for relay 'off' point (minutes) 1
Time period of precipitation accumulation for absence of precipitation detection

Averaging interval for relay 'off' point (minutes) 1

Enable precipitation in heater control? (Y/N) Y
Enable's the precipitation detection algorithm as part of decision to turn on heaters. If no precipitation is detected then no heaters will be on.

Heater Relay Ambient Temperature Low Limit. (F) 20
Ambient temperature below which heaters are always off

Heater Relay Ambient Temperature High Limit. (F) 40
Ambient temperature above which heaters are always off

Heater Relay Inlet Temperature Low Limit. (F) 38
Lower limit of maintained orifice temperature if heaters are activated

Heater Relay Inlet Temperature High Limit. (F) 44
Higher limit of maintained orifice temperature if heaters are activated

Heater off to 1 heater dwell time (minutes) 1
There are normally 3 orifice heaters that are activated sequentially to maintain orifice temperature within specified limits. This is the dwell time from "heaters off" to stage 1 activation.

Heater 1 to 2 heater dwell time (minutes) 2
Minimum time from heater 1 activation to heater number 2 activation

Heater 2 to 3 heater dwell time (minutes) 2
Minimum time from heaters 1 and 2 activation to heater number 3 activation.

Heater 3 to full on dwell time (minutes) 2
Minimum time heaters remain on before possible reduction to 2 stages

Enable daily heater test? (Y/N) N
Enable a daily test of orifice heater function.

Heater daily test on time (minutes) 10
Length of time heaters are turned on for daily test

Heater daily test highest temperature (F) 12
Highest orifice temperature allowed during the heater test

Enable heater report? (Y/N) N
Report heater on/off status in the expanded message output string.
0=off, 1=on

Enable Precipitation detection on Relay 3? (Y/N) N
Use heater 3 relay to provide an external indication of the presence of
precipitation. This option limits orifice heaters to 2 stages.

Terminal NZ (40) default 40
Zero crossings between pings

Ping-to-read delay (32Mhz clocks) 380
Settling time after the sensor is pinged until its frequency is read.

Lowest Ping Cycle (3) 3
The number of sensor ping cycles is variable depending on conditions. This
is the lower limit of the number of pings that will be used.

Medium Ping Cycle (5) 5
This is the medium number of pings that will be used.

Highest Ping Cycle (27) 9
This is the maximum number of pings that will be used.

Lowest Amplitude Threshold (800) 300
Used in determining number of pings

Medium Amplitude Threshold (1200) 400
Used in determining number of pings

Highest Amplitude Threshold (1800) 500
Used in determining number of pings

Temp. test qualifying range (0=disable) 0
Not used

Temp. test validity range (0=disable) 0
Not used

Sensors in this rain gauge. 3
Number of sensors installed in gauge, 1 or 3.

Enable Temperature Compensation in results? (Y/N) Y
Use temperature compensation in reporting gauge results. This minimizes the diurnal effects of ambient temperature changes.

Sensor 1 serial number 0176
Sensor number 1 serial number

Sensor 2 serial number 0191
Sensor number 2 serial number

Sensor 3 serial number 0175
Sensor number 3 serial number

Sensor 1 Temperature compensation factor (x 10^6) 12.500000
Sensor 1 temperature compensation factor

Sensor 1 temperature at calibration (degrees C) 29.070001
Temperature at which the temperature compensation variables were determined

Sensor 1 first order coefficient (lbs/kHz^2) 2.810877
First order coefficient in compensation algorithm

Sensor 1 second order coefficient (lbs/kHz^4) 0.013647
Second order coefficient in compensation algorithm

Sensor 2 Temperature compensation factor (x 10^6) 12.500000
Sensor 2 temperature compensation factor

Sensor 2 temperature at calibration (degrees C) 20.37999
Temperature at which the temperature compensation variables were determined

Sensor 2 first order coefficient (lbs/kHz^2) 2.652690
First order coefficient in compensation algorithm

Sensor 2 second order coefficient (lbs/kHz^4) 0.013569
Second order coefficient in compensation algorithm

Sensor 3 Temperature compensation factor (x 10^6) 12.500000
Sensor 3 temperature compensation factor

Sensor 3 temperature at calibration (degrees C) 22.57000
Temperature at which the temperature compensation variables were determined

Sensor 3 first order coefficient (lbs/kHz^2) 2.666890
First order coefficient in compensation algorithm

Sensor 3 second order coefficient (lbs/kHz^4) 0.012997

Second order coefficient in compensation algorithm

Enable Tipping bucket on Relay 2? (Y/N) N
 Use orifice heater relay number 2 to provide a simulated tipping bucket output. Limits orifice heaters to 1 or 2 stages.

Tipping Bucket fill size (millimeters)0.254000
 Tipping bucket tip capacity

Bucket Relay on time (tenths of Seconds)5
 Persistence time of tipping relay pulse

Millimeters of rain for span calibration225.958395
 Equivalent weight in millimeters of rain to calibrate span of gauge.
 Value determined by the Calibration Weight. Do not modify.

Calibration weight at empty (kgs)6.060719
 Value determined by the calibration function, do not modify.

Calibration weight at span (kgs)10.587782
 Value determined by the calibration function, do not modify.

Calibration weight at zero (kgs)6.051311
 Reported by the calibration function, do not modify

Information **underlined and in bold** is entered by the factory and should not be changed without consulting the factory.

"Inches or millimeters of rain for span calibration
X.xxxxxx" must be entered for a span calibration and comes from the calibration weights supplied as part of the AEPG Calibration Kit.

Calibration weight at empty, at span, and at zero need not be entered and are calculated and automatically stored by the span and zero functions.

Figure 7.2.5 - Results of RC Command

7.2.6 The RD Command

The RD command toggles the level of output string detail among 4 levels.

"details level: None" and "details level: Expanded response message" are the 2 messages normally used in operation of the gauge.

"details level: Sensor data" and "details level: Standard deviation data" are diagnostic messages used for trouble shooting with factory supervision.

RD Current details level: None.

[R]: SSS 15.518 4.715

Figure 7.2.6.1 RD details NONE

[Rain Gauge]: Search Search Search Total Weight Total Inches

S or **Search** means the indicated transducer is not reporting a stable frequency after a step change in weight in the bucket or a mechanical perturbation of the Gauge. The Gauge will continue to report a reduced accuracy Weight and Inches until the missing transducer returns to a P, indicating a stable frequency.

RD Current details level: Sensor data.

[R]: SPP 15.517 4.715

1:St=SENSREADY CurT(C)=20.748780 CRF(Hz)=N/A

1:PRF(Hz)=1374.066710 ERF(Hz)=1373.789430 CCL(lbs)=5.180218

1:PPHP(us)=00352 Count=00004

1:ReadDelay=00050 LRCK=1

1:NQS=014 NA=0000001437 TCY=05000 Rung=00008

2:St=SENSREADY CurT(C)=20.410736 CRF(Hz)=1375.399470

2:PRF(Hz)=1375.581503 ERF(Hz)=1375.399470 CCL(lbs)=5.218801

2:PPHP(us)=00352 Count=00004

2:ReadDelay=00050 LRCK=0

2:NQS=014 NA=0000001440 TCY=05000 Rung=00008

3:St=SENSREADY CurT(C)=20.767944 CRF(Hz)=1363.724351

3:PRF(Hz)=1364.094377 ERF(Hz)=1363.724351 CCL(lbs)=5.110146

3:PPHP(us)=00352 Count=00004

3:ReadDelay=00050 LRCK=1

3:NQS=014 NA=0000001428 TCY=05000 Rung=00008

Figure 7.2.6.2 RD details Sensor Data

RDCurrent details level: Standard deviation data.

[R]: PSP 15.517 4.715

1:Freq Avg=1030.640721 Freq StdDev=610.498953

2:Freq Avg=1306.897283 Freq StdDev=307.611752

3:Freq Avg=1364.002705 Freq StdDev=0.223526

RDCurrent details level: Expanded response message.

[R]: SPP 20.752900 20.413451 20.772033 N/A 1375.108004 1363.928556 5.179896

5.216588 5.111676 15.517 4.714

[Rain Gauge]: Search Pass Pass Temp 1 Temp 2 Temp 3 Freq 1 Freq 2 Freq
3 Wt 1 Wt 2 W3 Total Wt Total Inches

Figure 7.2.6.3 - RD details Deviation Data

7.2.7 The RF Command

The RF command is not required.

Figure 7.2.7 Results of RF Command

7.2.8 The RH Command

The RH command sequentially toggles the 3 heater relays on and then sequentially toggles the 3 heater off, one heater at a time. The LEDs on the heater control module indicate the status of the heater control relays.

The RH command does not return any acknowledgment of the command other than the indications on the 3 LEDs on the Orifice Heater Control Unit.

RH command issued	Heater 1 on Led 1 on.
RH command issued	Heater 2 on Led 2 on.
RH command issued	Heater 3 on Led 3 on.
RH command issued	Heater 1 off Led 1 off.
RH command issued	Heater 2 off Led 2 off.
RH command issued	Heater 3 off Led 3 off.

Figure 7.2.8 Results of 6 RH Commands

7.2.9 The RI Command

The RI command initializes all configuration parameters and should never be used. All calibration and instrument specific parameters will be lost. Factory service is required to recover from this command.

RR or a power reset will return the gauge to the configured operation.

7.2.10 The RJ Command

The RJ inhibits output when the Gauge is in the streaming data mode. This can be useful when logging configuration or calibration data in this mode.

Repeating the RJ command or entering the RR command or a power reset will return the gauge to the configured operation.

7.2.11 The RM Command

The RM command results in a display of the command menu for the Gauge

r0 = Display serial no. & firmware version.
r1 = Toggle 'report raw vs. averaged data' flag.
r2 = Toggle 'rounding enable' flag.
rC = Update configuration.
rD = Toggle 'output details' flag.
rF = Enable frequency fill for next calibration or zero.
rH = Toggle state of orifice heater relay.
rI = Initialize configuration.
rJ = Toggle 'output inhibit' flag.
rL = Poll for output data.
rM = Display menu (this).
rN = Display general configuration parameters.
rR = Reset system.
rS = Start a 'span' calibration.
rV = Display Sensor and calibration parameters.
rX = Abort a calibration in progress.
rZ = Start a 'zero only' calibration.

Figure 7.2.9 Results of RM Command

7.2.12 The RN Command

The RN command displays the Gauge configurable parameters.

```
Serial number . . . . . 78
Baud rate . . . . . 19200
Enable RS-485? (Y/N) . . . . . N
Enable Memory Stick Logging? (Y/N) . . . . . Y
Two Digit Year (20xx) . . . . . 11
Month . . . . . 4
Day of the month . . . . . 12
Hour . . . . . 15
```

```

Minutes past the hour . . . . . 52
Reporting interval (seconds) 0 for polled mode, 2-3600 . . . 2
Report in Metric Units? (Y/N) . . . . . N
Enable Units Reports? (Y/N) . . . . . N
Enable CSV compatible option? (Y/N) . . . . . N
Averaging interval (in seconds) . . . . . 60
Enable extended output message? (Y/N) . . . . . Y
Show ambient and orifice temperatures? (Y/N) . . . . . Y
Show ping amplitudes? (Y/N) . . . . . N
Enable frequency fill function? (Y/N) . . . . . N
Size of history data base for Frequency Fill, 1 - 30 . . . 30
Enable Precipitation Rate Calculation (Y/N) . . . . . Y
Time span for Precipitation Rate (minutes) . . . . . 5
Select number of inlet heaters. (0-3), 0 = None . . . . . 3
Relay 'on' point, inches of precipitation . . . . . 0.004000
Time period for relay 'on' point (minutes) . . . . . 1
Averaging interval for relay 'on' point (minutes) . . . . . 1
Relay 'off' point, inches of precipitation . . . . . 0.003000
Time period for relay 'off' point (minutes) . . . . . 1
Averaging interval for relay 'off' point (minutes) . . . . . 1
Enable precipitation in heater control? (Y/N) . . . . . Y
Heater Relay Ambient Temperature Low Limit. (F) . . . . . 20.000000
Heater Relay Ambient Temperature High Limit. (F) . . . . . 59.000000
Heater Relay Inlet Temperature Low Limit. (F) . . . . . 49.000000
Heater Relay Inlet Temperature High Limit. (F) . . . . . 53.000000
Heater off to 1 heater dwell time (minutes) . . . . . 1
Heater 1 to 2 heater dwell time (minutes) . . . . . 2
Heater 2 to 3 heater dwell time (minutes) . . . . . 2
Heater 3 to full on dwell time (minutes) . . . . . 1
Enable daily heater test? (Y/N) . . . . . Y
Heater daily test on time (minutes) . . . . . 10

Heater daily test highest temperature. (C) . . . . . 2.000000

Enable heater report? (Y/N) . . . . . Y
Enable Precipitation detection on Relay 3? (Y/N) . . . . . Y

```

Figure 7.2.10 - Results of RN Command

7.2.13 The RR Command

The **RR** command causes the Gauge to reset and return to normal operational mode. The super user mode will be exited on this command

7.2.14 The RS command

The **RS** command begins a Gauge Span calibration process. This process sets the slope of the curve used to convert sensor frequency to inches of rain.

It is most important that the inches of rain found on the calibration weight set is correctly entered in the configuration process at the line:

"Inches of rain for span calibration 5.499900".

Span calibration is used to compensate for changes in the instrument due to time. Span calibration should be performed annually or whenever a Data Processing and Power Conditioning board or individual sensor or sensors are changed.

Make sure the bucket assembly is not moving before proceeding with the span operation.

Make sure the bucket contains only the preload weight and press ENTER:

Cal: 9 readings to go.
Cal: 8 readings to go.
Cal: 7 readings to go.
Cal: 6 readings to go.
Cal: 5 readings to go.
Cal: 4 readings to go.
Cal: 3 readings to go.
Cal: 2 readings to go.
Cal: 1 readings to go.

Make sure the calibration weight is the same as requested, then place in the bucket along with the preload weight, **wait 1 minute for the weight change to be recognized** and press ENTER:

Cal: 9 readings to go.
Cal: 8 readings to go.
Cal: 7 readings to go.
Cal: 6 readings to go.
Cal: 5 readings to go.
Cal: 4 readings to go.
Cal: 3 readings to go.
Cal: 2 readings to go.
Cal: 1 readings to go.

Total preload weight: 35.786781
Total span weight: 18.618374

Calculated span factor: -0.320350
Commit calibration data to EEPROM? (Y/N) yy

Figure 7.2.11 - Results of RS command

7.2.15 The RV command

The **RV** command displays the configuration parameters and enabled functions in effect and is useful for logging the configuration of the Gauge after service.

```

Enable Precipitation detection on Relay 3? (Y/N) . . . . N
Terminal NZ (40) default . . . . . 40
Ping-to-read delay (32Mhz clocks) . . . . . 380
Lowest Ping Cycle (3) . . . . . 2
Medium Ping Cycle (9) . . . . . 4
Highest Ping Cycle (27) . . . . . 8
Lowest Amplitude Threshold (800) . . . . . 300
Medium Amplitude Threshold (1200) . . . . . 400
Highest Amplitude Threshold (1800) . . . . . 500
Temp. test qualifying range (0=disable) . . . . . 0
Temp. test validity range (0=disable) . . . . . 0
Sensor test max. tries to find top rung (0=disable) . . . 0
Enable Temperature Compensation in results? (Y/N) . . . . Y
Sensor 1 serial number . . . . . 364
Sensor 2 serial number . . . . . 351
Sensor 3 serial number . . . . . 352
Sensor 1 temperature compensation factor (x 10^6) . . . . 10.070000
Sensor 1 temperature at calibration (degrees C) . . . . . 21.900001
Sensor 1 first order coefficient (lbs/kHz^2) . . . . . 2.584433
Sensor 1 second order coefficient (lbs/kHz^4) . . . . . 0.013647
Sensor 2 temperature compensation factor (x 10^6) . . . . 9.800000
Sensor 2 temperature at calibration (degrees C) . . . . . 20.379999
Sensor 2 first order coefficient (lbs/kHz^2) . . . . . 2.652690
Sensor 2 second order coefficient (lbs/kHz^4) . . . . . 0.013569
Sensor 3 temperature compensation factor (x 10^6) . . . . 7.230000
Sensor 3 temperature at calibration (degrees C) . . . . . 22.570000
Sensor 3 first order coefficient (lbs/kHz^2) . . . . . 2.666890
Sensor 3 second order coefficient (lbs/kHz^4) . . . . . 0.012997
Enable Tipping bucket on Relay 2? (Y/N) . . . . . N
Inches of rain for span calibration . . . . . 5.499900
Calibration weight at empty (lbs) . . . . . 10.389900
Calibration weight at span (lbs) . . . . . 20.419135
Calibration weight at zero (lbs) . . . . . 10.389415

```

Figure 7.2.13 - Results of RV command

7.2.16 The RX command

The **RX** command aborts a Span or Zero calibration process.

The calibration in progress is about to be aborted.

Proceed (Y/N)? y

Calibration aborted.

Figure 7.2.14 - Results of RX command

7.2.17 The RZ command

The **RZ** command begins a Gauge Zero operation, same as first part of the **RS** Span function. It returns the reported Weight and Inches to a zero value regardless of the weight in the bucket. It can be used to zero the gauge after service and antifreeze and oil have been added to the bucket.

It may take a few minutes for the Gauge to stabilize after a step change of weight in the bucket. You should wait until there is no bucket movement. At the end of the process, you will be prompted to store the results of the calibration in memory.

Place required oil and antifreeze in the bucket

Wait until the bucket is not moving before you press ENTER:

```
Cal:    9 readings to go.
Cal:    8 readings to go.
Cal:    7 readings to go.
Cal:    6 readings to go.
Cal:    5 readings to go.
Cal:    4 readings to go.
Cal:    3 readings to go.
Cal:    2 readings to go.
Cal:    1 readings to go.
```

Total 'zero' weight: 35.787609

Commit calibration data to EEPROM? (Y/N) yy

Figure 7.2.15 - Results of RZ command

7.3 Gauge Zero Calibration

If your gauge is a 1 sensor gauge, special considerations need to be taken for Zero Calibration. Contact the Belfort Factory for Instructions.

To perform a gauge zero calibration after servicing the accumulation bucket, first remove the rain gauge Exterior Housing. It is not necessary to disconnect power from instrument before beginning to service the bucket.

1. Carefully remove the bucket from the instrument. Empty the bucket per your servicing instructions and requirements. Care should be taken on the disposal of the water, antifreeze and oil mixture.
2. After the required antifreeze and oil mixture is replaced in the bucket, carefully put the bucket back into the gauge. Care should be taken to NOT

drop the bucket onto the support ring. Gently set the bucket down on the ring and make sure it is concentric with the bucket holder and equally spaced from the vertical frame supports.

3. Allow several minutes for the gauge to stabilize after inserting the oil and antifreeze.
4. Watch the instrument for any movement of the bucket. Any movement of the bucket during zero calibration will result in a bad calibration. If the bucket is moving due to the wind, the Exterior Housing will need to be reinstalled before completing the Zero Calibration.
5. The Zero operation can be initiated in two ways. The user can press the Zero Button on the main electronics unit to start the Zero Calibration. There are no outside visual indicators that the Zero calibration is running. (See location of the button in Section 5 of this manual). The Zero Calibration results are automatically stored in the gauge non-volatile memory.

Or the user can follow the following directions to initiate the Zero Calibration via the user interface.

Attach an RS232 terminal or PC to the Model 600/1000 AEPG Sensor Serial cable. Serial communications parameters are 19200, 8, N, 1, No parity.

6. The operator will need to become Super User. Press **Ctrl-V**. That is, press AND HOLD the "**Ctrl**" key, then press the "V" key. The Sensor will then ask for a password.

The Password is: **thunder**.

The password is not case sensitive.

```
Password? -> *****  
Password accepted, Operator is now Super User.
```

9. Type "**RZ**" to determine the new "Zero" for precipitation measurement.
10. Monitor the instrument as it performs the Zero Calibration. The output message will include the following status header:

```
[R]: PPP
```

If the header includes "S" characters in place of the "P" characters, then the sensors are not yet stable and the gauge will continue testing the sensors until all 3 sensors are stable.

Once the sensors are stable, the gauge will automatically complete the Zero calibration.

11. The following messages are examples of what the zeroed messages will look like. Note that the total inches fields should now be zero value. All other fields will contain different values than what is shown in the examples below.

Short Message.

[R]: PPP 15.518 0.000

[Rain Gauge]: Pass Pass Pass Total Weight Total Inches

Expanded Response Message.

[R]: PPP 20.752900 20.413451 20.772033 1369.873923 1375.108004 1363.928556
5.179896 5.216588 5.111676 15.517 0.000

[Rain Gauge]: Pass Pass Pass Temp 1 Temp 2 Temp 3 Freq 1 Freq 2 Freq 3
Wt 1 Wt 2 W3 Total Wt Total Inches

12. If the External Housing has not yet been reinstalled on the gauge, then now reinstall the Exterior Housing back onto the rain gauge.

13. It is recommended to upload the Configuration Parameters of the instrument after calibration. Using the file capture function of the terminal emulation program, enable file capture. Execute the "RN" command. This uploads all configurable parameters. This file should be kept for future reference or use, in case the configuration stored in the instrument is lost.

14. Type "RR" or power cycle to reset the gauge to normal service.

15. Connect the serial cable to the data logger or data capture device.

7.4 Span calibration

If your gauge is a 1 sensor gauge, special considerations need to be taken for Span Calibration. Contact the Belfort Factory for Instructions.

To perform a gauge span calibration, first remove the rain gauge Exterior Housing.

Watch the instrument for any movement of the bucket. Any movement of the bucket during calibration will result in a bad calibration. If the bucket is moving due to the wind, the Exterior Housing will need to be reinstalled before each calibration step and then removed to allow access to the bucket to insert or remove any of the calibration weights.

Attach an RS232 terminal or PC to the Model 600/1000 AEPG Sensor Serial cable. Serial communications parameters are 19200, 8, N, 1, No parity.

The operator will need to become Super User. Press **Ctrl-V**. That is, press AND HOLD the "Ctrl" key, then press the "V" key. The Sensor will then ask for a password.

The Password is: **thunder**.

The password is not case sensitive.

Password? -> *****

Password accepted, Operator is now Super User.

1. Check configuration parameter file to "Disable the Frequency Fill" function and to verify that the total weight of the calibration weight set parameters are correctly entered in the configuration menu.

Enter the "RC" command. Press "Enter" to advance to the line "Enable frequency fill function? (Y/N)". Press the backspace key to backspace out the "Y" and type "N", then the Enter key.

Press ENTER to skip parameters lines until the following line is displayed.

"Inches of rain for span calibration 5.4999000".

If the value displayed in the line is correct, or the same inches of rain value as marked on the calibration weight in the calibration kit being used, press the "ESC" key to exit the FC command. Type "Y" to store the new information.

If the value in the "Inches of rain for Span Calibration" parameter is incorrect, press the backspace key to remove the incorrect value. Enter the correct value based on the value provided with your calibration kit.

Then press the Enter key, then the ESC key, to get to the end of the configuration menu. Type "Y" to store the new information.

2. Make sure the bucket is empty and dry. Insert the pre-load stabilizing weight into the center of the bucket. The stabilizing weight is the small five-pound weight provided in the calibration kit.

Note: After step changes of weight in the bucket, it will take up to 10 seconds for the gauge to stabilize. During that time, you may see the "Cal Delayed: Not all sensors ready". As soon as all the sensors are stabilized, the calibration will continue. A mechanical perturbation of the gauge can result in the same condition.

3. Disable averaging by typing on the PC terminal the R1 command. This command will toggle averaging off.

4. Type "RS" to begin the span calibration. The Gauge will first calculate a zero weight, which will include the stabilizing weight in the bucket. It may take up to 10 seconds for the Gauge to stabilize after the step change of adding weight in the bucket. Wait for the gauge to complete its measurements and display the prompt **"make sure the calibration weight is the same as requested, then place in the bucket along with the preload weight and press ENTER:"**.

5. Now add the calibrated 10-pound weight provided in the calibration set into the bucket, taking care to avoid any off center placement of the weights and press the **ENTER** key.

6. At the end of the process, you will be prompted to store the results of the calibration in memory.

Commit calibration data to EEPROM? (Y/N) Type "Y".

7. Remove all weights from the bucket.

Note: After step changes of weight in the bucket, it will take several minutes for the gauge to stabilize. During that time, you will see the "Cal Delayed: Not all sensors ready". As soon as all the sensors are stabilized, the calibration will continue. A mechanical perturbation of the gauge can result in the same condition.

8. Add one gallon 60%/40% methanol/propylene glycol plus 400ml or one pint of Automatic Transmission Fluid (ATF), or one gallon of water and one pint ATF. Allow several minutes for the gauge to stabilize after inserting the oil and antifreeze.

9. Type **"RZ"** to determine the new "Zero" for precipitation measurement.

10. Monitor the instrument as it performs the Zero Calibration. The output message will include the following status header:

[R]: PPP

If the header includes "S" characters in place of the "P" characters, then the sensors are not yet stable and the gauge will continue testing the sensors until all 3 sensors are stable.

Once the sensors are stable, the gauge will automatically complete the Zero calibration.

11. The following messages are examples of what the zeroed messages will look like. Note that the total inches fields should now be zero value. All other fields will contain different values than what is shown in the examples below.

Short Message

[R]: PPP 15.518 0.000

[Rain Gauge]: Pass Pass Pass Total Weight Total Inches

Expanded Response Message

(with US units of measurements enabled, Ambient and Orifice temp, Sensor amplitudes, heater status and Precipitation rate functions turned off)

[R]: PPP 20.752900 20.413451 20.772033 1369.873923 1375.108004 1363.928556
5.179896 5.216588 5.111676 15.517 0.000

[Rain Gauge]: Pass Pass Pass Temp 1 Temp 2 Temp 3 Freq 1 Freq 2 Freq 3
Wt 1 Wt 2 W3 Total Wt Total Inches

12. Enable averaging by typing the R1 command, which toggles averaging on.
13. Enable frequency fill by typing "RC" to enter the configuration menu. Then type ENTER to advance to the line "Enable frequency fill function? (Y/N)", backspace out the "N" and type "Y", "CR", ESC, to get to the end of the configuration menu. Type "Y" to store the new information
14. Reinstall the rain gauge Exterior Housing back onto the rain gauge.
15. It is recommended to upload the Configuration Parameters of the instrument after calibration. Using the file capture function of the terminal emulation program, enable file capture. Execute the "RN" command followed by the "RV" command. This uploads all configurable parameters. This file should be kept for future reference or use, in case the configuration stored in the instrument is lost.
16. Type "RR" to reset the gauge to normal service.
17. Connect the serial cable to the data logger or data capture device.

8.0 Additional Optional Outputs

If the AEPG Model 600/1000 has a heater control module installed on the gauge, the gauge has the capability of providing additional optional control outputs.

Mode 1

Three relays are used to modulate the heaters and no additional outputs are available.

Mode 2

Relay 1 is used with external high current relay to modulate heaters.
Relay 2 is utilized for a tipping bucket output.
Relay 3 is not used.

Mode 3

Relay 1 with external high current relay to modulate heaters.
Relay 2 is not used.
Relay 3 is used to signal presence of precipitation.

9.0 Memory Stick Logging

(This section still under construction and all information provided in this section should be considered PRELIMINARY.)

If the AEPG Model 600/1000 has a heater control module installed on the gauge, and the Memory Stick Logger option was purchased, the unit will be

able to save the ASCII output message string to a unique day labeled text file. The stored message will be the same message format and structure as the output message being sent to the two serial ports.

The Memory Stick storing can be started or stopped by enabling or disabling the Memory Storage Enable option in the Configuration Parameters. Access the configuration parameter function as described in Section 7.1. Initiate the "RC" command as described in Section 7.2.5. Press the enter key once at a time until the following line appears:

```
Enable Memory Stick Logging? (Y/N) . . . . . N
```

To enable the logging, Backspace once and change the N to Y, then press "enter".

To disable the logging, Backspace once and change the Y to N, then press "enter".

If enabled, update the logging start date as follows:

For the next 5 entries, update the existing values to the current date and time. Use the Backspace key and enter the new values followed by the "enter" key.

```
Two Digit Year (20xx) . . . . . 11
Month . . . . . 4
Day of the month . . . . . 12
Hour . . . . . 15
Minutes past the hour . . . . . 52
```

Once the date and time information has been entered, press the "ESC" key and reply with "Y" to save configuration the EEPROM.

With the unit powered up, press and hold the Memory Stick Control Button shown on the Digital Processor and Signal Conditioning Unit (P/N 36090). When the Memory Stick Safe LED comes on, it is safe to insert the memory stick into the Memory Stick USB Connector on the bottom edge of the Heater Control Module. Release the Memory Stick Control Button after the Memory Stick has been inserted.

To remove a memory stick press and hold the Memory Stick Control Button shown on the Digital Processor and Signal Conditioning Unit (P/N 36090). When the Memory Stick Safe LED comes on, it is safe to remove or replace the memory stick into the Memory Stick USB Connector on the bottom edge of the Heater Control Module. Release the Memory Stick Control Button after the Memory Stick has been removed or a new unit inserted.

The Memory Stick Safe LED will flash with each output message.

If the Date parameter has been entered, the date of file capture will be added at the start of the data in the file.

The stored date parameter is volatile. The date is the starting date of the capture sequence. For each day since the capture was started, a numbered folder will be created on the memory stick starting with "01" and incrementing up one count for each day since the start of capture.

Each file will be named as follows:

RAIN0215.TXT

Rain	(Rain Gauge Data File)
02	(Day number since capture started)
15	(Hour of the day that the capture data is from)
.TXT	(Data file extension---ASCII Text Data stored)

10.0 Firmware Upgrade

The Model AEPG 600/1000 Precipitation Sensor contains an in-circuit reprogrammable microprocessor. Occasionally, Belfort will release firmware upgrades that will add enhancements and new options to the instrument. Belfort will notify the customer of a firmware release and the importance of the revision.

The versions of firmware that may contain the Boot Loader are versions (4.4U 10/24/12) or later. If unsure that your unit contains the Boot Loader, contact the Belfort Factory for support.

Atmel AVR based products made by Belfort instruments can have code upgrades over their serial port 1 lines if they have been equipped with a Boot-loader program. This only works if the download device is connected to serial port 1.

The instrument should not require re-calibration after a firmware revision. But the customer can re-calibrate as an option at their choice to be done after firmware revision.

The customer will need to access the instrument and disconnect the monitoring equipment. Then connect directly to the instrument serial port with a PC and perform the firmware upgrade procedure. This download operation is not intended to be done across a customer's network.

Belfort strongly recommends that you record the AEPG configuration before attempting to upgrade the firmware. The configuration can be recorded by using the data capture function of Hyper-terminal or other terminal emulation program. Performing the FC command and entering Enter key for each line will dump the configuration to be captured to a text file. Belfort maintains copies of the original configuration of the unit as it was when the gauge was shipped from the factory. We will not have documentation of any changes made to the configuration parameters after shipment.

If the customer wants the upgrade but does not want to perform the Firmware Upgrade Procedure themselves, the main electronics unit of the instrument will need to be returned to the Belfort factory.

The following procedure is the method to reprogram the processor.

Equipment required

The following equipment is required to perform the programming. The equipment list is:

1. PC with a serial communications link to the device to be upgraded.
2. New code image to be downloaded (Supplied by Belfort).
3. HyperTerminal or equivalent terminal emulation.

Set Up

The Hyper-terminal program needs to be set so that typed characters are echoed locally. Line delay needs to be 40 milliseconds and character delay needs to be 0.

To get to the screens that control these delays the user needs to disconnect, then click File>Properties. Click the upper tab that says Settings. Click on the box that says "ASCII Setup." The choices of delays and the echoing will be presented there. When done, the user will need to click OK to establish the changes. Click the telephone icon to go back on line.

The Boot-loader is entered after running the application. The process will retain the same serial port set ups that the application is configured for, so no changes need be made to the terminal setup.

Programming process (code upgrade)

The programming process has several steps that may seem pointless, such as attempting to reset when not a super user. This has been done to prevent accidental entry by a user into the Boot-loader code. The steps must be done in the order described below else entry into the boot loader code will not be possible.

1. Establish communications with the device to be reprogrammed.
2. To start the process the user must NOT be logged in as a super user.

13. When the download has completed, the boot loader will post "LoadOK." If it does not, retry starting with step 9. If the boot-loader reports "BADSTR" or fails a second time, contact the Belfort Factory for support.
14. To start or execute the code that has just downloaded type "E". The Rain Gauge application should start or post an error. If the error is posted, the application must be erased and reloaded by redoing this procedure from step 9. If it fails or posts an error a second time, contact the Belfort Factory for support.
15. When the Rain Gauge sign-on message appears, it should contain the firmware revision information. Confirm that the displayed revision information matches the information provided with the load file. If the revision information is different, contact the Belfort Factory for support.

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