260-2595

User Manual

260-2595

Rain Gauge Calibrator

Phone (530) 823-7185
Email nova@novalynx.com **Website** www.novalynx.com

Receiving and Unpacking

Carefully unpack all components and compare to the packing list. Notify NovaLynx Corporation immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. Damages to equipment sent via Parcel Post or UPS require the consignee to contact NovaLynx Corporation for instructions.

Returns

If equipment is to be returned to the factory for any reason, call NovaLynx between 8:00 a.m. and 4:00 p.m. Pacific Time to request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage or additional damage during the return shipment. Call NovaLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available take the equipment to the nearest Post Office, UPS, or other freight service and obtain assistance with the packaging. Please write the RA# on the outside of the box.

Warranty

NovaLynx Corporation warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. NovaLynx Corporation's obligations under this warranty are limited to, at NovaLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall NovaLynx Corporation's liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by NovaLynx Corporation, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

Address

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CONTENTS

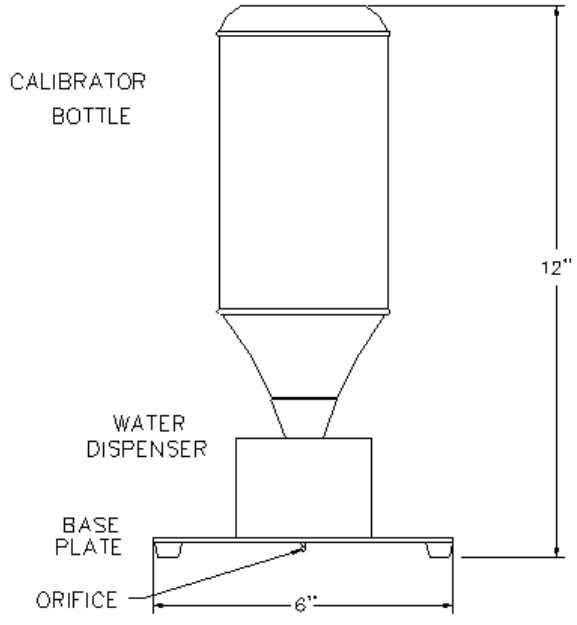
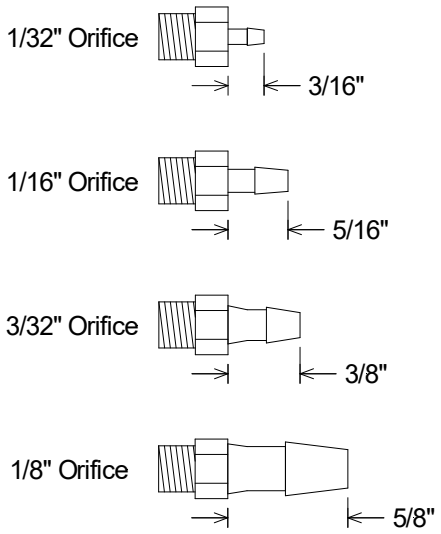
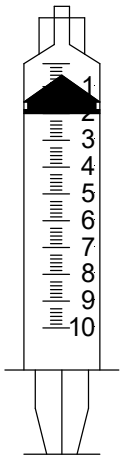
1 FORWARD

Thank you for purchasing NovaLynx products. NovaLynx has been designing and manufacturing weather instruments since 1988. NovaLynx represents several well-known brands of quality manufacturers, including Gill Instruments, RM Young, Kipp & Zonen, and Vaisala. It is our hope that our products will meet all your monitoring requirements.

2 INTRODUCTION

The 260-2595 Rain Gauge Calibrator provides a measured and controlled flow of water into the rain gauge funnel to simplify the task of rain gauge calibration and verification. The NovaLynx Calibrator is unique in that the flow rate is adjustable by selecting from 4 orifice sizes. Differing flow rates can be used to evaluate dynamic response of the tipping bucket above or below the calibrated rate. The included syringe is used to determine the amount of water required for the final rain bucket tip to complete each test.

3 COMPONENTS

Calibration Bottle Assembly	Nozzle Set	10 CC Syringe
		

NOTE: The orifices are made of a soft plastic and are easily damaged. Handle the base assembly carefully to protect the orifice after it has been installed. Whenever the base assembly is attached to the bottle, always place the bottom of the bottle onto the table (orifice pointing UP).

4 FLOW RATES

The orifice flow rate and volume of water determine how long it will take to run a calibration test. Starting with a smaller volume of water will shorten the test time for a quick calibration check. In general, the more water used the more accurate the test will be. The following chart estimates the time it takes to empty the bottle for various nozzles and starting volumes of water.

Orifice Diameter	Nom. Flow Rate (cc / minute)	Time to Empty (minutes)			
		150 cc	450 cc	750 cc	946 cc
1/32"	24	6.3	18.8	31.3	39.4
1/16"	70	2.1	6.4	10.7	13.5
3/32"	158	0.9	2.8	4.7	6.0
1/8"	361	0.4	1.2	2.1	2.6

5 NOZZLE SELECTION

Tipping bucket rain gauges are subject to a systematic mechanical error which is a function of rain intensity. The bucket takes a small time to tip, and during that time additional rain may enter the compartment. The error is non-linear, so a calibration curve is sometimes used to correct the data (See Appendix D).

The rain gauge can only be calibrated to one rainfall rate at a time, and accuracy falls off above and below that rate because of the systematic error. Average rain intensity varies by location. Government agencies may have information about average and maximum rainfall rates for your area.

The various nozzle sizes will produce corresponding simulated rainfall intensities. The gauge is calibrated to best accuracy at one "intensity", and then if desired can be checked at other rates using other nozzle sizes. Rain gauges manufactured by NovaLynx are all calibrated using the 1/16" orifice (red boxes). You may choose to calibrate for a different rain intensity based on your location.

Rain Gauge Inlet Diameter		Orifice Diameter				Rain Intensity
		1/32"	1/16"	3/32"	1/8"	
6	inch	3.11	9.06	20.46	46.75	inches/hour
8	inch	1.75	5.10	11.51	26.30	inches/hour
12	inch	0.78	2.27	5.12	11.69	inches/hour
6	inch	79	230	520	1187	mm/hour
8	inch	44	130	292	668	mm/hour
12	inch	20	58	130	297	mm/hour

6 USE AND CARE OF THE CALIBRATOR

6.1 Nozzle Installation

The nozzles are made of a soft plastic and are easily damaged. Inspect the orifice before installation to ensure it is not blocked with debris – rinse with water to flush out any obstruction. Align the threads carefully when installing the orifice in the base assembly. Tighten by hand only. If a nozzle is difficult to remove, use a soft cloth over the orifice while unscrewing by hand.

The nozzle usually projects beyond the rubber bumpers that support the base assembly, so do not set the base on any surface with the nozzle pointing down, as it will be damaged. Whenever the base assembly has been attached to the bottle, always place the bottom of the bottle onto the table (orifice pointing UP).

6.2 Water Measurement

The side of the calibration bottle is marked in various units including milliliters (ml)*. In addition, a black mark has been added at the 946 ml level. NovaLynx uses the 946 ml level for all final calibrations.

To fill the bottle, unscrew it from the base and fill to the desired level using the markings on the bottle, or fill from a graduated cylinder. The syringe may be used to add the last bit of water to bring the level to the correct mark. Another method is to use a digital scale capable of measuring in grams. (One gram = 1 cc = 1 ml. Be sure to deduct the weight of the bottle.)

Invert the base assembly over the bottle and engage the threads. Do not force the parts together or over-tighten to avoid damaging the bottle.

6.3 Technique for Inverting the Calibrator

The bottle must be turned over **quickly and smoothly** to avoid losing any water. Water can escape from the nozzle and from the slots in the top of the water dispenser. Use your fingertip to keep water from squirting out of the nozzle while turning the Calibrator over. Hold the Calibrator over the rain gauge while inverting it so that any water escaping from the slots is captured in the rain gauge. Practice a few times to get the technique. When placing the Calibrator into the rain gauge funnel, angle the bottle axis so that the water stream hits one side of the funnel rather than streaming directly through the funnel.

6.4 Storage after Use

With a little care the Rain Gauge Calibrator will last for many years. The most delicate components are the nozzles. Before storing or transporting the Calibrator, remove the nozzle from the base and return it to the bag with the other nozzles.

Unscrew the bottle from the water dispenser/base plate assembly and drain out any remaining water. If the syringe was used, remove the plunger and shake off excess water. Allow the parts to dry completely before replacing them in the storage box. Do not expose the syringe or bottle to continuous direct sunlight as this may degrade the plastic.

** In this manual milliliters (ml) and cubic centimeters (cc) are used interchangeably.*

7 CALIBRATION TEST PROCEDURE

For best results, be sure you have read and understand the following steps before you begin your calibration tests. Specific instructions are given for testing and adjusting rain gauges manufactured by NovaLynx. Rain gauges made by other manufacturers may be different and require some adaptation of these instructions.

NOTE: *Make a photocopy of the Calibration Worksheet (Appendix E) for recording your test results.*

7.1 Use of Calibration Table

The Calibration Table in Appendix B lists rain gauges manufactured by NovaLynx along with a few other selected models. If your rain gage is listed then look up the calibration factor, CC's per tip, and number of tips expected for a given test volume. Record these numbers on the Calibration Worksheet. If your rain gauge is not listed in the chart, see Appendix C which lists useful formulas.

7.2 Automated Counting

Automated counting is definitely the preferred way to determine the number of tips per test run. The NovaLynx 260-2598 Pocket-Size Digital Event Counter is a simple solution. In this application, the rain gauge being tested is disconnected from your usual monitoring device and connected to the two screw terminals on the Event Counter. The reset button on the counter clears the count to zero before each test. The readout counts tips, so there is no need for any calculations.

NOTE: Skip to section 7.3 if you are using the Digital Event Counter to count tips.

If you do not have a Digital Event Counter you may be able to test using the weather station to which the rain gauge is connected. Be aware, however, that a side effect of using already-connected monitoring equipment is that the tests will be recorded with your other data, possibly throwing off the yearly totals, etc. Adapt the following guidelines as needed:

1. Follow the instructions in **Section 7.3** to prepare the rain gauge for testing.
2. Wait until the station has reported fresh data (to ensure that any extra tips caused by cleaning the unit are counted before the test begins). Record the Rain before Test number.
3. Follow the instructions in **Section 7.4** to run the calibration test.
4. Wait until the station has reported fresh data (to ensure that all the water from the Calibrator bottle is counted). Record the Rain after Test number.
5. Calculate the amount of rain received:
   Amount = Rain after Test – Rain before Test
6. Calculate the number of tips:
   Tips = Amount / Calibration Factor

Example: **Rain before Test 4.19 inches**
Rain after Test 5.32 inches

Amount = 5.32 – 4.19 = 1.13 inches
Tips = 1.13 inches / 0.01 inches per tip = 113 tips

7.3 Rain Gauge Preparation

WARNING: Heated rain gauges are usually connected to high voltage sources. To avoid the risk of electrical shock and possibly death, disconnect all high voltage sources from the rain gauge BEFORE approaching the rain gauge.

1. **Disconnect any high voltage source from the rain gauge.**
2. Remove the top screen (if any) and set it aside. It will not be needed during the test.
3. If the rain gauge is NOT a NovaLynx model, test-fit the Calibrator by inverting it and setting it in the funnel of the rain gauge. Ensure the nozzle is not resting on the funnel (which might damage the nozzle or slow the flow rate). If the Calibrator does not fit the funnel then some ad hoc adjustment will be needed.
4. **Note regarding heated rain gauges:** The thermostat in the NovaLynx heated rain gauge is attached to the funnel of the rain gauge. Remove the funnel carefully and unplug the thermostat so that the thermostat support bracket is not damaged during removal.
5. Disassemble and clean out any debris in the funnel, tipping bucket mechanism, or drain holes according to the recommendations in the rain gauge's instruction manual. Ensure the buckets move freely and are clear of any sediment. **Warning: watch out for spiders that may be nesting in the rain gauge.**
6. Inspect the calibration adjustment screws which are below the tipping bucket. Make sure the top of each nylon bumper is clean (wipe with a clean cloth) and that the area where it contacts the bottom of each bucket is also clean. Debris, oils, or anything that is even slightly adhesive will greatly affect the calibration results. Using finger pressure only, make sure the jamb nut is snug enough to keep the calibration screw from turning. If it is at all loose then the calibration is probably already in error. Tighten the nut only if necessary, making sure the bumper does not rotate while doing so.
7. **Important:** Level the rain gauge according to the recommendations in the rain gauge's instruction manual.
8. Connect the 260-2598 Pocket-Size Digital Event Counter or other monitoring device to the rain gauge. Tip the bucket back and forth manually and verify that one tip is registered on the counter for every tip of the bucket.

7.4 Run a Calibration Test

1. Re-assemble the rain gauge so that the funnel is in place, but do not install the upper screen (NovaLynx models).
2. Select the appropriate nozzle for your test and install it in the Calibrator base.
3. Fill the Calibrator bottle to the amount required for the test (usually 946 ml).
4. Reset the counter to zero. If using other monitoring equipment read the Rain before Test amount and record it.
5. Invert the Calibrator over the funnel, making sure any spills fall into the rain gauge.
6. Monitor the counter to ensure the test is running properly. For longer runs the unit can be left to count providing that nothing disturbs the instrument during the test.

7. At the end of the test, lift the Calibrator slightly while holding it over the rain gauge. Tilt and rotate the Calibrator until all the water remaining in the water dispenser area escapes into the rain gauge. Be careful not to bump or tap on the rain gauge as this may cause an extra tip of the buckets. Record the number of tips collected on the Calibration Worksheet. If using other monitoring equipment read the Rain after Test amount and record it.

7.5 Interpret the Results

1. Compare the number of tips registered on the Digital Event Counter with the expected number of tips shown in the Calibration Table (Appendix B). Calculate the percent of error as follows:

   (Tips Counted (from Counter) – Tips Expected (from Table)) / Tips Expected * 100 = % error

   Example:

Rain Gauge Model	260-2500	
Test Volume	946 ml	
Tips Expected	114.8	
Tips Counted	113	(example)

   (113 – 114.8) / 114.8 * 100 = -1.57% error

2. If the results are satisfactory, then the rain gauge can be re-assembled and connected as before. If the results are out of specification then a calibration adjustment or factory service may be required. Note: a rain gauge can be calibrated to specified accuracy at one nozzle size. The error will be greater at other nozzle sizes according to the calibration curve (Appendix D).
3. Observant persons may note that the Tips Expected is not a whole number, whereas the counter can only register whole counts. One can measure the amount of water required to finish the final tip of the bucket using the syringe. Carefully remove the rain gauge cover or funnel so that you can see the tipping bucket assembly. Use the syringe to add water a little at a time to determine how much water is needed to complete the final tip. Calculate the amount of water that was in the bucket before the tip using the following:

   (cc's per tip – cc's added) / cc's per tip = decimal part of tip remaining

   Example:

Tips Counted	114	(example)
Cc's per tip	8.24	(from Calibration Table)
Cc's added	5	(example)

   (8.24 – 5) / 8.24 = 0.39 (decimal part of tip remaining)
   In this example, 114.39 tips would have been registered if the counter was capable of measuring the fraction.

8 CALIBRATION ADJUSTMENT

If the calibration test indicates the rain gauge is out of specification, the unit may be returned to NovaLynx for refurbishment and calibration. If the error is small then the user may wish to adjust the calibration on-site by making small adjustments to the calibration screws, then re-testing and continuing the process until the rain gauge is within specification.

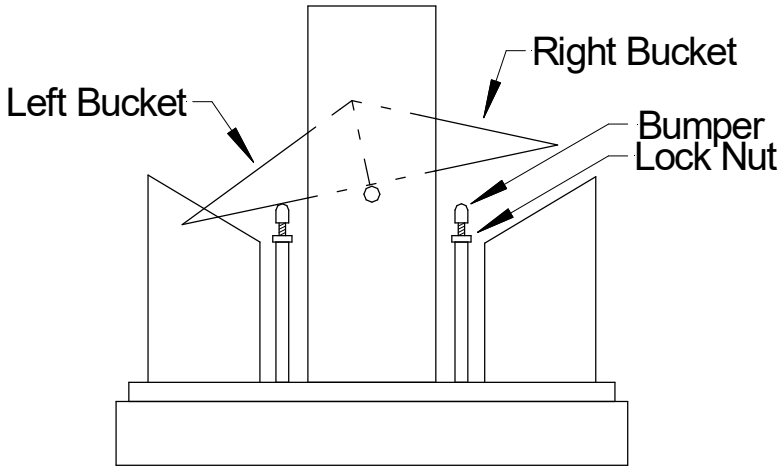
The following instructions and illustrations apply to NovaLynx rain gauges. Other manufacturer's equipment may require different techniques. Series 260-2500 rain gauges are adjustable from inside because the locking nut is on a post below the bumpers (see illustration below). The adjustment screws and locking nuts for Series 260-2501 rain gauges are only accessible from underneath the rain gauge so it may be necessary to dismount the whole assembly to perform a calibration.

To change the height of a calibration bumper:

1. Hold the bumper so that it cannot turn while loosening the lock nut.
2. Rotate the screw to raise or lower the bumper (the screw has a normal right-hand thread).
3. Hold the bumper so that it cannot turn while tightening the lock nut. Do not over-tighten.

8.1 Balance Adjustment

It is important that the amount of water required to tip the bucket mechanism is the same for both buckets. Usually this is attained when both calibration bumpers are at the same height. However, small variations in the bucket assembly may skew the balance. The syringe is used to measure the amount of water required to tip each bucket.



"Left Bucket" and "Right Bucket" are relative to the operator's position during testing only.

1. Remove the funnel and body of the rain gauge so that the base and tipping buckets are accessible.
2. Make sure the rain gauge is level and free of debris.
3. "Wet" the buckets by running some water into each and allowing them to drain.
4. Fill the syringe with 10cc of water, being sure to expel any air bubbles.
5. Carefully add water to the upper-most bucket until it tips. The amount of water required is 10cc minus the water remaining in the syringe. Record the amount on the Worksheet.
6. Do the same for the other bucket and compare the results. If the two are equal (+/- 0.1 cc) then the balance is adequate.

7. If the buckets did not balance, refer to the results of your original calibration (Section 7.5).
   If the rain gauge is reporting **too many** tips, **LOWER** the bumper under the bucket that requires MORE water to tip.
   If the rain gauge is reporting **too few** tips, **RAISE** the bumper under the bucket that requires LESS water to tip.
8. Re-check and adjust the balance of the buckets until there is agreement within +/- 0.1 cc

8.2 Tip Count Adjustment

Now that the bucket balance has been adjusted it is important to maintain the balance while making calibration changes. Use a marking pen to place a dot or line on the side of each bumper that is facing you when looking at the left and right buckets. These marks will assist in keeping the amount of movement equal each time a change is made.

1. Run a calibration test according to the instructions in Section 7.4 and 7.5, recording the results on the Calibration Worksheet.
2. If the rain gauge is reporting **too many** tips, **LOWER** both calibration bumpers an equal amount.
3. If the rain gauge is reporting **too few** tips**, RAISE** both calibration bumpers an equal amount.
4. Record each adjustment (UP or DOWN) and the amount of turns (⅛, ¼, ½ turn, etc.) on the Calibration Worksheet.
5. Once the adjustment is made re-assemble the rain gauge and run another calibration test. If necessary continue making slight adjustments until the calibration is within the specified accuracy of the rain gauge.
6. If it is not possible to progressively improve the calibration with successive small steps, then there may be a mechanical cause such as bad bearings. To determine whether this is the case, do several calibration runs without changing the calibration bumpers. If the rain gauge is mechanically faulty the results will be inconsistent and out of specification. In this case return the sensor to NovaLynx for service.

9 PARTS & ACCESSORIES

Part Number	Description
16000200	32 oz Plastic Bottle
16000201	1/32" Orifice Diameter Nozzle
16000202	1/16" Orifice Diameter Nozzle
16000203	3/32" Orifice Diameter Nozzle
16000204	1/8" Orifice Diameter Nozzle
16000205	10cc Syringe
260-2598 (accessory)	Pocket-Size Digital Event Counter
260-2599 (accessory)	Pocket-Size Digital Event Counter
260-2103 (accessory)	Rain Logger with Display

260-2598 Digital Event Counter

260-2599 Digital Event Counter

260-2103 Rain Logger

APPENDIX A (GLOSSARY)

Definitions

Calibration Factor	The ratio of the volume of water per tip (count) of the tipping bucket to the volume entering the rain gauge at the inlet. Common calibration factors are 0.01 inches per tip or 1 mm per tip.
cc/tip	The actual volume of water that causes the bucket assembly to tip (1 count).
Inlet Diameter	The effective diameter of the top lip of the rain gauge which determines whether a rain drop falls inside the gauge.
Rain Intensity	The measure of the amount of rain that falls over time. The intensity is measured as the depth of water covering a given horizontal area (if none escapes) over a period of time. Units are commonly inches per hour or millimeters per hour.

APPENDIX B (CALIBRATION TABLE)

								Tips per test volume			
Manufacturer	**Series**	**Models**	**Inlet Diameter**		**Calibration Factor**		**cc / tip**	**150 cc**	**450 cc**	**750 cc**	**946 cc**
NovaLynx	2500	260-2500, 260-2500D, 260-2500E	8	inch	0.01	inch/tip	8.24	18.2	54.6	91.1	114.8
	2500M	260-2500M, 260-2500ME	8	inch	1	mm/tip	32.43	4.6	13.9	23.1	29.2
		260-2500M.2, 260-2500ME.2	8	inch	0.2	mm/tip	6.49	23.1	69.4	115.6	145.9
		260-2500M.25, 260-2500ME.25	8	inch	0.25	mm/tip	8.11	18.5	55.5	92.5	116.7
		260-2500M.5, 260-2500ME.5	8	inch	0.5	mm/tip	16.21	9.3	27.8	46.3	58.3
	2500-12	260-2500-12, 260-2500E-12	12	inch	0.01	inch/tip	18.53	8.1	24.3	40.5	51.0
	2500M-12	260-2500M-12.2, 260-2500ME-12.2	12	inch	0.2	mm/tip	14.59	10.3	30.8	51.4	64.8
		260-2500M-12.25, 260-2500ME-12.25	12	inch	0.25	mm/tip	18.24	8.2	24.7	41.1	51.9
		260-2500M-12.5, 260-2500ME-12.5	12	inch	0.5	mm/tip	36.48	4.1	12.3	20.6	25.9
	2501	260-2501-A	8	inch	0.01	inch/tip	8.24	18.2	54.6	91.1	114.8
	2501M	260-2501M-A	8	inch	1	mm/tip	32.43	4.6	13.9	23.1	29.2
		260-2501M-A.2	8	inch	0.2	mm/tip	6.49	23.1	69.4	115.6	145.9
		260-2501M-A.25	8	inch	0.25	mm/tip	8.11	18.5	55.5	92.5	116.7
	2505	260-2505	7.874	inch	0.01	inch/tip	7.98	18.8	56.4	94.0	118.6
RM Young	52202	260-52202, 260-52202H, 260-52203	6.3	inch	0.1	mm/tip	2.01	75	224	373	470
Davis	7852	260-7852	6.502	inch	0.01	inch/tip	5.44	28	83	138	174
		260-7852M	6.502	inch	0.2	mm/tip	4.28	35	105	175	221
	6463	260-6463, 110-WS-16RC	6.5	inch	0.01	inch/tip	5.44	28	83	138	174
Qualimetrics	6011	260-6011-A, 260-6021-A, 260-6011-C	8.214	inch	0.01	inch/tip	8.68	17	52	86	109
		260-6011-B, 260-6021-B, 260-6011-D	8.214	inch	0.1	mm/tip	3.42	44	132	219	277
Campbell	TE525	260-TE525	6.06	inch	0.01	inch/tip	4.73	32	95	159	200
		260-TE525WS	8	inch	0.01	inch/tip	8.24	18	55	91	115
		260-TE525MM	9.66	inch	0.1	mm/tip	4.73	32	95	159	200
Rainwise	260-0111	260-0111-A, 110-WS-25RG, 260-WS-32RG	8	inch	0.01	inch/tip	8.24	18	55	91	115
Gill	MetPak RG	ARG 100	10	inch	0.2	mm/tip	10.13	15	44	74	93
			Length	Width							
La Crosse	TX10U	110-WS-18RG, 110-WS-25RG-P	4.94	2.156	0.02	inch/tip	3.49	43	129	215	271

APPENDIX C (FORMULAS)

Formulas for calculating cc/tip (round inlet)

cc/tip = Surface area of inlet x Calibration Factor
where Surface area of inlet = pi x r^2

Example for 8" Rain Gauge with a 0.01"/tip Calibration Factor

1.	Convert 8" to cm	8" x 2.54 cm / inch = 20.32 cm
2.	Divide by 2 to find radius	20.32 / 2 = 10.16 cm
3.	Calculate surface area	pi x 10.16^2 = 324.29 cm^2
4.	Convert 0.01" to cm	0.01 x 2.54 = 0.0254 cm
5.	Calculate cc/tip	324.29 * 0.0254 = 8.237 cc/tip

Formulas for calculating cc/tip (square or rectangular inlet)

cc/tip = Surface area of inlet x Calibration Factor
where Surface area of inlet = length x width

Example for 2.156" x 4.94" Rain Gauge with a 0.01"/tip Calibration Factor

1.	Convert 2.156" to cm	2.156" x 2.54 cm / inch = 5.4762 cm
2.	Convert 4.940" to cm	4.940" x 2.54 cm / inch = 12.5476 cm
3.	Calculate surface area	5.4762 cm x 12.5476 cm = 68.7132 cm^2
4.	Convert 0.01" to cm	0.01 x 2.54 = 0.0254 cm
5.	Calculate cc/tip	68.7132 * 0.0254 = 1.745 cc/tip

Formula for calculating tips per test run

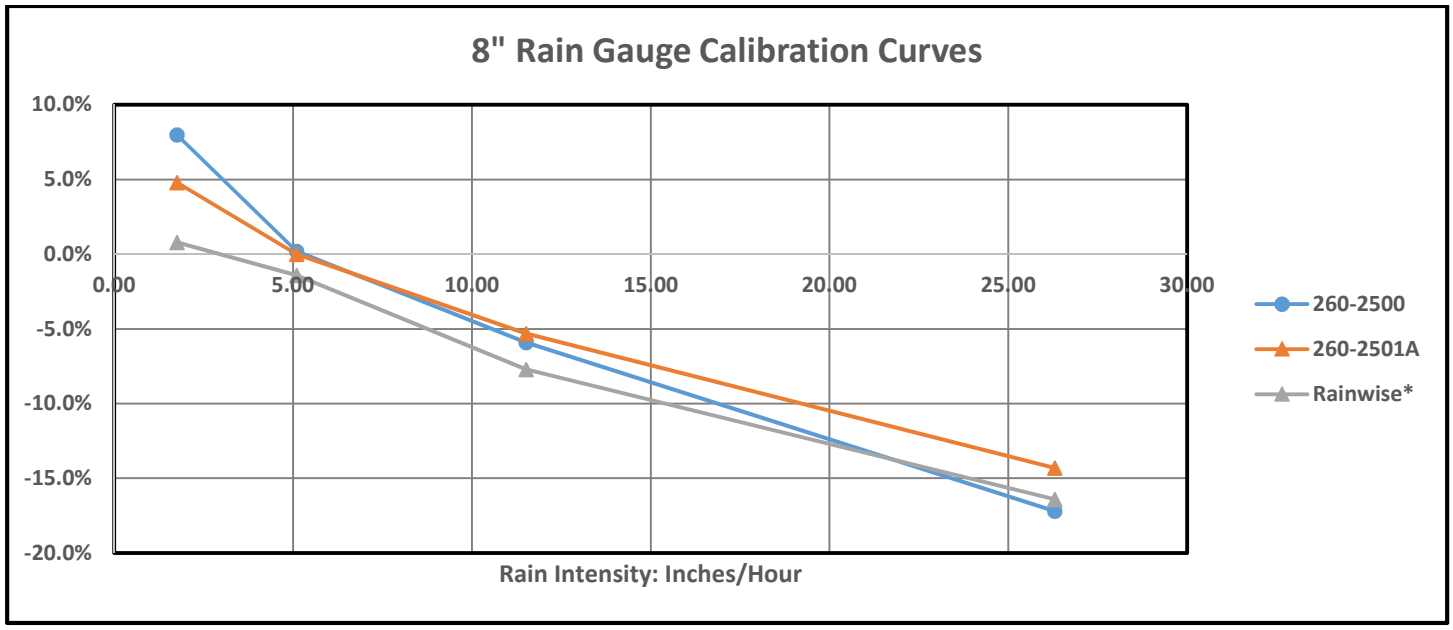
Total tips = Calibration Volume / cc/tip

Example for 8" Rain Gauge with a 0.01"/tip Calibration Factor
Given 946 cc Calibration Volume 946 / 8.237 = 114.8 tips

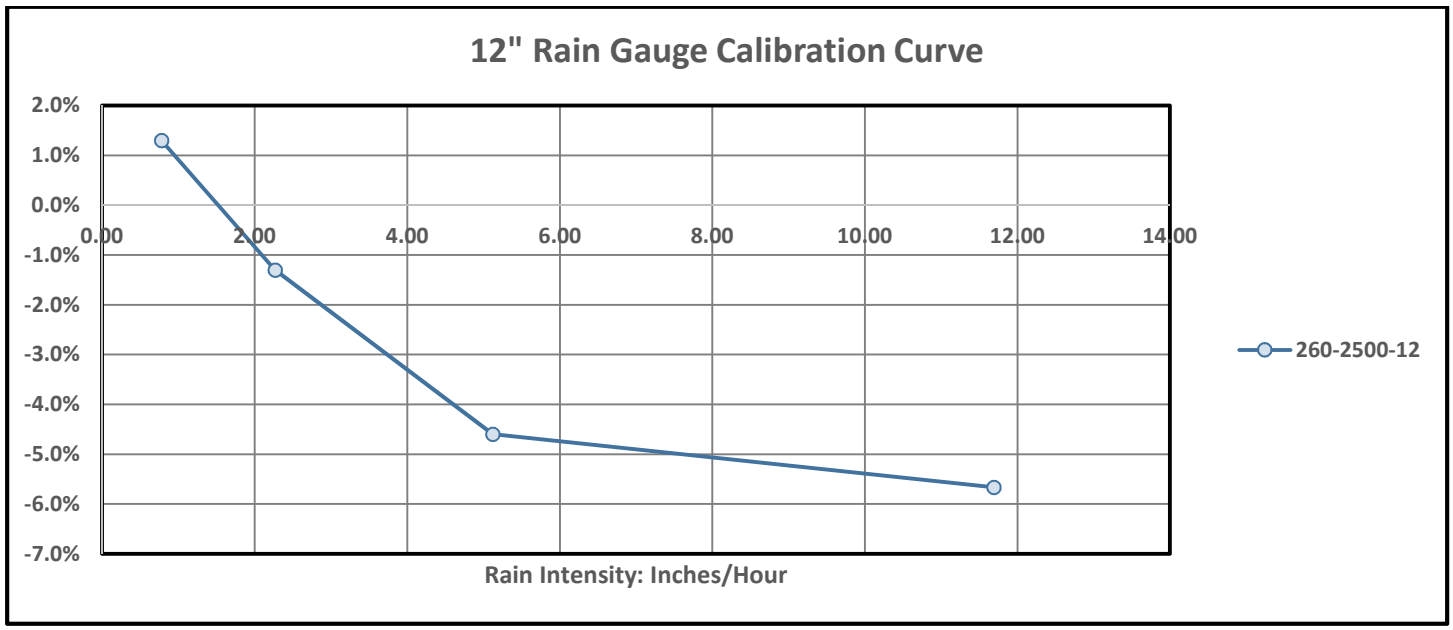
Formulas for calculating rainfall intensity (8" rain gauge example)

1.	1/16" Nozzle Flow Rate x 60 = cc's per hour	70 cc/min x 60 = 4,200 cc/hr
2.	cc's per hour / cc's per tip = tips per hour	4,200 / 8.24 cc/tip = 509.71 tip/hr
3.	Tips per hour x Calibration Factor = Rainfall Intensity	509.71 * 0.01 = 5.10 inches/hour

APPENDIX D (CALIBRATION CURVES)



* NovaLynx aluminum screen installed



APPENDIX E (CALIBRATION WORKSHEET)

Rain Gauge Model	
Serial Number	
Calibration Date	
Calibration Factor	**inch / mm** (circle one)
CC per tip (see chart)	

Test #	Orifice				Test Volume				Tips Measured	Tips Expected (from chart)	Error (subtract)	Error (percent)*	Adjustment Made			
	1/32	1/16	3/32	1/8	150 ml	450 ml	750 ml	946 ml					None	Up (ccw)	Down (cw)	Turns
example		x						x	113	114.8	-1.8	-1.57%		x		1/8
1																
2																
3																
4																
5																
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* Error % = Error / Tips Expected * 100