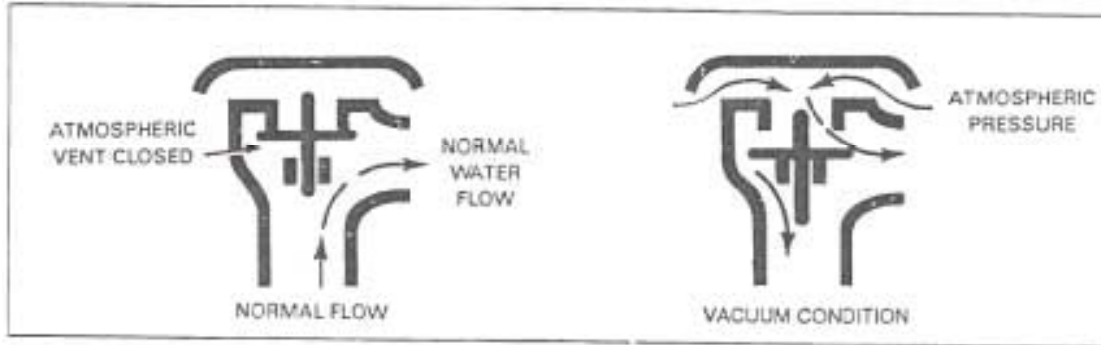
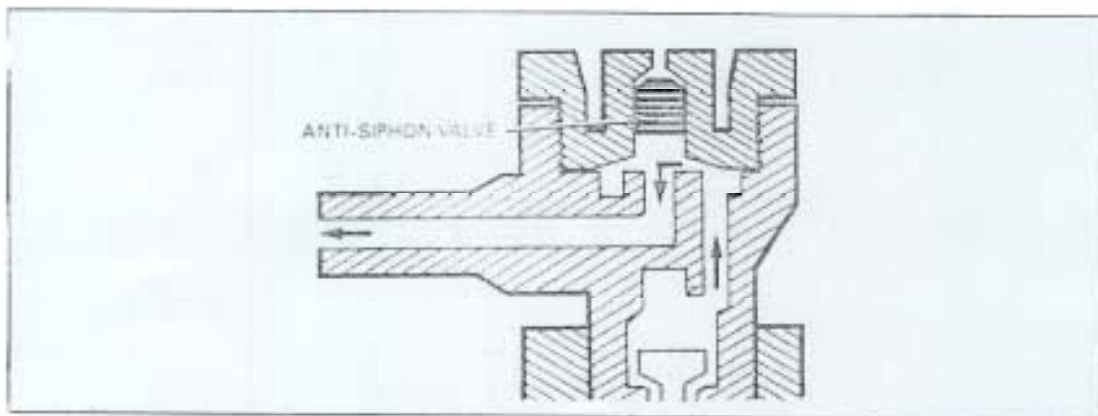


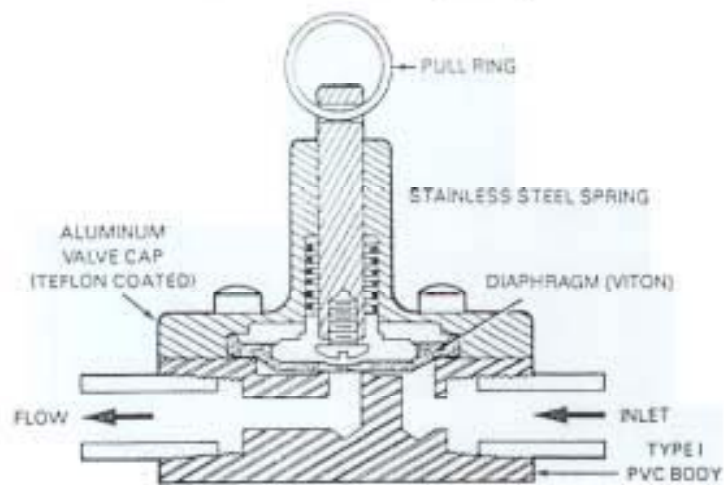
**FIGURE 3-9
VACUUM BREAKER**



**FIGURE 3-10
ANTI-SIPHON VALVE (PUMP MOUNTED)**



**FIGURE 3-11
ANTI-SIPHON VALVE (IN-LINE)**



When in operation, and water is normally flowing through, the disc in the vacuum breaker is kept closed by water pressure. Whenever the water stops flowing through, the valve disc drops, thus opening the atmospheric vent and allowing air to be drawn in rather than pulling the fluoride solution back into the line.

Most vacuum breakers are of the atmospheric or non-pressure type. The vacuum breaker must, therefore, be installed after the last shut-off valve or solenoid valve (downstream) and be elevated 6 inches above the top of the saturator liquid level.

Always install the vacuum breaker where it will be accessible for observation and cleaning. Do not install it where it will be under water, subject to freezing, out of sight, or where emergency water spillage will create problems.

If the vacuum breaker is functioning correctly, air bubbles will be momentarily visible from the bottom of the upflow type saturator during each fill cycle. Failure to see air bubbles means the vacuum breaker needs immediate service or replacement.

The vacuum breaker is important for adequate cross-connection protection and must not be removed. Keep a spare vacuum breaker on hand, inspect the disc for wear annually, and replace as directed by the manufacturer.

3.5.5 Anti-siphon Valves

Most states require that an anti-siphon valve or spring be located on the discharge side of the fluoride metering pump wherever a fluoride solution is added to any pipeline, channel, or clearwell. Of all the auxiliary equipment used, the anti-siphon valve is probably the most important from a safety viewpoint. (See **Figures 3-10 and 3-11, page 51**) The lack of an anti-siphon valve has resulted in several overfeeds that could have been prevented. The anti-siphon valve is different from an atmospheric or non-pressure type vacuum breaker, which was discussed previously.

The purpose of the anti-siphon valve is to prevent a potential overfeed of fluoride, which could occur when the metering pump is not pumping or is unplugged. It prevents dynamic siphoning ("free wheeling") and flow-through when suction pressure exceeds discharge pressure. Always install an anti-siphon valve on the discharge (pressure) side of the metering pump head when it is accessible for observation and cleaning. Also install an anti-siphon valve at the fluoride injection point, if this point is under pressure. Do not install it where it will be under water or out of sight.

The anti-siphon valve operates by a spring being compressed when the pump diaphragm strokes. Usually the spring is protected by a hypalon or teflon diaphragm.

If fluorosilicic acid is used, the spring must be protected by a diaphragm or be coated. The diaphragm type anti-siphon valve is better than the coated valve because the spring itself is protected from the fluoride solution. Some anti-siphon valves can be adjusted by turning a screw and some are pre-set at the factory. Most are set in the range of 15-20psi. Some anti-siphon valves are built into the pump head, but most are considered additional and must be purchased separately. Always check with the pump manufacturer or distributor to determine if it is included with the pump assembly.

The anti-siphon valve spring should be inspected for wear annually and replaced as directed by the manufacturer. A spare should be kept on hand.

3.5.6 Day Tanks

A day tank is just what the name implies—a tank that holds a day's supply of a particular water treatment chemical. It is a convenient and often necessary means for isolating the supply of fluoride solution that will be fed during 1 day or shift at the water plant. Sometimes these tanks are called 30-hour tanks. Also, there are times the day tank will hold enough solution to last for a week, but this is not recommended.

The day tank is a necessity when feeding large amounts of fluorosilicic acid particularly if the acid is received and stored in a large tank (bulk storage). In order to provide a record of the weight of acid fed, a small quantity of the acid is pumped or siphoned into a small tank mounted on a platform scale, and it is from this day tank that the fluorosilicic acid is fed into the water system.

The types of construction materials used in day tanks are determined by the chemical being used but generally are of three types: rubber-lined steel tanks, fiberglass and polyethylene. Polyethylene day tanks are the most common in the United States, but care must be taken to protect them from intense sunlight. Strong sunlight will cause the plastics to "age" and eventually crack. Black coloring reduces the effects of sunlight, but most plastic day tanks are made of the white translucent polyethylene.

Day tanks are made in all kinds of shapes, but the best for fluoridation is the cylindrical tank with a flat bottom and seamless construction. The lid should have a lip gasket and be airtight, and the day tank should be mounted on a scale. The tank can be provided with graduations or a gauge so that approximate volume measurements can be used.

For systems using fluorosilicic acid and bulk storage, the day tank should be sealed and vented to the outside. The day tank lid should be sealed around the edges or lip, and the three openings where the vent line, fill line entrance, and the pump suction line exits must also be sealed. These line openings are frequently left unsealed. There is no need for an overflow line if the day tank is properly vented.

3.5.7 Mixers

Whenever solutions are prepared, whether manual preparation of sodium fluoride solutions, dilution of fluorosilicic acid, or the output of a dry feeder, it is particularly important that the solution be homogeneous. Slurries must not be tolerated in the feeding of fluorides, since undissolved fluoride compounds can go into solution, subsequently causing a higher-than-optimal concentration. If the fluoride compound remains undissolved, a lower-than-optimal concentration will result. Undissolved material can also cause clogging of equipment and other devices having small openings, and if allowed to accumulate, results in considerable waste.

Two kinds of mixers are commonly used in fluoridation—the in-line and small mechanical high speed. The in-line mixer is used in the main water line to ensure proper mixing of the fluoride solution prior to the potable water being consumed.

The mechanical mixer is used in the solution tanks of dry feeders and in the manual preparation of fluoride solutions.

The dissolving of sodium fluorosilicate in the solution tank of a dry feeder can be accomplished by a jet mixer, but, again, a mechanical mixer is strongly recommended. (See **Figure 3-12 page 55**). Because of the low solubility of sodium fluorosilicate, particularly in cold water, and the limited detention time available for dissolving, violent agitation is essential to prevent the discharge of a slurry. Preferred construction materials are 316 stainless-steel or PVC-coated steel. One note of caution: if the mixing is too vigorous, water may splash up into the feed mechanism and cause plugging problems.

An in-line mixer (see **Figure 3-13 page 55**) should be a simple motionless mixer made of a fixed arrangement of geometrically designed elements enclosed in a tube or pipe. The flowing water provides the energy needed for mixing. (There are no moving parts in an in-line mixer.) Surprisingly, most in-line mixers are very efficient, with very little head loss. Mixers are available in sizes from 3/4 inch to 6 feet in diameter. Construction materials include stainless steel, carbon steel, fiberglass, and PVC. For fluoridation, 316 stainless steel is generally recommended.

An in-line mixer requires very little, if any, maintenance, thus it can be installed underground or in other inaccessible locations. Any location that requires proper mixing of the fluoride chemical but is close to the point of injection is a place that may require an in-line mixer. CDC recommends an in-line mixer if the first customer is 100 feet or less from the fluoride injection point and there is no storage tank located before the customer, and the fluoride content of the treated water varies by more than 0.1mg/L. This is a minimum distance, assuming normal valves and bends in the line.

FIGURE 3-12
TYPICAL MECHANICAL HIGH SPEED MIXER

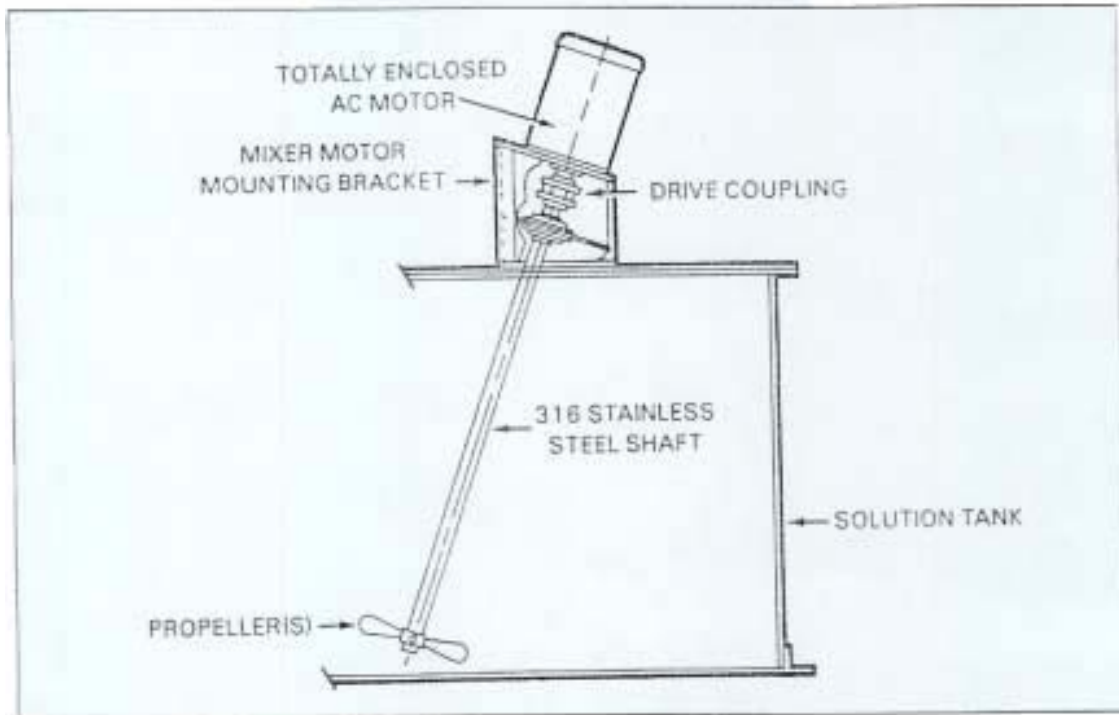
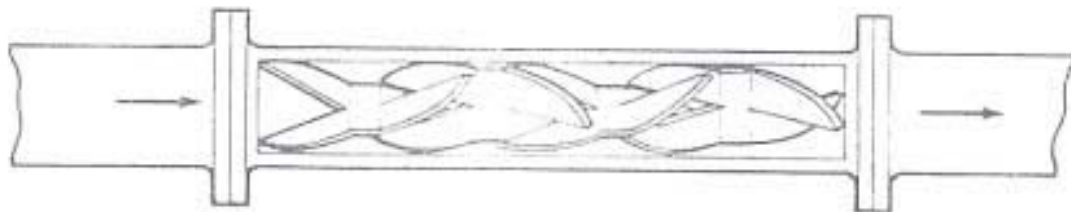


FIGURE 3-13
TYPICAL IN-LINE MIXER

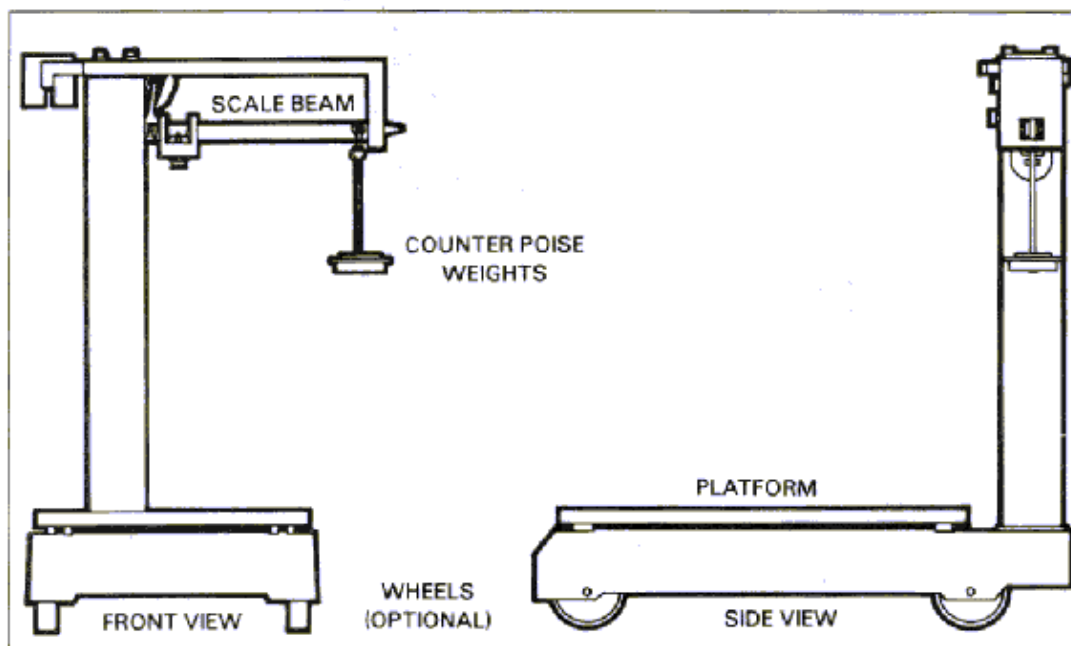


3.5.8 Scales

In any fluoridation installation, except for one based on a sodium fluoride saturator, scales are a necessity for weighing the quantity of solution fed, or weighing the quantity of dry fluoride compound or fluorosilicic acid delivered by the appropriate feeder. The type of scale can vary-from a small household-type used for weighing a pound or two of sodium fluoride for solution preparation-to a complex type with a built-in mechanism. The general types are beam scales, dial scales, and digital read-out scales. The most generally applicable is the beam-type scale with a platform. It is frequently erroneously called a platform scale. (See Figure 3-14 page 56)

A solution tank, a carboy of acid, or an entire volumetric dry feeder can be placed on the platform of the beam scales. Although the scales may be designed for a specific application, as are those supplied by manufacturers of volumetric dry feeders, in many cases an ordinary hardware-store type of scale will be perfectly acceptable. Some minor modifications, such as removing the wheels or rotating the beam, may be necessary, but as long as the scales have sufficient capacity and sensitivity, there is no reason why they cannot be used. Capacity and sensitivity are the only serious considerations. The scales must be capable of weighing the tank and its contents when full, or the volumetric feeder and its hopper when full. Measurement to the nearest pound or better is adequate for dry feeders. Fluorosilicic acid should be weighed to the nearest 1/2 pound. For small scales used for measuring sodium fluoride in manual solution preparation, sensitivity to the nearest ounce should be sufficient. Generally, a 1000-pound minimum scale should be specified, as it is better constructed. The life of a good beam scale is approximately 15 years.

FIGURE 3-14
TYPICAL BEAM SCALES



No particular problems should be encountered when mounting equipment on beam scales, except when there is a connection to a vent, suction line, water line, or discharge line. All such connections must be flexible enough to permit the scale to operate properly. This flexible connection should be horizontal for best results.

3.5.9 Other Appurtenances

Unions

Unions are a type of plumbing fitting used for joining pipes or tubing that may be disconnected at a later date for maintenance or repair purposes. Unions save time and money when removing or disconnecting any fixtures for repair or replacement.

Unions may be constructed of many materials, such as bronze or PVC and should be compatible with the fluoride chemical in the pipe. Unions are especially recommended on a saturator system, because equipment must be removed, drained, and cleaned more often than other fluoridation systems. The cleaning process requires disassembly of: the overflow pipe; the submerged make-up water line to the upflow saturator; and the make-up water line inlet to the saturator. All of the above connections should have unions.

Other places to consider using unions are at connections to softeners, small water meters, and at reduced pressure backsaw presenters. If plastic pipes are used on a saturator make-up line, unions should be included.

Strainers

Pump check valves, reduced pressure blacktop presenters, and other parts of the equipment are highly susceptible to dirt and other contaminants in the water. To prevent accumulation of dirt or sediment, which can cause a malfunction, Y-strainers are recommended for most water plumbing lines. The Y-strainer must be installed in the direction of flow. It is easy to install them backwards by mistake. One hundred mesh size screen (0.01 inch square) is commonly used in the strainers used in fluoridation systems. A spare mesh screen should be kept on hand.

Timers

An interval timer as used in fluoridation is basically a clock mechanism, usually electric, which will operate an electric pump upon receipt of a signal. Timers are frequently used in conjunction with water meter contractors to operate electric-motor operated feeders. Thus the timer serves to extend the impulse received from the contacted.

Another application of a timer is in those installations where the minimum reliable feeder setting is still too high for the water flow. In these cases, the timer can be set to provide a proportion of the full-time feed rate. For example, by setting the timer to operate the feeder at 75 percent of each 10-minute period, the feed rate will only be 75 percent of that obtained without the use of the timer.

A word of caution: Using a proportional timer at low percentages, particularly for long interval settings can result in cyclic fluoride levels. If there is insufficient detention time

in clear wells or pipelines before the water reaches the consumers, the on-off action of the feeder will result in alternately too high and too low fluoride readings. The remedy, other than using a smaller metering pump, is to make the provisioned time interval as short as possible. If possible, it is best not to use timers in water fluoridation.

Alarms

To prevent underfeeding or even loss of feed alarm systems can be included in either solution or dry feed systems. The alarm alerts the operator when the solution level in the day tank is low or when a new bag of dry chemical should be put into the hopper. An alarm can also signal that the water supply to a saturator or dissolving tank has either stopped or diminished. The alarms are rigged by level switches flow switches or pressure switches.

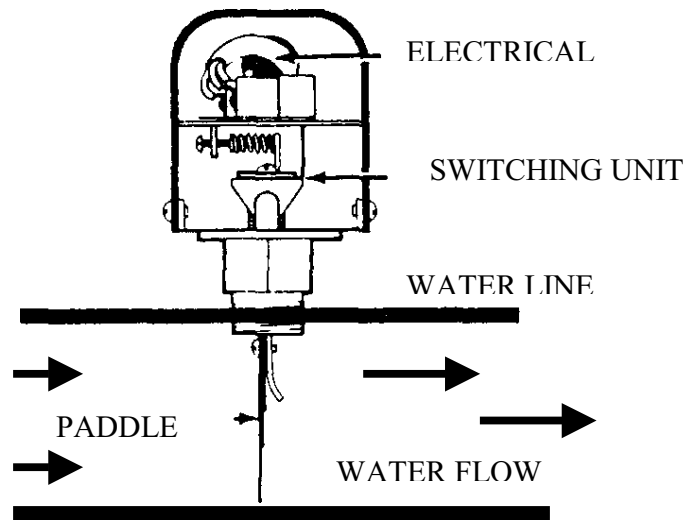
Flow Switches

In fluoridation installations it is important that the fluoride metering pump operate only when the water is flowing. This is especially true in school fluoridation systems. CDC recommends that an additional safety device, the flow switch, be electrically interconnected with the well pump and the fluoride metering pump. **(See Chapter Six.)**

A flow switch is a device installed in a water main that will trip an electrical switch whenever there is flow in the water line. When there is no flow, the electrical switch will remain open. The two general types of flow switches used in water fluoridation are the mechanical and the thermally actuated. Both are used in the United States in fluoridated school systems.

The mechanical flow switch has a paddle or wheel inserted into the water line, **(see Figure 3-15 page 59)**. When there is flow, the paddle (wheel) will close an electrical contact. This type of flow switch can fit into a water line as small as 3/4 inch or as large as 16 inches. This is a high maintenance item and needs to be provided with regular care. The most common problem is with corrosion or breakage of the paddle.

FIGURE 3-15
TYPICAL MECHANICAL FLOW SWITCH



The thermally actuated flow switch is a temperature differential flow sensor. It detects variations in flow velocity by sensing changes in the heat transfer properties of the flowing water. The sensing head consists of three stainless steel thermowells (two matched pairs of resistive temperature sensors (one active and one referenced and a low-powered heating element in the third thermowell). The heating element is located so as to heat the active temperature sensor. This creates a temperature differential between the active and the reference temperature sensors. Changes in the flow rate cause changes in the temperature differential. This temperature differential is electronically converted to a signal that is inversely related to actual flow.

The thermally actuated (low switch is much more expensive than the mechanical flow switch but requires less maintenance. The response time is very fast (2-50 seconds, depending on the switch point adjustment). It can operate at almost any water pressure (up to 2,000psi) and can detect flow velocities as low as 0.01 ft/sec.

Pressure Switches

The pressure switch is a simple device that is installed to detect changes in pressure. In a water line, the change in water pressure will cause a diaphragm to flex and thus open or close on electrical contact. This, in turn, will activate or deactivate an electrical circuit.

Pressure switches are commonly used in individual well systems such as those found in rural school systems. The pressure switch will regulate the operation of the well pump, and should be electrically interlocked with the fluoride metering pump. Also, as an additional safety measure, some states have recommended that the pressure switch be installed in-line and electrically in series with a flow switch (or switches). This would be an additional safe guard against a fluoride overfeed. CDC believes that this additional protection is unnecessary.

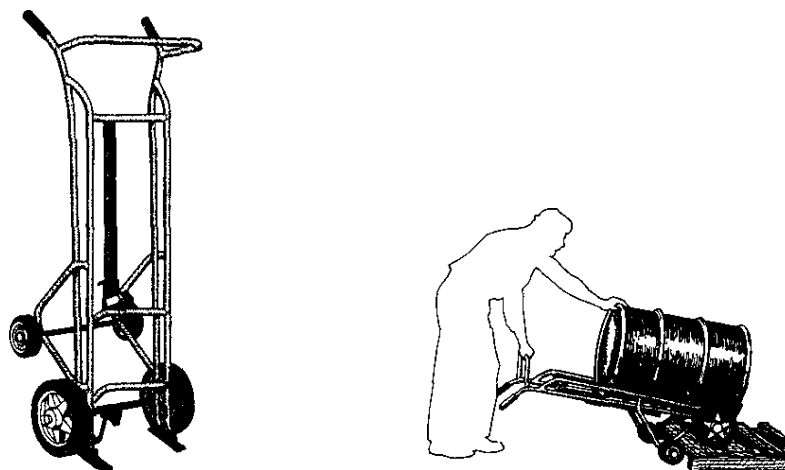
Hauling Equipment

The weight of 15gallon drums of fluorosilicic acid is approximately 150 lbs. This is obviously too heavy for an ordinary man to lift. Thus, a drum truck, or something similar must be used. (See **Figure 3-16**). Even carboys of acid should be moved by a "truck."

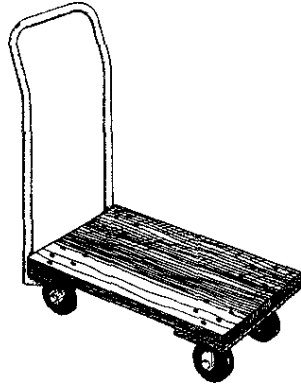
FIGURE 3-16

HAULING EQUIPMENT

Drum Truck



Platform Truck



Convertible Truck

