



MACH 10[®] Commercial and Industrial Ultrasonic Meter
Field Testing Guide



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FCC Notice

The device used for testing complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.

RF Exposure Information

The equipment related to the testing procedures in this guide complies with the FCC RF radiation requirements for uncontrolled environments. To maintain compliance with these requirements, the antenna and any radiating elements should be installed to ensure that a minimum separation distance of 20 cm is maintained from the general population.



Caution! Changes or modifications not expressly approved by the party responsible for compliance could void the users' authority to operate the equipment.

Professional Installation

In accordance with section 15.203 of the FCC rules and regulations, the Neptune endpoint must be professionally installed by trained installers. Changes or modifications not expressly approved by the party responsible for compliance void the user's authority to operate the equipment.

Industry Canada

The Class B digital apparatus related to the testing procedures in this guide meets all requirements of the Canadian Interference Causing Equipment Regulations. Operation is subject to the following conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

The device has been designed to comply with safety standards for exposure to radio waves (SAR) in accordance to RSS-102, and should be installed and operated with a minimum distance of 20 cm between the equipment and the user's body.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1. l'appareil ne doit pas produire de brouillage, et
2. l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet artifice a été conçu pour se plier à la sécurité les exigences pour l'exposition aux ondes radioélectriques (SAR) dans conformité avec RSS-102. Cet artifice devrait être installé et fait marcher avec la distance minimale 20 centimètres entre l'équipement et votre corps.

*MACH10[®] Commercial and Industrial Ultrasonic Meter
Field Testing Guide*
Literature No. FT MACH 10 02.2025

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This chapter provides general information on field testing, testing methods, and flow tests for the MACH 10[®] Commercial and Industrial (C&I) meter that includes 3-inch through 12-inch meters.

Field Testing

In a utility, large meters move the most water, so they in turn generate the most revenue. C&I MACH 10 meters maintain their accuracy over the life of the meter. You can optionally test MACH 10 meters with test ports or test spools to verify their accuracy in the field.

Testing Best Practices

Consider the following before testing the MACH 10 meter:

- Pressure immediately downstream from the meter must be at least 30 psi during testing. Cavitation can occur through a test port at flows lower than the maximum rated flow of the meter, especially at lower pressures. It is recommended that more than 30 psi is available in the pipe during testing. More pressure allows higher flow rates to be tested through the test port without cavitation.
- Air must be completely removed from the meter before testing begins through the bleed screw and by purging at high flow. Attaching a line to the test port can introduce air into the system.
- Perform at least three flows per meter, starting at the high flow.

Testing Methods

Accuracy is determined using a point of reference. Following are three common points of reference:

- Gravimetric – weight scale.
- Volumetric – calibrated tank.
- Calibrated reference meter– known good meters.

Gravimetric

- Uses a weight scale for measurement.
- Calibrate scale annually.
- Does not require a wet tank.



Gravimetric is recommended because it is the most accurate and repeatable way to measure water.

Volumetric

- Uses a visual sight glass for measurement.
- Calibrate volumetric tanks annually.
- Wet the tanks prior to conducting initial tests.
- Volumetric is not recommended due to its reduced capability to achieve repeatable measurements.

Reference Meter

This is the most common field testing method. The reference meter has its own level of error and accuracy deviation from nominal. Consider the measured accuracy of the reference meter in the accuracy calculation since mechanical reference meters are not 100% accurate across their entire flow range. Neptune recommends using a NIST traceable reference meter that is electronically calibrated and linearized across its entire flow range.

- Keep calibration certificates up to date on known good meters.
- Run a volume-to-volume comparison.
- Ensure the reference meter is capable of operating accurately at the flow rate chosen for low flow.

Things to Remember

Consider the following:

- Keep in mind that some reference meters cannot test the full range of a meter.
- The meter may experience cavitation at flows less than the maximum flow rate through the test port, especially if there is not ample pressure. The exact pressure for each flow rate varies by meter size and test setup.
- After purging, start at high flow, then intermediate, then low flow.
- Ensure isolation valves are fully sealed off and do not allow any unaccounted-for flow to seep through.
- Maintain minimum 30 psi at the reference meter to avoid cavitation. More pressure is preferred for higher flow rates because cavitation can occur at lower pressures through the test port.
- Remember that a reference meter that has not been electronically calibrated and linearized will not be accurate at all flow rates.
- Make sure the reference meter has an up-to-date calibration certificate.
- Make sure to follow reference meter setup recommendations.
- Ensure the reference meter's strainer is cleaned before testing. The strainer may get clogged during the initial purge due to debris dislodged during the valve movements.
- Ensure the discharge hose from the reference meter is at a higher elevation than the reference meter to keep the pipe full during testing.
- Ensure there is at least 3 feet (preferably more) of straight hose before the reference meter to dissipate the effects of swirling in the hose.

Equipment Needed

This section discusses the equipment needed to test the meter.

Recommended Tools

The following figure shows the recommended tools you need to perform the field testing on the MACH 10 meter.



Figure 1 – Tools Needed

The following table lists the recommended tools you need to successfully test the meter.

Table 1 – Recommended Tools

Item	Description / Recommendation	Use
Tool Kit	Contains standard tools including: <ul style="list-style-type: none">• Pipe wrenches.• Crescent wrench.• Hammer.• Pliers.• Phillips screwdriver for bleed screw adjustment.	Perform various installation procedures.
Flashlight	–	Activate the register LCD display, if necessary.
Ladder	–	Get into a deep pit.
Safety glasses	–	Protect eyes.

Chapter 2: Test Requirements

This chapter provides information on testing requirements for the MACH 10[®] meter.

Required Tests

Testing a MACH 10 meter requires a minimum of one each of the following three tests:

- High flow.
- Intermediate flow.
- Low flow.

Recommended Flow Rates

This section provides recommended flow rates and the recommended minimum volume for each test. The C&I MACH 10 sizes 3"-8" meets or exceeds AWWA Type I and Type II specifications. Only Type I specifications are shown for 3"-8" due to the stricter low flow accuracy requirements that can be met by the MACH 10. AWWA Type I is limited to 8" meters and below, so Type II flows are shown for 10" and 12" meters.



AWWA recommendations come directly from the AWWA M6 Manual. AWWA recommendations in Table 2 and Table 3 were specifically developed for bench testing. Due to the inherent variability associated with field testing, Neptune recommends doubling the test quantities for best results.

Table 2 – AWWA Recommended Test Specifications for Ultrasonic Meters (Type I ANSI/AWWA C715)

Size	Flow	Flow Rate (Gallons per Minute)	Test Quantity in Gallons	Test Quantity in Cubic Feet (ft ³)	Accuracy Limits (Percentage)
3	Full	200	500	50	100 +/-1.5
3	Intermediate	15	100	10	100 +/-1.5
3	Low	2.5	100	10	100 +/-5.0
3	Intermediate (alternate)	30	100	10	100 +/-1.5
3	Low (alternate)	7.5	100	10	100 +/-1.5

Table 2 – AWWA Recommended Test Specifications for Ultrasonic Meters (Type I ANSI/AWWA C715) (continued)

Size	Flow	Flow Rate (Gallons per Minute)	Test Quantity in Gallons	Test Quantity in Cubic Feet (ft ³)	Accuracy Limits (Percentage)
4	Full	400	1000	100	100 +/-1.5
4	Intermediate	20	500	50	100 +/-1.5
4	Low	3.5	300	40	100 +/-5.0
4	Intermediate (alternate)	40	500	50	100 +/-1.5
4	Low (alternate)	10	300	40	100 +/-1.5
6	Full	800	2000	200	100 +/-1.5
6	Intermediate	40	1000	100	100 +/-1.5
6	Low	9	300	40	100 +/-5.0
6	Intermediate (alternate)	80	1000	100	100 +/-1.5
6	Low (alternate)	20	300	40	100 +/-1.5
8	Full	1000	5000	500	100 +/-1.5
8	Intermediate	80	3000	400	100 +/-1.5
8	Low	18	2000	300	100 +/- 5.0
8	Intermediate (alternate)	160	3000	400	100 +/-1.5
8	Low (alternate)	40	2000	300	100 +/-1.5

Table 3 – AWWA Recommended Test Specifications for Ultrasonic Meters (Type II ANSI/AWWA C715)

Size	Flow	Flow Rate (Gallons per Minute)	Test Quantity in Gallons	Test Quantity in Cubic Feet (ft ³)	Accuracy Limits (Percentage)
10	Full	3,000	7000	900	100 +/-1.5
10	Intermediate	300	5000	500	100 +/-1.5
10	Low	50	3000	400	100 +/-5.0
12	Full	4000	10,000	1,000	100 +/-1.5
12	Intermediate	400	5000	500	100 +/-1.5
12	Low	65	3000	400	100 +/-5.0

- AWWA recommends relatively short tests. If poor accuracy results are achieved, consider doubling the length of the AWWA test.
- Ensure all digits on the register are recorded. Do not leave out digits on an accuracy test as this invalidates the test and can lead to failed results.

The previous tables provide the AWWA maximum flow rates and limits for ultrasonic meters in revenue applications (Type I and II ANSI/AWWA C715.) The flow rates are suggested test flows and test quantities. You can test for high rates of flow by testing the meter at 25% of the meter's flow rating (while maintaining the same test quantity), if the AWWA high flow cannot be attained with the test port.

Quantity should result in not less than three minutes running. When limited test capabilities force the use of smaller test quantities, the resultant increase in total test uncertainties and errors should be recognized when establishing acceptance criteria tolerance.

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This chapter provides information on testing the meter. The Commercial and Industrial MACH 10[®] has sustained accuracy over the life of the meter. The acceptable accuracy range can be determined specifically by each utility. However, potential error during in-field test setup should always be taken into account.

Introduction

The MACH 10 can include a test port, or you can use a spool with a test port downstream of the meter.



Figure 2 – MACH 10[®] with Integrated Test Port

The integrated test port or downstream test port allows a reference meter to be connected to the MACH 10.

Preparing to Test

This section provides steps to prepare a MACH 10 meter for testing. Unless integrated into the meter design, Neptune recommends locating the test port at least a 1x pipe diameter downstream of the meter for optimal results.

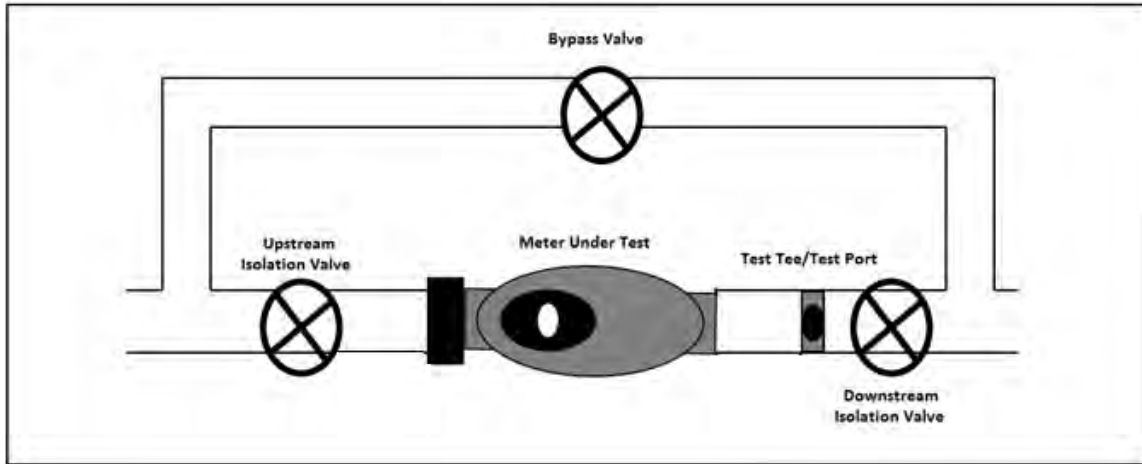


Figure 3 – MACH 10[®] Test Setup

1. Open the bypass valve.
2. Close the downstream isolation valve.

Now that the downstream isolation valve is closed, all water is moving through the bypass.



Usually, a permanent gate or ball valve is installed in the downstream test port.

3. Keep the valve on the test riser closed, and remove the test plug from the valve.



Figure 4 – Remove Test Plug

4. Purge the line before connecting the hose to the reference meter.
5. Ensure the inlet / strainer of the reference meter is clean and free of debris.



Figure 5 – Connect the Fire Hose to Meter Under Test

6. Connect the other end of the fire hose to the reference meter.
7. Ensure there is at least 3 feet or more of straight fire hose before the reference meter.

8. Connect a fire hose to the outlet of the reference meter. Ensure the fire hose outlet is elevated above the reference meter to keep the reference meter full of water.
9. Slowly open the valve on the test riser at the meter under test to pressurize the reference meter.
10. Open the high flow side of the reference meter.
11. Purge any air from the test setup at max flow before running the first test.



Figure 6 – Purge Air from Test Setup



The meter under test and the reference meter are at equal pressure, and testing can begin.

Testing the MACH 10[®] C&I Meter

This section provides steps to test the MACH 10 C&I meter.

1. Record the initial reading from the LCD display on the meter under test.



Figure 7 – Take the Initial Read from the MACH 10[®] Display

2. Record the initial reading from the display on the reference meter.



Figure 8 – Display on Reference Meter

3. Run the maximum flow test first until the volume shown in the tables on pages 5 through 8 has been accumulated. Run the test for a minimum of three minutes.
4. If the meter appears to be under-registering, make sure the downstream isolation valve is fully closed. Do this by opening and closing the valve several times to break loose any buildup on the valve seat.
5. Record the consumption from the meter under test.
6. Record the consumption from the reference meter.
7. Calculate the accuracy using the formula $[(\text{Consumption of MUT})/(\text{Consumption of Ref Meter})]$.
8. Repeat these steps for the intermediate and low flow tests.

After the Test is Complete

After completing the test, back flush the line to avoid sending dirty water to the customer.

1. Close the test riser.
2. Close the inlet valve of the meter under test.
3. Reopen the inlet valve upstream of the meter under test.
This breaks up any debris built up on the seat of the isolation valve upstream of the meter.



Figure 9 – Inlet Valve

4. Slowly open the test riser.

5. Open the high side of the reference meter to back flush the meter.



Figure 10 – Back Flushing the Meter

6. Run until the water coming out of the reference meter turns from brown to clear.



Figure 11 – Color of Back-Flush Water



Figure 12 – Clear Water after Back Flush

Breakdown and Cleanup

1. Close the valve at the test riser attached to the meter under test.



Figure 13 – Test Riser Valve Attached to Meter Under Test

2. Open the high side valve on the reference meter slowly.



The reference meter and the fire hose running from the meter under test to the reference meter are depressurized.

3. Inspect the pressure gauge at the reference meter to make sure all pressure is vented before disconnecting the fire hose.



Figure 14 – High Side Valve on Reference Meter

4. Disconnect the fire hose from the test riser and the reference meter and remove it from the test site.

5. Open the isolation valve downstream of the meter under test.



Figure 15 – Isolation Valve - Downstream of the Meter Under Test

6. Close the bypass valve.
Full service is restored to the meter monitoring the site.



Figure 16 – Bypass Valve

7. Ensure the LCD on the meter under test is registering flow.

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This chapter provides information on how to run a successful test. See the *MACH 10[®] Commercial and Industrial Installation and Maintenance Guide* for instructions on installing and maintaining the meter.

Before and During the Test

Before and during a test, do the following:

- Start with high flow and then move to intermediate and low flow for new and used meters.
- Ensure all digits on the LCD display are used in the accuracy calculation.
- Check the pressure gauge at the reference meter to be sure it maintains at least 30 psi to avoid cavitation, which causes faulty results.
- Require calibration certificates for all reference meters. If the reference meter is inaccurate, then it shows the meter under test to be inaccurate.
- Check all connections, hoses, and meters for any leaks. Leaks can cause the meter under test to appear inaccurate.
- Ensure the meter under test and the reference meter are purged after attaching all hoses to ensure the system is free of air.
- Ensure the reference meter is rated for the flow being tested.
- Ensure there are no pressure reducers or check valves immediately upstream of the MACH 10[®].
- Ensure all upstream valves are completely open. Partially open valves can skew results.
- Ensure there are no major pressure fluctuations during the test.
- Ensure the reference meter strainer is clean as it may become clogged during purges and testing.
- Ensure the outlet of the reference meter is elevated above the reference meter to keep the fire hose full at all times.
- Ensure there is at least 3 feet of straight fire hose before the reference meter to reduce the negative effects of swirling in the hose.
- Ensure the flow is held constant during the entire test. Do not adjust the flow or bump valves during the test.
- If poor accuracy results are achieved, consider doubling the length of the test to improve results.
- If a meter fails accuracy, always perform multiple tests to determine the repeatability of the measurements.

The following table defines the potential testing results and troubleshooting steps you can take to achieve better results.

Table 4 – Test Results Troubleshooting

Results	Potential Remedies
Low flow over-registration	<ul style="list-style-type: none"> When using the low side reference meter, ensure there is no water leaking through the high side reference meter during the test. Ensure there are no leaks between the meter under test and the reference meter.
High flow under registration (or no registration)	Ensure at least 30 psi of back pressure is maintained at the outlet of the reference meter, and all air is purged from the line.
Under registration (any flow)	Ensure the downstream isolation valve is fully sealed. If the value is not fully sealed, open and shut the downstream isolation valve several times to ensure a full seal.
Dry pipe icon	<ul style="list-style-type: none"> Purge the meter at maximum flow with the bleed screw open until the icon clears the screen. Ensure there is no air in the line.
Meter tests inaccurately at any flow rate	See “Before and During the Test” tips in the previous section.

Contact Information

Neptune Customer Support is available in the United States Monday through Friday, 7:00 A.M. to 5:00 P.M. Central Time by telephone or email.

By Phone

To contact Neptune Customer Support by phone, call (800) 647-4832 and complete the following steps.

Press one of the following:

- **1** for Customer Service.
- **2** for System Support.
- **3** for Return Material Authorizations (RMAs).
- **4** for Subscriptions or Renewals.
- **5** for Customer Success and Onboarding.

For System Support or Customer Success and Onboarding, press one of the following:

- **1** if you know your site ID.
- **2** to input your PIN or if you do not have a PIN.

For RMAs, press one of the following:

- **1** for reading device support.
- **2** for meter, endpoint, and register support.

Neptune Customer Support Specialists are dedicated to you until the issue is resolved to your satisfaction. When you call, be prepared to provide the following information:

- Your name and a callback number.
- Your utility name, company name, or site ID / PIN.
- A description of what occurred and what you were doing at the time.
- A description of any actions taken to correct the issue.

By Email

To contact Neptune Customer Support by email, send your message to support@neptunetg.com.

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Appendix A: Reading the MACH 10[®] Commercial and Industrial Ultrasonic Meter

This appendix provides information on the Commercial and Industrial (C&I) MACH 10[®] meter LCD display icons and how to read them.

LCD Meter Display

The light sensor is located in the center of the faceplate of the C&I MACH 10, and it activates the power for the Liquid Crystal Display (LCD) panel.



Figure 17 – Commercial and Industrial MACH 10[®] Meter

Timeout Period

Typically, the display is OFF. The meter includes a light sensor used to activate the LCD when you open the meter lid. You cannot reactivate a timed out LCD just by shining a light on the light sensor. To reset the LCD, close the lid and re-open after two seconds.

Meter Display

The C&I MACH 10 ultrasonic meters use a nine-digit LCD to show consumption, flow rate, and alarm information.

LCD Panel

Following is an example of the C&I MACH 10 LCD panel. The table on the following page provides a description of each icon.

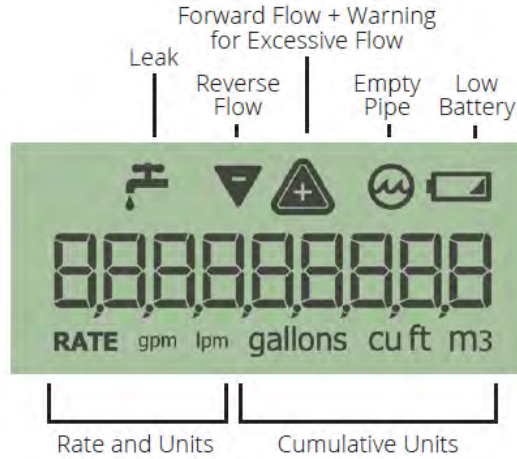


Figure 18 – MACH 10[®] LCD Panel



The LCD can display commas or decimals, depending on the configuration of each register to show digits in the tens position, ones position, tenths position, and so forth. For example, some sizes display 1,234,567.89. Others display 123,456.789, 12,345,678.9, or 1,234,567,89 depending on the meter's size and unit of measure combination.

How to Read the Meter

It is important to become familiar with the information available from the meter. The icons and displays provide helpful information.


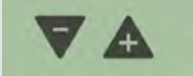



Alarms

Indicators and alarms appear in the displays as icons that illuminate when the condition is active, and disappear when the alarm condition is eliminated.

LCD Icons

The following table defines the C&I MACH 10 LCD icons and the status they indicate.

Table 5 – MACH 10® Icons and Displays

Icon	Description	Status	Explanation
Leak 	Icon used to indicate a period of continuous flow. Continuous flow status is determined by keeping track of the number of 15-minute intervals where the volume consumption exceeds Vmin in the previous 24-hour period. Vmin is factory programmed depending on meter size. It is defined as a change of the ninth digit on the LCD.	OFF	Water use has occurred in less than 50 15-minute intervals during the last 24-hour period.
		Flashing	Intermittent flow indicates that water has been used in at least 50 of the 96 15-minute intervals during the previous 24 hour period.
		ON	Indicates water use for all 96 of the 15-minute intervals during the previous 24-hour period.
Reverse and forward flow 	Icons used to indicate the reverse and forward direction of flow.	OFF	No flow is detected.
		ON	The meter has detected flow in either direction.
Excessive flow warning 	Icons used to indicate higher than normal flow conditions where the meter is incapable of measuring water use.	OFF	Flow is operating below maximum flow rate within normal flow range specifications.
		ON	Flow has exceeded the maximum flow rate specification for at least 60 seconds.
Empty pipe 	Icon used to indicate a condition where the meter is incapable of measuring water use.	OFF	Meter condition is acceptable for typical operation.
		ON	Indicates less than full pipe or the presence of air in the meter for at least 60 seconds.
Battery status 	Icon used to indicate battery life of the meter.	OFF	Battery life normal.
		ON	Battery life has less than one year remaining.
		FLASHING	Battery beyond expected life; replace immediately.

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A

AWWA

American Water Works Association.

C

calibrate

Correlated readings of an instrument with those of a standard in order to check the instruments accuracy.

cavitation

Rapid formation and collapse of vapor pockets in a flowing liquid in regions of very low pressure.

G

gravimetric

Weighted scale.

M

meter under test

Meter at the test side for which you are performing the field test.

MUT

Meter under test.

N

NIST

National Institute of Standards and Technology.

P

psi

Pounds per square inch.

R

reference meter

Meter you bring to the test site as a standard that the meter under test is checked against.

U

UME

Unitized Measuring Element.

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