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Technical Reference

CBW® Tunnel Washer Water Flow and Chemical Injection

Read the separate safety manual before installing, operating, or servicing

PELLERIN MILNOR CORPORATION POST OFFICE BOX 400, KENNER, LOUISIANA 70063-0400, U.S.A.

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MATCBWTRAE/18103A

PELLERIN MILNOR CORPORATION
LIMITED STANDARD WARRANTY

We warrant to the original purchaser that MILNOR machines including electronic hardware/software (hereafter referred to as “equipment”), will be free from defects in material and workmanship for a period of one year from the date of shipment (unless the time period is specifically extended for certain parts pursuant to a specific MILNOR published extended warranty) from our factory with no operating hour limitation. This warranty is contingent upon the equipment being installed, operated and serviced as specified in the operating manual supplied with the equipment, and operated under normal conditions by competent operators.

Providing we receive written notification of a warranted defect within 30 days of its discovery, we will at our option repair or replace the defective part or parts, FOB our factory. We retain the right to require inspection of the parts claimed defective in our factory prior to repairing or replacing same. We will not be responsible, or in any way liable, for unauthorized repairs or service to our equipment, and this warranty shall be void if the equipment is tampered with, modified, or abused, used for purposes not intended in the design and construction of the machine, or is repaired or altered in any way without MILNOR's written consent.

Parts damaged by exposure to weather, to aggressive water, or to chemical attack are not covered by this warranty. For parts which require routine replacement due to normal wear such as gaskets, contact points, brake and clutch linings, belts, hoses, and similar parts the warranty time period is 90 days.

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How to Get the Necessary Repair Components

This document uses Simplified Technical English.
Learn more at http://www.asd-ste100.org.

You can get components to repair your machine from the approved supplier where you got this machine. Your supplier will usually have the necessary components in stock. You can also get components from the Milnor® factory.

Tell the supplier the machine model and serial number and this data for each necessary component:

- The component number from this manual
- The component name if known
- The necessary quantity
- The necessary transportation requirements
- If the component is an electrical component, give the schematic number if known.
- If the component is a motor or an electrical control, give the nameplate data from the used component.

To write to the Milnor factory:

Pellerin Milnor Corporation
Post Office Box 400
Kenner, LA 70063-0400
UNITED STATES

Telephone: 504-467-2787
Fax: 504-469-9777
Email: parts@milnor.com

— End of BIUUUD19 —

Trademarks

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AutoSpot™	GreenTurn™	Milnor®	PulseFlow®
CBW®	GreenFlex™	MilMetrix®	PurePulse®
Drynet™	Hydro-cushion™	MilTouch™	Ram Command™
E-P Express®	Linear Costa Master™	MilTouch-EX™	RecircONE®
E-P OneTouch®	Linear Costo™	Miltrac™	RinSave®
E-P Plus®	Mentor®	MultiTrac™	SmoothCoil™
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Dealer Bulletin	PELLERIN MILNOR CORPORATION P.O. Box 400, Kenner, LA 70063

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DEALER BULLETIN # B22DB02001 All
Update A
Revised April 27, 2012

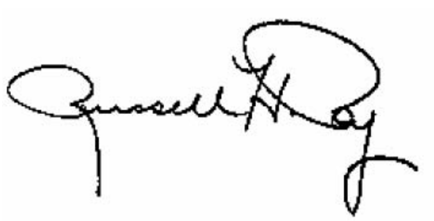
Subject: Update to B22DB02001 Stainless Steel Is Corrosion Resistant NOT Corrosion Proof

The attached referent bulletin introduced the key concepts to prevent corrosion issues by maintaining a Healthy Tunnel Washing Profile. In this update to the Bulletin, we are bringing forward additional best practice ideas that have been derived during the years since the issuance of that original bulletin.

1) Sour Selection - We want to clarify that neither the original bulletin nor this update prohibits the use of any sours. It is just that some sours need more attention than others. We cited potential issues when improperly using certain sours especially when intermixed in any way with chlorine bleach. If corrosion occurs then it is necessary to correct the cause. Please again refer to the original bulletin regarding Healthy Tunnel Profile. This is extremely important as many states and municipalities restrict the types of sours, especially phosphoric acid, that may be discharged.
   Using one of the more aggressive sours requires paying STRICT attention to the proper profile along with additional steps listed in this update bulletin.
2) Sour must be injected below the water line.
3) Venting - The absolute best practice is to segregate the vents of the bleach zone and sour modules. Powered ventilators add another layer of security to prevent vapor interaction between bleach and sours. This is explained in document BIPCUI02 “Connecting Ancilliary Equipment and Services,” which is part of the installation manual for the CBW® tunnel washer.
4) Chlorine in the wash liquor must be completely neutralized prior to the rinse zone modules.
5) If you see corrosion, fix it. Don’t let it go unattended. We pointed this out in the original bulletin and suggested some methods of remediating corrosion on stainless steel.

Sincerely,

PELLERIN MILNOR CORPORATION



Russell H. Poy Vice President – Product Development

Dealer Bulletin

PELLERIN MILNOR CORPORATION
P.O. Box 400, Kenner, LA 70063

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All Dealers

Dealer Bulletin B22DB02001
September 9, 2002

Subject: Stainless Steel Is Corrosion Resistant NOT Corrosion Proof!

A few of our CBW washer customers have recently asked our advice concerning corrosion appearing at the discharge end of the tunnel and on certain parts of presses or extractors. Although our expertise is in machinery design and manufacture rather than chemicals and metallurgy, we did investigate the situation and, in conjunction with an expert in corrosion, have come up with some suggestions for preventative measures to render the system as corrosion resistant as possible.

It's important to be vigilant in maintaining a "Healthy Tunnel Washing Profile" described below. Many chemical products used improperly or misused can cause problems. Coupled with a Tunnel Washer that is operated improperly, there are arrays of problems that can manifest and compound. A Healthy Tunnel Washing Profile includes:

1. Proper supply water quality.
2. Industry standard quantity and method of injecting chemicals.
3. Proper water flow in each zone – Refer to "Quick Guide for Setting Counterflow in Milnor CBW Washers" (Attachment A).
4. Proper Levels in each module – Refer to "Quick Guide For Setting Weir Plates & Level Switches On Milnor CBW Washers" (Attachment B).
5. Proper temperature in each zone.
6. Proper pH.
7. No intermixing of sours and bleaches.

Chemical products commonly found in the laundry industry when utilized in **established** dosages and proper tunnel operating parameters under the auspices of an experienced tunnel chemical specialist will produce satisfactory results and no consequential detrimental effects.

It is not the steel!

Improper laundering process conditions can destroy the corrosion resistance of stainless steel. Stainless steel provides resistance to corrosion because of its capacity to be passivated. In simple terms, most scientists explain that a protective oxide film acts as a barrier between the metal and its environment (Handbook of Stainless Steels, Peckner and Bernstein, 1977).

Pitting and stress corrosion cracking can occur when the conditions of the wash liquor break down the passive layer of the steel. These conditions are well known, some of which are: high concentrations of chlorine bleach, improper (low) pH, iron-laden process water, corrosive supply water, and reactions of sours and bleach.

Milnor has manufactured washer-extractors and tunnel washers with the same stainless steel specification since our founding. Every batch of steel we use is certified and documented by the steel mill. We tested samples of the stainless after reports of corrosion. Every instance has proven the steel to be well within the AISI 304 specification.

Corrosion is a complex, multifaceted problem. When some or all of the following factors come into play together, corrosion has occurred.

- **Carboy strength bleach and sours are now routinely directly injected into machines.**

  Even though the chemicals may be injected below the water line, localized chemical reactions may cause corrosive conditions. **Injections must be flushed with water.** Make sure fittings connecting chemical supply lines are not leaking.

- **Excessive quantities of chlorine bleach are being used.**

  The industry has published standards in Riggs and Sherrill, <u>Textile Laundering Technology</u>. We have seen machines programmed with much greater quantities of bleach instead of extending the bleach zone and/or transfer rate to achieve contact time for special fabrics. (Refer “Rust Never Sleeps”, Samuel Garofalo, TRSA, February 2002).

  Exacerbating the issue, some tunnels have been programmed with “first dosing” for bleach. We have seen CBW washers programmed to inject 300% of the maintenance hypochlorite dose when changing from a light soil to heavier soil classification. We do not recommend programming Hypochlorite injections with First Dosing “compatibility”.

- **Acid sours react with Hypochlorite to form corrosive compounds.**

  Acid sours reacting with Hypochlorite form chlorine gas and hydrochloric acid – resulting in corrosive conditions to stainless steel and a potential danger to personnel. This bleach carryover into the sour module(s) can be the result of:

  1. Too much bleach – too much programmed or too small a batch size for the programmed dosage.
  2. Flow rate too low in the rinse zone.
  3. Improper antichlor.
  4. Blocked flow splitter and/or lifters. Normal maintenance is required to keep the screens clean and free flowing. With hard water supply, calcium carbonate will deposit in the wedge wire, blocking the screen.

5. Low water pressure. The counterflow may be interrupted to such a degree to allow chemistry to be present in downstream modules.
6. Using a dual bath (half time for counterflow rinse and half time for standing bath finishing) last module with Hypochlorite bleaching in the adjacent module.

A Caution About Hydrofluosilicic Acid

Comparatively, Hydrofluosilicic (HFS) acid is ***much more*** aggressive to stainless steel than other common laundry sours such as phosphoric, citric, formic and acetic acid. The presence of Hypochlorite increases its corrosive potential. Moreover, HFS is specifically called out in the Handbook of Stainless Steel as aggressive in vapor form.

While HFS acid is successfully used with proper conditions, we have seen a number of instances of misuse of this chemical. Tunnels differ from washer extractors because finishing modules are a “standing bath”. Washer extractors flush with fresh water after every use of acid sours.

Thus, it’s even more important to have proper washing conditions when using this sour.

- **Sours in vapor form are highly concentrated and thus more corrosive.**

Formic, HFS and acetic acid have high vapor pressures compared with phosphoric and citric acid, readily forming corrosive vapors.

	Vapor Pressure (mm Hg @20 C)
Formic	44.8
HFS (@25 C)	24.0
Acetic	14.0
Phosphoric	2.2
Citric	Nil

- **Corrosive supply water (low pH and measurable presence of iron) in the presence of certain types of piping and chemistry results in conditions conducive to corrosion of stainless steel.**

Water with the characteristics of high concentrations of dissolved oxygen, carbon dioxide and low pH is aggressive to carbon steel and galvanized carbon steel piping. Corrosion of this piping releases significant amounts of iron to the process wash liquor.

Low pH water may also contribute to corrosion by depressing the wash water pH to levels sufficiently low to accelerate the decomposition of sodium Hypochlorite.

We urge you to:

1. Make sure water flow, level settings, and temperatures are proper. Insure proper and constant maintenance of flow splitters and lifters. Keep the wedge wire screens clean. Refer to “Technical Reference Water Flow and Chemical Injection” Milnor Manual Number MATCBWTRAE.

2. Ensure your chemicals are dosed correctly. Ask your chemist to verify that your bleach and sour concentrations are within industry standard limits.

3. If you have evidence of corrosion near the discharge end of the CBW washer, then speak with your chemist immediately. Get back to a “Healthy Tunnel Washing Profile”.

4. Remove corrosion products and re-passivate the steel. Corrosion left untreated in the presence of continuing abnormal process conditions can result in failure and/or staining of laundry. If the observed corrosion is severe enough, after cleaning, you will need to re-passivate the material to prevent future corrosion.

   DeRustit, www.derustit.com and Chemetall Oakite, www.oakite.com offer products for cleaning and passivating stainless steel. Do not skip the passivation step or the stainless will be more susceptible to corrosion than before.

Our goal herein is to prevent the potential for corrosion. And if it does occur help you resolve it. Please contact us with any questions.

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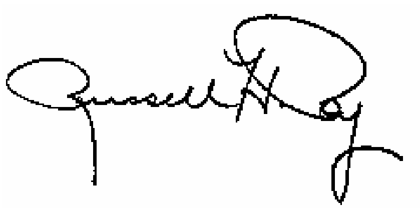


Russell H. Poy
Vice President
Engineering

RHP/kf

Attachment A

Quick Guide for Setting Counter Flow Rates in Milnor Tunnels

To set the Flow Rate into the Rinse Zone, use the following formula:

$$\text{Flow Rate In GPM} = \frac{\text{Lbs Per Hour * Desired Gal/Lb}}{60}$$

$$\text{Lbs Per Hour} = \text{Soil Weight * Soil Factor * Transfers/Hr}$$

$$\text{Transfers Per Hour} = \frac{\text{60 * \# of Modules}}{\text{CBW Washer Process Time}}$$

Figure 1 illustrates the "flow balance" of a Milnor tunnel. The Milnor CBW washer uses counterflow washing and rinsing. Generally, a CBW washer is configured to have four or five zones, each have an appropriate number of modules for its function and production rate: Wet out And Flush, Wash (may be comprised of two or more zones depending on goods and production rate), Bleach, Rinse, Finishing.

Water counter flows from the Rinse Zone through the Bleach and Wash zones as shown. As a starting point, a typical configuration is shown, based on 1 Gallon per Pound of Goods (Many light soil classifications can be processed with much less than 1 Gal/Lb. Bar mops and other heavy soil goods may use in the range of 1.2 to 1.4 Gal/Lb). Water used in each zone is shown in Gallons per Pound of Goods, Cotton and Polycotton.

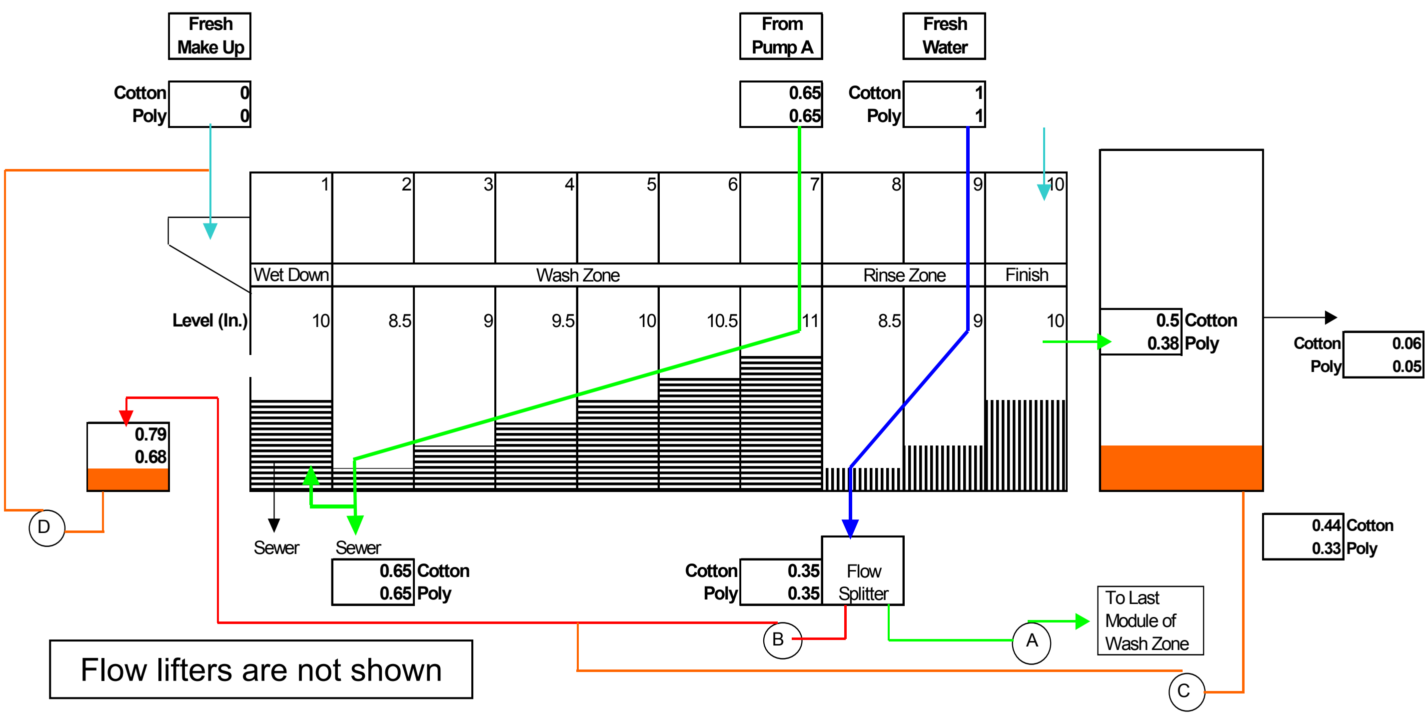


Figure 1

Attachment B

Quick Guide for Setting Weir Plates and Level Switches on MILNOR CBW Washers

1. Make sure the bottom of the float tube is positioned as shown in Figure 2. Water will be just at the bottom of the drum and also at the bottom of the float tube. This is set at the factory and generally does not need to be readjusted.

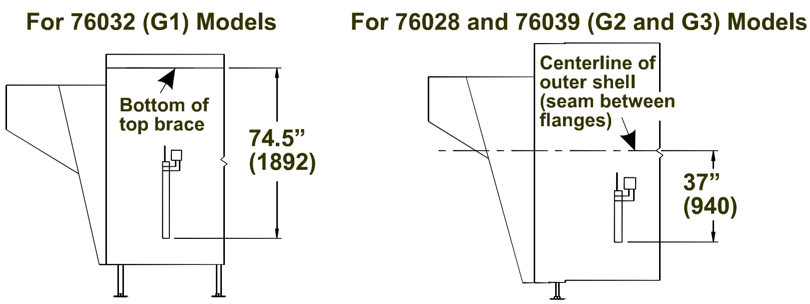


Figure 2

2. Level switches are used to insure proper water level for successful transfer in the CBW washer. Whenever a tunnel goes into “hold” for a prolonged period, water is pumped over the weir. The low level switch has to be set so that it can accurately sense level even with the undulation of water due to drum rotation. **It’s essential to precisely follow these instructions in order to prevent potential jamming.**

   Set Output Time, “Maximum Time in Hold” to 3 minutes (applicable to Mentor and Serial Miltron Software Date Code 0000D.)

   On modules equipped with drains and fast fill valves, the level switch is also used for opening and closing the fast fill valve. Also in this case please refer to the special case described in the “Weir Plate section, Item 4”.

3. Here’s the simple way to set the level switches:
   a) Remove the clips from the rod and insert the rod through the level switch lever.
   b) Let the float sit on the bottom of the float tube. If the machine is full of water, push the rod to the bottom of the float tube.
   c) Hold down the level switch actuator, marking the rod at the top of the level switch actuator. See Figure 3A. Cut the rod.
   d) Place the float rod clips as illustrated below in Figure 3B or 3C, whichever applies.

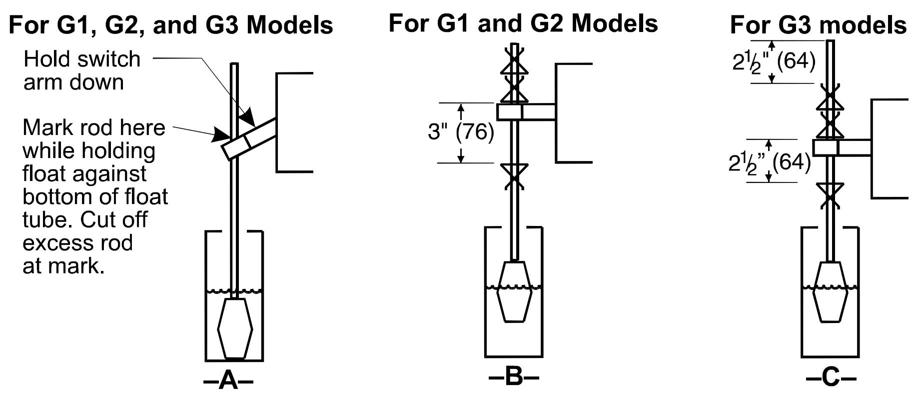


Figure 3

4. Here's how to set weir plates:

   a) The weir plate, not the level switch, sets the level in a module.

   b) Module 1 is normally set at a 10” (254) level. However, if Module 2 has a “Flow Not” valve, set Module 1 at the 8½” (216) weir setting and Module 2 at 9” (229), etc.

   c) Start at the front of the next zone (i.e. first module of the zone) at an 8½” (216) weir setting. Each subsequent module will have a weir plate setting ½” (013) higher than the previous module. Example: Module 2 is set at 8½” (216), Module 3 will be set at 9” (229), Module 4 set at 9½” (241) (considering that these modules flow to each other).

      A flow lifter is employed when a zone exceeds 4 to 5 modules. In this case, the module flowing to a flow lifter defines the beginning of a “sub” zone – thus a 8½” (216) weir setting.

      See Figure 1 in “Quick Guide for Setting Counter Flow Rates in Milnor Tunnels.”

   d) If a module is equipped with a drain and fast fill valve, start the zone at a 9½” (214) weir setting. Otherwise, the level switch may not sense high level and therefore leave the fast fill valve on.

   e) Set the standing bath finishing module(s) at a 10” (254) weir setting.

   f) When flowing water through a CBW washer, there must be level over the weir in order to flow. As flow <u>rates</u> increase, the resultant level in each module goes higher. In some cases, the resultant level may be as much as 3” (076) higher than the weir setting in a given module. On G2 and G3 CBW washers, the divider plate, between modules, is at the 14” (356) water level. If the weir plate in a module is set at 12” (305) and the <u>flow</u> through the zone is set such that the level in the module is 3” (76) higher than the weir plate, then obviously water would be able to flow over the divider in the module. This is counterproductive to washing and should always be avoided.

   g) This issue is most likely to surface in the last module of the rinse zone where water flow is highest and water <u>level</u> is traditionally set high. The result is sometimes water splashing or flowing over the divider into the last module where sour, softener (and sometimes starch) is applied. The result is a dilution of this bath, which sometimes requires increased chemical dosing. If the weir setting is reduced in the rinse zone, this problem will simply disappear.

USING THE WATER FLOW FEATURES OF THE MILNOR® CONTINUOUS BATCH WASHER

NOTE: The following represents our best appreciation of the known facts as of this writing. Naturally, actual field performance will always be influenced by many factors including, but not limited to the degree of soiling, the expected quality standards, and quantity and efficacy of the chemicals used.

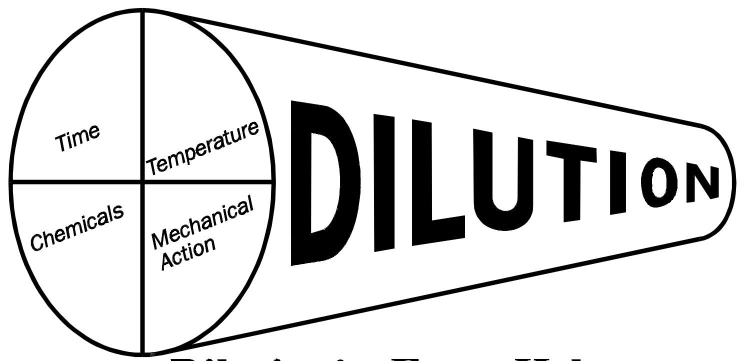
⚠ CAUTION ⚠

Specific textiles (e.g., barrier cloths used in medical procedures, etc.) may require particular laundering processes. Nothing herein is intended to recommend any particular process. Although we suggest each textile manufacturer's laundering recommendations be strictly observed, it is the sole responsibility of others to ensure that the necessary results during and after laundering are consistently obtained.

Why the MILNOR® Tunnel Washes Better

All other factors being equal (same class of goods, degree of soiling, and standard of quality), the MILNOR® “top transfer” CB ® tunnel washer will wash faster, better, and cheaper, with less energy, water, and chemicals—wi h fewer modules—than any known “Archimedian screw” (“bottom transfer”) tunnel washer in the world. It will also wash faster, better, and cheaper with less energy, water, and labor—and with no more additional chemicals—than any washer-extractor in the world. Because most other tunnel washers are bottom transfer m hines, chemical consultants may overlook the special nature (and requirements) of the MILNOR® CBW® tunnel washer’s top transfer design. This section is intended to explain how the MILNOR® CBW® top transfer tunnel washer differs from bottom transfer tunnels so the performance of your machine can be optimized.

The Importance of Dilution

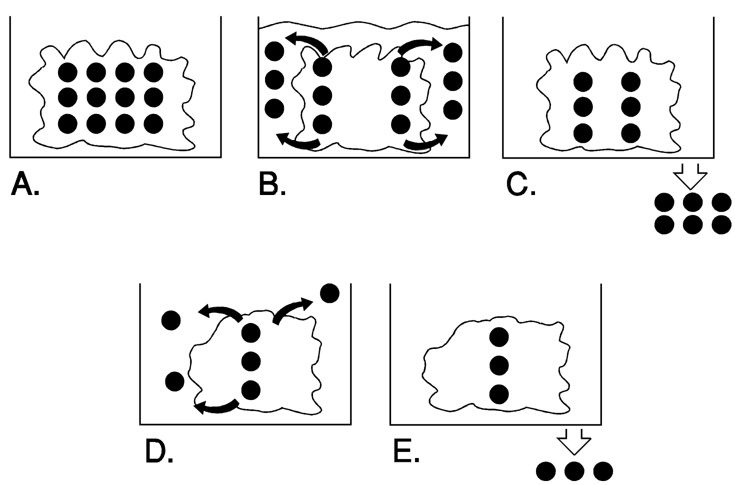


Dilution’s Four Helpers

All washing processes employ water—together with time, temperature, chemicals, and mechanical action—to loosen and suspend soil so the water may remove the soil by the process of dilution. Dilution is the most important factor—since time, temperature, chemicals, and mechanical action won’t work without dilution (and dilution cannot take place without the miracle solvent called water). In fact, scientific studies indicate that dilution plus mechanical action, not temperature, is probably the major mechanism in the washing process responsible for removing most of the bacteria from the goods—and that even small quantities of chlorine bleach effectively eliminate whatever bacteria is not removed by dilution. These studies also tend to indicate that the more important role of temperature is to facilitate the dilution effect and the release of soil (as well as whatever bacteria is entrapped therein) from the goods.

In the washing process, every bath is actually a “rinse”—except that some baths have chemicals in them. Bottom transfer tunnel washers cannot use their water as effectively as top transfer machines do, and thus do not optimize the dilution effect so necessary for proper washing. This is why it is important to understand how the water flows through a MILNOR® CBW® tunnel washer so as to best utilize its superior washing/rinsing/finishing capabilities.

How Dilution Occurs in Conventional Washers



Drawing A shows dirty linen with soil represented by black dots. The linen is placed into a washer, which is then filled with water (B). Roughly half of the water will be absorbed by the linen and the other half will be nonabsorbed or “free water.”

Helped by time, temperature, and chemical and mechanical action, the soil migrates so as to become more or less equally distributed in all the water. This is the dilution process. Then, as the unabsorbed half of the water is drained from the washer (C), half of the soil is also carried away. As the process is repeated (D), the drain from the second bath (E) carries away half of what was left after the first bath—leaving about a fourth of the original soil.

Similarly, the drain after the third bath carries away about half of the fourth which was left in the second bath, leaving about an eighth, and so on, until the goods are clean. Thus, each and every bath in the wash formula is truly a *dilution*—only some have chemicals.

How Dilution Occurs in Tunnel Washers
(The Difference between Bottom Transfer and Top Transfer Tunnels)

When Archimedian screw type (bottom transfer) tunnels transfer their goods, all the water in each chamber also transfers forward with the goods—so the goods continue to "take a bath in the same dirty water." Thus, archimedian screw type (bottom transfer) tunnels can only dilute by counterflowing the water through the goods. However, it can be readily proven that, all other factors being equal, the counterflow process requires about 1.5 times as much water to achieve the same degree of dilution attainable via the fill and dump dilution process (a complete explanation of this fact appears at the end of this section). Hence, dilution by counterflow alone is simply not very efficient. And, it must be remembered that "dilution" is the only mechanism all washing machines use to wash. There are no exceptions!

Because of its top transfer design, each time the MILNOR® tunnel transfers, only about half of the total water in the module is transferred forward with the goods. (The total water includes both the water absorbed by the goods themselves and the free water in the spaces between the goods and between the rotating inner cylinder and the stationary outer shell.) The half of the water that is left behind results in approximately a 50% dilution. In addition, the MILNOR® top transfer CBW® tunnel washer also employs counterflow, yielding approximately an additional 50% dilution. However, the two 50% dilutions in the MILNOR® CBW® tunnel washer (which theoretically would equate to 25% of the soil and chemicals remaining in the goods) are naturally not as effective as two fills and dumps in a washer-extractor, each causing a 50% dilution, because fresh water would be used each time in the washer-extractor while the water in the tunnel is reused again and again.

However, it must be remembered that, in the MILNOR® top transfer CBW® tunnel washer, totally fresh water is used in the last rinse module and only once-used water in the adjacent rinse zone module. This explains why, except for extremely heavy soil, or extremely long tunnels, rarely more than two MILNOR® rinse zone modules are ever required.

In any event, one thing is certain; the two 50% dilutions per module in the MILNOR® CBW® top transfer tunnel washer yields approximately twice the dilution effect compared to the average per-chamber dilution effect attainable in most archimedian screw (bottom transfer) tunnels. Washroom chemists must thoroughly understand this phenomenon if the MILNOR® CBW® top transfer tunnel washer is to be utilized to its fullest advantage.

Although washroom chemists believe that a higher percentage of soil and chemicals remain in the water absorbed by the goods compared to the soil and chemicals in the free water, even this phenomenon is minimized in the MILNOR® CBW® tunnel washer because of the enormous "open area" in our fully perforated cylinder and the high liquor ratio in each module, both of which speed up the attainment of equilibrium and enhance the washing effect. The consequence is better and faster washing in the MILNOR® top transfer CBW® tunnel washer—with fewer modules, and less water, energy, and chemicals—compared to any known bottom transfer tunnel washer in the world.

Where to Add Chemicals in the MILNOR® Tunnel

Another unique advantage of the top transfer MILNOR® tunnel is that chemicals have a greater tendency to stay in the module into which the chemicals are injected, rather than migrating both forward and backwards as much as in bottom transfer designs. The comparison is readily seen in the accompanying graphs at the end of this section. (These graphs are presented to illustrate the capabilities of the MILNOR® top transfer CBW® tunnel washer, not to recommend any specific formulas or dosages.) In fact, most bottom transfer tunnel makers suggest that the majority of their wash zone chemicals be added "in the middle of the wash zone"—to compensate for the inevitable "camel's hump" (forward and backward chemical migration) in such machines. In the MILNOR® tunnel, there is no chemical "camel's hump" phenomenon. Instead, it is usually desirable to add less chemicals to each of several wash zone modules. This doesn't mean that the MILNOR® tunnel uses more chemicals—since the water in the MILNOR tunnel does not itself "use up" chemicals; instead, it simply means that once the water in each module is "first dosed" (to bring up the chemical ppm to the proper level), each "maintenance dose" of chemicals only corresponds to that which would ordinarily be used up by the goods and the soil. (An explanation of "First Dosing" will be found in "DISPLAY P." How to "First Dose" automatically at start up is explained in "STARTUP, THE AUTOMATIC EMPTY POCKETS AND AUTO-PURGE FEATURES, AND SHUT DOWN PROCEDURES" see Table of Contents) Other texts and writers commenting on the so-called "camel's hump" prevalent in bottom transfer tunnel washers insist that special steps must be taken to insure that peak chemical concentrations coincide with peak water temperatures in the wash zone of such machines. As seen by the accompanying graphs, because each MILNOR® module is a completely independent washing machine with separated baths, each individual module can also be heated exactly as desired for each specific formula, and there need be neither a chemical nor temperature "camel's hump" in the MILNOR® top transfer CBW® tunnel washer.

Another misconception is that chemicals should never be added to any module that overflows its weir to the sewer. But remember that when a conventional washer-extractor drains, only about half of the water (and half the soil and chemicals) drain out, thus causing a 50% dilution. The other half of the water, soil, and chemicals remain in the goods—to be used in the next bath. In the MILNOR® CBW® top transfer tunnel washer, only about half the water, soil, and chemicals are transferred to the next bath. The other half usually doesn't drain out; instead the remaining bath is diluted both by the water in the next incoming batch of goods, and by the incoming counterflowing water, both of which usually contain some washing chemicals. The percentage of "lost chemicals" from a MILNOR top transfer module, because of the counterflow which overflows to the sewer, is rarely greater than the chemicals "lost" following a drain and refill in a conventional washer-extractor!

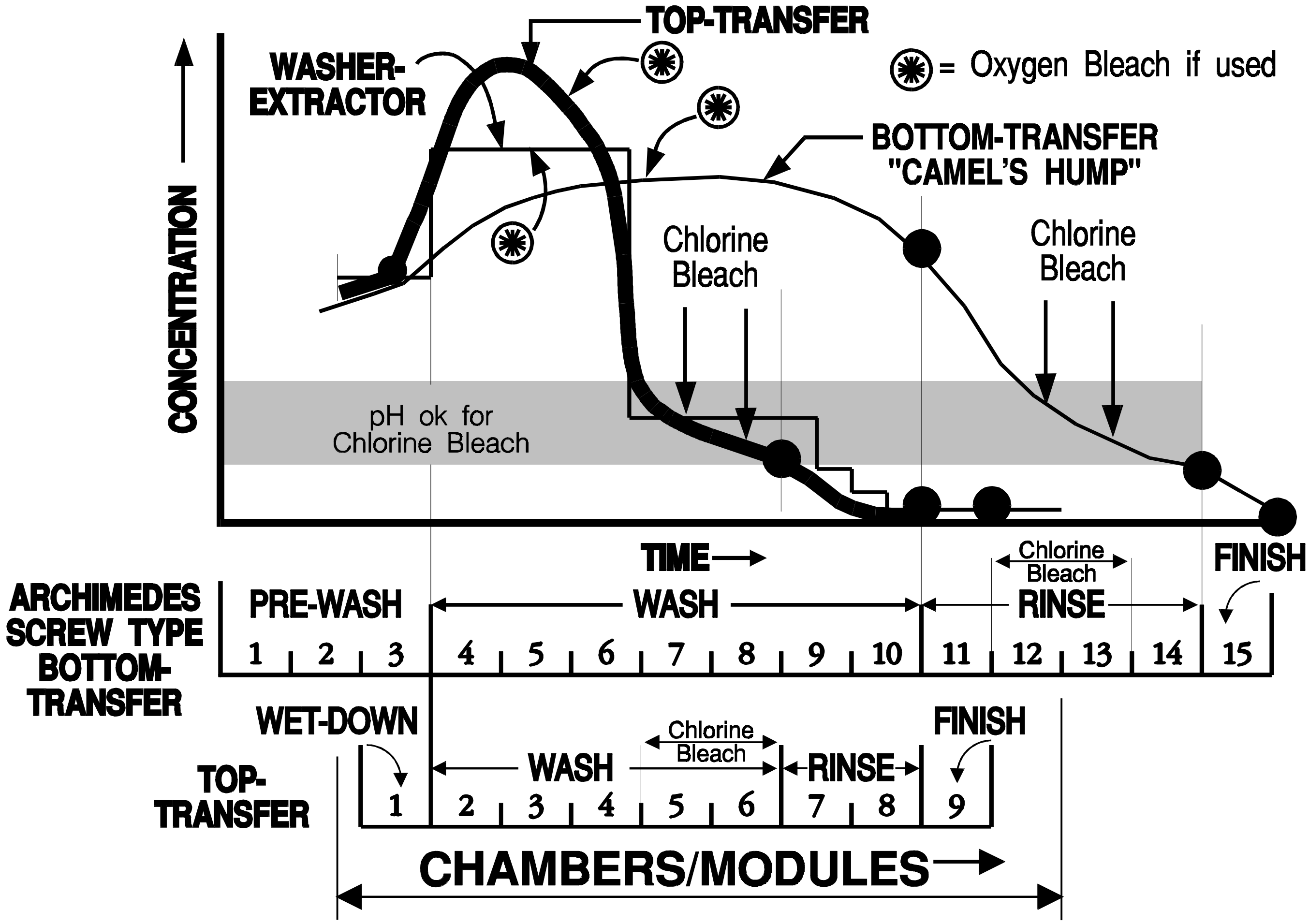
Bleaching in the MILNOR® Tunnel

Chlorine bleaching in the MILNOR® tunnel, even to relatively high concentrations, can be safe and quite acceptable, providing the usual safeguards are observed—especially with respect to the proper and safe combination of the pH, the temperature, and the actual ppm (mg/l) of active chlorine in each bath. The control of pH in the bleach bath is particularly important because of the remarkable rinsing effect of the MILNOR® tunnel which can lower the pH dramatically between adjacent modules similar to the rate at which the pH is lowered between successive baths in a washer-extractor. It is also important that the bleach be absolutely dissolved and completely soluble. Never attempt to use in-house liquified dry bleach or any other in-house liquified dry product unless the manufacturer absolutely guarantees his dry product to be completely soluble and completely satisfactory for use in stock solutions and recommends this use without qualification. In any event, never add such a liquified dry bleach to the tunnel in concentrations higher than 1% available chlorine (i.e., 10,000 ppm or 10,000 ml/l). It is also best—and highly recommended—to dilute concentrated "carboy" bleach with water down to a concentration of approximately 1% available chlorine (10,000 ppm or 10,000 mg/l) before injecting the bleach into the tunnel. "Carboy" bleach is usually delivered at a strength of approximately 15% available chlorine (150,000 ppm or 150,000 mg/l). Moreover, all chemical injection times should be reasonably long—surely no less than 10 seconds (preferably 15 - 25 seconds) so the goods do not receive a concentrated "slug" of chemical that might cause fabric damage. This is especially important in shorter tunnels with longer transfer times.

The MILNOR® steam "sparger" (steam and water mixing device) in each steam-heated module is quite efficient. Tests have shown that when the tunnel is supplied with saturated steam at pressures up to 125 psi (8.5 bar), the maximum temperature in the immediate vicinity of the sparger discharge is temporarily only 12°F (7°C) higher than the temperature of the remaining bath. Thus, if the above precautions are observed faithfully, and if the steam spargers are kept clean and free from lint, it is usually quite permissible to inject steam directly into a bleach bath. Of course, this is a decision which must be made by the user and his chemical consultant.

Oxygen Bleaches can also be employed in the known manner whenever desired.

APPROXIMATE
COMPARATIVE WASH CHEMICAL CONCENTRATION CURVES FOR:
WASHER-EXTRACTORS
TOP-TRANSFER TUNNELS
BOTTOM-TRANSFER TUNNELS



Additional graphs of actual titration are at the end of this section.

The CBW® Zones

How Zones Are Used—Each bath in each tunnel module is completely segregated from each bath in all other modules. Unlike bottom transfer tunnel washers, all water leaving each MILNOR® CBW® top transfer module must pass over that module's weir. Usually, water counterflows from the cleaner end to the more soiled end of each individual module in the zone, as it is usually considered counterproductive and utterly useless for the water to ever flow in the same direction as the goods. Modules are usually grouped into flushing, was hing, rinsing, and finishing zones. Temperatures and chemicals can be independently controlled within each individual module while flow rates are usually controlled within zones.

When a Wash Zone Flow LIfter Is Needed—Generally, there is actually only a single wash zone because it is generally better to pass all the wash zone water through all the modules in the wash zones. But the actual level of water in a water-sending module depends on the height of the highest weir in any of its interconnected receiving modules. For water to flow from one module into the next, the water level in the water-receiving module must be approximately 1/2" to 3/4" (13 to 19) lower than the water-sending module. In tunnels with six or more wash zone modules, thi phenomena may cause the water level to be either too high in the wash zone module nearest the tunnel's discharge end, or too low in the wash zone module nearest the load end. With longer wash zones it is even possible that the level in the first water-sending module (the module that receives water directly from the Rinse Zone Flow Splitter) can become so high as to actually flow backwards toward the discharge end of the tunnel—and thus in the same direction as the goods. This will seriously affect washing efficiency; thus wash zones with six or more modules frequently have a "Wash Zone Flow Lifter" (FIGURE 1) to raise the water level in the last module of the first wash zone so the desired water flow rate can be maintained throughout both sections of the wash zones.

⚠WARNING⚠

This laundry-type machine is manufactured specifically to be used with water—not with any type solvent, nor with any other material that might be flammable. Laundry-type machines must not be used to process goods containing any significant quantity of flammable solvent that might burn or explode. <u>Numerous cold flushes</u> must always precede any hot baths if the goods contain flammable solvent, even if the quantity of flammable solvent is deemed not "significant." When any doubt exists as to the meaning of "significant quantity," you must consult with your state and local fire departments <u>and</u> your property, casualty, liability, fire, and workmen's compensation (et al.) insurance providers.

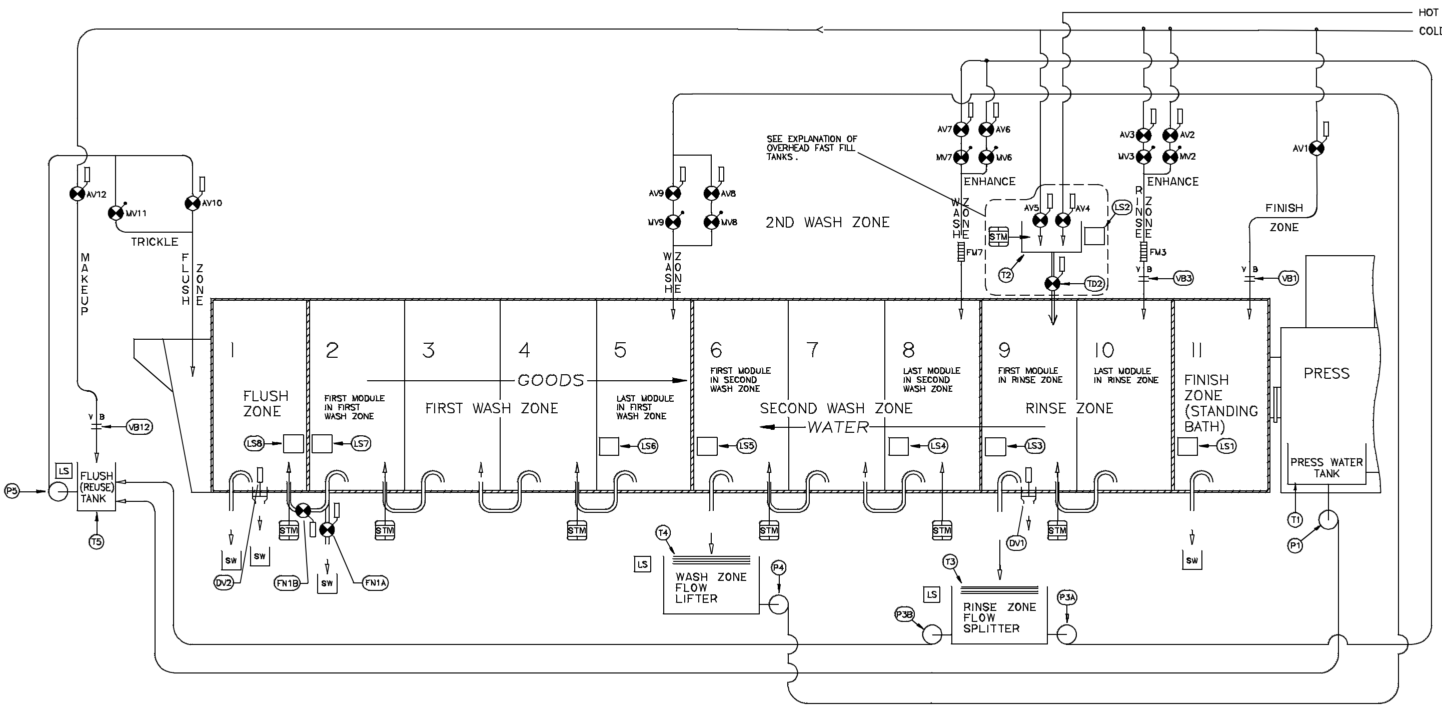


FIGURE 1 (MSSMD405BE)
Flow Diagram—Typical CBW Tunnel Washer

Water Flow in a Typical CBW® Tunnel Washer

The flow diagram of a typical tunnel in the USA is shown in FIGURE 1. Laundering practices in some localities may require certain alterations. The item numbers in the following explanations are shown on this figure.

Press Water Return Pump—Press Water Return pump (P1) sends the water extracted from the goods to the Reuse tank. It turns on when press extract water tank (T1) level rises above high and shuts off when the level drops below low.

Standing Bath Modules—Automatic fill valve (AV1) and level switch (LS1) maintain an adjustable level in an isolated module (a module that does not flow into another module; under certain circumstances, two or more interconnected modules can also be fitted with this feature). This is useful to establish a standing bath (usually in the last module which is the Finish Zone) where a continuous flow of water is not required. See **“Reuse Tank”** in this section for how the first module may also utilize a standing bath.

Rinse Zone Inlet—Fresh water enters the Rinse Zone via Rinse Zone automatic inlet valve (AV3), adjusted by vernier valve (MV3) and flowmeter (FM3). During the morning start-up procedure, the Rinse Zone automatic valve opens until levels are achieved (see FIGURE 1). When the tunnel is washing, this valve supplies counterflow water to the tunnel, except during non-level related holds.

Optional C-Bit-controlled flow enhance valve (AV2) and vernier valve (MV2) may be supplied to command an increased flow through the rinse zone when required by specific formula or goods types.

Rinse Zone Flow Splitter—Rinse Zone Flow Splitter T3 accepts all water from the rinse zone, de-lints it and splits it by pumping, via P3A, a reduced quantity of water to the wash zone, and via P3B, the surplus water to the Reuse tank. Both Wash Zone Pump P3A and Surplus Pump P3B are off when the level in T3 is below low. As soon as th level in T3 rises above low, the Wash Zone Pump turns on and Second Wash Zone automatic inlet v lve AV7 opens. Using flowmeter FM7, Wash Zone vernier valve MV7 should be calibrated so approximately 65% o the Rinse Zon water enters the Wash Zone. Surplus Pump P3B turns on whenever the level in T3 rises above high nd remains on until the level drops below low. To prevent backflow, automatic valve AV7 closes and the Wash Zone Pump shuts o when the tunnel is in **hold**. However, Surplus Pump P3B remains active during a hold to prevent overflows.

Optional C-Bit controlled Wash Zone flow enhance valve AV6 and vernier valve MV6 may be supplied to command an increased flow through the Wash Zone when required by a specific formula or goods type.

Wash Zone Flow Lifter (Only If Two Wash Zones)—If two wash zones are required, Wash Zone Flow Lifter T4 accepts the water from the first module in the Second Wash Zone, de-lints it, and sends it to the last module in the First Wash Zone via Wash Zone Pump P4 and the First Wash Zone automatic inlet, which contains normal flow (main) valve AV9, vernier valve MV9, and supplemental valve AV8 with vernier valve MV8. Wash Zone Pump P4 turns on and the main auto valve AV9 opens whenever the liquor level in T4 is above l ow. The supplemental inlet only opens when the water level rises above high level, thus providing additional flow. Once open, this valve stays open for 7.5 seconds after the water level falls below high. Both auto valves AV9 and AV8 close whenever pump P4 turns off, to prevent water from siphoning into flow lifter tank T4.

For detailed information on the Flow Splitter/Lifters, see “RINSE ZONE FLOW SPLITTERS AND WASH ZONE FLOW LIFTERS.”

Reuse Tank—Reuse tank T5 receives water from Press Water Tank T1 via Press Return Pump P1 and from Rinse Zone Flow Splitter T3 via Surplus Pump P3B. Automatic fresh water make-up valve AV12 opens whenever the Reuse tank level drops below low and closes when the level rises above high. Reuse tanks may be optionally equipped with (1) automatic drain valves, usually in conjunction with the Bath Exchange feature, and (2) thermostatically controlled cooldown or heat up as described below.

The Flush Inlet automatic valve AV10 opens at transfer to wet down the incoming goods and remains open unti the Module 01 level switch LS8 is satisfied, or for the duration specified in **CRST2** on Display H, Page 01, **whichever is longer**. This valve also opens when Module 01 level drops below low and remains open until the level rises above high. Ordinarily, Flush Pump P5 that supplies water to Module 1 remains on whenever the Tunnel Power is on and th tunnel is not in **hold**, and manual trickle flow valve MV11 remains permanently open to provide a small steady flo of water into Module 01 as long as the Flush Pump is on. However, to create a standing bath, th Flush Pump can b commanded to shut off when the Module 01 low level and the minimum flush time commanded in CRST2 are both satisfied. This function is controlled by C-Bit 07 in Module 01 as described in “DISPLAYS AND G: CREATING BASIC FORMULAS AND FORMULA VARIATIONS”

Optional Cooldown or Steam in the Reuse Tan —The Reuse tank may be equipped with either Cooldown to cool the flush water or steam injection to pre-heat the flush water, but not both. With the Reuse Cooldown option, a maximum temperature is commanded to prevent hotter water from setting st ains. With the Reuse Steam option (usually employed only in special tunnels) a minimum reuse water temperature is commanded to heat the water to a more desirable temperature. A single (but commandable) temperature ra nge applies to all formula/goods codes. See TCMAX and TCMIN on Display H, Page 01.

Module 01 Flow-not and Drain Valve Options—Optional C-Bit controlled flow-not valve assembly FN1A and FN1B can be used to direct the out-flow from the first wash module (generally Module 02) so that its water, chemicals, and energy can be used in the last wetdown module (generally Module 01) whenever the goods in the last wetdown module will not be adversely affected by doing so.

Optional C-Bit controlled drain DV2 can drain Module 01 as certain (some or all) new loads enter. The drain valve can also drain the module when half the time between transfers has elapsed. The module can be refilled by reuse water alone, or via the optional, C-Bit controlled flow-not valve, by the combination of reuse water and the counterflow of heated, chemical-laced water from Module 02, thus slowly raising the temperature of the load. Optional flow-not and drain valves can be supplied on any module.

Optional Vacuum Breaker—Vacuum breakers VB1-VB12 are required by some jurisdictions to prevent the siphoning of contaminated water into the potable (drinkable) water supply. When necessary, these valves should be added to each automatic inlet valve set on the tunnel that controls potable water (usually from the city water main). Vacuum breakers are not required for water that has already become "contaminated" (e.g., pumped water from a flow splitter). Moreover, because of potential leaking problems, vacuum breakers cannot be used with any water source containing lint or other impurities.

Overhead Fast Fill Tanks

Up to three overhead fast fill tanks may be optionally provided for Module Cooldown or Dual Bath applications.

Overhead Fast Fill Tanks for Module Cooldown—This option is generally used on the first rinse module when, due to the flow of incoming cold rinse water, the temperature in the first rinse module has dropped sufficiently to risk wrinkling a warmer, next-to-enter load of polyester goods. After draining the module via drain valve DV1, overhead fast fill tank T2 (as in FIGURE 1) quickly refills the module, via drain valve TD2, with pre-heated water at a commanded temperature appropriate for the goods that have just entered the module. When TD2 closes, tank T2 is refilled via thermo water fill valves AV4 and AV5 and thermo steam injection at a commanded temperature appropriate for the next load of goods to enter the module. The thermo-modulated fill ends when level switch LS2 detects level satisfied in the tank.

Overhead Fast Fill Tanks for Dual Bath Modules—Dual baths are used (generally in the last module of shorter tunnels) with longer transfer times so the last module can function as both a rinse and finishing module. During the <u>first half of the time between transfers</u> (FIGURE 2a), fresh water enters the last module in the Rinse Zone via Rinse Zone automatic valve AVD, adjusted by a vernier valve MVD, calibrated by flowmeter FMD, then routed through automatic valve AVDA into the last module. Water then counterflows to the first Rinse Zone module through flow-not valve FNAB. As with a typical tunnel, liquor exits the Rinse Zone to the Rinse Zone Flow Splitter TB. Surplus Rinse Zone water is pumped via Surplus Pump PBB to the Reuse tank. A reduced quantity of liquor is pumped via Wash Zone pump PBA to Wash Zone automatic inlet valve AVE, adjusted via vernier valve MVE and calibrated via flowmeter FME. During the <u>second half of the time between transfers</u> (FIGURE 2b), the fresh water entering through the Rinse Zone inlet is sent to the first Rinse Zone module through Automatic Valve AVDB. The last module then becomes a Finish Zone with a standing bath maintained by automatic valve AVA, which is controlled by level switch LS1. Water outflowing the finish module is sent to the sewer via flow-not valve FNAA. At <u>transfer</u>, the last module's drain valve DVA drains all finishing water to the sewer (or a storage tank), then the module is quickly refilled by AVA, or if insufficient water pressure exists, by optional overhead fast fill tank TA via tank drain valve TDA. TA is filled by optional electronically controlled thermo-water fill valves AVB and AVC and optional thermostatically controlled steam injection.

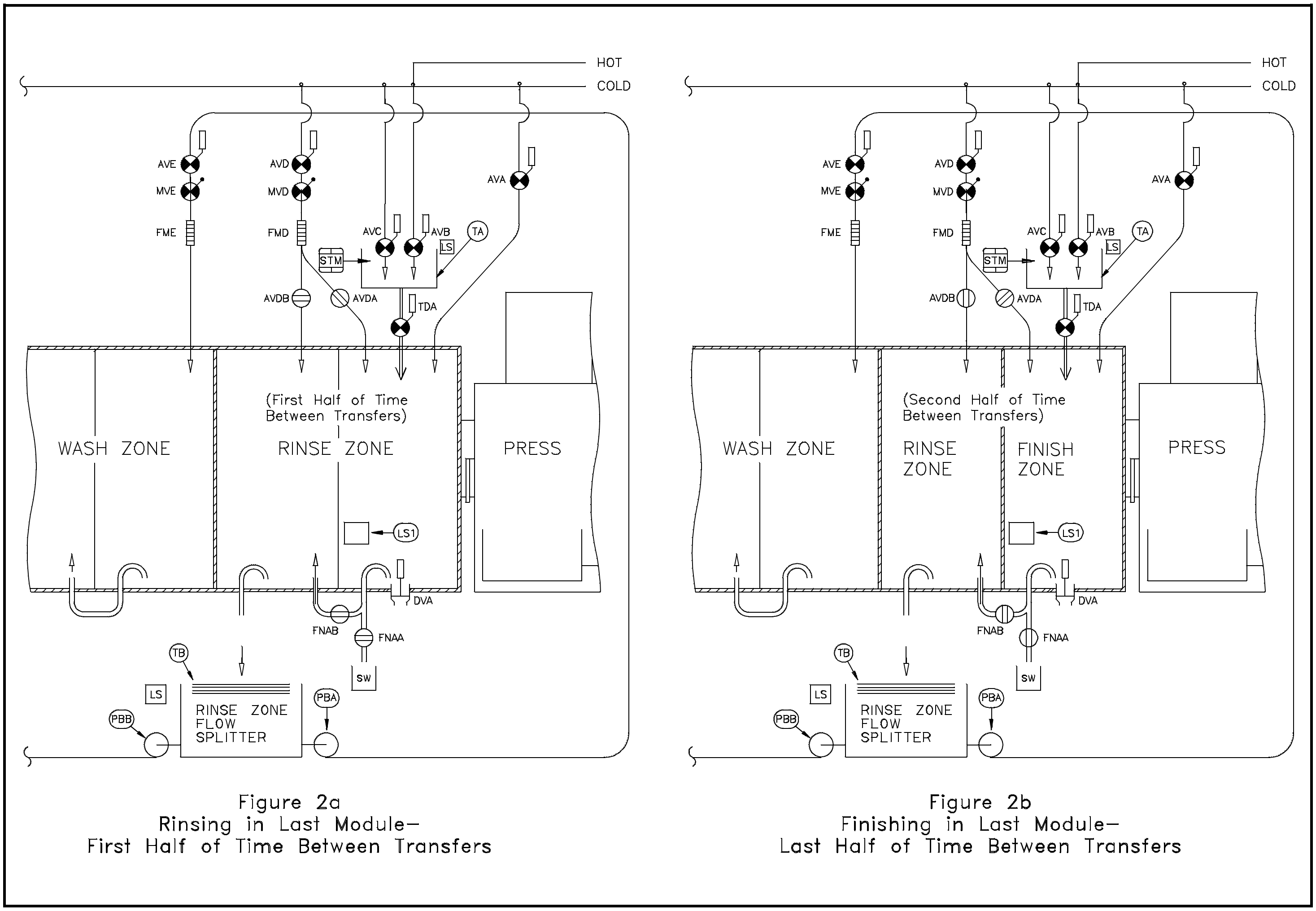


FIGURE 2 (MSSMD405BE)
Flow Diagram - Dual Bath

Bath Exchange (FIGURE 3)

Optional Bath Exchange may be specified when it is desired to prevent intermixing the “bad”bath liquor in a module with the “good” goods that are next to enter that module.

Flow-not Valve —These valves divert the bath liquor that, for example, normally counterflows from Module X to Module X-1, sending it instead to the sewer when “good” goods are in Module X-1 and a “bad”bath is Module X. In FIGURE 3a, red goods are in Modules X and X+1, and white goods are in Module X-1. Water counterflows normally from Module X+1 through flow-not valve FNBB into Module X (valve FNBA being closed), but because of the red goods in Module X, flow-not valve FNCB is closed, preventing Module X’s bath liquor from entering Module X-1, and instead sending it to the sewer via valve FNCA.

Alternate Water Inlet—The alternate water inlet on a bath exchange module is commanded to open during the time between transfers when the first load of “good” goods is in that module, and the “bad” bath liquor that

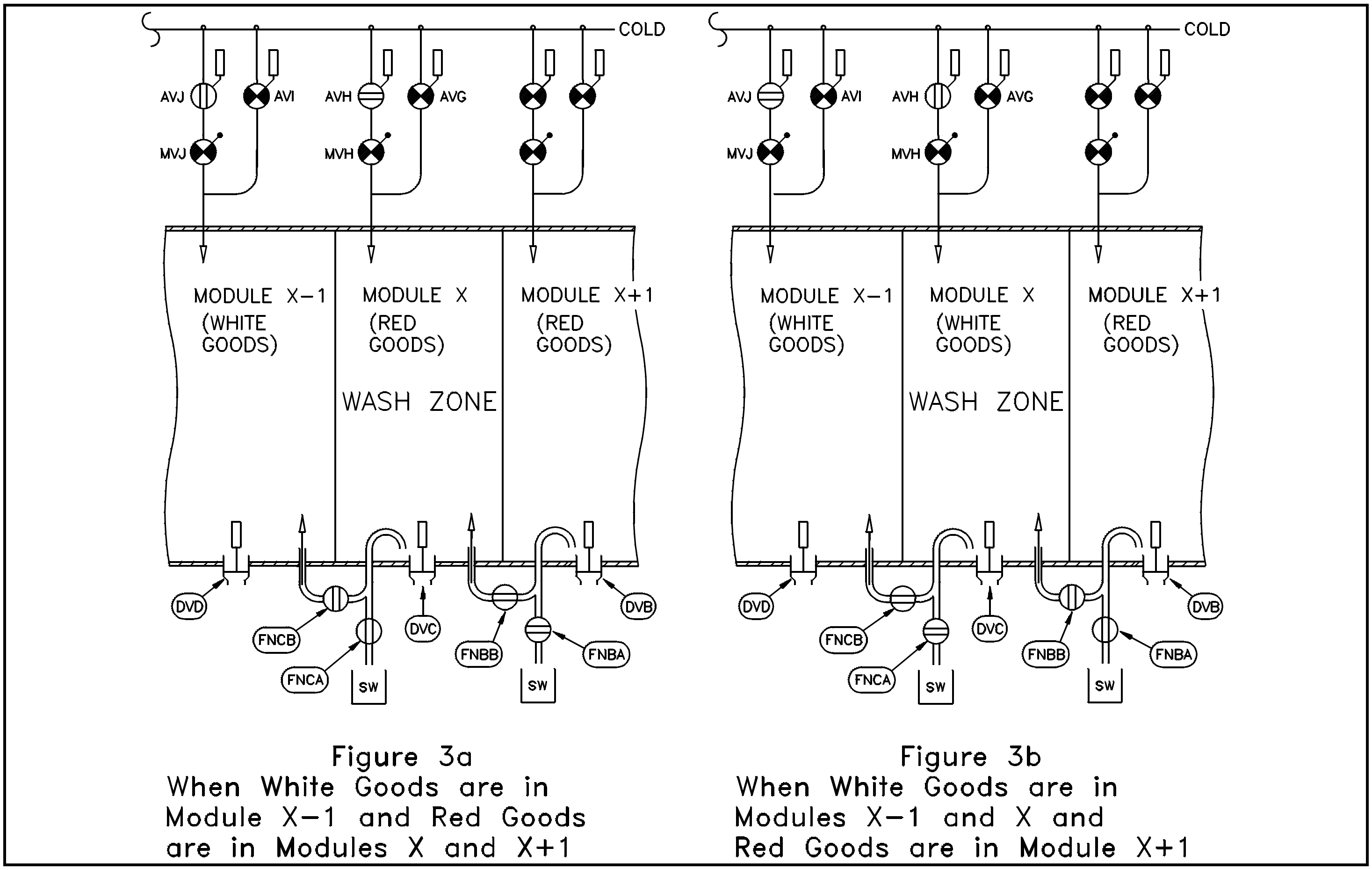


FIGURE 3 (MSSMD405BE)
Flow Diagram - Bath Exchange

would normally counterflow into that module is instead diverted to the sewer. In FIGURE 3a, Module X-1's automatic alternate water valve AVJ is open, and Module X's automatic alternate water valve AVH is closed. Manual valve MVJ on Module X-1's alternate water inlet is permanently adjusted so that the inlet admits a flow of fresh water equivalent to the counterflow water it normally receives.

Drain Valve—The drain valves on a Bath Exchange module open whenever the first load of "good" goods follows a "bad" bath. The module is completely drained of "bad" liquor before the goods actually transfer. In FIGURE 3a, Module X's drain valves DVC completely drain Module X just before the first load of white goods follows red goods into Module X.

Fast Fill Inlet—To quickly refill the module, the Fast Fill inlet admits fresh water into a Bath Exchange module just after that module's drain valve closes. In FIGURE 3A, Module X's automatic fast fill valve AVG opens when drain valves DVC close, until the water level is restored in Module X.

FIGURE 3b shows the state of the various flow-not valves and automatic alternate water valves on Modules X-1, X, and X+1 during the time between transfers following the one shown in FIGURE 3a.

Workwear (FIGURE 4)

Workwear Module Modification —Workwear modules are used to process industrial workwear and/or other goods laden with sand, metal particles, heavy protein and/or mineral contaminants. Workwear modules have two large center-mounted, air-closed, self-cleaning drain valves, DV1, (one in each shell sump) to purge the shell sumps of heavy non-solubles. The drain valves are operated both manually by toggle switch and automatically by C-Bit. Two air-operated water valves, FV1, flush the weir boxes and shell sumps, then automatically refill the module after manual or automatic purging. For flushing procedure, see "START UP, THE AUTOMATIC EMPTY POCKETS AND AUTO-PURGE FEATURES, AND SHUT DOWN PROCEDURES."

Workwear Flow Splitter Modification —WORKWEAR flow splitters and flow lifters include a specially designed self-sluicing leveling tank with independent manual flushing valves for leveling tank FV2 and holding tank FV3. Manual bypass valve FV4 directs the outflow from the surplus (reuse) water pump to either the Reuse tank (for normal operation) or to the sewer. The tank has a MANUAL/AUTOMATIC switch for when the pump is used with one of the above mentioned flushing water valves to purge the holding and leveling tanks. The

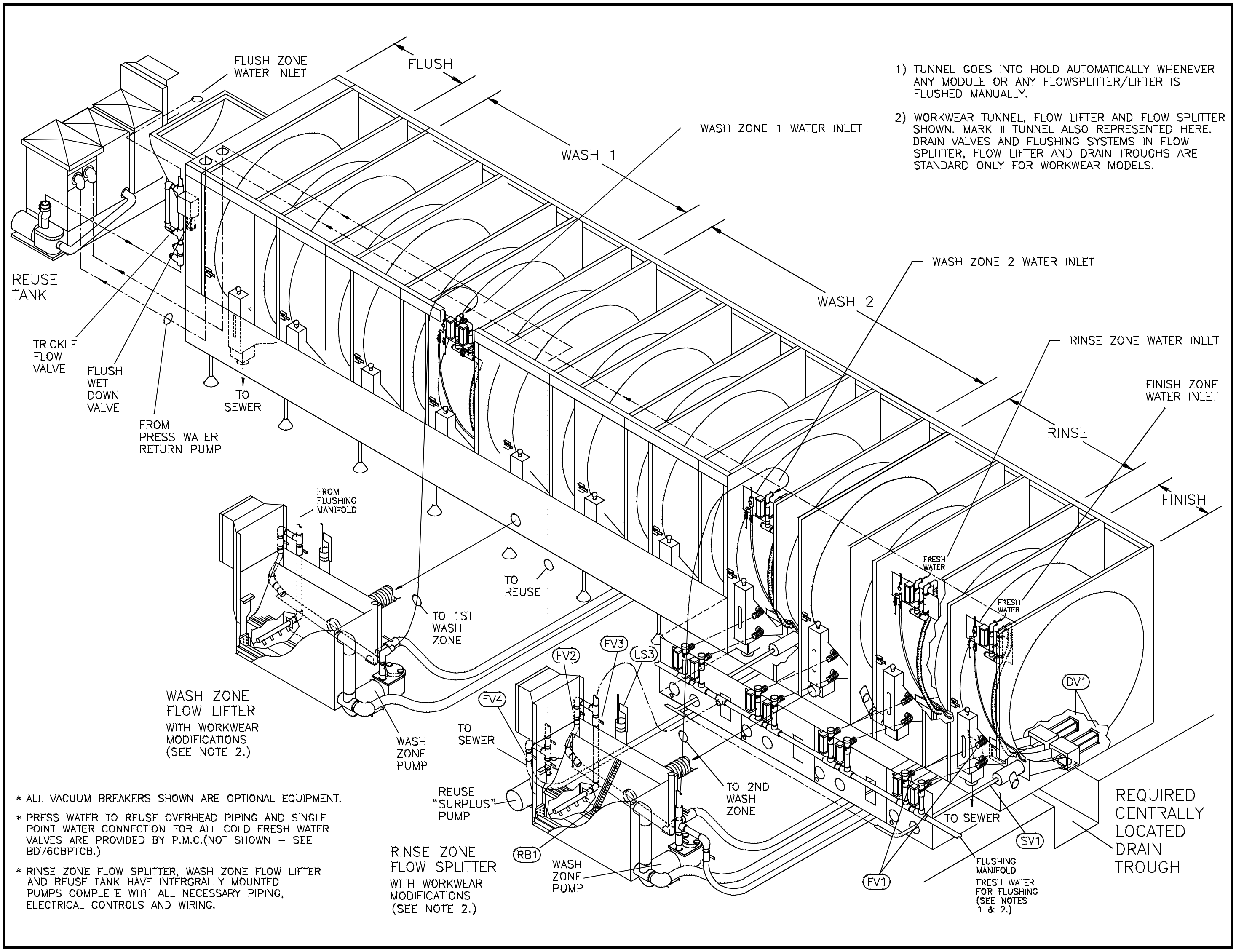


FIGURE 4 (MSSMD405BE)
Typical Workwear CBW Tunnel Washer

tunnel is placed in **hold** when switch is in MANUAL. A level switch (LS3) on the flow splitter overrides the manual switch so the pump will not run dry. For WORKWEAR flow splitter and flow lifter flushing procedure, see “RINSE ZONE FLOW SPLITTERS AND WASH ZONE FLOW LIFTERS.” An air-operated reciprocating brush mechanism, RB1, is optional on all flow lifter/splitter tanks.

How Levels Are Controlled and Monitored

Counterflow Module —All tunnel modules are supplied with weirs. In counterflow modules, the level rises until the continuously flowing water is overflowing the weir, as shown in FIGURE 5. Thus, the level is basically controlled by setting the height of the weir plate. See “Why a Module’s Water Level May be Higher than its Own Weir” in this section. Level switches are strategically placed to monitor the levels throughout the tunnel to assure that the tunnel will not transfer if the liquor levels fall below the safe operating height.

Standing Bath Modules—Although standing bath modules are equipped with weirs, the level in these modules is controlled by a level switch assembly containing both a low level switch and a high level switch which keep the module level between the low and high levels set on the level switches.

Drain and Fast Fill Modules—Tunnel modules may be provided with wash formula-controlled drain and fast fill capability. These modules combine level switch and weir control, such that after a drain, if the water level drops below the low level switch, the fast fill valve opens until high level is achieved then counterflow takes over to regain the level controlled by the weir setting.

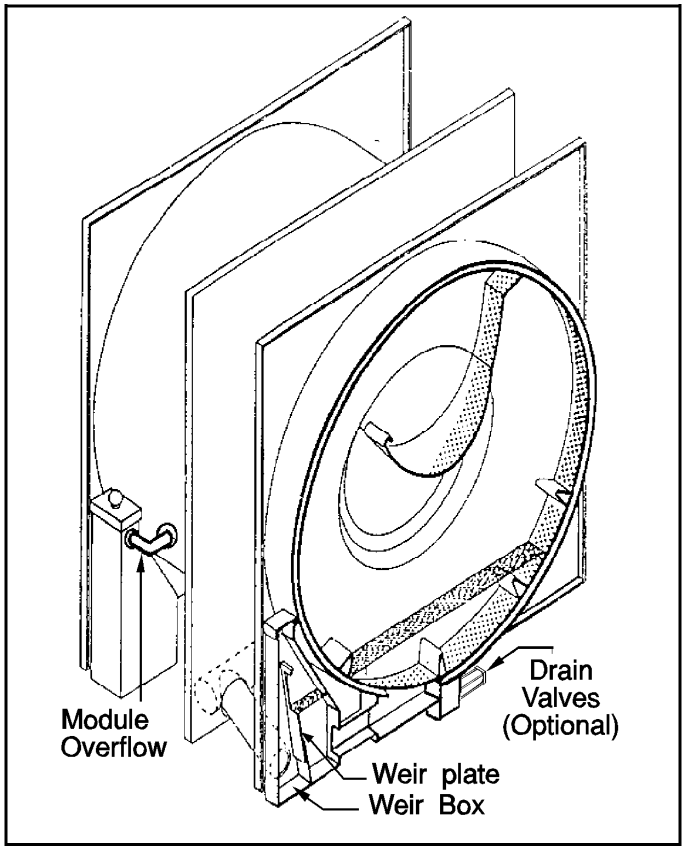


FIGURE 5 (MSSMD405BE)
Weir Box/Module Cross Section

Rules for Setting Module Level Switches

—The low and high level switch settings on all module level switch assemblies must be checked at installation, and they must adhere to the following:

1. **The absolute minimum safe level for transfer without risk of goods jamming during transfer is 6 1/2" (165)**. The **low level switch** on all module level switch assemblies, (regardless of what type of module they’re on) must be set (a) always as high as possible, but never less than a 6½" (165) water level [A=31.5(800)]; (b) never closer than 1" (25) below the adjustable weir otherwise, because of the undulating water level, the low level switch will not be satisfied and the tunnel will HOLD, and (c) never closer than 1" (25) from the bottom (high level) slip on the float rod.
2. The **high level switch** on any module level switch assembly with an active high level (any standing bath or drain and fast fill module) must be set 1" (25) below the module weir height, to ensure that high level will be achieved and the fast fill valve will close before the bath liquor begins overflowing the weir.

3. As shown in FIGURE 6 of this section, the two adjustable clips on the float rod must never be set closer than1" (25). Clips set closer may intermittently bind the level switch lever and cause a malfunction.

The above rules mandate a 9.5" (241) minimum water level in any module equipped with drain and/or refill valves.

How to Set Module Level Switches (FIGURE 6)

1. Adjust the lowermost top clip on float rod so it depresses the lever and actuates the lower switch when water level complies with Rule 1. Now for security, position the uppermost top clip immediately above the lower-most top clip.
2. Cut off remaining portion of float rod above the two top clips.
3. Adjust the bottom clip so it lifts the lever and actuates the upper switch when the level complies with Rule 2.

DIMENSION a (see FIGURE 10)		FOR WATER LEVEL b		
30.5	(775)	7.5"	(190)	**Do not use these levels if module has drain and/or refill valves.**
30"	(762)	8.0"	(203)	
29.5"	(749)	8.5"	(216)	
29"	(737)	9"	(229)	
28.5	(724)	9.5"	(241)	
28"	(711)	10"	(254)	
27.5"	(699)	10.5"	(267)	
27"	(686)	11"	(279)	
26.5"	(673)	11.5"	(292)	
26"	(660)	12"	(305)	
25.5"	(648)	12.5	(318)	

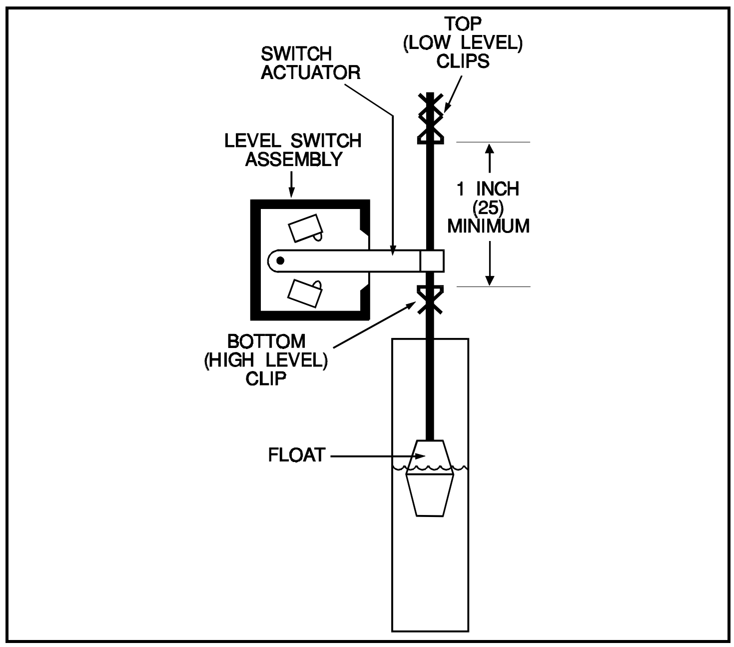


FIGURE 6 (MSSMD405BE)
Setting Level Switches

The upper and lower clip must be at least 1" (25) apart as shown in FIGURE 6.

How to Avoid Tunnel Blockag

The tunnel will jam if it transfers without enough water in each module. If an inadequate water level occurs immediately prior to transfer, the MILTRON controller will prevent transfer, display a message, and indicate the offending module. Do not attempt to "fix" this by holding the lever upmechanically, or by merely readjusting this level switch (cutting off the float rod above the two top clips will discourage readjusting). Instead, check for logical reasons for loss of water flow (shut offwater valves, or pumps, lint-blocked pumps or strainers, etc.).

⚠ CAUTION ⚠

Weir boxes must be checked periodically for lint build-up. If the weir box drain clogs and water flow is reduced, wash quality will diminish, the module blocked may overflow, and the water level will become too low in any modules that depend upon water from the blocked module.

Why a Module's Water Level May Be Higher Than Its Own Weir

1. Even with the weir removed, a module's water level will be 1/2" (13) to 3/4" (19) higher than the level in the adjacent downstream module, because of the cascade effect caused by restrictions to the flowing water, as in FIGURE 7. Larger variances will tend to occur with faster flow rates and smaller variances will occur with slower flow rates.

2. A module's level will be at least as high as the high-est downstream weir within its zone (FIGURE 8).

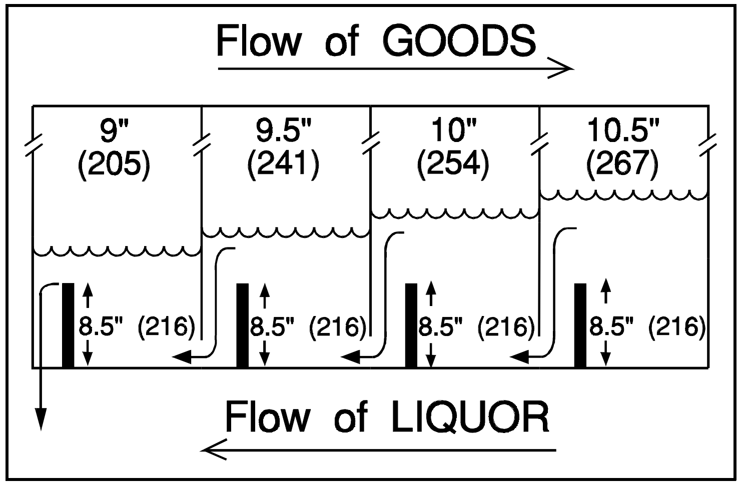


FIGURE 7 (MSSMD405BE)
INCORRECT - Weirs Don't Cascade

Rules for Setting Weir (FIGURE 9)

1. In a long zone, never set the downstream weir too high, as this may cause the water to flow backwards toward the discharge end of the tunnel, sending dirty liquor into the adjacent cleaner bath. A backward flow may occur if inter-module piping is restricted by lint or soil build-up.

⚠ CAUTION ⚠

Reduced wash quality may indicate that inter-module piping is restricted. Check for and remove any lint or soil build-up.

2. Graduate the weirs so they coincide with the naturally cascading levels. This prevents backflow and helps maintain liquor levels during **holds** when water flow is shut off, thus conserving water and permitting the machine to recover levels faster.

3. Weirs are intended to be set permanently. Special case adjustments are not needed.

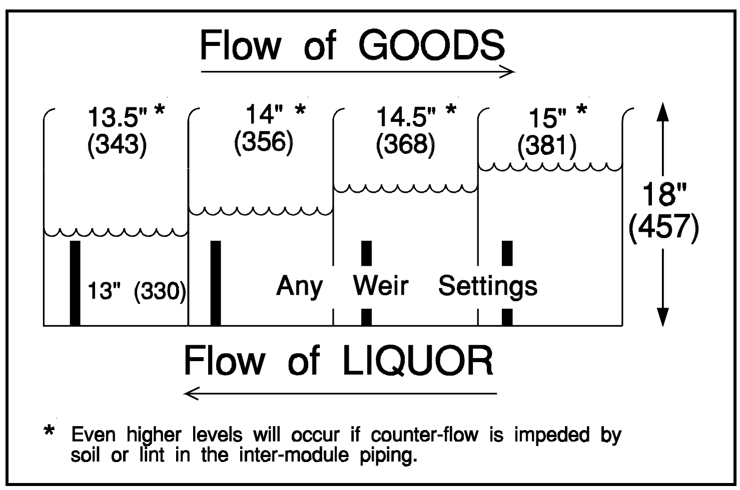


FIGURE 8 (MSSMD405BE)
INCORRECT - Downstream Weir Too High

4. In lieu of specific instructions from the chemical supplier, make the following weir settings first then set all other weirs so they cascade properly:
   - **a.** 12" (305) in Module 01 when water does not flow into Module 01 from adjacent module(s), but never lower than 10" (254) (should water flow into Module 01 from adjacent module(s).)
   - **b.** 12" (305) in the last module of each wash zone
   - **c.** 10" (254) in the last module of the rinse zone
   - **d.** 12" (305) in the last (discharge) module

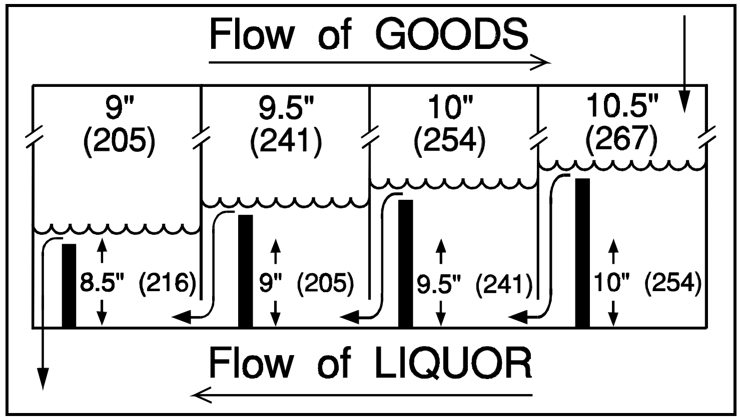


FIGURE 9 (MSSMD405BE)
CORRECT - Weirs Follow Desired Levels

How to Set Weirs

1. Determine desired water level (see explanation in “Rules for Setting Weirs,” preceding page).
2. Attach bolts to weir in proper holes for desired water level, as shown in FIGURE 10A. Install bolts pointing in opposite directions so weir can’t slip below the set height.

CAUTION

The number of weir plate holes varies on some tunnels. The top hole always corresponds to 7.5" (190) but the bottom hole does not always correspond to 12.5" (318). Locating the desired hole by counting from the bottom up may result in an unintended level.

- **Always count from the top hole down (in 1/2" (12.7) increments) when identifying the hole corresponding to the desired level.**

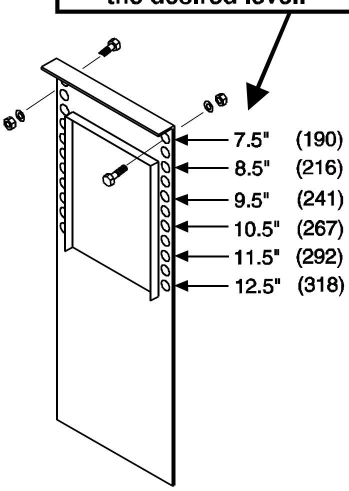


FIGURE 10A
ATTACHING WEIR
SETTING BOLTS

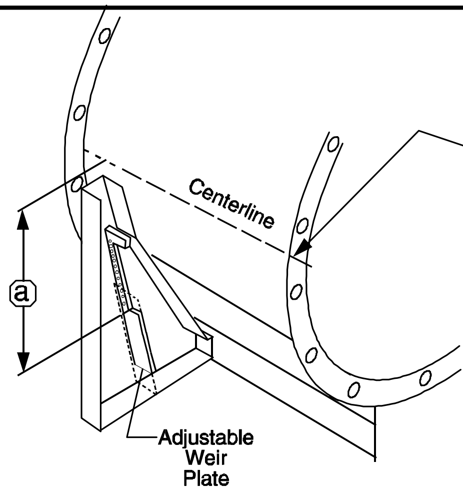


FIGURE 10B
WHERE TO MEASURE
DIMENSION a

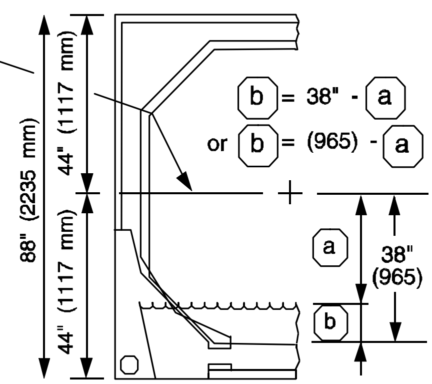


FIGURE 10C
HOW TO FIND
MODULE CENTERLINE AND
HOW TO USE DIMENSIONS
a & b

FIGURE 10 (MSSMD405BE)
Setting and Checking Weirs

3. Slide weir into the two slots in level box.

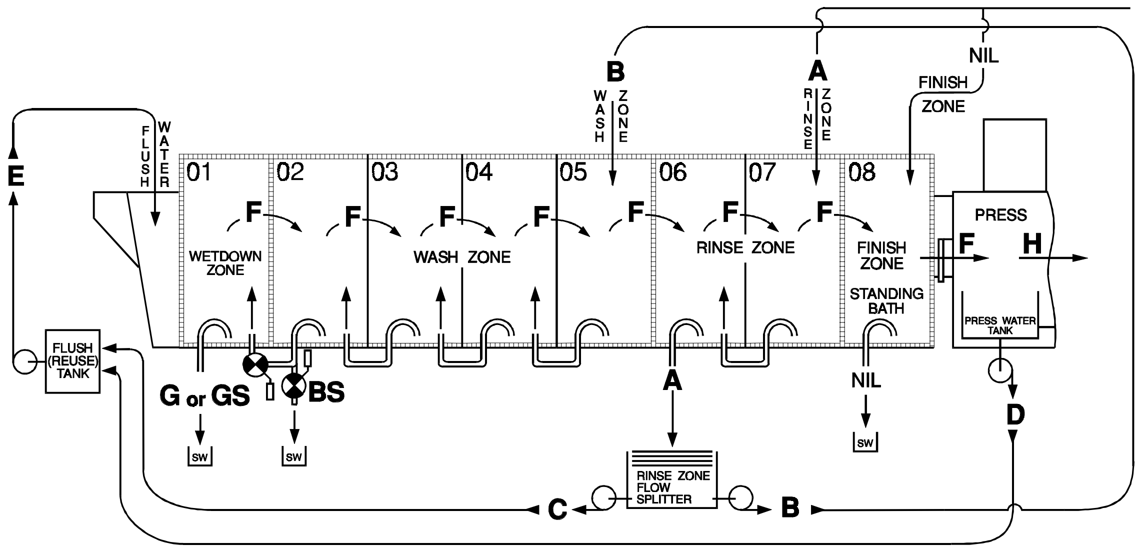
4. Determine module centerline as shown in FIGURE 10C. Centerline will fall between two bolts on shell side plate flange as shown in FIGURE 10B.

5. Check water level by measuring down from the module centerline to the top of the weir (Dimension **a**), as shown in FIGURE 10B and calculating module level (Dimension **b**) as shown in FIGURE 10C.

CAUTION

WEIRS and WEIR BOXES can collect lint. Each weir should be cleared weekly so the flow of wash liquor is not restricted.

Approximate Water Flow Values in the Typical Milnor® 76032 CBW® Tunnel Washer



LEGEND

A Rinse Zone Water
B Wash Zone Water
BS Wash Zone Water when Routed to Sewer
C Surplus Rinse Zone Water to Reuse Tank (C=A-B)
D Press Water to Reuse Tank (D=F-H)
E Reuse Water Available for Wetdown (E=C+D)

F Water Transferred with Goods (F=E-G) or (F=D+H)
See NOTE B below
G Water Out of Module 01 (G=E-F)
when Module 02 flows to sewer
GS Water Out of Module 01 (G=E+B-F)
when Module 02 flows to Module 01
H Water Remaining in Goods after Extraction

BS, G, GS, and H are shaded in the tables at right to indicate where water exits the tunnel.
Thus: A=BS+G+H when Module 02 flows to sewer, or A=GS + H when Module 02 flows to Module 01.

FIGURE 11 (MSSMD405BE)
Where Water Enters and Exits the Tunnel

The usual practice is to flow approximately 65% of the Rinse Zone water into the Wash Zone, as indicated by the rows shaded in the tables at right. The tables at right may be read directly in U.S. Gallons or in Liters when the water flow into the rinse zone is 1 U.S. Gallon/Pound or 10 Liters/Kilogram respectively. For other water flow rates into the rinse zone, (1) multiply the columns marked ⊗ by the desired new flowrate, (2) use the new values in the ⊗ columns and the published values in the ✓ columns to calculate new values for the columns E, G, and GS marked (!). The formulas for columns E, G, and GS are shown above.

NOTE A: In the tables based on one U.S. Gallon /Pound, multiply the value in all columns other than D F, and G by 100 to express the indicated water flows as a percent of the total water flowing into the rinse zone at A on FIGURE 11.

1 U.S. Gallon per Pound, 100% Cotton

A	B	BS	C	D	E	F	G	GS	H
1.0	.35	.35	.65	.44	1.09	.50	.59	.94	.06
1.0	.40	.40	.60	.44	1.04	.50	.54	.94	.06
1.0	.45	.45	.55	.44	.99	.50	.49	.94	.06
1.0	.50	.50	.50	.44	.94	.50	.44	.94	.06
1.0	.55	.55	.45	.44	.89	.50	.39	.94	.06
1.0	.60	.60	.40	.44	.84	.50	.34	.94	.06
1.0	.65	.65	.35	.44	.79	.50	.29	.94	.06
1.0	.70	.70	.30	.44	.74	.50	.24	.94	.06
1.0	.75	.75	.25	.44	.69	.50	.19	.94	.06
1.0	.80	.80	.20	.44	.64	.50	.14	.94	.06

1 U.S. Gallon per Pound, 50/50 Polycotton

A	B	BS	C	D	E	F	G	GS	H
1.0	.35	.35	.65	.33	.88	.38	.50	.85	.05
1.0	.40	.40	.60	.33	.83	.38	.45	.85	.05
1.0	.45	.45	.55	.33	.78	.38	.40	.85	.05
1.0	.50	.50	.50	.33	.73	.38	.35	.85	.05
1.0	.55	.55	.45	.33	.68	.38	.30	.85	.05
1.0	.60	.60	.40	.33	.63	.38	.25	.85	.05
1.0	.65	.65	.35	.33	.58	.38	.20	.85	.05
1.0	.70	.70	.30	.33	.53	.38	.15	.85	.05
1.0	.75	.75	.25	.33	.48	.38	.10	.85	.05
1.0	.80	.80	.20	.33	.43	.38	.05	.85	.05

All values above are U.S. Gallons. All values below are liters.

10 Liters per Kilogram, 100% Cotton

A	B	BS	C	D	E	F	G	GS	H
10.0	3.5	3.5	6.5	3.7	10.2	4.2	6.0	9.5	.50
10.0	4.0	4.0	6.0	3.7	9.7	4.2	5.5	9.5	.50
10.0	4.5	4.5	5.5	3.7	9.2	4.2	5.0	9.5	.50
10.0	5.0	5.0	5.0	3.7	8.7	4.2	4.5	9.5	.50
10.0	5.5	5.5	4.5	3.7	8.2	4.2	4.0	9.5	.50
10.0	6.0	6.0	4.0	3.7	7.7	4.2	3.5	9.5	.50
10.0	6.5	6.5	3.5	3.7	7.2	4.2	3.0	9.5	.50
10.0	7.0	7.0	3.0	3.7	6.7	4.2	2.5	9.5	.50
10.0	7.5	7.5	2.5	3.7	6.2	4.2	2.0	9.5	.50
10.0	8.0	8.0	2.0	3.7	5.7	4.2	1.5	9.5	.50

10 Liters per Kilogram, 50/50 Polycotton

A	B	BS	C	D	E	F	G	GS	H
10.0	3.5	3.5	6.5	2.8	9.3	3.2	6.1	9.6	.42
10.0	4.0	4.0	6.0	2.8	8.8	3.2	5.6	9.6	.42
10.0	4.5	4.5	5.5	2.8	8.3	3.2	5.	9.6	.42
10.0	5.0	5.0	5.0	2.8	7.8	3.2	4.6	9.6	.42
10.0	5.5	5.5	4.5	2.8	7.3	3.2	4.1	9.6	.42
10.0	6.0	6.0	4.0	2.8	6.8	3.2	3.6	9.6	.42
10.0	6.5	6.5	3.5	2.8	6.3	3.2	3.1	9.6	.42
10.0	7.0	7.0	3.0	2.8	5.8	3.2	2.6	9.6	.42
10.0	7.5	7.5	2.5	2.8	5.3	3.2	2.1	9.6	.42
10.0	8.0	8.0	2.0	2.8	4.8	3.2	1.6	9.6	.42

NOTE B: The following assumes that for Module 01, the "standing bath" option which is controlled byC-Bit 07 in Module 01 and described in Display L is chosen. The "F" values represent the water required to replenish all the water transferred with the goods including the water to wet each new incoming dry load. Thus at a 1 USG/LB (8.3 l/kg) flow rate, even when up to 80% of the rinse zone flows into the wash zone, there should be always more water (E) than needed (F), except when the first module is drained and refilled at each transfer. In the latter case, there is enough water when up to 55% of the rinse zone flows in the wash zone. And, when Module 02 flows into Module 01, there is enough water (B+E) to satisfy a drain and refill regardless of the percent of rinse water sent to the wash.

Rinse Zone Water Flow Rates in the Tunnel

Select the FACTOR for the desired WASH TIME in MINUTES.

U.S. GALLONS/MINUTE = FACTOR x NUMBER OF TUNNEL MODULES x DESIRED U.S. GALLONS PER POUND x ACTUAL LOAD WEIGHT IN POUNDS

LITERS PER MINUTE = FACTOR x NUMBER OF TUNNEL MODULES x DESIRED LITERS PER KILOGRAM x ACTUAL LOAD WEIGHT IN KILOGRAMS
(For cubic meters/hour, multiply liters/minute by .06.)

WASH TIME (MINUTES)	FACTOR
12	.084
13	.077
14	.072
15	.066
16	.063
17	.059
18	.055
19	.053
20	.050
21	.047
22	.045

WASH TIME (MINUTES)	FACTOR
23	.044
24	.042
25	.040
26	.038
27	.037
28	.036
29	.035
30	.034
31	.033
32	.032
33	.031

WASH TIME (MINUTES)	FACTOR
34	.030
35	.029
36	.028
37	.027
38	.026
39	.025
40	.025
41	.025
42	.024
43	.024
44	.023

EXAMPLE 1: 20:00 minute wash time; 9 module tunnel; 105 pound batches; .95 gallons/pound
Factor for 20 minute wash time=.050
Calculation: .050 x 9 x .95 x 105
=45 U.S. gallons /minute

EXAMPLE 2: 18:00 minute wash time; 11 module tunnel; 52 kilogram batches; 12 liters/kilogram
Factor for 18 minute wash time=.055
Calculation: .055 x 11 x 12 x 52
=377 liters/minute (377 liters/minute x .06= 22.6 cubic meters/hour)

Water Quantities at Various Levels in the MILNOR® 76032 CBW® Tunnel Washer

	LEVEL	100% COTTON TERRY			50/50 POLYCOTTON SHEETS		
	INCHES (CM)	U.S. GALLONS (LITERS) FOR 110 LBS (50 KG)	LIQUOR RATIO NOTE 1	VS TOTAL H_2O	U.S. GALLONS (LITERS) FOR 110 LBS (50 KG)	LIQUOR RATIO NOTE 1	VS TOTAL H_2O
H_20 ABSORBED		34 (128)	2.6		20 (75)	1.5	
FREE H_20	8" (20)	57 (215)	4.3	63%	53 (200)	4.0	73%
	10" (25)	65 (246)	4.9	66%	61 (230)	4.6	75%
	12" (30)	75 (283)	5.7	69%	71 (268)	5.4	78%
	14" (36)	87 (329)	6.6	72%	83 (314)	6.3	81%
TOTAL H_20 INCLUDING ABSORBED	8" (20)	91 (344)	6.9	100%	73 (276)	5.5	100%
	10" (25)	99 (374)	7.5	100%	81 (306)	6.1	100%
	12" (30)	109 (412)	8.2	100%	91 (344)	6.9	100%
	14" (36)	121 (457)	9.1	100%	103 (389)	7.8	100%
TOTAL H_20 TRANSFERRED (INCLUDING ABSORBED)	8" (20)	51 (193)	3.9	56%	38 (144)	2.9	52%
	10" (25)	52 (196)	3.9	53%	39 (147)	2.9	48%
	12" (30)	55 (208)	4.2	50%	42 (159)	3.2	46%
	14" (36)	58 (219)	4.4	48%	45 (170)	3.4	44%
FREE H_20 REMAINING AFTER TRANSFER	8" (20)	40 (151)	3.0	44%	35 (132)	2.6	48%
	10" (25)	47 (178)	3.6	47%	42 (159)	3.2	52%
	12" (30)	54 (204)	4.1	50%	49 (185)	3.7	54%
	14" (36)	63 (238)	4.8	52%	58 (219)	4.4	56%

NOTE 1: LIQUOR RATIO = POUNDS OF WATER PER POUNDS OF GOODS
or LITERS OF WATER PER KILOS OF GOODS

Water Quantities at Various Levels in the MILNOR® 76028 45 KG CBW® Tunnel Washer

	LEVEL	100% COTTON TERRY			50/50 POLYCOTTON SHEETS		
	INCHES (CM)	U.S. GALLONS (LITERS) FOR 99 LBS (45 KG)	LIQUOR RATIO NOTE 1	%VS TOTAL H_2O	U.S. GALLONS (LITERS) FOR 99 LBS (45 KG)	LIQUOR RATIO NOTE 1	%VS TOTAL H_2O
H_20 ABSORBED		31 (115)	2.6		18 (68)	1.5	
FREE H_20	8" (20)	57 (215)	4.8	65%	53 (200)	4.4	75%
	10" (25)	65 (246)	5.5	68%	61 (230)	5.1	77%
	12" (30)	75 (283)	6.3	71%	71 (268)	6.0	80%
	14" (36)	87 (329)	7.3	74%	83 (314)	7.0	83%
TOTAL H_20 INCLUDING ABSORBED	8" (20)	88 (331)	7.4	100%	71 (268)	5.9	100%
	10" (25)	96 (361)	8.0	100%	79 (297)	6.6	100%
	12" (30)	106 (399)	8.9	100%	89 (335)	7.4	100%
	14" (36)	118 (444)	9.9	100%	101 (380)	8.4	100%
TOTAL H_20 TRANSFERRED (INCLUDING ABSORBED)	8" (20)	48 (181)	4.0	55%	36 (136)	3.0	51%
	10" (25)	49 (184)	4.1	51%	37 (139)	3.1	47%
	12" (30)	52 (196)	4.4	49%	40 (151)	3.4	45%
	14" (36)	55 (207)	4.6	47%	43 (162)	3.6	41%
FREE H_20 REMAINING AFTER TRANSFER	8" (20)	40 (151)	3.4	45%	35 (132)	2.9	49%
	10" (25)	47 (177)	3.9	49%	42 (158)	3.5	53%
	12" (30)	54 (203)	4.5	51%	49 (184)	4.0	55%
	14" (36)	63 (237)	5.3	53%	58 (218)	4.8	59%

NOTE 1: LIQUOR RATIO = POUNDS OF WATER PER POUNDS OF GOODS
or LITERS OF WATER PER KILOS OF GOODS

Water Quantities at Various Levels in the MILNOR® 76039 68 KG CBW® Tunnel Washer

	LEVEL	100% COTTON TERRY			50/50 POLYCOTTON SHEETS		
	INCHES (CM)	U.S. GALLONS (LITERS) FOR 150 LBS (68 KG)	LIQUOR RATIO NOTE 1	%VS TOTAL H_2O	U.S. GALLONS (LITERS) FOR 150 LBS (68 KG)	LIQUOR RATIO NOTE 1	%VS TOTAL H_2O
H_20 ABSORBED		46 (174)	2.6		27 (102)	1.5	
FREE H_20	8" (20)	74 (279)	4.11	62%	69 (259)	3.8	72%
	10" (25)	85 (318)	4.72	65%	79 (299)	4.4	75%
	12" (30)	98 (367)	5.44	65%	92 (347)	5.1	77%
	14" (36)	113 (426)	6.28	71%	108 (406)	6.0	80%
TOTAL H_20 INCLUDING ABSORBED	8" (20)	120 (453)	6.67	100%	96 (363)	5.3	100%
	10" (25)	131 (495)	7.82	100%	106 (400)	5.9	100%
	12" (30)	145 (548)	8.1	100%	119 (450)	6.6	100%
	14" (36)	159 (601)	8.8	100%	135 (510)	7.5	100%
TOTAL H_20 TRANSFERRED (INCLUDING ABSORBED)	8" (20)	69 (261)	3.8	57%	51 (193)	2.8	53%
	10" (25)	70 (264)	3.90	53%	52 (196)	2.9	49%
	12" (30)	74 (280)	4.1	51%	56 (212)	3.1	47%
	14" (36)	78 (295)	4.3	49%	59 (223)	3.3	44%
FREE H_20 REMAINING AFTER TRANSFER	8" (20)	51 (192)	2.8	42%	45 (169)	2.5	47%
	10" (25)	61 (230)	3.4	47%	54 (203)	3.0	51%
	12" (30)	70 (264)	3.9	48%	63 (237)	3.5	53%
	14" (36)	84 (316)	4.7	52%	76 (286)	4.2	57%

NOTE 1: LIQUOR RATIO = POUNDS OF WATER PER POUNDS OF GOODS
or LITERS OF WATER PER KILOS OF GOODS

Water Quantities at Various Levels in the Milnor 92048 CBW Tunnel Washer

	Level Inches (CM)	100% Cotton Terry			50/50 Polycotton Sheets		
		U.S. Gallons (Liters) for 242 LBS (110 KG)	Liquor Ratio (Note 1)	VS Total H20 (percent)	U.S. Gallons (Liters) for 242 LBS (110 KG)	Liquor Ratio (Note 1)	VS Total H20 (percent)
H20 Absorbed		75 (283)	2.6		44 (166)	1.5	
Free H20	8" (20)	74 (280)	2.55	50	70 (264)	2.41	61
	10" (25)	90 (340)	3.01	54	86 (325)	2.96	66
	12" (30)	108 (408)	3.72	59	104 (393)	3.58	70
	14" (36)	127 (480)	4.38	63	123 (465)	4.23	74
Total H20 including absorbed	8" (20)	149 (564)	5.135	100	114 (431)	3.92	100
	10" (25)	165 (624)	5.68	100	130 (492)	4.48	100
	12" (30)	183 (692)	6.31	100	148 (560)	5.1	100
	14" (36)	202 (764)	6.96	100	167 (632)	5.75	100
Total H20 transferred (including absorbed)	8" (20)	105 (397)	3.62	70	75 (284)	1.9	48
	10" (25)	107 (405)	3.69	65	77 (291)	1.93	43
	12" (30)	110 (416)	3.79	60	80 (303)	2.03	40
	14" (36)	115 (435)	3.96	57	84 (318)	2.14	37
Free H20 remaining after transfer	8" (20)	44 (166)	1.51	29	39 (147)	1.34	34
	10" (25)	58 (219)	2.00	35	53 (200)	1.82	40
	12" (30)	73 (276)	2.51	40	68 (257)	2.33	46
	14" (36)	87 (329)	3.00	43	83 (314)	2.86	50

Note 1: Liquor ratio = pounds of water per pounds of goods or liters of water per kilos of goods

Why Fill and Dump Baths Are More Efficient Than Counterflow (Continuous Rinses)

Like all tunnel washers, the MILNOR® CBW® top transfer tunnel washer counterflows water from the "clean end" toward the "dirty end." But unlike all bottom transfer tunnel washers (which transfer all the water forward with the goods), in the MILNOR® CBW® top transfer tunnel washer only about half the total water in the module is transferred with the goods. The other half remains in the module from which the goods were transferred. While the results from counterflowing will be about the same in both bottom and top transfer tunnel washers, the additional dilution in the MILNOR® tunnel (transferring only half the water forward) most closely resembles a "fill and dump" bath. The following will prove that using a fixed quantity of water for counterflow or "continuous" rinsing requires almost 50% more water to achieve the same dilution effect as can be achieved with the same quantity of water in fill and dump baths.

The mathematical equations for the two types of dilution baths are as follows.

FOR FILL AND DUMP BATHS

$$SN = So\left(\frac{W}{R+W}\right)^{N}$$

Where: SN = Soil remaining after N baths
So = Original soil
N = Number of baths
R = Free water in bath (the water that drains out)
W = Absorbed water in bath (the water that stays in the goods)

It will also follow that:

$$SN = So\left(\frac{W}{RS+W}\right)^{NW} x \left(\frac{W}{RR+W}\right)^{NR}$$

Where: RS = Free water that drains out after a suds bath
RR = Free water that drains out after a rinse bath
NW= Number of baths at a wash level
NR = Number of baths at a rinse level

FOR COUNTERFLOW BATHS

$$SN = So\left(\frac{1}{e}\right)^{\frac{QF}{QV}}$$

Where: e = 2.1782 . . .
1/e = 0.3678 . . .
QF = Quantity of counterflow
QV = Quantity of water in vessel
QF/QV = The ratio of total counterflow water to the water in the vessel

Explanation of the Fill and Dump Equation —Imagine one 100 gallon tank of grape juice and one 100 gallon tank of water.

To simulate the fill and dump baths, imagine draining out half of the grape juice and refilling the tank with 50 gallons of water. After stirring, the tank will contain 100 gallons of 50% grape juice—the grape juice being uniformly distributed through all 100 gallons because of the stirring. Now, again, drain half of the contents of the tank, then refill it with the remaining 50 gallons of fresh water. Stir once more and the tank will now contain 100 gallons of 25% grape juice and 75% water. In other words, the grape juice will have been diluted down to 25% of its original concentration.

The above is approximately the dilution effect of two fill and dump baths in a laundry washer-extractor without intermediate extracts.

Explanation of the Counterflow Equation —Imagine another 100 gallon tank of grape juice and another 100 gallons of water.

Starting with the 100 gallons of pure juice, drain out 0.1 gallon, then add 0.1 gallon of water and stir until the remaining 99.9 gallons of juice are completely distributed, creating a homogeneous mixture containing 99.9% juice and 0.1% water. Now, drain out another 0.1 gallon of the 99.9% juice, and again add 0.1 gallon of water, stirring once more. The mixture will now consist of .999 x .999 = .9980 or 99.80% juice. If this is repeated 1000 times, the 100 gallons of fresh water will have been used up—the same amount as in the fill and dump baths in the earlier example—but the remaining concentration of juice after using all 100 gallons of fresh water will be .999 times itself 1000 times or $(.999)^{1000}$ = .3677, hence a 36.77% concentration of juice.

NOTE: The .3677 value is almost exactly the value of $\frac{1}{e}$ = .3678.

Comparison of Fill and Dump and Counterflow Method —To calculate the relative inefficiency of **counterflow** (continuous rinse) baths vis-a-vis **fill and dump** baths when 25% of the "juice" (soil) remains, use the following mathematical equation.

$$\left(\frac{1}{e}\right)^{X} = .2500, \text{ therefore} \qquad X \log\left(\frac{1}{e}\right) = \log .2500, \text{ and}$$

$$X = \frac{log .2500}{log .3678} \qquad \text{or } \mathbf{X = 1.386}$$

To check: $\left(\frac{1}{e}\right)^{1.386} = .2500$

Therefore, to obtain a 75% dilution (i.e., 25% remaining soil or grape juice), we would be compelled to use 1.386 times or 38.6% more water in counterflow or continuous rinse type baths compared to fills and dumps.

However, a wash process that leaves 25% of the soil in the goods is not acceptable. Instead, let's use a light soil formula comprising two suds and three rinses and assume the following.

1. The goods absorb 2.6 pounds of water per pound of goods.

2. The fill and dump suds baths have a total liquor ratio (pounds of water to pounds of goods) of 4.5:1.

3. The fill and dump rinse baths have a total liquor ratio (pounds of water to pounds of goods) of 6.5:1.

Thus, the remaining water (and remaining soil) in a suds baths will be 2.6/4.5 = .578 and the amount of water to add back in each of the two suds will be 1 - .578 = .422. Similarly, the dilution effect in the rinse baths will be 2.6/6.5 = .400 and the amount of water to add back to each of the three rinse baths will be 1 - .400 = .600.

The total dilution effect in this hypothetical fill and dump washing formula will be $(.578)^2\,(.400)^3 = .02131$. In other words, 2.131% of the grape juice (soil) would remain. Disregarding the water initiall y absorbed by the goods (it would be the same for both processes), the water used in this process would be .422 x 2+ .600 x 3 = 2.644.

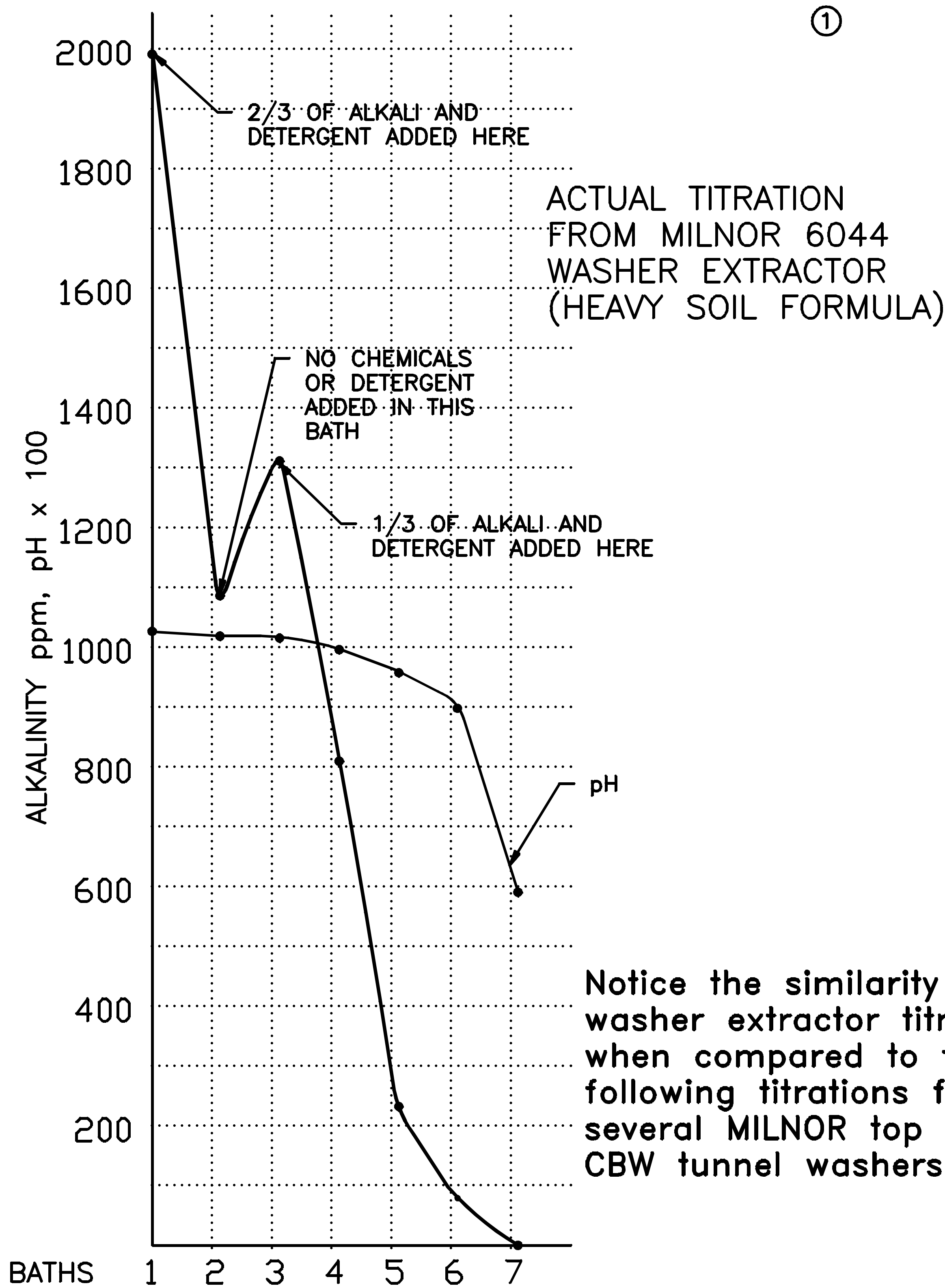
To obtain the same .02131 dilution effect in a counterflow or continuous rinse bath, one must solve the following equation.

$$\left(\frac{1}{e}\right)^X = .02131, \text{ therefore}$$

$$X \log\left(\frac{1}{e}\right) = \log .02131, \text{ and therefore } X = \log .02131/\log .3678 \text{ or } \mathbf{X = 3.849}$$

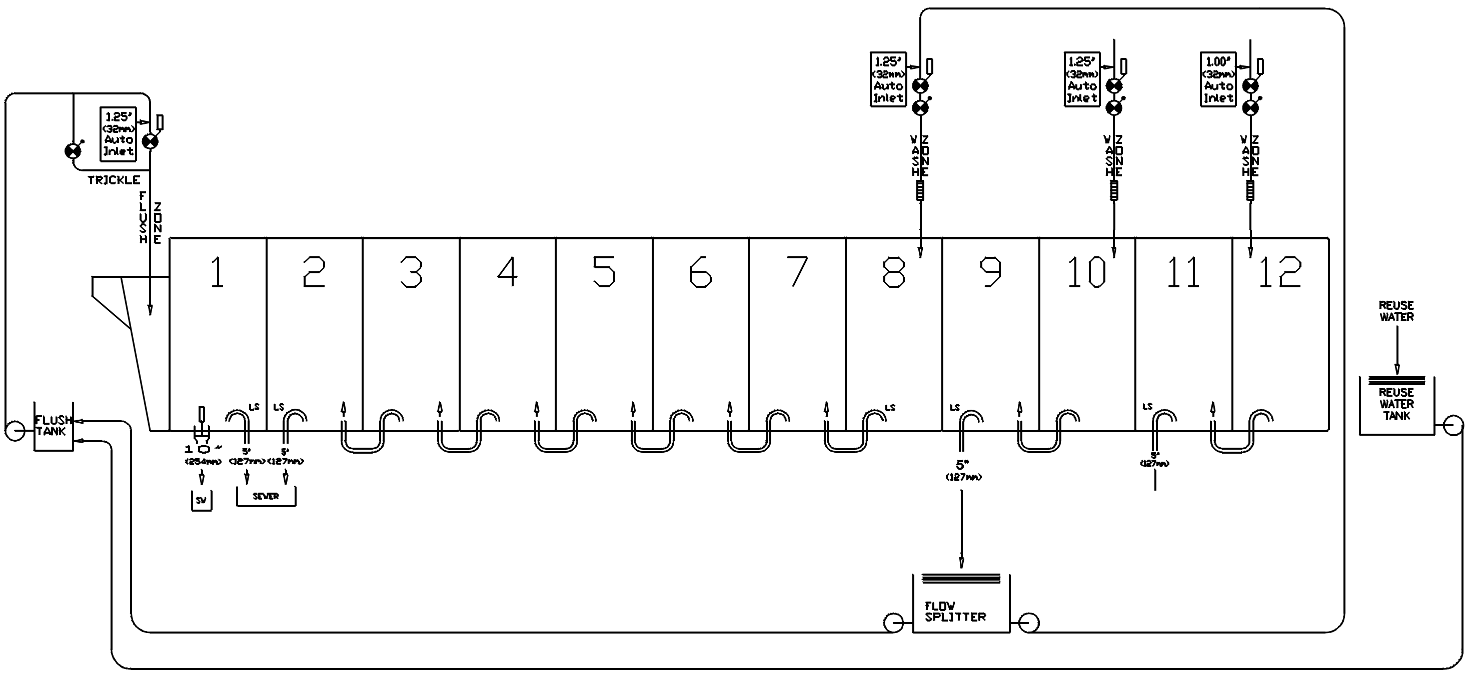
So, to continuous rinse to .02131 (i.e., 2.131% remaining soil) requires 3.849 units of water compared to 2.644 units of water for the fill and dump method—**or in other words continuous rinsing requires 3.849/2.644 = 1.456 or 45.6% more water to achieve the same dilution effect! Moreover, in a heavy soil formula with more baths, an even greater dilution (even less remaining juice) would be required and counterflow or continuous rinsing would become even more costly in terms of water use. This is why the MILNOR® Top Transfer CBW® Tunnel Washer washes faster, better, and cheaper—with fewer modules, and less water, energy, and chemicals than any known bottom transfer tunnel in the world.**

Additional Graphs of Actual Titrations



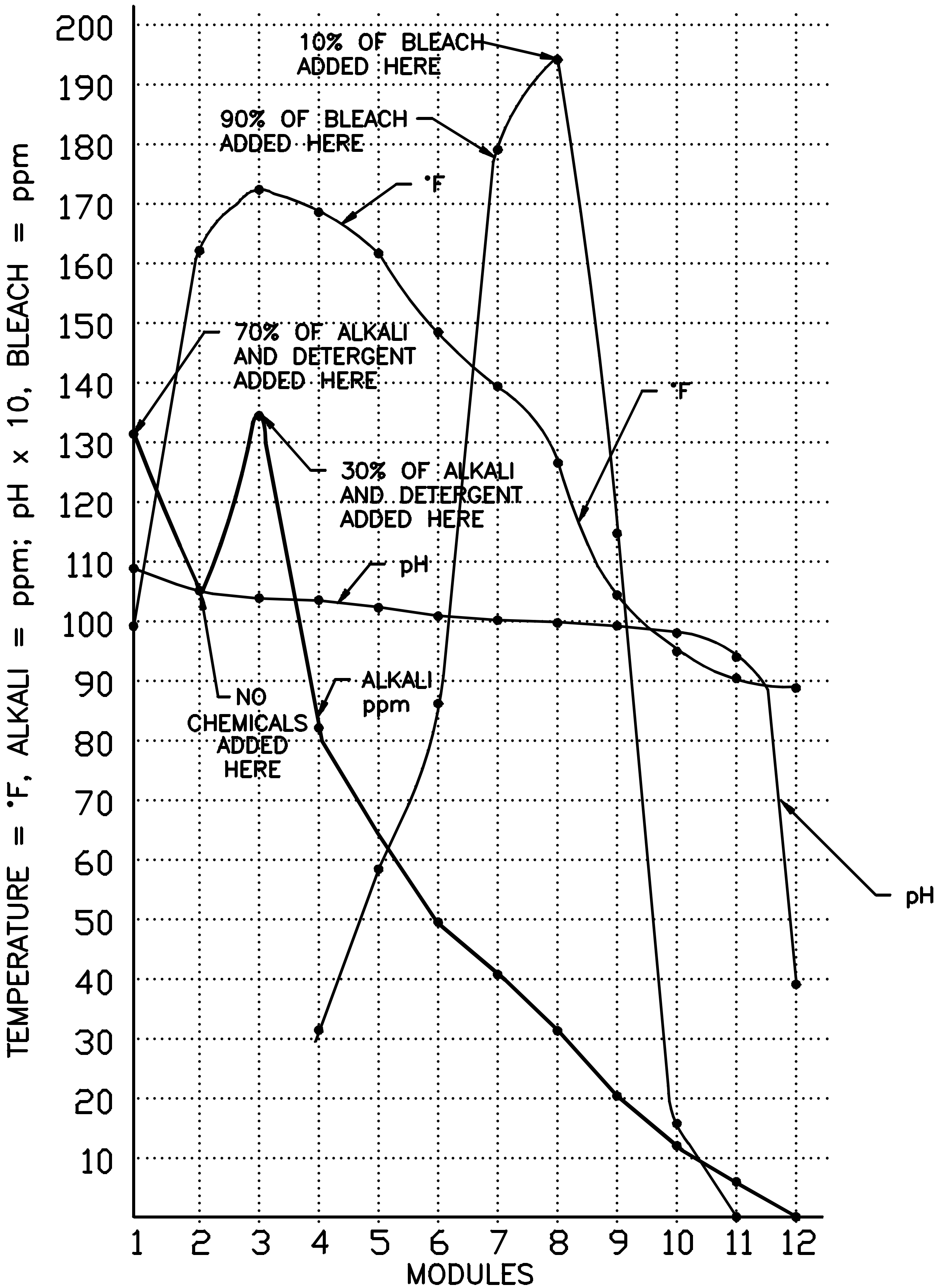
Notice the similarity of this washer extractor titration when compared to the following titrations from several MILNOR top transfer CBW tunnel washers.

A



SEE FACING PAGE FOR THIS TUNNEL'S TITRATION CHART,
TO COMPARE WITH THE 6044 WASHER EXTRACTOR.

ACTUAL TITRATION OF MILNOR 12 MODULE CBW TUNNEL WASHER
HOSPITAL DIAPERS 1.6 MINUTE TRANSFER 19.2 MINUTE TOTAL TIME
100LB SOIL WEIGHT 88LB CLEAN WEIGHT
46USG/MIN = .84USG/LB (7.0L/KG)



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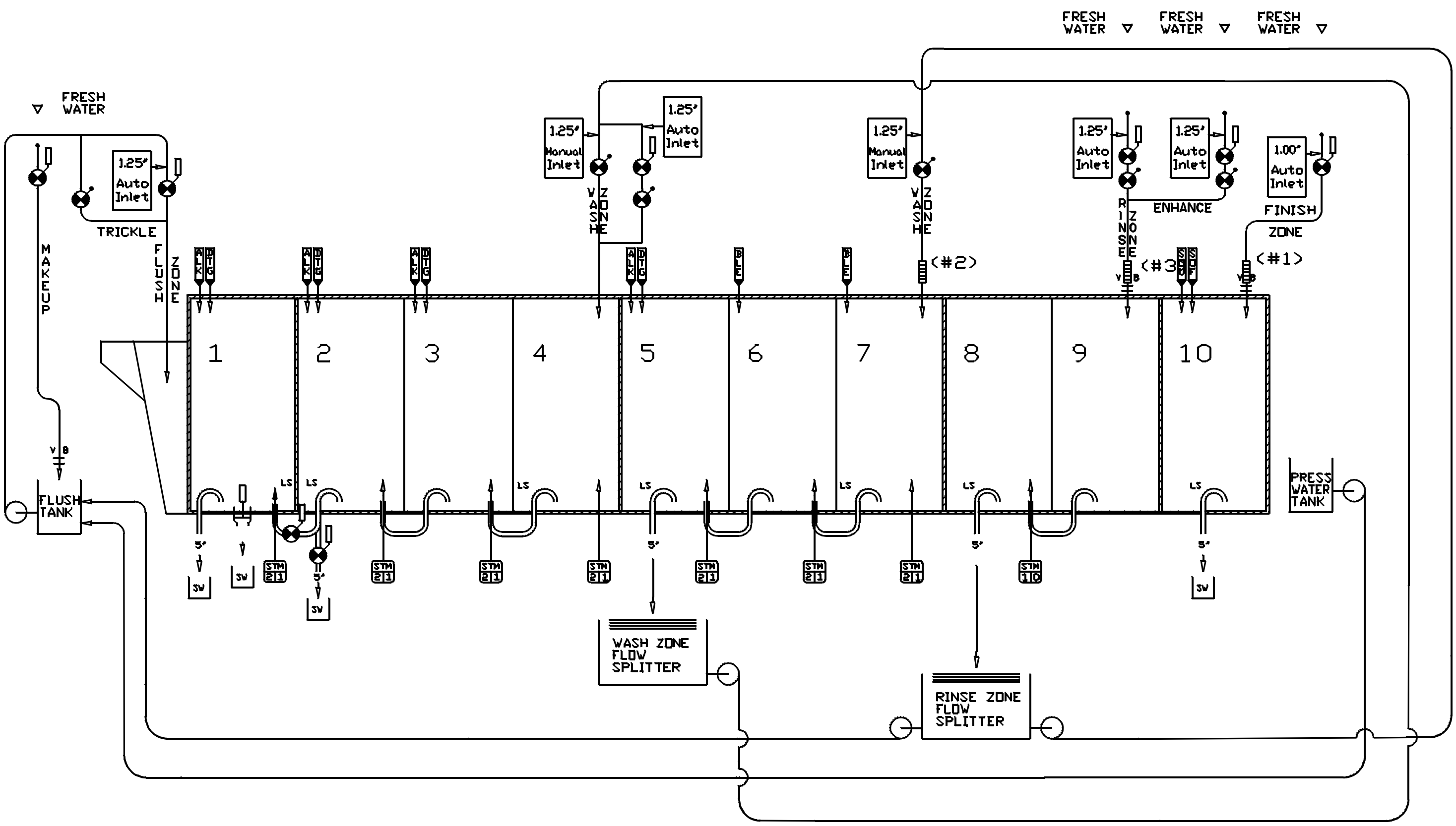
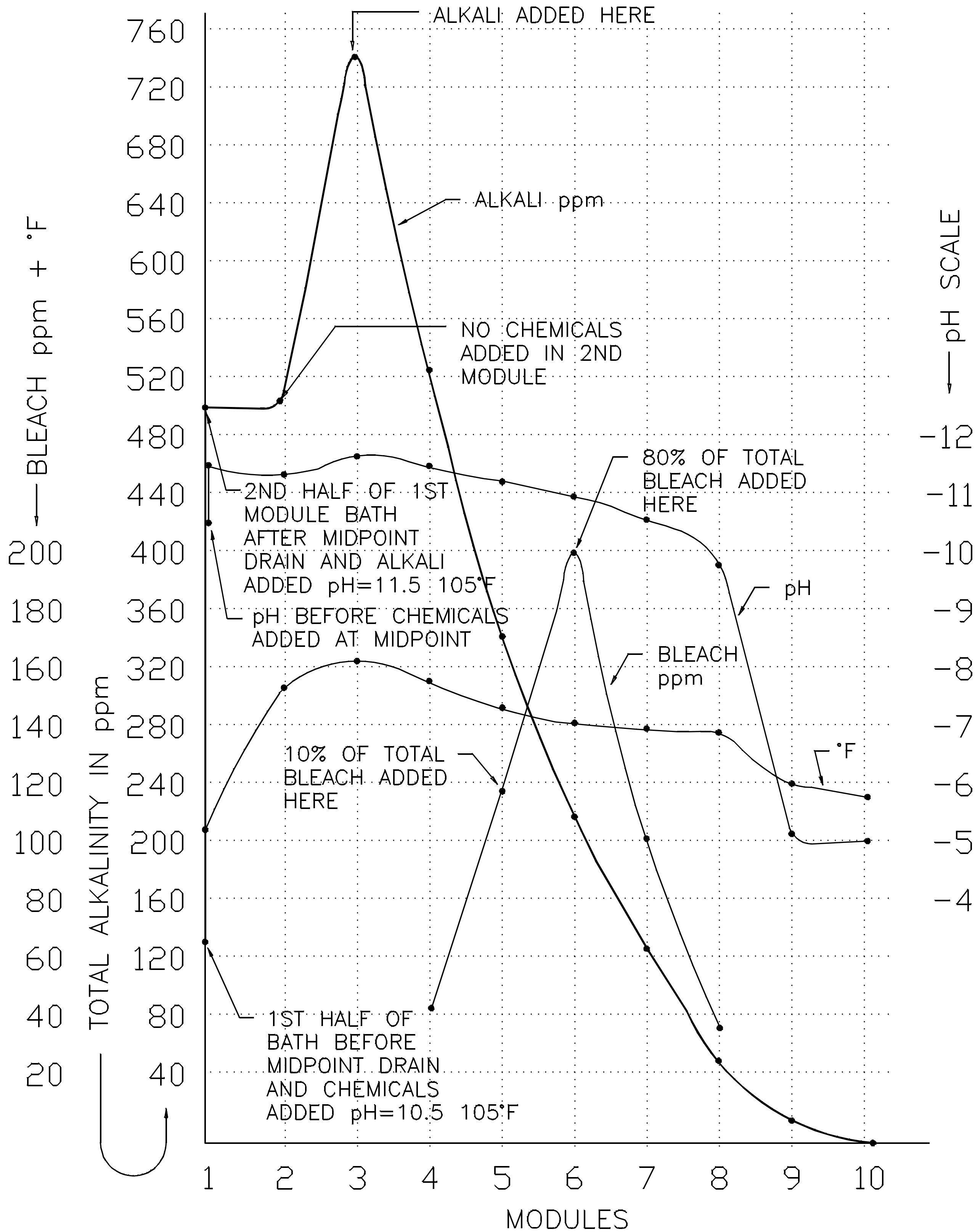


SEE FACING PAGE FOR THIS TUNNEL'S TITRATION CHART, TO COMPARE WITH THE 6044 WASHER EXTRACTOR.

ACTUAL TITRATION OF 10 MODULE 76032 MILNOR CBW TUNNEL WASHING 100LB (45KG) LOADS OF DIAPER SERVICE BABY DIAPER AT A 3.3 MINUTE TRANSFER FOR A 33 MINUTE TOTAL WASH TIME.



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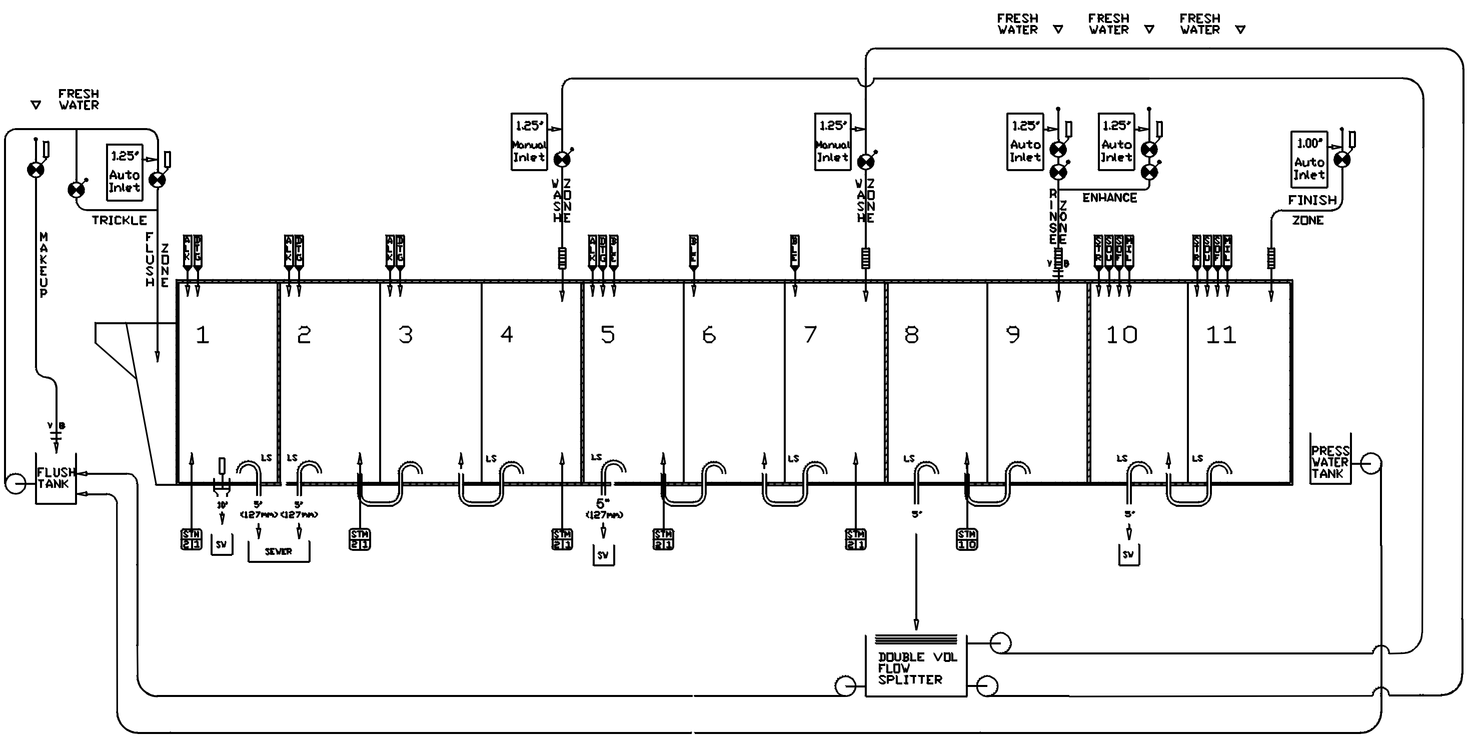
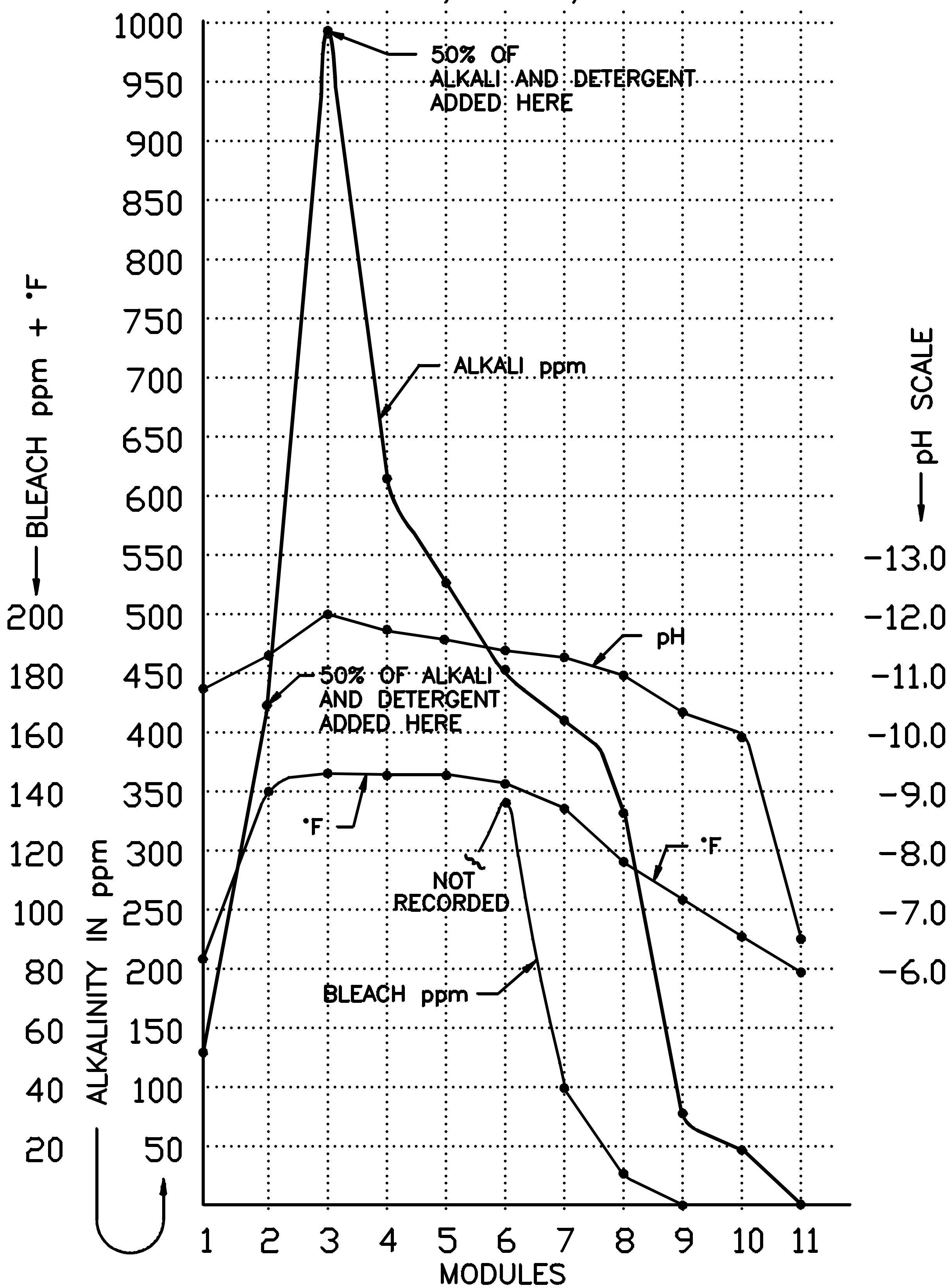


SEE FACING PAGE FOR THIS TUNNEL'S TITRATION CHART, TO COMPARE WITH THE 6044 WASHER EXTRACTOR.

ACTUAL TITRATION OF AN 11 MODULE 76032 MILNOR CBW TUNNEL WASHER WASHING 115LB (52KG) LOADS OF HOSPITAL PADS WITH 110 SECOND (1.88 MINUTE) TRANSFERS = 20.2 MINUTE PROCESS TIME USING 60GPM = .96USG/LB OR 8L/KG



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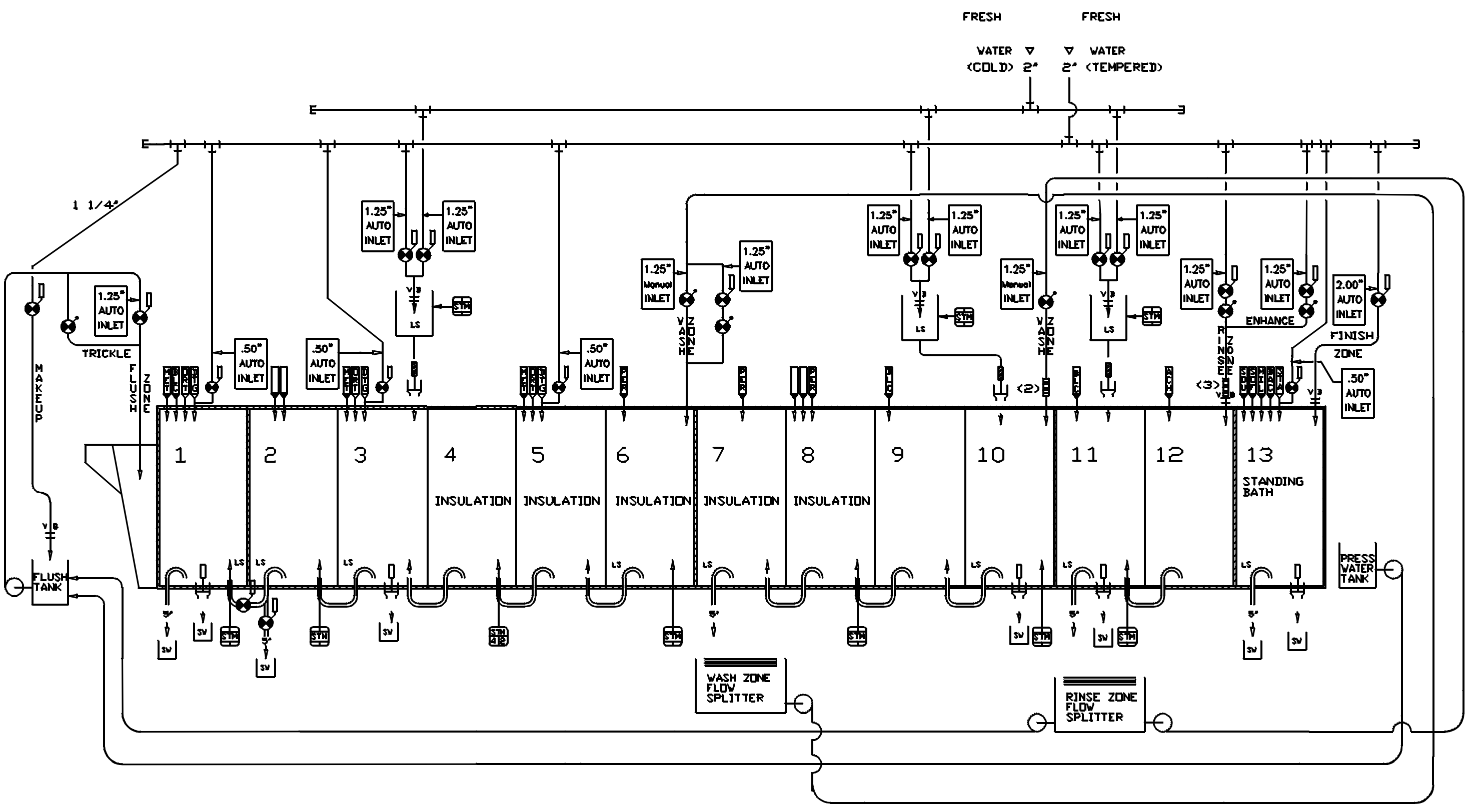
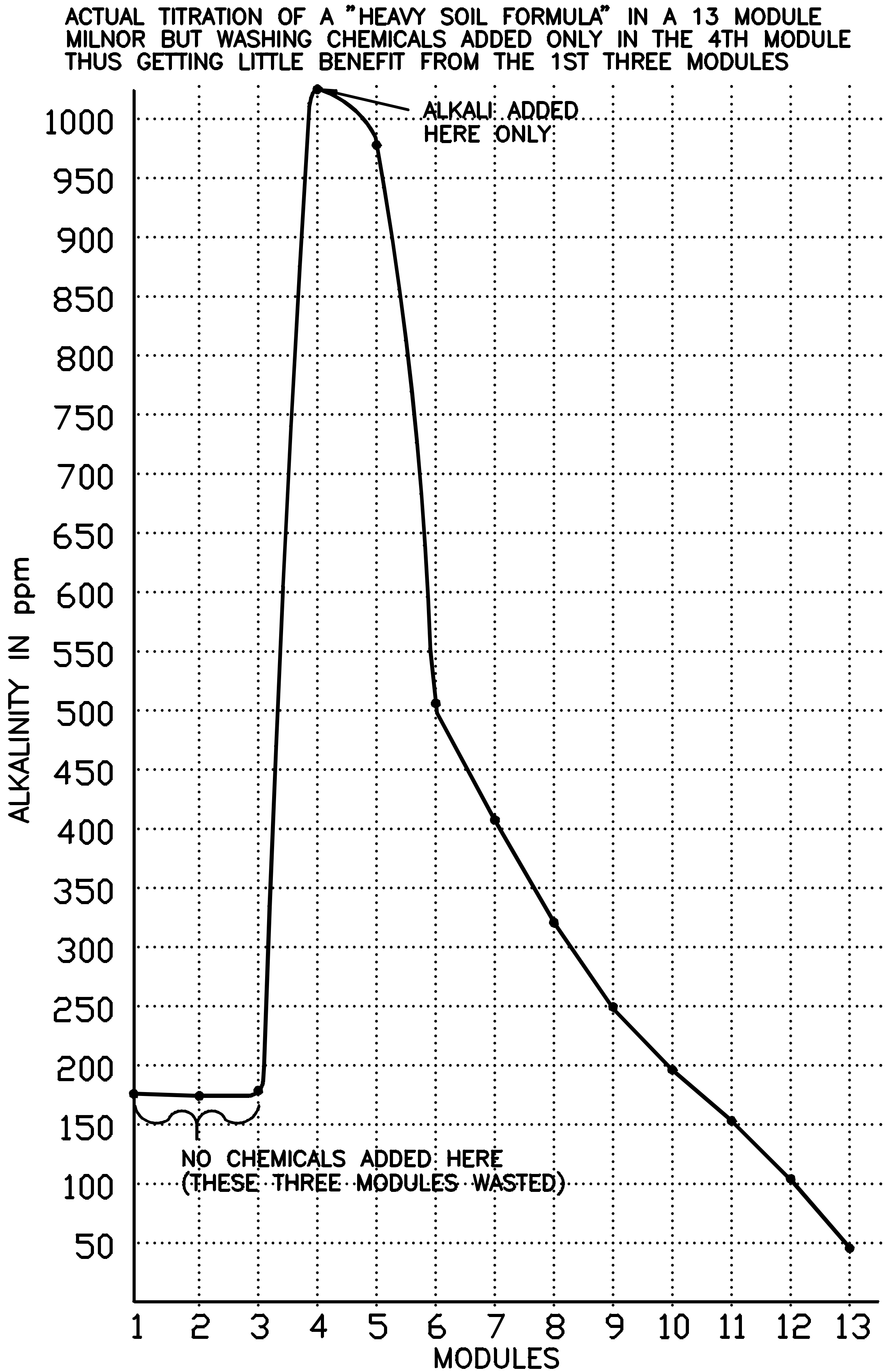
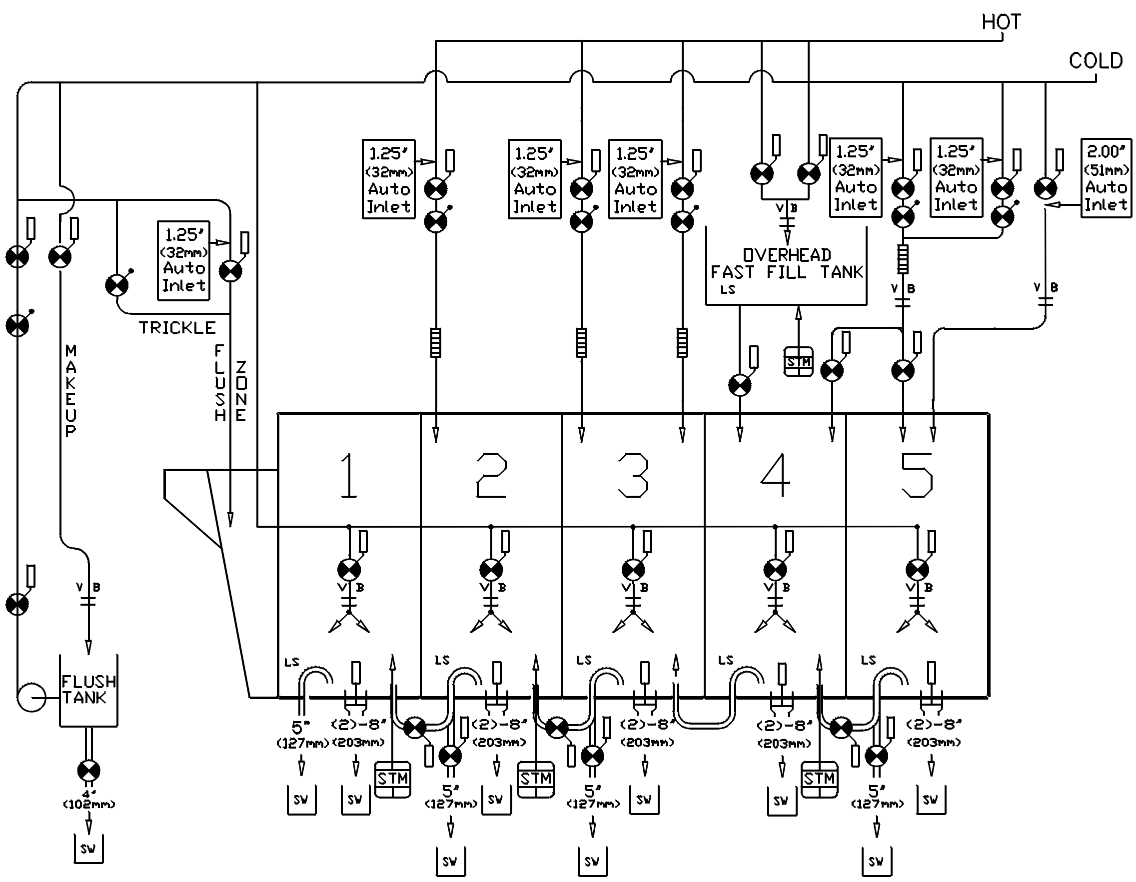


SEE FACING PAGE FOR THIS TUNNEL'S TITRATION CHART,
TO COMPARE WITH THE 6044 WASHER EXTRACTOR.

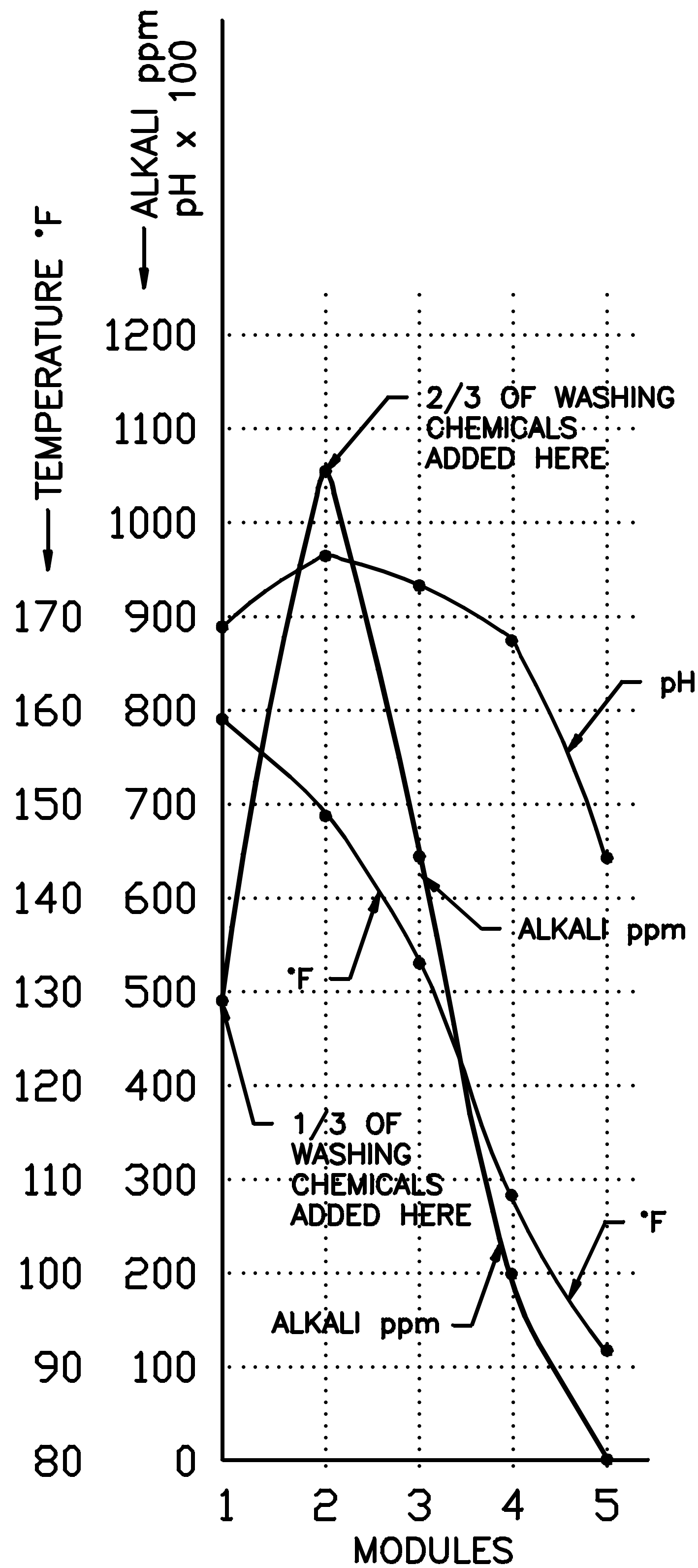

ACTUAL TITRATION OF A "HEAVY SOIL FORMULA" IN A 13 MODULE
MILNOR BUT WASHING CHEMICALS ADDED ONLY IN THE 4TH MODULE
THUS GETTING LITTLE BENEFIT FROM THE 1ST THREE MODULES
ALKALI ADDED
HERE ONLY
ALKALINITY IN ppm
1000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
NO CHEMICALS ADDED HERE
(THESE THREE MODULES WASTED)
1 2 3 4 5 6 7 8 9 10 11 12 13
MODULES

E



SEE FACING PAGE FOR THIS TUNNEL'S TITRATION CHART, TO COMPARE WITH THE 6044 WASHER EXTRACTOR.

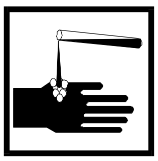
5 MODULE 35KG MILNOR TOP TRANSFER TUNNEL WASHER
65LB (30KG) LOADS OF COLORED 65/35 WORKWEAR PANTS
5.25 MINUTES PER TRANSFER = 26.25 MINUTES TOTAL TIME
WATER CONSUMPTION + 1.9USG/LB (15.9L/KG)



ABOUT CHEMICAL INJECTION

Chemicals may be added in several ways, including: *constant pressure recirculating ring main systems, blow bottle systems, peristaltic pumps*, etc. The specific system employed is generally the joint decision of the user and his chemical supplier. For constant pressure recirculating ring main systems, Milnor® supplies only the chemical injection valves. The tanks, pumps, and circulating mains required to deliver the liquid chemicals to the machine at a relatively constant pressure must be provided by others. Blow bottles and peristaltic pump delivery systems must also be provided by others.

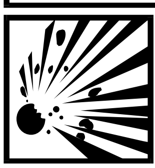
WARNING



CHEMICAL BURN HAZARD—It is solely the user's responsibility to ensure that safety precautions are used to store, handle, transport, and inject all chemicals. Chemicals can burn skin and eyes.

Milnor®-Supplied Chemical Valve for Use With Constant Pressure Recirculating Ring Main System

WARNING



EXPLOSION HAZARD—Using chemical injection valves when chemicals are delivered by a blow bottle system or any positive displacement pump (including a peristaltic pump) may cause excessive pressures if a valve fails to open. These pressures can burst plastic tubes, spraying dangerous chemicals over a wide area and causing chemical burns to skin and eyes.

Milnor®-supplied chemical inlet valves must *never* be connected to a source of pressurized chemicals that might exceed 14.7 PSI (1ATU). Chemical inlet valves include a C-Bit controlled automatic valve plus three manual PVC valves with plastic tubing. Chemicals can be sent either to the tunnel module or to a measuring bucket to calibrate the quantity injected.

These valves are intended to be Miltron-controlled, on a *time open=quantity injected* basis. Milnor®-supplied chemical injection valves will deliver fluid with the viscosity of water at 14.7 PSI (1 ATU), at a rate of up to approximately 10 U.S. Gallons (38 liters) per minute. Each liquid supply inlet comes with three constrictors: a factory-installed .187"(.47) constrictor (see FIGURE 1) and two additional constrictors (.25"(.64) and .125"(.32)) shipped with the inlet. **For accuracy's sake, injection times shorter than 10 seconds are not recommended. Modify chemical concentrations, adjust the throttle valve, or exchange the constrictor as necessary so injection duration is at least 10 seconds.**

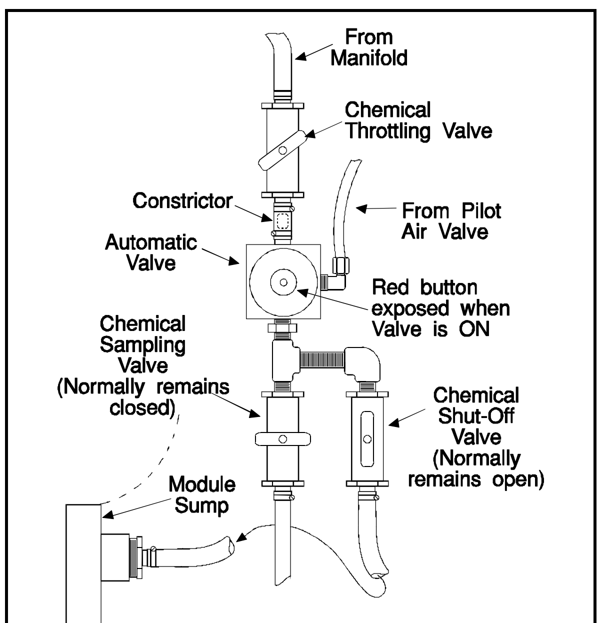


FIGURE 1 (MSSMD418BE)
Chemical Supply Inlet

How to Determine the Flow Rate of Milnor® Chemical Inlet Valves—Once the manifold pressure, chemical viscosity, throttling valve setting, and constrictor size are established (FIGURE 1), determine the flow rate as follows:

1. With the tunnel stopped, close the chemical shut-off valve to the module and open the chemical sampling valve fully. Be sure the chemical throttling valve from the manifold is fully open.
2. Take several sample quantities from the chemical sampling valve into a measuring bucket by commanding the automatic valve *on* for various durations, using Display E. Begin with short durations of a few seconds as not to overflow the bucket.
3. Average the samples to determine the flow rate for the valve. Use the results to determine the C-Bit value for each formula. See “DISPLAYS L AND G: CREATING BASIC FORMULAS AND FORMULA VARIATIONS” (see Table of Contents).
4. Return the chemical shut-off and sampling valves to their normal positions.

Chemical Connections

All chemicals must be injected into the drain trough on the same side of the trough in which the water enters the module. This is identifiable as the side without the weir box. Use any of the three inlets available. If necessary, two chemicals may enter through the same inlet by using a tee fitting.

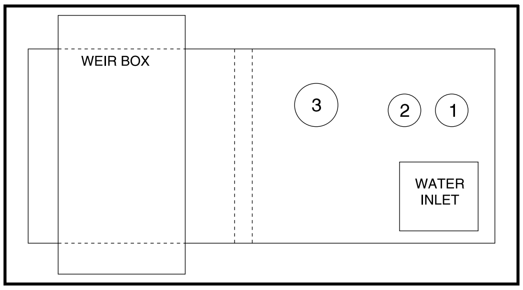


FIGURE 2 (MSSMD418BE)
Chemical Inlets

Blow Bottle System
(Supplied By Others)

Blow bottle systems deliver liquid chemicals by blowing a precise quantity from a pre-measure bottle directly into a module, but never through a chemical inlet valve. While the quantity injected is set by the depth of an adjustable snorkel tube rather than the C-Bit; the C-Bit must be commanded *on* for a duration sufficient to permit complete chemical injection, including purging the supply tube all the way to the injection site on the washer.

Peristaltic Pumps
(Supplied By Others)

Peristaltic pumps operate on a time on=quantity injected basis. Depending on make, peristaltic pump units require either a *start injection* signal to initiate an internal timer or a signal of the desired inject duration. Miltron C-Bits can easily accommodate either requirement via optional Milnor®-supplied interpret relays. See the manufacturer’s instructions for calibration procedures. **However, for accuracy’s sake, injection times shorter than 10 seconds are not recommended. Modify chemical concentrations or utilize smaller pump sizes as necessary to accomplish this.**

See “USING THE WATER FLOW FEATURES OF THE MILNOR® CONTINUOUS BATCH WASHER” for hints on where to inject chemicals.

RINSE ZONE FLOW SPLITTERS AND WASH ZONE FLOW LIFTERS

How the Lint Filter Works

The lint filter is an integral component of every Rinse Zone Flow Splitter and Wash Zone Flow Lifter. As shown in FIGURE 1, water enters the flow splitter/lifter at the rear, through a leveling tank which provides a smooth non-turbulent flow of water over the weir. **The weir must be level so there will be a constant head of water over the weir.**

As lint-laden water flows down the curved wire-type filter screen, the water passes through the apertures and most of the lint flows to the bottom of the filter where it falls into the lint basket. The water which falls through the filter is deposited in a holding tank beneath it. The lint basket cavity is drained to the sewer. It will be necessary to empty the lint basket from time to time and clean off any lint that might have accumulated on the filter. Be sure to also scoop out any lint that might have fallen into the lint basket cavity. This will prevent lint from blocking the drain. It is desirable to steam clean the screen from time to time, expecially if excessive quantities of oil, sand, etc., in the water tend to block the screen. From time to time, it may also be necessary to remove the screen and to clean its reverse side and the holding tank, especially if the level switches are set improperly, allowing the water level in the lint basket to rise above the bottom of the filter screen, as cautioned against in “Rules for Setting Flow Splitter/Lifter Levels” elsewhere in this section.

Optional Automatic Brushing System—This air-operated, reciprocating brush mechanism helps keep the wire filter clean.

How the Rinse Zone Flow Splitter Works

The **Rinse Zone** Flow Splitter receives all of the water from the rinse zone. Its Wash Zone pump sends a reduced quantity of water—controlled by a manual flow control valve and a flow meter—to the Wash Zone (hence the term “flow splitter”), and its Surplus pump sends the surplus water to the Reuse tank.

When the tunnel goes into **hold**, the Wash Zone pump automatically shuts off to prevent dilution of the Wash Zone chemicals. However, the Surplus pump remains active so the flow splitter tank cannot overflow.

A level switch senses the water level in the holding tank. The level switch has both a high and a low level setting, and influences the pumps as follows:

- Whenever the level is lower than low, both pumps are off.
- Whenever the level is higher than low, the Wash Zone pump(s) is on.
- Whenever the level rises above “high,” the Surplus pump also turns on to pump down the level in the tank until the level is again lower than low, whereupon both pumps shut off, but the wash zone pump turns on again—as soon as the the liquor level rises above “low.”

Momentarily turning off both pumps when the liquor level is below low assures that neither pump loses its suction. This is very important, even though the pumps are self priming, because once suction is lost, a self-priming pump may take as long as two or three minutes to start pumping again. Since the pumping cycle is generally far shorter than two minutes, it would thus be possible for one or both pumps to lose their primes, and stop pumping almost indefinitely.

⚠ CAUTION ⚠

Some centrifugal pumps must pump against a minimum back pressure to prevent cavitation. Be sure to adjust the manual throttling valve on any pumps so equipped to achieve the minimum back pressure as explained in "WHY AND HOW TO SET THE MANUAL MINIMUM PRESSURE THROTTLING VALVE ON CBW SYSTEM PUMPS" (see Table of Contents).

Optional C-Bit-Controlled Leveling and Holding Tank Drains for Bath Exchange CBW® Tunnel Washer—C-BIT enabled bypass of flow splitter/lifter when incoming water is incompatible with the goods in the tank's receiving module. When the drains open,

1. All pumps shut off.
2. The leveling and holding tanks drain to sewer.
3. Water normally entering the Flow Splitter/Lifter is sent to sewer.
4. The alternate automatic water inlet valve with flowmeter (and enhance, if appropriate) opens on the module that normally receives Flow Splitter/Lifter water.

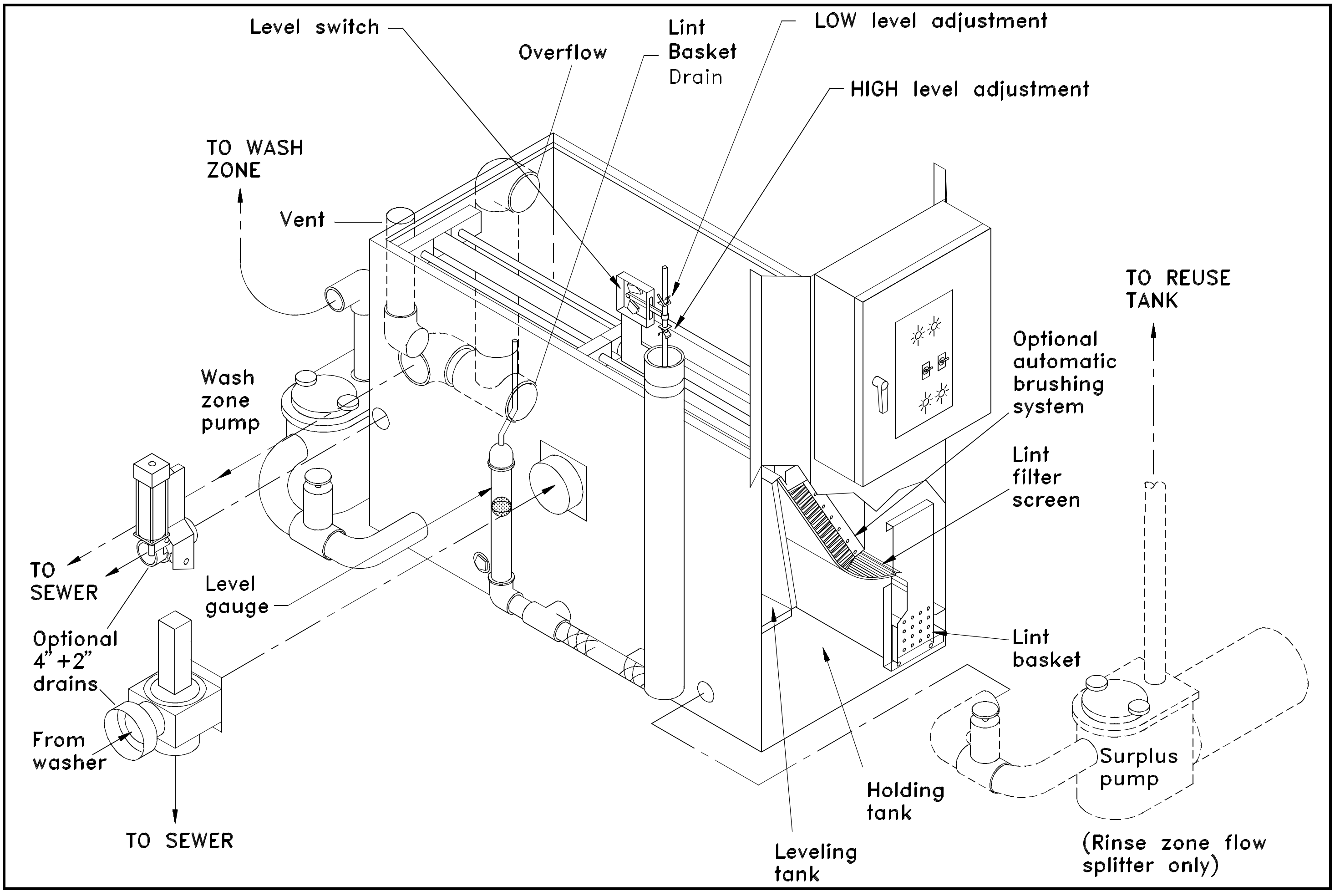


FIGURE 1 (MSSMD419AE)
Standard Flow Splitter/Lifter

How the Wash Zone Flow Lifter Works

The **Wash Zone** Flow Lifter pumps **all** the water that enters it from the First Wash Zone back into the Second Wash Zone—unlike a **Rinse Zone** Flow Splitter which splits its water into two independent destinations. To ensure that water and chemicals are not lost to the overflow drain, the special valve arrangement shown in FIGURE 2 is used on the flow lifter's pump. This works as follows:

The Wash Zone Flow Lifter pump is turned off and Valves B and E are both closed whenever the Flow Lifter water level is lower than low. The pump turns on and Valve B opens whenever the liquor level is above low. Valve C should be throttled so the pump delivers a little less than the average water flow into the lifter when Valve B is open and Valve E closed. Valve E is normally closed, but opens when the water rises above high, providing an additional path for the water and increasing the pumped flow. Once opened, Valve E stays open for 7.5 seconds after the water level falls below high. Valve A should be throttled so the total water flow through A and C is greater than the maximum expected flow into the the filter from the Second Wash Zone. Otherwise, the surplus water, its chemicals, and energy will be lost down the overflow drain. Valve D is the Minimum Pressure Throttling Valve (See CAUTION on page 1). **It is important to adjust valves A and C (and D if the pump has one) at the same time to achieve the desired flow rates while maintaining the minimum back pressure mandated for the specific pump**.

Valves B and E are both closed whenever the pump is off, thus preventing water from siphoning into the flow lifter tank.

Rules for Setting Flow Splitter/Lifter Levels

Flow Splitter/Lifters are equipped with a level gauge and a level switch assembly containing two level switches (see FIGUREs 1 and 3).

1. Set the LOW LEVEL adjustment clip on the float rod so the pump(s) shut OFF when the level drops below the Low Level dimension shown in FIGURE 4.

⚠ CAUTION ⚠

Pump(s) will run dry causing pump damage if Low Level is set lower than specified.

2. Set the HIGH LEVEL adjustment clip on the float rod so the Surplus Pump turns ON (Rinse Zone Flow Splitter) or Valve E OPENS (Wash Zone Flow Lifter—FIGURE 2) when the level rises above the High Level dimension shown in FIGURE 4.

⚠ CAUTION ⚠

If High Level is set higher than specified, water will inundate the lower portion of the lint screen causing lint to seep into the holding tank through the filter apertures.

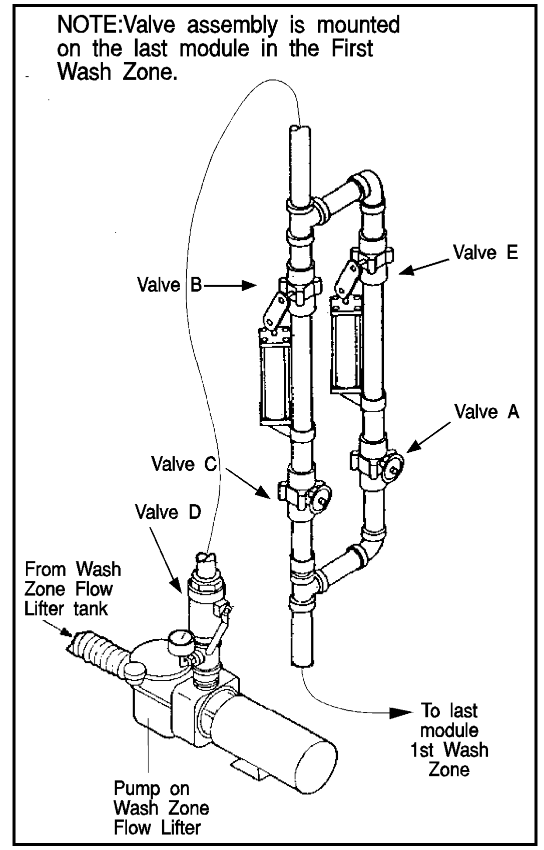


FIGURE 2 (MSSMD419AE)
Flow Lifter Pump and Valves

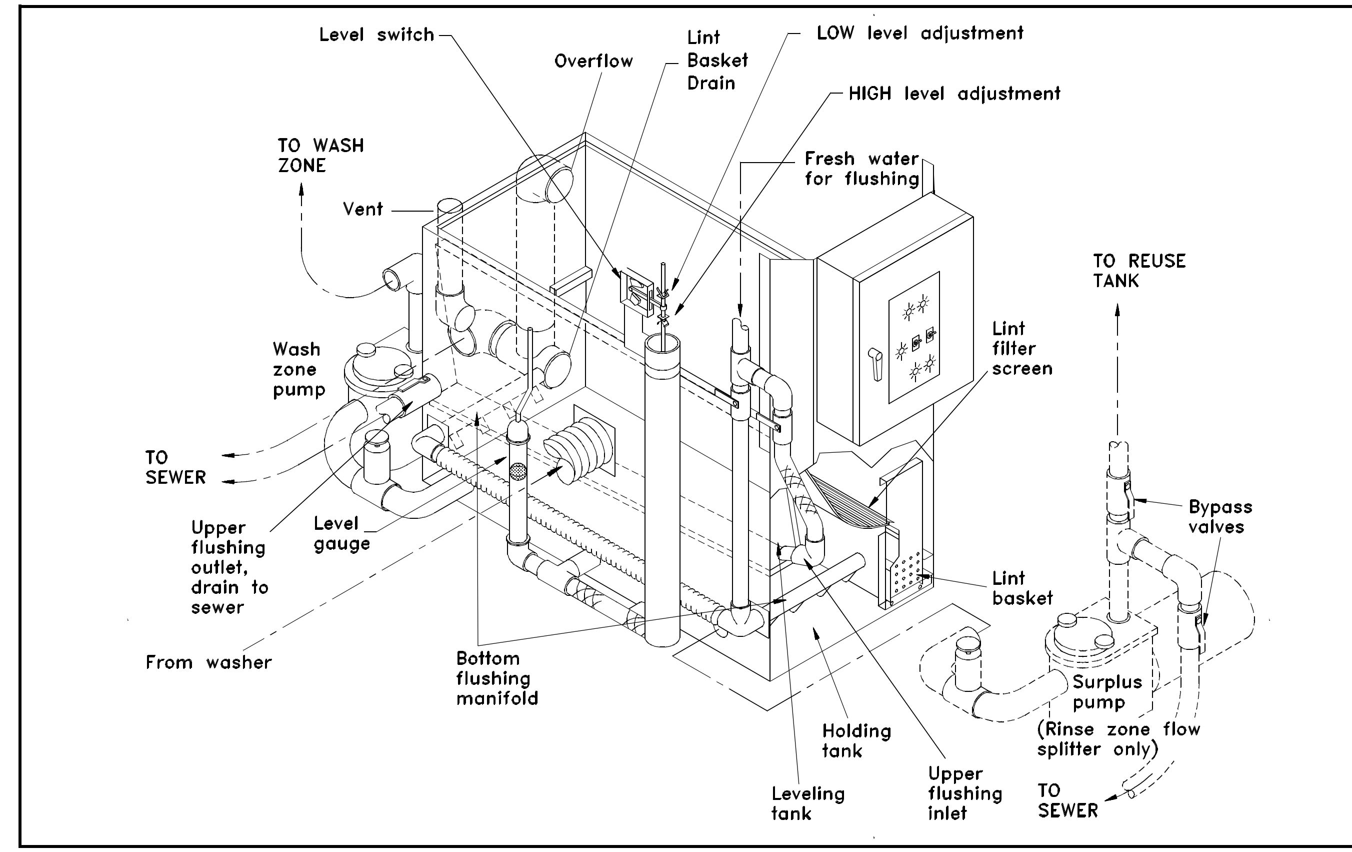


FIGURE 3 (MSSMD419AE)
Workwear Flow Splitter/Lifter

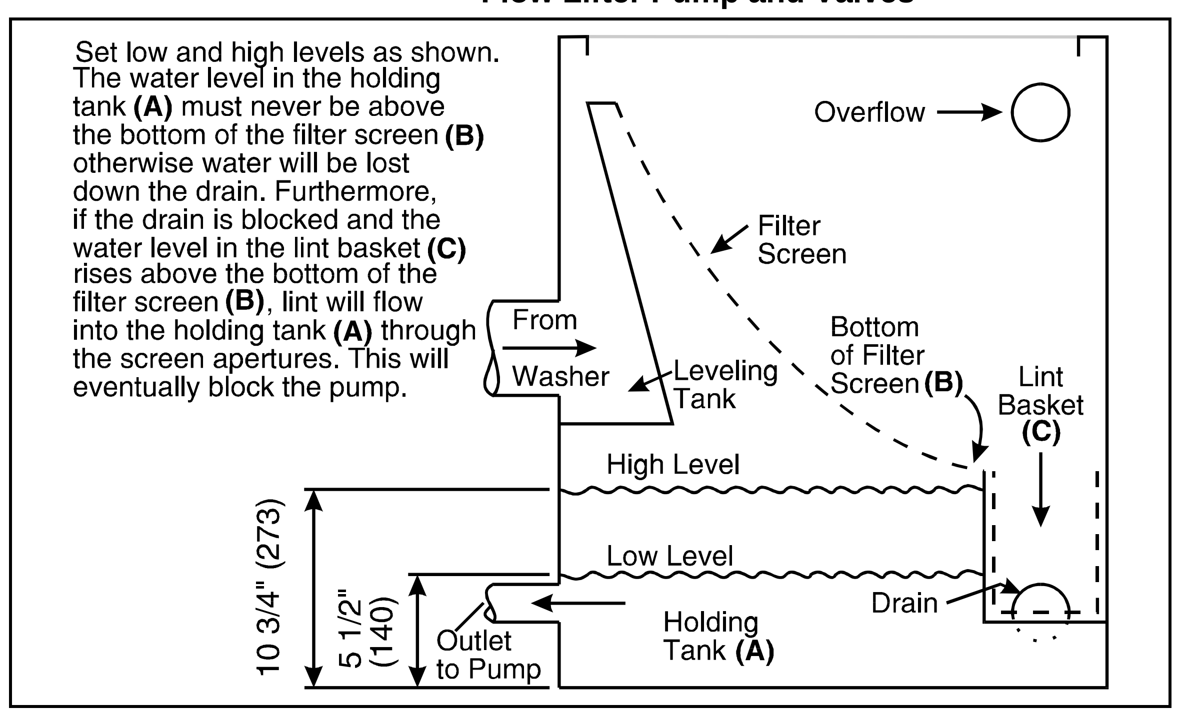


FIGURE 4 (MSSMD419AE)
Where To Set Flow Splitter/Lifter Tank Levels

How to Flush WORKWEAR Flow Splitters/Lifters

The Flow Splitter/Lifter for a WORKWEAR tunnel is shown in FIGURE 3. WORKWEAR Flow Splitters/Lifters should be flushed daily, or more often when quantities of oil, sand, etc., are present. As fresh water flushes the leveling and holding tanks, the Surplus pump turns on when levels go above high and shuts off when levels go below low. This pumps insolubles and debris to the sewer via the Surplus bypass valves. The flushing valves also refill the tank with fresh water. To flush Flow Splitters/Lifters,

1. Move FLUSH-AUTOMATIC switch to FLUSH. This will place the tunnel in **hold**, turn off pumps, and shut automatic inlets. This also enables the level switch to control the Surplus pump.
2. Use the Surplus pump bypass valves to direct outflow to the sewer.
3. Open manual flushing valves and at the tank's other end, open the leveling tank manual drain valve.

Flow Splitter/Flow Lifter Controls
(Control Circuit Only—see "DANGER" below)

Auto/Off switch (/)–(One switch per pump)—When set to ( ) the MILTRON controller provides 110-120VAC to pump contactor coils through a circuit breaker and level relays.

Pump On light ( )–(One light per pump)—Illuminates when pump is running.

Pump Should Run But Did Not light ( )—Illuminates when the control attempts to turn on a pump. Light will remain on because,

1. Air pressure less than 50 psi (only on machines manufactured after MILNOR® date code 92192, 10/03/91), or
2. (/) switch is ( ), or
3. An overload opens motor circuit breaker inside control box (circuit breaker must be manually reset), or
4. A coil in pump motor contactor is defective.

⚠ DANGER ⚠

SHOCK HAZARD will cause death or severe injury. Lock OFF and tag out three-phase power to tunnel washer main bus at wall disconnect. Circuit breakers on tank control box disable only control circuit power, not pump power.

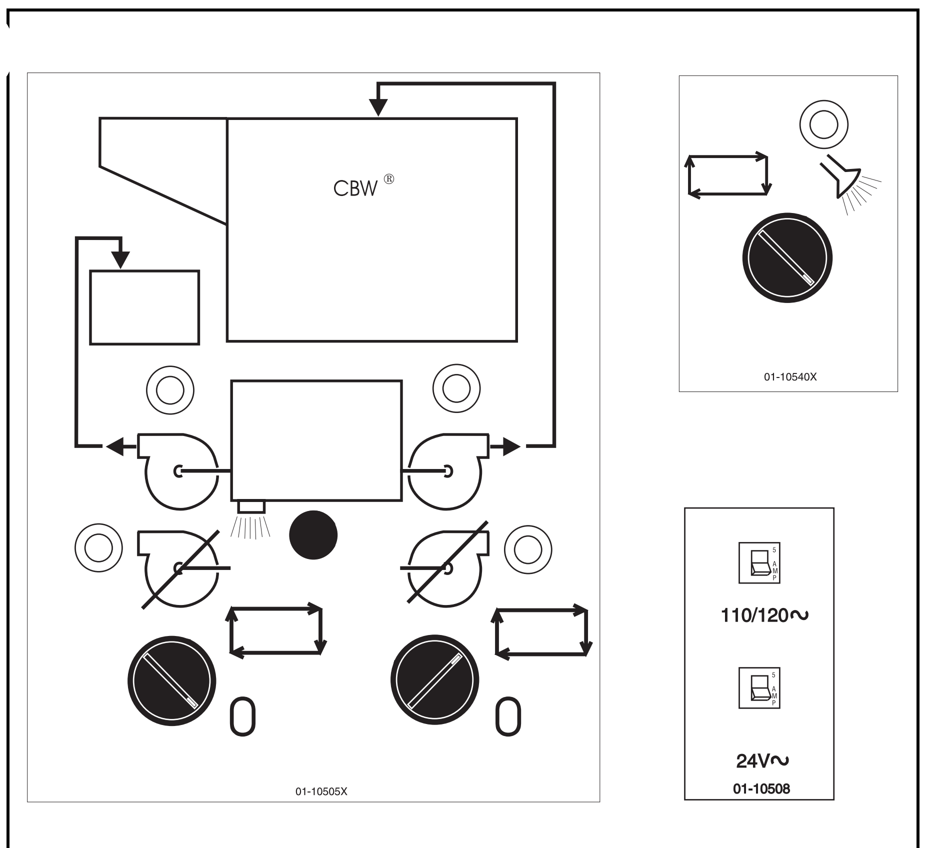


FIGURE 5 (MSSMD419AE)
Flow Splitter Controls

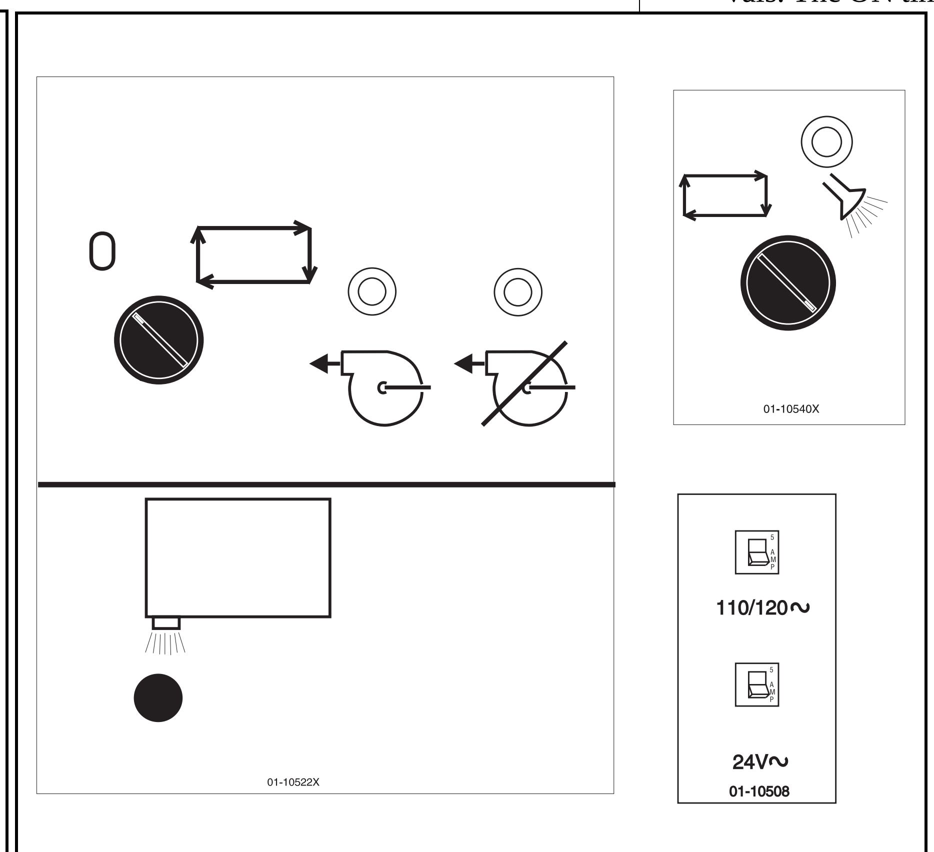


FIGURE 6 (MSSMD419AE)
Flow Lifter Controls

110/120 VAC circuit breaker—When open, prevents 110-120 VAC control circuit power to (/), level control relay contactors, and pump contactor coils.

24 VAC circuit Breaker—When open, prevents 24VAC control circuit power to level switches and level control relay coils.

Bypass Enabled For Increased Flow—Indicates that Valve E, FIGURE 2 (the second automatic inlet valve to the First Wash Zone) has opened.

Automatic/Flush (/) (WORKWEAR only)— When in flush ( ), allows tank to be flushed of soil. See "How to Flush Workwear Flowsplitters/Flowlifters" in this section.

Flow splitter/Lifter is Draining ( ) (Optional)—Illuminates when automatic drains are open during a Bath Exchange Operation. See "DISPLAY P: COMPATIBILITY "

Optional Automatic Brushing System Controls

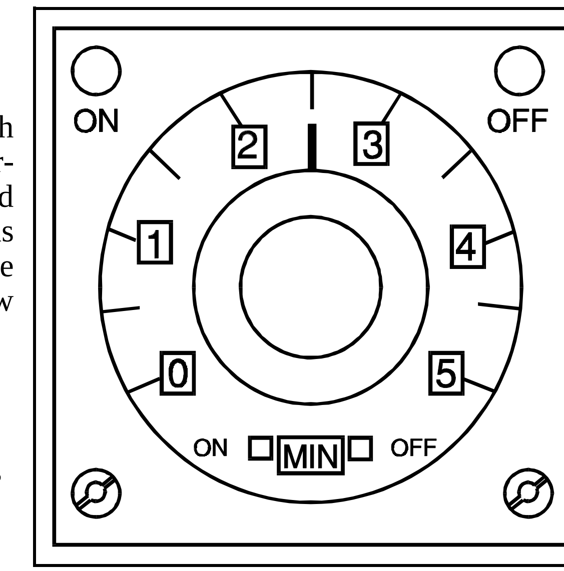


FIGURE 7 (MSSMD419AE)
Brush Timer Setting Dial
(0-5 Minutes, Shown)

Optional Automatic Brushing System with Electromechanical Time Delay Controls—The brush moves via an air cylinder which extends and retracts at preset intervals. The ON time interval is the time the air cylinder is extended, and the OFF time interval is the time the air cylinder is retracted. Set both ON and OFF to the same time (usually 1.5 to 3 minutes), corresponding to how often the brush should be activated.

On/Off lights—Illuminate to indicate ON or OFF.

Dial—The outer dial (yellow indicator) selects time OFF. The inner (orange indicator) dial selects time ON.

Range selector—Lower left sets time range.

Time Unit selector—Lower right sets time unit.

⚠ CAUTION ⚠

CRUSH HAZARD. Contact with moving parts can pinch, crush, and/or cut hands. If lint brush is provided, do not raise tank cover unless lint brush air source is disconnected or power to the tank is locked off at the external disconnect. Never place body parts under cover unless cover is up and latched.

Optional Automatic Brushing System Controlled by MILTRON controller—The air cylinder pilot valves are operated by the same standard output which controls the chain oiler. ON time begins at the start of transfer (cylinder extends). OFF time begins at the end of transfer (cylinder retracts).

REUSE TANK CONTROLS

Reuse Tank Controls

Automatic/Off switch (/) —When set to (), the Miltron controller provides 110-120VAC to pump contactor coils through a circuit breaker and level relays.

Pump on light ( )—Illuminates when pump is running.

Pump Should Run But Did Not light ( )—Illuminates when the control attempts to turn on the Flush pump. The light will remain off in any of the following circumstances:

1. The (/) switch is (), or
2. An overload opens the motor circuit breaker inside the control box (circuit breaker must be manually reset), or
3. A coil in the pump motor contactor is defective.

⚠ DANGER ⚠

SHOCK HAZARD will cause death or severe injury. Lock OFF and tag out three-phase power to the tunnel washer main bus at wall disconnect. Circuit breakers on tank control box disable only control circuit power, not pump power.

Load Chute Flush Valve On light ( )—Illuminates when the Flush valve is open to admit flushing water into the load chute.

Enable Flush Valve button ( )—Flushes the load chute with reuse water while it is held depressed.

Reuse Tank Fresh Fill On light( )—Illuminates when the fresh water makeup for refilling the Reuse tank is open.

110/120 VAC circuit breaker—When open, prevents 110-120 VAC to Auto/off switches, level control relay contactors, and pump contactor coils.

Reuse Tank Draining light ( ) (Optional)—Illuminates when the Miltron controller has commanded the Reuse tank to drain.

Manual Tank Purge Switches (Optional)

When the Miltron controller commands a Reuse tank drain, the flush and trickle flow water automatically shift to fresh water, thus preventing the tunnel from going into low level **hold**. However, there may be instances when it is desirable to manually purge the Reuse tank. Always leave the Manual Tank Purge switches disabled except when when manually purging the Reuse tank, the Flush pump, and its piping.

Makeup Fresh Water switch ( )

If **enabled(✓)**, when the drain valve opens, the fresh water makeup valve opens as soon as tank level drops below low, flushing or sluicing the tank during drains.

If **DISABLED(✕**), the fresh water makeup valve cannot open when the drain valve opens, and the Reuse tank drains without flushing or sluicing. The tank will refill when the drain valve closes.

⚠ CAUTION ⚠

If tank levels drop too low, pump will cavitate. This may cause serious mechanical damage to the pump.

Reuse Pump When Level Below Low switch ( )

If **enabled** (✓), the Flush pump runs while the tank is draining. The pump and its piping are purged if the Flush Pump Water to Sewer manual valve is open. If tank level drops below low with the pump running, it may cavitate. See caution statement above.

If **disabled (✕)**, the Flush pump remains off during the tank drain.

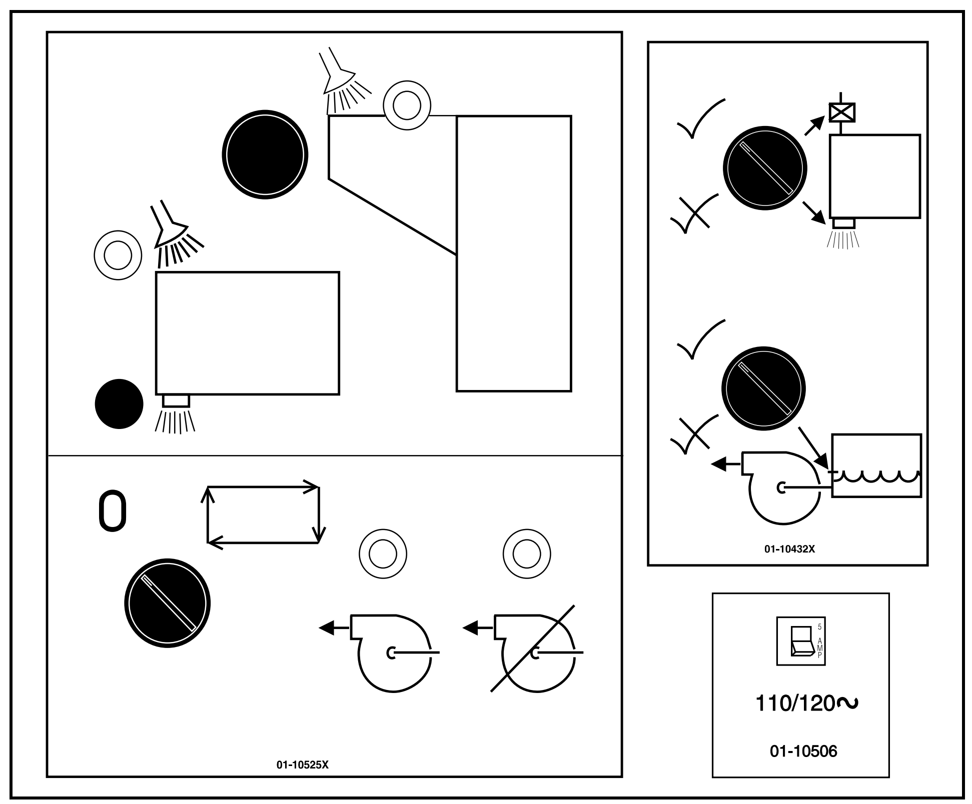


FIGURE 1 (MSSMD440BE)
Reuse Tank Controls

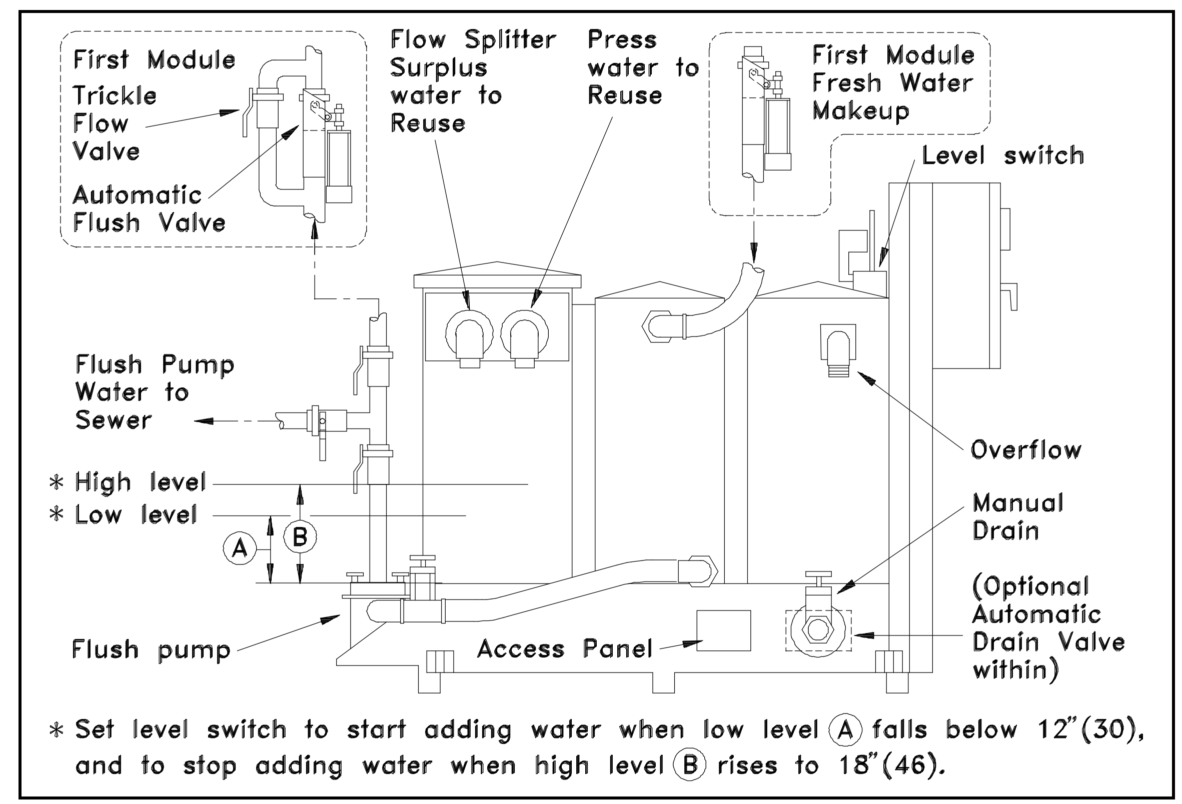


FIGURE 2 (MSSMD440AE)
Reuse Tank (view of the side that faces the tunnel)

Setting the Level Control on the Reuse Tank

The reuse tank level control adds fresh water to this reuse tank if there is insufficient reuse water available.

One of the two low level switches opens the fresh water makeup valve. The high level switch closes the fresh water makeup valve. The spacing between the upper and lower spacing between the upper and lower float rod clips determines how much fresh water will enter once the low level switch is actuated.

The second low level switch in this level control interrupts the “press is free” signal thus preventing transfer when there is insufficent reuse water available to guarantee that the incoming load will be thoroughly wet down.

Set the low level (uppermost) float clip to admit water when level is aproximately 12" (305 cm) above the bottom of the tank. Set the high level (lowermost) float clip to shut off water after adding approximately 6" (152 cm).

WHY AND HOW TO SET THE MANUAL, MINIMUM PRESSURE THROTTLING VALVE WHEN ITT MARLOW PUMPS ARE USED ON THE CBW®

NOTE: As of this writing, pumps manufactured by Milnor are furnished with new CBW's. The ITT Marlow 1 1/2 x 1 1/2 pump, which this section applies to, is only found on older CBW's, but may also be furnished as a replacement pump for these older machines. The manual, minimum pressure throttling valve and pressure gage described herein, are only needed and used with the ITT Marlow pump, not the Milnor pump.

Why It Is Necessary for Certain Centrifugal Pumps To Pump against a Minimum Outlet Pressure—Certain centrifugal pumps require a minimum outlet pressure to pump against, otherwise the pump may "cavitate." Cavitation occurs when the outlet pressure is so low that the pump actually tries to suck a greater quantity of water into the pump than can pass smoothly through the pump body. This causes momentary "bubbles" of vacuum to form inside the pump. The vacuum bubbles then collapse or "implode," causing serious mechanical damage to the pump.

Cavitation causes the pump to make a chattering or rattling sound. The sound (and the phenomenon) disappears with sufficient outlet pressure.

Cavitation-damaged pumps are not covered by warranty.

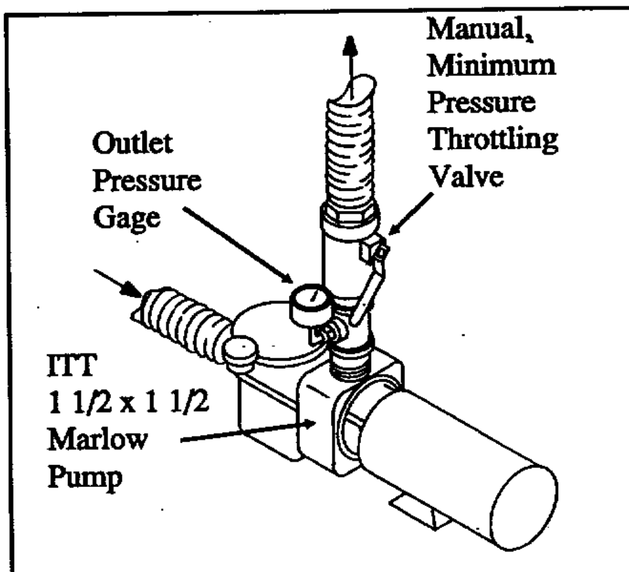


FIGURE 1 (MSSM0906AE)
ITT Marlow Pump for CBW® System

How To Set the Manual Minimum Pressure Throttling Valve—The manual throttling valve must be set to the pressures given in the table below while the pump is delivering its maximum flow rate. This means that, for example, if the pump is supplying water from a flow splitter to a wash zone with a wash zone flow enhance feature, both the normal water inlet valve and the enhanced flow water inlet valve must be open with the vernier valve(s) set to the maximum flow that will be actually used in service. Moreover, because different installations have different amounts of outlet pressure depending upon the total length of pipe, number of elbows, etc., in the discharge piping, the valve must be set with all the down-stream piping installed exactly as the pump will be actually used in service.

What Pressures to Use

ELECTRICAL POWER FREQUENCY	MINIMUM OPERATING PRESSURE
50 HZ	10 PSI (0.7 KG/CM^2)
60 HZ	15 PSI (1.1 KG/CM^2)