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Antidrain Requirements for Liquid Retail Motor-Fuel Devices

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Liquid retail motor-fuel device (RMFD) systems come in a wide array of shapes and sizes; however, there are certain basic requirements that are common to all dispensers. One such requirement found in Section 3.30. Liquid-Measuring Devices of NIST Handbook 44 (HB 44) is that all wet-hose pressure-type dispensers are to include antidrain means. This article describes the antidrain requirement; shares an example that illustrates how the antidrain means helps to ensure a more accurate measurement of fuel quantity; and explains how the antidrain means is to be tested.

NIST HANDBOOK 44 REQUIREMENTS

The antidrain requirements in HB 44 apply only to “wet-hose” type devices. As shown below, in Appendix D – Definitions of NIST HB 44, the terms “wet hose” and “wet-hose type” are defined respectively as a discharge hose or a type of device with a discharge hose that is intended to be full of product at all times. RMFD systems are of the wet-hose type.

wet hose. – A discharge hose intended to be full of product at all times. (See “wet-hose type.”)[3.30, 3.31, 3.38] (Amended 2002)

wet-hose type. – A type of device designed to be operated with the discharge hose full of product at all times. (See “wet hose.”)[3.30, 3.32, 3.34, 3.37, 3.38] (Amended 2002)

In contrast, the terms “dry hose” and “dry-hose type” are defined as a discharge hose or a type of device with a discharge hose that is intended to be completely drained at the end of each delivery.

dry hose. – A discharge hose intended to be completely drained at the end of each delivery of product. (See “dry-hose type.”)[3.30, 3.31] (Amended 2002)

dry-hose type. – A type of device in which it is intended that the discharge hose be completely drained following the mechanical operations involved in each delivery. (See “dry hose.”)[3.30, 3.31, 3.34, 3.35]

The requirements for RMFD systems are found in HB 44 Section 3.30. Liquid-Measuring Devices (LMD Code). Paragraph S.3.3. Pump-discharge Unit. of the LMD Code requires that a flexible discharge hose on a pump-discharge unit be of the wet-hose type, that is, it must remain full of liquid at all times and not be drained between deliveries.

S.3.3. Pump-discharge Unit. – A pump-discharge unit equipped with a flexible discharge hose shall be of the wet-hose type.

Another LMD code paragraph, S.3.6. Discharge Valve states that a discharge valve may only be installed in the discharge line if the device is of the wet-hose type. Shutoff valves other than the discharge valve (such as a breakaway valve on an RMFD) are permitted on the discharge side of the meter; however, they must either be of the automatic or semiautomatic predetermined-stop type or else they must require a separate tool or the breaking of a security seal to operate.

S.3.6. Discharge Valve. – A discharge valve may be installed in the discharge line only if the device is of the wet-hose type. Any other shutoff valve on the discharge side of the meter shall be of the automatic or semiautomatic predetermined-stop type or shall be operable only:

- (a) by means of a tool (but not a pin) entirely separate from the device; or
- (b) by mutilation of a security seal with which the valve is sealed open.

The requirement for the antidrain means is described in LMD code paragraph S.3.7. Antidrain Means. Paragraph S.3.7. requires that a method be incorporated to prevent the drainage of the discharge hose in a wet-hose pressure-type device. Typically, the antidrain means requirement is met by employing an antidrain valve that is designed to help keep the discharge hose full of product at all times.

S.3.7. Antidrain Means. – In a wet-hose pressure-type device, means shall be incorporated to prevent the drainage of the discharge hose.

(Amended 1990)

Although the subject of this article is antidrain valves on RMFDs, it will be of interest to some to note that similar requirements also appear in other code sections in HB 44, including: Vehicle-Tank Meters (3.31), LPG and Anhydrous Ammonia Liquid-Measuring Devices (3.32), Mass Flow Meters (3.37), and Carbon Dioxide Liquids (3.38).

FUNCTIONING OF AN ANTIDRAIN VALVE IN A WET-HOSE TYPE DEVICE

As mentioned earlier, a wet-hose type device is designed to keep the product discharge hose full of product at all times. Consider the segment of the discharge hose between the meter and the nozzle shown in Figure 1 below. As noted in the NIST training course on RMFDs, the fuel that fills the hose at the beginning of a delivery actually passed through the meter during the previous delivery. The assurance that the customer always receives exactly the quantity of fuel he or she is paying for is based on the concept of displacement. Fuel metered during a delivery will initially displace exactly the quantity contained in the discharge hose. Gravity is always acting on the product in the hose. Left unchecked between deliveries, gravity will drain at least part of the hose, leaving a void. So, in order to keep the hose full at all times, and assure accurate deliveries, the nozzle must have some means of preventing the hose from being partially or completely drained of fuel after the dispenser has been shut off. Without the antidrain valve, one customer might receive more fuel than he or she has paid for by draining the hose into his or her vehicle after the transaction. In turn, the subsequent customer might receive less fuel than he or she paid for, because at the beginning of the delivery, fuel flowing through the meter would be displacing air, not liquid fuel.

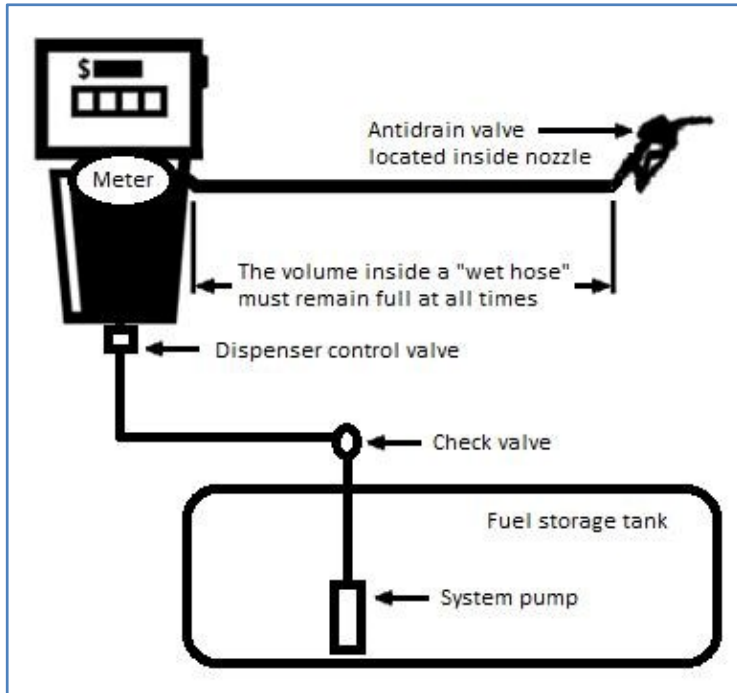


Figure 1. Fuel Dispenser System with Wet Hose

overcome the resistance of the spring. The pressure needed to push the valve open against the spring comes from the system pump (see Figure 1). The pressure resulting from the weight of any fuel that is in the hose higher in elevation than the antidrain valve should not be enough to open the valve alone without additional pressure from the system pump.

The dispenser must be switched on by an operator or customer to activate it for a fuel delivery. When the dispenser is not activated, the dispenser control valve is closed (see Figure 1). The pump may shut off when the dispenser is inactive, or it may remain on to pressurize other dispensers if it is shared. In either case, an inactive dispenser will not be fully pressurized downstream of the closed control valve. When the dispenser is switched on and becomes activated, the system pump will be on, the dispenser control valve will be open,

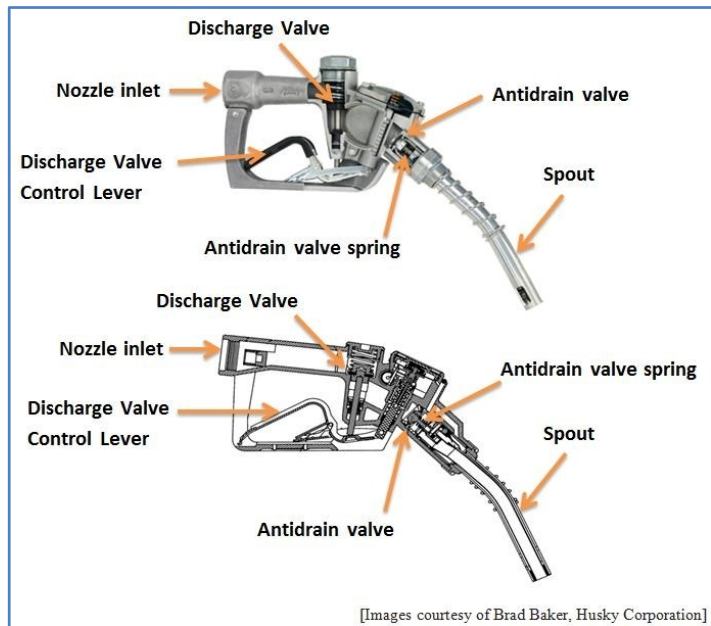


Figure 2. Internal Components of a Typical Fuel Dispenser Nozzle

and the dispenser will be fully pressurized. Under these conditions, when an operator opens the discharge valve by squeezing the discharge valve control lever, the pressure from the pump will be sufficient to push open the antidrain valve and fuel will flow from the spout of the nozzle.

To keep the hose full at all times, an antidrain valve is typically located at or very near the end of the hose where the product is delivered into a customer's fuel tank or other container. In an RMFD system, the antidrain valve is almost always located inside the same nozzle that contains the discharge valve near the point where the spout is attached to the body of the nozzle. Figure 2 includes both a photograph and a diagram showing a cutaway view of a typical nozzle and displaying the location of the antidrain valve inside.

The antidrain valve is normally held shut by a spring and will only open to allow fuel to pass through the nozzle when the fuel is under sufficient pressure to

The antidrain valve is designed to allow the free flow of fuel through the nozzle when fuel is being delivered, but it will automatically shut to prevent draining when a transaction is not underway. The primary function of the antidrain valve is to prevent draining of product in the forward direction. By preventing draining in the forward direction, the antidrain valve stops product that has not been purchased from flowing out of the hose if someone opens the discharge valve while the dispenser is not activated.

RMFD systems contain a check valve between the storage tank and the dispenser (See Figure 1) that is in place to prevent the backward flow of fuel into the storage tank. Although preventing flow in the reverse direction is primarily the function of the check valve, the antidrain valve also helps to prevent flow in the reverse direction. When the antidrain valve is tightly sealed shut, it prevents air from entering the hose through the nozzle. If air is not freely able to enter the hose to fill the void that would be created by fuel draining back through the system, it creates a vacuum that aids the check valve in preventing reverse flow. By helping to prevent draining in the reverse direction, the antidrain valve stops product from flowing back out of the hose and the dispenser into the storage tank, which could drain the hose and result in the next customer being charged for product that was not received.

PURPOSE OF THE ANTIDRAIN REQUIREMENT

The simple purpose of the requirement for an antidrain valve is to ensure that the consumer receives all the fuel that they have paid for. Suppose, for example, that you are at an RMFD to purchase some fuel and the hose was empty when you first arrived because the fuel was either allowed to drain into the vehicle that preceded you or it had drained back into the station storage tanks. The sequence of stages that occur to refill the hose are shown in Figure 3 and explained in more detail in this example:

1. Normally, the hose will be filled with liquid at the beginning and of a delivery as shown in diagram 1 of Figure 3.
2. If liquid is allowed to drain from the hose between deliveries, a void is created in the hose as shown in diagram 2 of Figure 3.
3. When you arrive and activate the dispenser, it will become pressurized and product will begin to flow through the meter and into the empty hose. The meter will measure and indicate the volume of the fuel that passes through it. Some fuel will partially fill the hose by compressing the air that is trapped in the hose before you even squeeze the lever to open the discharge valve, as is shown in diagram 3 of Figure 3.
4. After you open the discharge valve to allow flow, as the rest of the hose is filling up, the meter will indicate that quantity of fuel as part of your transaction, even though no fuel has yet made it into your vehicle. Only after the hose is finally completely full, as shown in diagram 4 of Figure 3, will fuel begin to fill your vehicle.

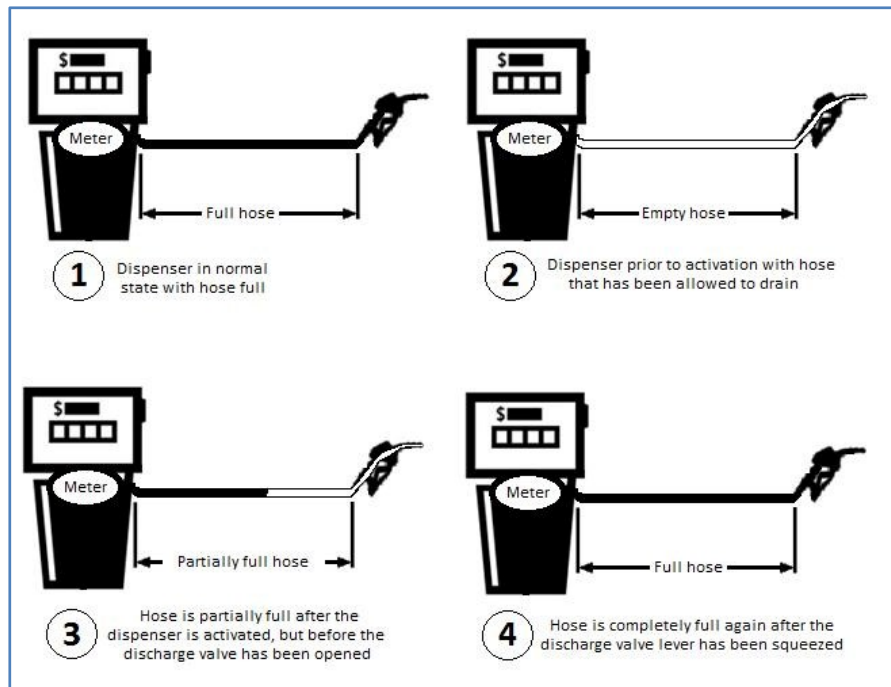


Figure 3. Sequence of hose filling stages during a transaction that starts with an empty you, but they will only hose. receive it if it is not allowed to drain out of the hose before they arrive.

Sometimes an ant drain valve can malfunction. An ant drain valve might fail to perform its intended function for any number of reasons. If a piece of debris or particulate contamination lodges inside the nozzle, it could prevent the valve from seating properly. A damaged seal on the valve could also result in a leak that would allow the hose to drain. If the spring that pushes the valve shut fails, the valve may remain open or be pushed open by the small pressure that results from the weight, or in some cases, expansion of the fuel in the hose above the nozzle. Whatever the cause, a faulty ant drain valve can result in an incomplete delivery of the total metered quantity that is indicated, as described in the example above. A hose with a 5/8-inch internal diameter and a length of 18 feet will contain approximately 0.3 gallons of fuel when full, and at today's gasoline prices, this amount can represent a value in excess of \$1.00¹.

Another phenomenon that is often reported by consumers and weights and measures officials is commonly referred to as "computer jump." Computer jump can happen at the start of a transaction if the hose is empty or partially empty when the pump first comes on to pressurize the system. As with our earlier example, fuel can flow through the meter into the hose, filling the empty space, before the consumer ever opens the discharge valve at the nozzle to release fuel into their vehicle. When this happens, if any quantity or money-value appears on the dispenser indication before the customer has squeezed the discharge valve control lever, the consumer is being charged for something they have not received.

Computer jump can sometimes be observed when a dispenser is first activated after a long period of non-use. This may indicate normal wear over time of the check valve and the ant drain valve. Slow leaks that allow a system to drain very slowly back into the storage tank will usually not affect accuracy during

Once your vehicle tank is full and you are ready to end your transaction, you will release the discharge valve and stop the flow, leaving the hose full of fuel. In this example, you will be charged for the amount of fuel that you received plus the amount that it took to fill the empty hose. This fixed the hose actually belongs to the next customer that

normal operation because the time between fueling events is typically shorter than the time it will take for product to drain back out of the system in a case like this. If computer jump is observed when you first activate a dispenser, you should shut it off and immediately try again. If computer jump is observed a second time, you should notify the equipment owner that the system is not functioning properly and needs prompt attention. If you do not observe computer jump on the second try, you may still want to inquire with the equipment owner about how long the dispenser will go unused between transactions and inform them that customers may experience computer jump if the system goes unused for long periods of time and that this should be addressed.

CONDUCTING THE TEST OF THE ANTIDRAIN VALVE

The test of the antidrain valve is very simple to perform and should be done near the end of an examination, after completing all the normal and special test drafts. All tests, including the antidrain test, should be conducted under conditions that are usual and customary with respect to the location and use of the device, as prescribed in the General Code in HB 44 under paragraph G-N.2. Testing with Nonassociated Equipment.

G-N.2. Testing With Nonassociated Equipment. – Tests to determine conditions, such as radio frequency interference (RFI) that may adversely affect the performance of a device shall be conducted with equipment and under conditions that are usual and customary with respect to the location and use of the device.

(Added 1976)

Nothing that might change the status of the hydraulic system at the location should be altered from the usual and customary conditions while testing the antidrain valve. For example, if customers can access and use other dispensers at the facility without creating an unsafe condition, they should be permitted to do so during the test since preventing them access could impact the normal pressure in systems where multiple dispensers share the same pump.

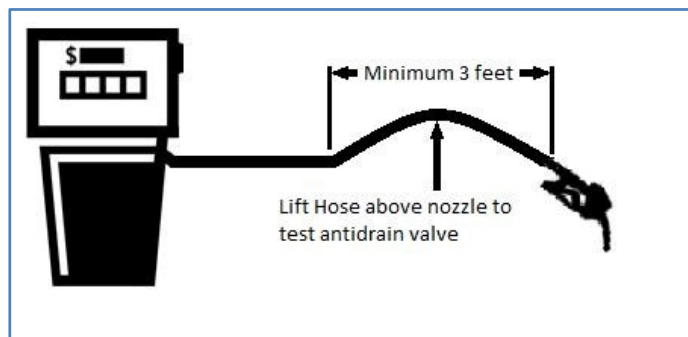
The steps to perform a test of the antidrain valve are as follows:

1. Turn the dispenser “off” by moving the lever, switch, or other control to the “off” position in the same way that customers do following each normal transaction.
2. With the discharge valve closed, direct the nozzle into a safe and appropriate container (such as a metal bucket or your test measure) so that the end of the nozzle is still visible and you will be able to see any product exiting it. Make sure both the container and the nozzle are grounded by placing the container on the ground or attaching a grounding cable and by touching the nozzle to the container. The container should comply with all established safety guidelines and procedures in your jurisdiction.
3. Open the discharge valve by squeezing the discharge valve control lever.
4. Observe whether any fuel exits from the nozzle. Discharge of a small amount of residual product is permissible and may result from draining of the small space inside the nozzle and spout that are downstream of the antidrain valve.

5. Continue to hold open the discharge valve. After verifying that there is no more flow, raise the hose so that the entire section that is within 3 feet of the discharge valve is higher in elevation than the valve (as shown in Figure 4). This will cause the weight of the fuel in the hose that is higher in elevation than the valve to apply a small amount of pressure on the antidrain valve. If it is set and maintained properly, the antidrain valve spring inside the nozzle should not allow the antidrain valve to open with only this small pressure acting on it. It should require the higher pressure of the pump to open.
6. Continue to observe the nozzle. If no additional flow is observed after raising the hose, the antidrain valve is working properly and the device passes this test. Any small amount of product that may have still been clinging to the inside of the nozzle spout that dribbles out is permissible. However, a prolonged flow that continues beyond what might be expected to cling to the inside of the nozzle is not acceptable.
7. Note whether the device passed or failed the antidrain test on your overall report and communicate any failure to the equipment owner.
8. Return any residual product that is in the container into the storage of the lowest grade of the fuel that is dispensed from that device.

CONCLUSION

The Liquid-Measuring Devices Code of NIST HB 44 includes a specification requiring RMFDs to be equipped with means to prevent drainage of the discharge hose between deliveries. The antidrain means is a very important feature of a wet-hose, pressure-type fuel dispenser and helps to ensure that the discharge hose remains full of liquid product at all times. If it is not functioning properly, consumers may receive



Picture 4. Proper Lifting of the Hose for the Antidrain Test. less than the total indicated quantity or may experience “computer jump” at the start of a delivery. Weights and measures officials can perform the simple test described in this article while they are inspecting retail motor-fuel dispensers to ensure proper operation of the antidrain means and compliance with NIST HB 44.

For questions about this article, contact Marc Buttler by email at marc.buttler@nist.gov or by phone at (301) 975-4615.

ENDNOTE ¹ It is NIST policy to use the metric (SI) system of units in reference to quantities and measurements wherever practical. English units of inches, feet, and gallons were used in this article to describe quantities related to specific RMFD indications and component sizes as these are the units applied in the United States for RMFD commercial applications in reference to these specific quantities.