



THE DAIRY PRACTICES COUNCIL®

GUIDELINES FOR EFFECTIVE INSTALLATION, CLEANING AND SANITIZING OF BASIC PARLOR MILKING

Publication: DPC 2

JANUARY 2007

First Edition September 1993

Second Edition January 2007

Prepared by:

**MILKING SYSTEMS & PROCEDURES TASK FORCE,
Miles Beard, Director**

Committee Co-Chairs: Gary Steingraber and Armand Dragon

Lead Reviewer: Daniel L. Scruton

Revision Contributors:

Glen Armstrong

Miles Beard

Glen Goldschmidt

Thomas Herremans

Paul Kent

Dale Ledebuhr

Rex Metz

Charles Miller

Jim Parker

Norm Schuring

Larry E. Seaman

This Revision Sponsored by:

THE DAIRY PRACTICES COUNCIL®

Don M. Breiner, President

Michael Schutz, Vice President

Terry B. Musson, Executive Vice President

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ABSTRACT

This guideline provides a practical discussion, for dairy producers and equipment dealers, of the installation, cleaning and sanitizing of milking parlors up to about double 12 in size with a single receiver. The installation sections cover basic information regarding: applications and approvals; the electrical power supply; the vacuum system; and the sanitary piping and components. The recommendations are kept in line with those of 3-A Accepted Practices for the Design, Fabrication and Installation of Milking and Milk Handling Equipment, the Milking Machine Manufacturers Council of the Association of Equipment Manufacturers and the American Society of Agricultural and Biological Engineers. Subjects discussed pertaining to cleaning and sanitizing include: steps in cleaning mechanically cleaned pipeline systems, cleaning pulsator airlines, and troubleshooting cleaning problems. Also provided are: model application forms, scheduled maintenance recommendations for milking and cooling systems, and a checklist for troubleshooting high PI counts. Related Guidelines are Guideline 4, *Effective Installation, Cleaning, and Sanitizing of Large Parlor Milking Systems*, Guideline 102, *Effective Installation, Cleaning, and Sanitizing of Tie Stall Milking Systems*, and Guideline 70, *Guideline for the Installation and Cleaning of Small Ruminant Milking Systems*. Additional information on cleaning can also be found in Guideline 28, *Troubleshooting Residual Films on Dairy Farm Milk Handling Equipment*.

PREFACE

This guideline was written to supersede *Effective Installation, Cleaning, and Sanitizing of Milking Systems*, last revised in 1993. It was revised in 1993 under the leadership of Mr. William D. Godwin, Kipe Steel Inc., and Mr. Robert E. Turner, Westfalia Systemat, A Division of Centrico, Inc. Providing substantive assistance were: Mr. Gus Beck, Don Beck Inc.; Mr. Terry D. Hartman, Sr., Alfa-Laval Agri. Inc.; Dr. Graeme A. Mein, University of Wisconsin; Mr. Karl Miller, Babson Bros. Co.; Mr. John C. Porter, University of New Hampshire, Mr. John A. Scheffel, Diversey Corp.; and Professor Stephen B. Spencer, The Pennsylvania State University.

This revision was Co-Chaired by Gary Steingraber, BouMatic; and Armand Dragon, IBA, Inc. The lead reviewer was Daniel L. Scruton, Vermont Agency of Agriculture, Food and Markets. Contributors were Glenn Armstrong, Westfalia-Surge, Inc.; Miles Beard, IBA, Inc.; Glen Goldschmidt, Wisconsin Department of Agriculture, Trade and Consumer Protection; Thomas Herremans, Michigan Milk Producers Association; Paul Kent, IBA, Inc.; Dale Ledebuhr, Michigan Milk Producers Association; Rex Metz, Metz Sales, Inc.; Charles Miller, Dairymaster USA, Inc.; Jim Parker, WestfaliaSurge, Inc.; Norm Schuring, WestfaliaSurge, Inc.; and Larry E. Seaman, Maryland and Virginia Producers Co-op.

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While all attempts have been made to be accurate and thorough, no guideline can cover all equipment or repairs to be found in the field. Therefore, the authors and publisher of this guideline make no warranties, either expressed or implied, with respect to the procedures described in this guideline, or their applicability to any particular machine or situation. The entire risk as to the repair and performance of any particular machine is with the reader. In no event will the authors or the publisher be liable for direct, indirect, incidental or consequential damages resulting from the procedures described in this guideline.

SCOPE OF GUIDELINE

This guideline was developed to be useful in putting in place and operating basic parlor milking systems to consistently yield high quality milk. It is not intended to be a definitive manual covering installation, cleaning, and sanitizing.

INTENT OF THIS GUIDELINE

1. The words "must" or "shall" indicate a requirement that is to be adopted, in order for the installation to conform to these guidelines while the words "should" or "may" indicate a recommended practice.
2. All milk and milk handling equipment should be designed and installed to meet or exceed these guidelines. The installer must advise the producer and regulatory authority when the installation does not meet these guidelines.
3. Notice of installation may be required for all milking and milk handling equipment, including replacement components, which affect the performance of the milking equipment, except for parts which need to be replaced due to normal operation, i.e., teatcup liners, gaskets, belts, etc.
4. Each installer may be required to supply the appropriate regulatory agency with a plan concerning any system change.
5. An operator's manual, including a trouble-shooting guide, must be provided for all major components and shall include cleaning instructions. A start-up analysis by the installer is recommended using a milking system performance analysis guide such as that provided.
6. The installer must properly instruct the operator in the method of operation, maintenance and cleaning of the equipment.
7. Manufacturer's specifications should be followed, as well as 3-A Sanitary Standards, American Society of Agricultural and Biological Engineers (ASABE) Standards and appropriate milk regulatory agency requirements.
8. The standards used in these guidelines for all airflow measurements are set by the American Society of Mechanical Engineers (ASME), test code PTC9 (displacement compressors, vacuum pumps and blowers).

GUIDELINE PREPARATION AND REVIEW PROCESS

The Dairy Practices Council (DPC) Guideline development and update process is unique and requires several levels of peer review. The first step starts with a Task Force subcommittee made up of individuals from industry, regulatory and educational institutions interested in and knowledgeable about the subject to be addressed. Drafts, called "white copies," are circulated until all members of the subcommittee are satisfied with the content. The final "white copy" may be further distributed to the entire Task Force; DPC Executive Board; state and federal regulators; educational and industry members; and anyone else the Task Force Director and/or the DPC Executive Vice President feel would add strength to the review. Following final "white copy" review and corrections, the next step requires a "yellow cover" draft to be circulated to representatives of participating Regulatory Agencies referred to as "Key Sanitarians." Key Sanitarians may suggest changes and insert footnotes if their state standards and regulations differ from the text. After final review and editing, the Guideline is distributed in the distinctive DPC "green cover" to DPC members and made available for purchase to others. These guidelines represent our state of the knowledge at the time they are written. Currently, DPC Guidelines are primarily distributed electronically in pdf format without colored covers, but the process and designation of the steps remains the same. Contributors listed affiliations are at the time of their contribution.

DPC DISCLAIMER

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BACKGROUND AND OVERVIEW

During the 20th century, milking dairy cows with machines replaced hand milking, saving time and labor. Although bucket milkers were used before World War I, their widespread use followed the Rural Electrification expansion in the 1930's. Through the 1940's and 1950's most milk cans were replaced by refrigerated bulk milk tanks, and tank trucks for every-other-day pick up became common. Dumping bucket milkers into milk transfer systems saved manual strain when carrying milk, and around-the-stable milking pipelines became common with larger milking barns. The advent of elevated milking parlors reduced stooping and squatting for the operator. Developments with chemical cleaners, as well as water heaters, insured effective and automatic cleaning-in-place of milk handling equipment.

Automatic cluster removers and in-place cleaning of milking units in all types of parlors have become more popular. Concentrate feeding in parlors has generally been replaced by computerized feeding systems and total mixed rations (TMR). Automatic recording of milk yields, coupled to electronic identification of cows, is increasing. Criteria for properly designed Automatic Milking Systems (Robotic milkers) were added to the Grade "A" Pasteurized Milk Ordinance (PMO) in 2003 and these systems are available for use in the U.S.

Basic to the operation of milking machines is a partial vacuum or "negative" pressure between one-third and one-half atmosphere. This pressure differential moves milk away from the cow's teats, or fluids away from any opening, since air rushes in to equalize pressure. A continuous vacuum stresses teats, so pulsing air collapses the teatcup liners (inflations) and massages the teats. Milk flows directly away from each teat, preventing flooding or cross contamination among quarters. Shaking or agitating milk leads to possible foaming and increased rancidity, so milk should flow gently through the milk lines and not be mixed with the air. However, pulsing air and fluids create turbulent and fast moving slugs of rinsing, washing and sanitizing solutions used to effectively clean the milking systems.

Milk is an ideal medium for the growth of bacteria. In the early 20th century, several outbreaks of human illness were caused by pathogens in milk. Because of these outbreaks the production, pasteurization and other processing of milk and dairy products became a public health concern. Regulations, inspections and enforcement of strict standards have since effectively minimized pathogens in milk,, and ensured a safe, high quality pasteurized milk supply throughout the United States.

APPLYING FOR, AND APPROVAL OF, MILKING AND MILK HANDLING SYSTEMS

An application to install new equipment or make changes in existing milking equipment must be submitted to the appropriate regulatory authority in the state where the dairy farmer produces milk. The application, including properly prepared plans, must be signed by the installer and must be submitted before installation is to begin. Contact the local regulatory authority for lead time requirements in your area. This includes any equipment in contact with milk such as milking units, in-line heat exchangers, automatic cluster removers, stimulators, back flush systems, bulk milk tanks and other components. Although each state may have different application forms, the appendices provide examples of application forms which

include all of the important data needed for the approval of components or a complete system.

The equipment should be installed or modified by a qualified dealer following the manufacturer's guidelines.

Approval, disapproval or conditional approval should be from the regulatory authority and returned to the installer and/or dairy producer. Installation of milk handling equipment should not begin until approval is given. Note: Check with the local regulatory authority to verify the review time required. (Refer to DPC # 3, Selected Personnel in Milk Sanitation.)

Testing and training should be done by the installer, in the presence of the producer, so the producer is knowledgeable in the proper operation and performance of a milking system or any components. Proper milking, gentle milk handling and thorough cleaning should be demonstrated to the producer, dairy workers and sanitarian. A copy of the system's test results should be reviewed and left with the dairy producer.

Operating instructions and maintenance schedules from the manufacturer, dealer and

installer must be provided. These include: daily assembly and disassembly procedures; lubrication or replacement schedules; and routine maintenance of teatcup liners, milk hoses, vacuum hoses, pulsators, vacuum controllers, vacuum pumps, milk pumps, etc. Several items apply to many systems and Appendix C lists items to check at each milking, once weekly, monthly, and for the semi-annual check with a dealer. If a dairy producer suspects any malfunction, they should notify the dealer promptly to prevent more costly breakdowns or problems.

ELECTRICAL POWER SUPPLY

Check With Power Supplier

Before changing electrical wiring, or adding electrical equipment, contact your power supplier to see if existing power lines or transformers are adequate for the increased load. They also may suggest improvements that can save time, money and electric power.

Conform With Codes

The electrical system must conform to the **National Electric Code (NEC)** and other local regulations and codes. The power company's lines and service entrance wire size should be large enough to carry the maximum current without overheating. Proper grounding helps prevent accidents.

Protect Yourself

The milking system should be bonded to metal stalls, concrete reinforcing and the electrical system ground. When bonding stainless steel, use stainless steel or compatible connectors to minimize corrosion due to electrolysis.

Transient or stray voltage between equipment and the ground (neutral to earth), if excessive,

can cause cow behavior changes. Testing for stray voltage should be done by trained personnel. Refer to DPC #42, Stray Voltage on Dairy Farms for more information.

Ground Fault Circuit Interrupters (GFCI's) save lives and should be installed in damp locations as recommended by the **NEC**. All electrical equipment and motors must be rated for the location and the environment it is operating in. Consult NEC, Article 547 for proper wiring methods for agricultural buildings. Electrical cords should be resistant to moisture, oil and fats and connected with waterproof connectors.

Protect Your Milk

Each pipeline milking machine should be installed with a milk line position switch on the milk delivery (discharge) line. This can prevent wash water from accidentally going into the bulk milk tank during the wash cycle, and also can prevent accidental discharge of milk into the wash sink during milking, and it is highly recommended. Some states require milk line position switches.

THE VACUUM SYSTEM

Vacuum Pump

Locate the vacuum pump close to the milking area in a clean, dry, well-ventilated space. The vacuum pump and other necessary power units should be in a room large enough for regular maintenance, and separate from the milkroom or

milking parlor to minimize problems from both oil and noise.

Types of pumps available include sliding-vane rotary pumps, water-ring pumps, rotary lobe and turbine pumps. Some pumps can be damaged by small amounts of water or cleaning solutions.

Size:

Size needed for milking - To meet the milking performance standard for receiver stability of +/- 0.6" Hg (2kPa); the vacuum pump size will be approximately the total of one unit falling off; (refer to testing section to determine this number); plus 3% of that number for each unit in the system; plus pulsators, air bleeds and ancillary equipment; plus 20% of the subtotal. The total is then adjusted for elevation and rounded to the nearest cubic foot per minute (CFM). (Refer to Table 2).

Size needed for washing - Airflow required during washing is usually less than that required for milking, if air and liquid flow rates are controlled. Calculate the vacuum pump capacity

required for cleaning by multiplying the number of units times the volume of air consumed during washing by the units and ancillary equipment (typically 2 cfm (60 l/min) or as specified by the manufacturer) and adding the air injector use for each milkline loop. (Refer to Table 1). Compare this number to the number determined for milking and use the higher value. Airflow used by the units and ancillary equipment can be obtained from the manufacturer.

Caution: Controlled capacity or variable frequency drives (VFD) need to have a minimum operating speed to function properly without over heating. Consult the manufacturer's recommendations.

Vacuum Pump Sizing Example:

The following example uses a double 5 lowline parlor designed to operate at 13" Hg (44 kPa) with 10 units; an inverted unit consumes 40 CFM of air; each pulsator and air-bleed consumes 1.5 CFM; vacuum take-offs that consume 0.3 CFM each; and the farm is at 1000 feet of elevation above sea level:

Component	Amount for this example
1 unit fall-off	40 CFM
3% allowance	1.2 CFM
Pulsator/air-bleed consumption	1.5 CFM
Vacuum take-offs	0.3 CFM
Vacuum consumption during wash other than air injector	2 CFM
Vacuum consumed by air injector	33 CFM

For Milking:

The calculation is:

One unit fall off base		40 CFM
3% allowance	10X1.2 =	12 CFM
Pulsator/air-bleed consumption	10X1.5 =	15 CFM
Vacuum take-offs	10X0.3	3 CFM
Sub Total		70 CFM
20% allowance		14 CFM
Sub Total		84 CFM
Elevation adjustment for 1000 feet	4/0.96	87 CFM

For Washing:

The calculation is:

Air injector needs:		33 CFM
Airflow used during washed other than air injector:		
	<u>2 X 10=</u>	<u>20 CFM</u>
Sub total:		53 CFM
Adjustment for elevation of 1000 feet	53 / .96 =	55 CFM

Using this example the vacuum pump size recommendation is a pump that can produce at least 87 CFM at 13" Hg (44 kPa).

Table 1. Minimum Air Injector Airflow Requirements for Washing

Milkline Diameter	cfm* per loop	Liters/min* per loop
2" (50.8mm)	17	480
2 1/2" (63.5mm)	24	680
3" (76.2mm)	33	930

* For multiple loop systems, multiply the number of loops times the air injector requirement, unless the air injectors are sequenced.

Table 2. De-rating for Vacuum Pumps at Elevations Above Sea Level

CFM	
Elevation (Feet above sea level)	Estimating Factor X times capacity at sea level equals true capacity
0	1.00
1,000	0.96
2,000	0.93
3,000	0.90
4,000	0.86
5,000	0.83
6,000	0.80
7,000	0.77
8,000	0.74

To use this Table divide the needed CFM by the estimating factor.

Vacuum Level - Follow the manufacturer's suggestions for vacuum level settings. The following are typical ranges for operating vacuum levels:

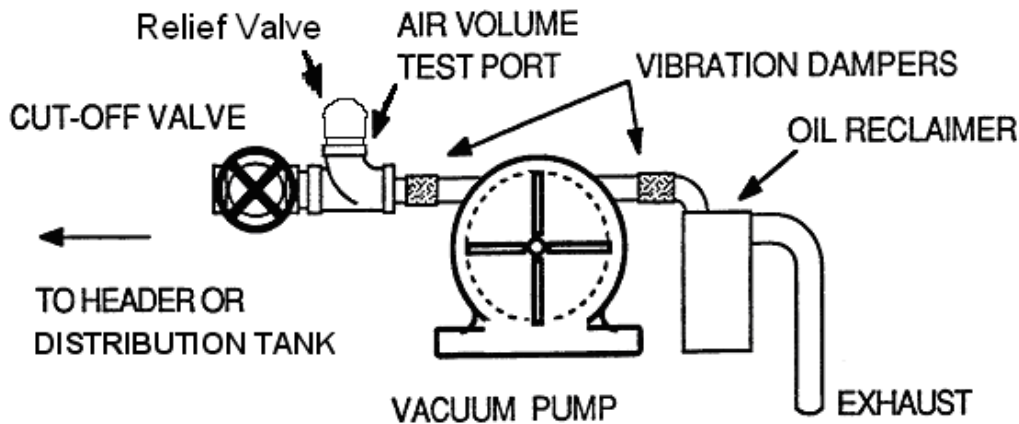
System	Mercury (in.)	kPa
High line	14 to 15	47 to 51
Low line	12 to 14	41 to 47
Mid line	13 to 14.5	44 to 49

Pump exhaust pipes should meet the manufacturer's recommendations. The exhaust port on oil-exhausting pumps should go directly outside the building, using a minimum of fittings and not exhaust near the refrigeration condenser unit, or into the barn, parlor, milkroom, or feed room. The exhaust should be directed downward and away from any openings in the building. Pumps other than oil-exhausting may be exhausted differently. Note: **Oil lubrication from sliding vane pumps must not be allowed to contaminate soil and/or ground water.** Follow the manufacturer's recommendations.

Rotary sliding-vane pumps exhaust oil from lubrication. Therefore oil reclaimers should be installed to conserve oil and to reduce the risk of soil contamination from the oil-laden exhaust air. To prevent possible damage if the pump reverses rotation during shut down, install one-way check valves to limit backpressures. This also minimizes the risk of contaminating the vacuum system with oil.

Connections to vacuum pumps should include vibration dampers to isolate noise, vibrations, and fatigue in steel or plastic pipe. Careful cleaning, priming and gluing is needed for joining rigid polyvinylchloride (PVC) pipe. An air volume test port with fittings and a full flow cut-off valve should be installed so the airflow from the vacuum pump can be tested. (Refer to Figure 1).

Figure 1. Vacuum Pump with Air Volume Test Port and Connections



Vacuum Controllers and Safety Valves:

The capacity of mechanical vacuum controllers (regulators) should equal the full capacity of the vacuum pumps at the operating vacuum. Normal loading of the system should not reduce the vacuum level more than 0.6 inch of mercury (2 kPa).

Locate mechanical vacuum controllers to receive clean air and be easily accessible for cleaning. Filters protect the vacuum controller, but must be serviced regularly. Install vacuum controllers or vacuum sensors according to the manufacturer's recommendations on the main airline at or near the distribution tanks, or close to the sanitary trap, but not on sanitary piping (milklines) or pulsator airlines.

Safety relief valves allow air to enter the vacuum system in case of vacuum controller failure. This prevents possible pump, tank or line damage. Safety relief valves are designed to protect the system from increasing vacuum level beyond a safe operating level. It is recommended that the relief valve be located between the cut-off valve and the vacuum pump so that accidental cut-off valve closure will not harm the pump. (Refer to Figure 1).

Milking System Test Procedure

Regularly testing the milking system is essential for consistent system performance. The goal is to assure that under normal operating conditions the milking system vacuum does not vary more than 0.6" Hg (2 kPa). This includes a one unit fall off for up to 32 units and 2 units after that. This guideline presents a basic test procedure. Most

equipment manufacturers, National Mastitis Council and others have detailed test procedures that can also be used. The procedure used should be consistent with the latest versions of ASABE EP445-Test Equipment and Its Application for Measuring Milking Machine Operating Characteristics, International Standards Organization (ISO)-6690 Milking Machine Installations-Mechanical Tests, and 3-A Accepted Practices for the Design, Fabrication and Installation of Milking and Milk Handling Equipment, No. 606.

The simple installation of system test ports helps provide easy access to the system and makes routine service and checking an easy task. An airflow meter and a vacuum gauge are also required for these tests. Accurate test gauges should be used to assure the precision of the tests being conducted.

A test port should be installed in the main airline adjacent to the vacuum pump(s). (Refer to Figure 1). It consists of a tee or wye fitting, a cutoff valve, a temporary connector for a vacuum gauge, an adapter and plug fitting. Pipe diameters should be equal to or greater than the pump intake diameter. In large systems (over 100 cfm / 2800 l/min), it may be desirable to install two tee or wye fittings to accommodate the use of two flowmeters at the same time.

Vacuum test fittings are required at the receiver jar (or on the trap line close to the sanitary trap), in the pulsator airline at the location farthest from the vacuum pump, as close as practical to the inlet of the vacuum pump, and at the vacuum controller. A method for temporarily connecting

the airflow meter to the receiver or milkline is also needed. For weigh vessel (jar) systems the test fitting should be on the vacuum pipe supplying vacuum to the sanitary trap supplying the vacuum to the weigh vessels. References in the rest of the test procedure to the receiver, on a weigh vessel system, would use the vacuum in the pipe feeding the weigh vessels.

VFD vacuum pumps are gaining in popularity due to the energy savings involved, especially on systems with long operating times. The speed of the pump is controlled by a vacuum sensor to maintain a stable vacuum supply. They are slightly different to test than constant speed pumps, and differences are noted in the appropriate steps.

Dynamic Milking Time Testing:

Dynamic milking time testing is a verification of adequate system performance. The vacuum level in the receiver shall remain +/- 0.6”Hg or 2kPa during normal milking.

System reserve. An effective way to check for sufficient system reserve is to invert one unit while all of the units are set-up and ready to milk. Doing this when cows are being milked will be the most accurate; however, the test should be done without any cows being milked first and only done with cows being milked if the system clearly passes with the units not milking. If the system vacuum does not remain stable then more precise testing needs to be done to determine the cause. (Refer to the static testing section or call your dealer).

Pulsators should also be tested with equipment capable of determining the A, B, C, and D phases as specified in ASABE 445 to be sure they are all functioning properly and are within the range recommended by the manufacturer. Pulsation testing may be done during milking or as part of the static testing. If done during milking, be consistent, test with units always on a cow milking or use artificial teat plugs to assure a similar amount of air is removed from the shells each time.

Response test. While observing the system vacuum level, admit an amount of air equivalent to one milk hose being removed from the milk line into the milking system. This can be done with an airflow meter or by removing a milk hose from the milk line or meter. Admit the air for about 3 seconds and then stop abruptly. The

system vacuum should overshoot no more than the undershoot observed, and should settle back to the set point without excessive oscillation. Excessive overshoot or oscillation is a sign of the system being “out of tune”. Contact the dealer to have the problem corrected. **Note: The +/- 0.6”Hg (2 kPa) standard does not apply here. It is not important how much the vacuum drops. This test is designed to be worse than an anticipated “normal milking” occurrence purposely to test the response of the vacuum controller and the pump system.**

Static Testing:

All new systems, any system that has experienced a change in performance noted by the milkers or a system that fails the dynamic performance testing should have the following, or equivalent, testing performed.

VFD Caution: A VFD will typically run faster at maximum speed than the data plate reading on the motor. Do not run a variable frequency control pump for more than a few minutes at maximum speed unless the manufacturer gives specific instructions that it is permissible for the particular pump. Turn the pump off between each of the test steps while you set up for the next test

- 1) **System Vacuum Differences.** Assemble the system to operate in the milking position, with teatcups plugged and all shutoffs to the claws open. The regulator should be operating, and the cutoff valve should be open. Start the vacuum pump.
 - a) Check the vacuum level at the receiver jar with the test gauge and compare with the gauge on the system. Measure the vacuum level at the vacuum controller (or its sensor), in the pulsator airline, and at the vacuum pump inlet. Record your results. All readings should be within 0.6” Hg (2 kPa) of each other.
 - b) Open one milking unit and hang it upside down to simulate a unit fall-off, with any auto-shutoff mechanisms disabled, and record the vacuum level measurements at the above locations again. Record your results. The vacuum level should be no more than 0.6” Hg (2kPa) lower than the results in “a” and all readings in step “b” should be within 0.6” Hg (2 kPa) of each other.

- 2) **Pump Capacity.** Turn off the vacuum pump if operating, then install the airflow meter and vacuum gauge at the vacuum pump test port and with the airflow meter opened well beyond the airflow of the vacuum pumps, close the cutoff valve and turn on the pump. **Caution: Some types of cutoff valves should not be opened or closed under vacuum, because they may be damaged in the process.**
- Take an airflow meter reading at 15" Hg (51 kPa). Record the vacuum pump capacity and the manufacturer's rating. The measured reading should be similar to the manufacturer's rating.
 - Readjust the airflow meter so the vacuum gauge at the pump reads the same as the original receiver vacuum level noted above and record the capacity and the pump inlet vacuum. The CFM reading should equal or exceed the capacity needed based on the formula noted in the Vacuum Pump section of this guideline. The vacuum level at the pump inlet should be no more than 0.6 Hg (2kPa) different than the receiver level.
- 3) **Air Used by System Components.** For "a" – "f" the system should be set as it was for 1a except that the vacuum controller should be disabled. Variable frequency controllers need to be run at a constant speed for these steps. Consult the manufacturer for the proper procedure. If a VFD is allowed to run at maximum speed for these tests remember the VFD caution.
- Adjust the airflow meter so it reads the same receiver jar vacuum as it did in step 1a. Record the airflow meter reading.
 - Disconnect, or switch off, the pulsators. Readjust the airflow meter to the original receiver vacuum level, and record the flow reading. "a" minus "b" is the amount consumed by the pulsators.
 - Invert one unit and readjust the airflow meter to the original receiver vacuum level. "b" minus "c" is the one unit fall-off amount and will be used to calculate the recommended "Effective Reserve."
 - Disconnect, shut-off, or isolate the milking units. Readjust the airflow meter to the original receiver vacuum level, and record the flow reading. "b" minus "d" is the amount consumed by the air bleeds in the claws.
 - Remove the vacuum controller and plug the connection. Readjust the airflow meter to the original receiver vacuum level, and record the airflow reading. This step is not done with VFD systems. "d" minus "e" is the vacuum controller leakage.
 - Deactivate ancillary equipment that consume vacuum, such as teat dip pumps, milk meters with air bleeds, etc. Readjust the airflow meter to the original receiver vacuum level, and record the flow reading. "e" minus "f" is the amount of air consumed by the ancillary equipment.
- 4) **Effective and Manual Reserve.**
- With the system set-up as it was for step 1a, install the airflow meter at the receiver (to the vacuum supply line for weigh vessel systems). Open the airflow meter until the vacuum gauge at the receiver reads 0.6" Hg (2 kPa) less than it did in step 1. Record airflow as Effective Reserve (cfm or liters per minute). Effective reserve should equal the one unit fall off, plus 3% per unit , plus an allowance for other vacuum equipment used on that vacuum system not active during the testing. (Refer to Guideline 4 for a system larger than 24 units).
 - Turn off the vacuum pump(s). Remove or close the vacuum controller, with pulsation operating as before. Open the airflow meter fully before starting the pump. Close the airflow meter at the receiver until the same vacuum level at the receiver is obtained as during the effective reserve test. Record the airflow meter reading as the manual reserve. The manual reserve should not exceed the Effective Reserve by more than 10%. If it does, further investigation is warranted; contact your dealer.

(Note: VFDs should skip step 4b unless otherwise directed by the manufacturer.)

- 5) **System Leakage.** Calculate the difference between 2b and 3f. The pump capacity minus the total air flow measured at the receiver with no equipment consuming air is leakage. Leakage should be less than 10% of the pump output.
- 6) **Continue testing other parts** of the system such as individual pulsators and the mechanical cleaning system. Be sure to perform all the tests and checks suggested by the manufacturer for all components of the milking system.
- 7) **Recheck Receiver Vacuum and Effective Reserve.** Restore the system to the operating condition. Repeat step 4a, to ensure that the system has been restored to its operating condition.
- 8) Inspect the vacuum lines to be sure they are free of build-up and potential blockages and do a visual inspection of all rubber goods

Vacuum Lines

Refer to Figure 2.

Materials for main (vacuum) airlines should withstand vacuum levels of 25" Hg (85 kPa) as well as cleaning fluids. Rigid plastic pipe (Schedule 40 or heavier) is common and supports should be installed to prevent any sagging.

Size main airlines large enough to carry the air flowing through them without an excessive vacuum drop. Table 3 shows the size and length of pipe for a 0.6" Hg (2 kPa) vacuum drop with several airflow rates. The total output of the pump goes through the main airline from the vacuum pump to the distribution tank and through the airlines to the vacuum controller and receiver jar.

Table 3. Recommended Minimum Main Air Line Diameter

Approx. Vacuum Pump H.P.	Expected Max. Airflow Rate (cfm ASME air)	<u>Effective Length of Main Air Line (ft) (pipe size in inches)</u>					
		<u>20</u>	<u>40</u>	<u>60</u>	<u>80</u>	<u>100</u>	<u>200</u>
5	50	2	3	3	3	3	3
6	60	2	3	3	3	3	3
7	70	3	3	3	3	3	3
10	100	3	3	3	4	4	4
15	150	4	4	4	4	4	4

Adapted from: ASABE S518.2 JUL96

Notes:

1. The main air line is defined as the air pipeline between the vacuum pump and the sanitary trap near the receiver.
2. These calculations are based upon a maximum vacuum drop of 0.6" Hg (2 kPa) between the receiver and the vacuum pump. The maximum flowrate normally is from the vacuum regulator to the pump, but the system must accommodate the falloff test from the receiver to the vacuum pump.
3. This Table includes an allowance for 8 elbows, a distribution tank, and a sanitary trap. If the system includes more than 8 elbows, use the next pipe length column to the right for each 3 additional elbows.
4. Cfm per H.P. will vary by manufacturer and type of vacuum pump, i.e., oil vane, water ring or lobe pump.

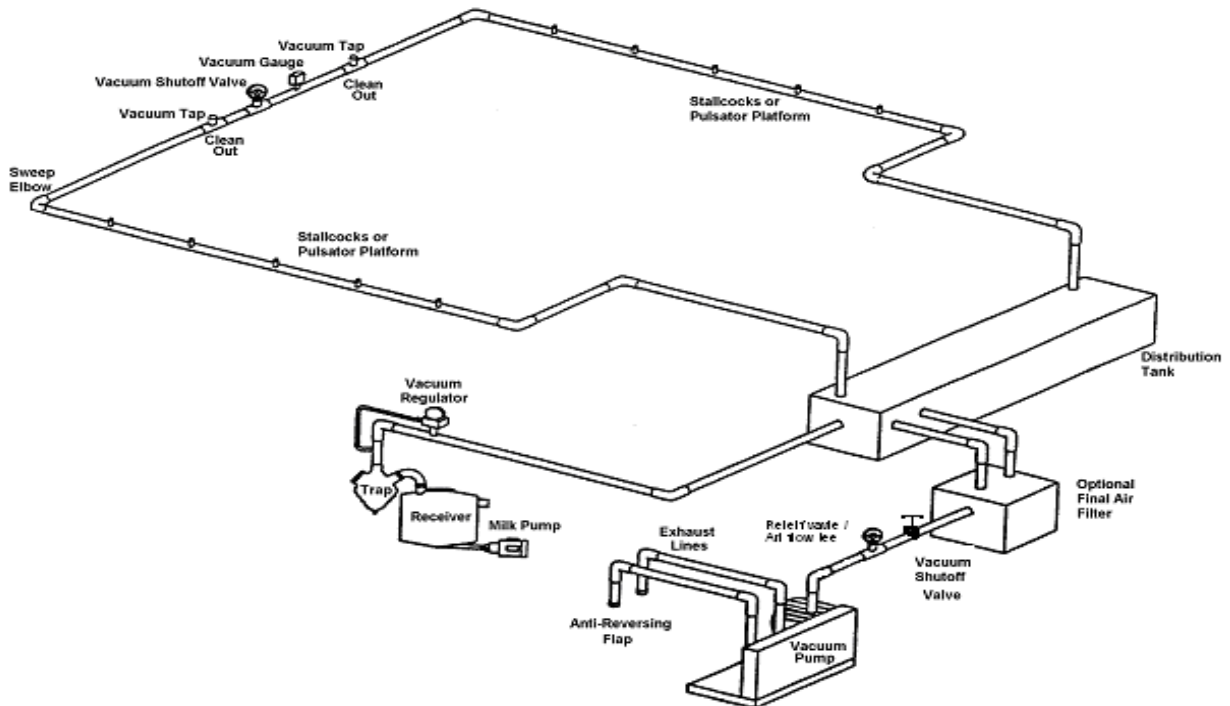
Pulsator airlines should be at least two inches in diameter (2"D), and three inch diameter (3"D) lines are recommended with 15 or more milking units. Install vacuum taps (stall cocks) in the top half of the air or pulsation lines. On systems with a single feed line from the distribution tank that crosses the barn to connect two or more rows of cows, it should be one size larger than the pulsator line unless the pulsator line is already oversized.

Install pulsator airlines with a continuous slope of 1/2" per 10 feet (0.4%) or more toward the distribution tank, and in the direction of airflow from the milking units. Install the lines as straight as practical and support them rigidly to prevent sagging. Stall cocks should have additional reinforcement or use the clamp-on type. Minimize the number of fittings and elbows but use tees and full flow valves to facilitate cleaning, inspection, and testing. Install automatic drain valves at all of the low points.

Operating vacuum is shown with a calibrated and properly operating vacuum gauge. Locate so that it can be observed during milking. High vacuum levels may cause teat injuries. Low vacuum levels indicate excessive leaks or low capacity pumps and may lead to slow milking and units dropping off. A qualified dealer should calibrate all gauges. Use of gauges containing mercury is not recommended by many state environmental agencies.

Sanitary traps connect and separate milk lines and main airlines. They have a vacuum shut-off if the trap is filled with liquids from the milk line, and are self draining. The top of the line feeding from the sanitary-side of the system to the sanitary trap should be located less than 12" above the milk receiver, and the receiver-trap connection should be readily dismountable, sanitary piping, sloping toward the trap.

Figure 2. Vacuum Line and Vacuum System Layout



SANITARY PIPING AND COMPONENTS

Milk and Wash Lines – Refer to Figure 3.

Fabrication - All milk contact surfaces shall meet applicable 3-A Sanitary Standards for finish and be free of imperfections such as pits, folds, and crevices in the final fabricated form.

All milk handling lines shall meet the current versions of "3-A Sanitary Standards for Polished Metal Tubing for Milk and Milk Products, Number 33- 3-A Sanitary Standards for Multiple-Use Rubber and Rubber-Like Materials used as Product Contact Surfaces in Dairy Equipment, No. 18-" and "3-A Sanitary Standards for Multiple-Use Plastic Materials, No. 20-" or they shall meet the PMO Section 7, Items 9(r) and 12(r). PVC is not acceptable for either milk or recirculating wash lines.

Welding stainless steel pipelines by skillful welders using the Gas Tungsten Arc Welding (GTAW) method can produce smooth joints with no pits. Inspection of welds with a boroscope may be required. To check the welder's performance, have the welder set aside the first weld each day for inspection.

Two inspection ports or removable elbows are recommended for each loop of a pipeline, one near the high point and one on the return wash line. Additional inspection ports may be needed in lines with unusual configurations.

Ferrules and gaskets are needed to disconnect elbows, sweeps and other fittings or components. Pipe should be cut using a saw guide or cut-off saw. Gaskets should be installed flush with the interior of the piping and properly seated. All ferrules must be welded. Rolled-on ferrules are no longer acceptable in new installations. Existing rolled-on ferrules may remain in use, provided they are functioning properly and were properly installed.

Inspect gaskets periodically and replace when air leaks or deterioration occurs. Because they are

resistant to stretching and decomposition, gaskets used between elbows that need to be turned, such as a swing-line, should be special gaskets that are resistant to stretching and decomposition.

Support - All milk lines should be rigidly supported to maintain a continuous slope of at least 0.8% (1" per 10 linear feet) as specified by regulatory requirements.

Support hangers should be:

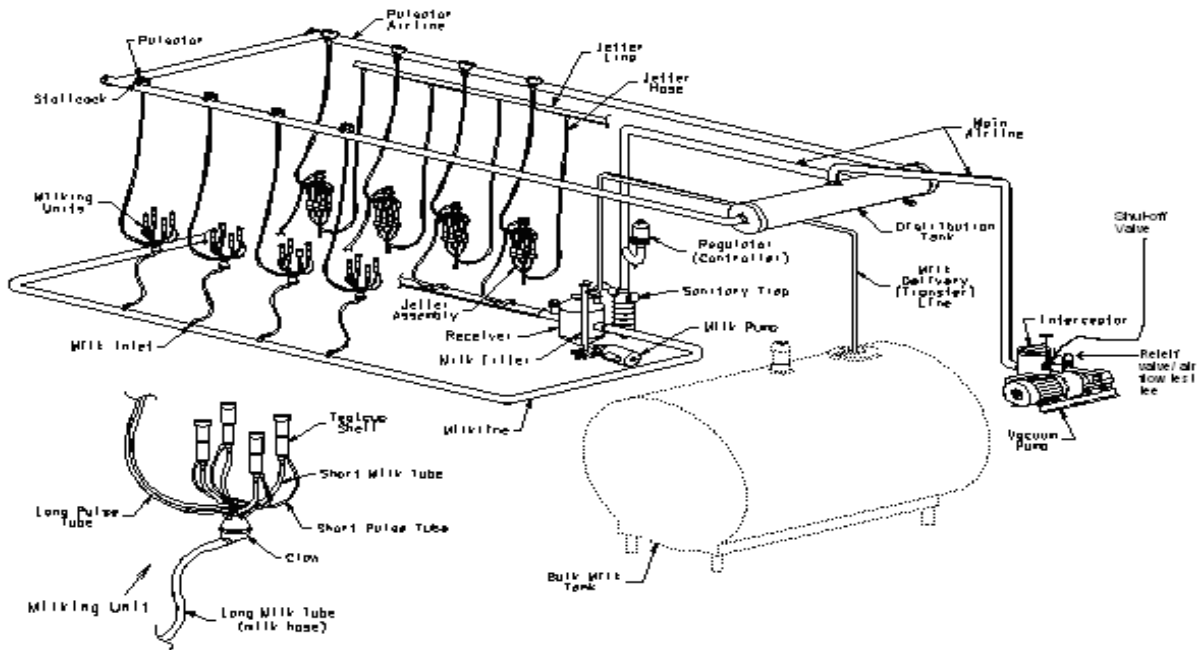
- fully adjustable vertically
- able to flex for the thermal expansion and contraction of the milk lines
- insulated to prevent electrolysis between dissimilar materials
- located close to each milk inlet to limit line deflection during use
- less than 10 feet apart
- attached to a secure base to avoid sags in the line

Sleeves should be installed wherever sanitary piping passes through walls, solid partitions, etc. Use sleeves large enough to easily remove pipes and do not put connections within the sleeves. Block the space between the milkline and the sleeve to prevent the entrance of dust, flies or other insects into the milkroom.

Bonding of stainless steel milk lines and all exposed metal that may become energized by nearby electrical fixtures or equipment to the electrical system ground is generally required in the **NEC**. Copper and aluminum conductors should not make direct contact with stainless steel milk lines because of the potential for electrogalvanic corrosion to occur.

Insulating milklines, washlines and/or wash tanks may be necessary if the wash solution temperature cannot be properly maintained. Use closed-cell insulation approved by the regulatory agency, and do not cover inlets or couplings.

Figure 3. Lowline Pipeline Milking System



From Milking Units to Receiver

Air inlets in the milking unit (teatcup and claw assembly) should be as small as practical to move milk.

Milk hoses between the milking unit and the milk line should be as short as practical to reduce vacuum differential between the lines and the units. Opaque hoses should not exceed 8ft. (2.4 m).

Milk inlets and inlet valves should be air-tight, self-draining, designed for mechanical cleaning and installed so that milk enters the top half of the milkline. Deburr and polish the holes and align the inlets perpendicular to the holes.

Milking pipelines should be large enough to carry both milk and air from the milking units without flooding the lines, or creating excessive turbulence. Milking pipelines should be sloped

to the receiver, be the same diameter for any loop and not include any risers in the direction of milk flow. Low lines are more common in milking parlors and generally provide gentler milk flow and more stable milking vacuum, but high lines are isolated from animal damage. The number of milking units used limits the amount of milk in the pipeline. The current recommendations are shown in Table 4.

Lowlines should be a horizontal loop. Typically this is done with a wash/divert valve located in the milkline, adjacent to the receiver.

Other configurations: Some manufacturers utilize alternative configurations. These systems should be installed following the manufacturer's guidelines. The manufacturer should supply the producer with system performance and cleaning information.

Table 4. Guidelines to Assure Stratified Flow in Looped Milk lines

These charts are adapted from ASABE S518.2 and are designed to meet the challenge of milking cows with flow rates in the top 5% of those in the US and France. The chart assumes no fittings that significantly reduce the internal diameter of the piping.

Peak flowrate: 5.5 l/min/cow (12 lb./min)
Steady air admission: 10-20 l/min/unit (0.35-0.7 cfm)

**Parlor with units attached sequentially by careful operators.
Transient air admission of 100 L/min (3.5 cfm)**

Maximum Number of Units Per Slope

<u>Nominal Line Size</u>	<u>Inches of Slope in 10 Ft.</u>			
	<u>1"/0.8%</u>	<u>1.25"/1.0%</u>	<u>1.5"/1.2%</u>	<u>1.75"/1.5%</u>
48 mm (2 in)	2	3	3	4
60 mm (2.5 in)	6	6	7	9
73 mm (3 in)	11	13	14	16

**Parlor with units attached sequentially by typical operators.
Transient air admission of 200 L/min (7 cfm)**

Maximum Number of Units Per Slope

<u>Nominal Line Size</u>	<u>Inches of Slope in 10 Ft.</u>			
	<u>1"/0.8%</u>	<u>1.25"/1.0%</u>	<u>1.5"/1.2%</u>	<u>1.75"/1.5%</u>
48 mm (2 in)	1	1	2	2
60 mm (2.5 in)	4	4	5	6
73 mm (3 in)	9	10	12	13

From Receiver to Bulk Milk Tank

The receiver group includes a container where milk is released from vacuum by a pump. The milk receiver group should be located in the milkroom, milking parlor or area meeting milkroom or parlor PMO specifications for floors, walls, ceilings, lighting, cleanability and drainage. The receiver is constructed of an approved material and all milk contact surfaces shall be easily inspected. It is also a receiver for washing solutions, which are pumped to the wash tank or vat while preventing the sanitary trap from flooding.

The milk pump is at a low point in the system and must have an automatic drain. The pump motor should be totally enclosed with waterproof electrical connections and proper grounding. The milk pump must be sized to accommodate the washing and milking equipment on the system;

i.e., pre-coolers and filters. The pump should have an electrical disconnect to easily replace the unit in case of malfunction.

Probes to start and stop the milk pump shall be cleanable by recirculation, and removable without disconnecting any milk lines. Provide sufficient clearance and long enough electric cords to easily remove the probes for inspection and cleaning. Locate so that the milk does not rise to the level of the inlets. Many new systems are being designed with variable frequency drives on the milk pump. This helps to reduce electrical power consumption, slows down to pump the milk more gently, yet is capable of speeding up to pump the wash solution at high volumes.

Milk filters remove extraneous sediment from the milk, and provide an indication of the cleanliness of the milk to the producer. Based

upon the maximum flow rate and the number of animals milked, the dealer should recommend the proper size filter and its limitations in performance. Clean housing, clean cows and the proper cleaning of the cows' teats help produce clean milk.

Milk filters should be non-toxic, non-shedding, insoluble and not impart a flavor to the milk. Cotton, linen, or synthetic materials may be used for single service filter media. (Ref: "3-A Sanitary Standards for Milk and Milk Product, Filters Using Single Service Filter Media, Number 10-")".

It is recommended that the filter housing be installed to allow the opening to drain to the floor, instead of to the milk pump. This will allow sediment and straw to fall to the floor instead of collecting in the milk pump line. This will reduce the chances of allowing contaminants to reach the pre-cooler.

Milk filters should be changed every 3 hours or less to minimize the chance of bacterial growth on the filter media.

Milk should be filtered before entering an in-line plate or tube cooler where sediment could collect and adversely affect milk and wash solution flow. A clean filter should be installed prior to washing to prevent the deposit of foreign materials in in-line heat exchangers during the wash cycle.

In-line heat exchangers (pre-coolers) are optional heat exchangers, which partially or completely cool milk. Plate coolers should be located in the milkroom, and all milk and cleaning solutions should be filtered before entering an in-line heat exchanger. They can also be used to keep the wash solution hot by circulating hot water on the side normally used for the cooling water during the hot cycle of the wash. The circulator for the hot water should be on a time delay so that it will not heat the heat exchanger surface before the cleaning solution reaches it. If the surface of the exchanger heats before the cleaning solution is in contact with it there is a risk of "cooking" on the proteins in the milk, making it more difficult to clean.

The milk delivery (discharge) line into the bulk milk tank should minimize foaming by discharging milk as close to the bottom of the tank as practical. Lines discharging milk into a

tank should end with a polished angle cut (approximately 45 degrees), and have a weep hole below the lid and above the milk level to prevent siphoning. All lines entering through but not permanently attached to the top of the receiving vessel must have a sanitary drip shield that closely overlaps the edges of the opening in the cover.

Bottom filling of the bulk milk tank, that is in compliance with applicable PMO requirements, is recommended, and connection to the tank should have a check valve to prevent accidental milk loss.

Sliding a hose over a sanitary line is not an acceptable mechanical cleaning connection. Hoses are not allowed where a rigid line would work.

A milcline position switch for the "swing line" of the milk delivery line can prevent wash water from accidentally going into the farm bulk milk tank during the wash cycle, and also prevents accidental discharge of the milk into the wash vat during milking. A milk line position switch is recommended.

Washing Components

Wash divert valves allow the single direction flow for cleaning milklines. The wash valve should be adjacent to the receiver jar and constructed to pass sufficient solution to thoroughly clean between the valve and receiver inlet and to allow the piping to drain.

CIP wash lines, if connected to the milcline, must be disconnected to make an atmospheric break and capped above the flood rim of the sink during milking or shall have a valving system that provides for an air break equal to the diameter of the wash line. In-line shut-off valves do not provide sufficient protection. Wash lines and valves must be sized to the system according to manufacturer's recommendations.

Wash tanks or vats hold the solutions for rinsing, washing and sanitizing operations and are sized to hold the greatest amount of solution needed for one cycle. If the fill time is longer than five minutes or more than 50 gallons are needed per cycle, an enclosed sink or vertical tank with a removable cover or access port is recommended. Vertical wash tanks take up less floor and wall space than vats, and with less exposed liquid surface area, have less heat loss and higher

temperatures for return solutions. They should have removable covers for cleaning and inspecting.

Inlets should be designed so that milk contact surfaces are effectively cleaned during the CIP process.

Jetter assemblies in milking parlors are used for in-place cleaning of individual milker units. It is recommended that a flow restrictor be installed at the entrance of the jetter to allow each unit to receive the same amount of wash solution and balance the cleaning system. (One gallon per minute of flow is recommended.) Jetter cups that are stored in the milking parlor during milking must be covered while animals are being milked.

Diversion valves or automatic diverters should be installed to discharge and prevent recirculation of the first rinse.

Air Injectors

Purpose: Air injectors are utilized to maintain the wash slug throughout the milkline. The slug of solution must return with enough force to wash the receiver and probes. There should be enough solution carry-over to wash the sanitary trap without flooding it.

Wash Slug Volume Control: Wash slug volume must be controlled to prevent solution overflow into the sanitary trap, shutting down the system. It is possible to adjust the air injector off-time to control wash slug volume. Restrictors in wash solution suction lines may be used to balance solution uptake to the capacity of the receiver group.

Operation: The wash solution accumulates in the milkline next to the wash valve until sufficient solution for the desired length of slug to be formed is present. Air is suddenly admitted to the system to form a slug or plug flow condition. The slug of solution must traverse the entire circuit being cleaned without losing contact with all surfaces of the milkline. This means that air admission from the air injector must continue until the slug nearly returns to the receiver. Premature closing of the air injector will cause the slug to lose velocity and result in wash slug failure. Cleaning failures can occur by admitting air at too high a

frequency, admitting air for too short a period of time, not admitting a high enough volume of air, or admitting too much air. The larger the diameter of the pipeline, the more precise the adjustment of the air injection system needs to be. Multiple air injectors frequently need to operate in synchronization.

Location: The air injectors should be located where they can be kept clean and easily accessible. To assure a source of clean air, air injectors should be located inside the milkroom. Generally, the air injector should admit air to the main circuit of the milk pipeline. The air injector line should be as close as possible to the wash valve. Air admission is often combined with a wash feed line to the main milkline. Jetter lines may be supplied by a separate air injector valve and/or valve and controller. Systems utilizing wash volume restrictors in the jetter assemblies often do not need an air injector on the jetter line.

Adjustability: Air injector valves need to be adjustable for volume, frequency and time duration of the air admitted to the wash line. The on-time determines the time the slug is traversing the system and the volume of the air determines the velocity of the slug. The air injector timing should be set to assure long enough wash solution slugs to adequately wash all of the milk line. Air injectors using milk hoses for air admission, i.e., 9/16 and 5/8 inches (14 and 16 mm), are limited to pipelines of 2 inches (51 mm) or less in diameter and should be located less than 2 feet (600 mm) away from the wash line.

Mixing Components: Care must be taken when mixing components of systems from different manufacturers. Incompatible components may affect the washing performance of the system. The last installer modifying a milking system should be responsible for the performance of the system and the interrelationship of other components already in service.

Drainage: Hoses and piping should be self-draining.

Volume of Water: Satisfactory cleaning of a pipeline milking system requires that an adequate amount of water be available for cleaning. To estimate the amount of water for

each wash cycle, refer to Table 4 and Table 5. The water volume should be 30-50% of the internal capacity of the lines and receiver group, 100% of the delivery line and wash line, plus an

allowance for maintaining water in the vat and accessories (typically 10 – 20%). Four gallons (15 liters) per unit is generally considered to be the minimum recommended volume.

Table 5. Tubing Lengths to Contain 1 Gallon, Full Flooded

Pipe Size, Material	Length
1-1/2" (38 mm) S/S tubing	13 feet (4 m)
2" (51 mm) S/S tubing	7 feet (2 m)
2-1/2" (63 mm) S/S tubing	5 feet (1.5 m)
3" (76 mm) S/S tubing	3 feet (1 m)

Table 6. Typical Capacity of Accessories

(See manufacturer's specifications for exact capacities)

Item	Capacity
Sanitary trap	2.0 to 4.0 gallons (7.5 to 15 liters)
Receiver	7.0 to 20 gallons (25 to 75 liters)
Milk meters	0.1 to 1.0 gallons (0.4 to 4 liters)
Plate coolers*	1.0 to 3.0 gallons (4 to 11 liters)
Weigh vessel (jars)**	7.5 to 10 gallons (28 to 38 liters)

* A typical allowance is 0.5 gallons (1.9 liters) per unit for a plate cooler.
 **A typical allowance for washing is 1 gallon (4 liters) per vessel.

Example calculations for a double 6 herringbone parlor with 12 units:

<u>Item</u>		<u>Volume Required</u>
Weigh vessels (12)	12 X 1.0	= 12.0 gallons (45 liters)
Pipeline, 80 feet, 3"		
80' @ 3'/gal = 26.6 gal	26.6/3 {33%}	= 8.9 gallons (33.5 liters)
Receiver, 15 gal	15/2 {50%}	= 7.5 gallons (28.4 liters)
Trap, 3 gal	3/2 {50%}	= 1.5 gallons (5.7 liters)
Discharge pipe, 50 feet, 1-1/2"		
50' @ 13'/gal = 3.9 gal	3.9 {100%}	= 4.0 gallons (15.1 liters)
Washline, 100 feet, 2"		
100' @ 7'/gal = 14.3 gal	14.3 {100%}	= 14.3 gallons (54.1 liters)
Plate cooler @ 0.5 gal. per unit	12 X 0.5	= 6.0 gallons (22.7 liters)
	Sub total	54.2 gallons (205 liters)
	Add 15% (sink)	8.1 gallons (30.6 liters)
	Total	62.3 gallons (235.6 liters)

Thus, the suggested wash vat size is 65 gallons (250 liters). This compares favorably to using a value of 4 gallons per unit as a guide. The installer will need to make adjustments for each individual system. At ambient temperatures below 50°F (10°C) more hot water or thermal mass from a heat exchanger may be needed to properly maintain adequate wash temperatures. If additional hot water is used, additional cleaner will also be needed.

Weight & Volume of Water at 60°F (16°C)

1 cu ft = 62.4 lbs. = 7.48 US gal = 6.23 Imp gal = 28.32 liters

1 US gal = 8.34 lbs = 0.134 cu ft = 0.833 Imp gal = 3.79 liters

Booster Heaters - Electric booster heaters are not recommended. They are energy intensive and dangerous, so they are no longer used. On long pipelines or large parlors where maintaining wash solution temperatures are a problem, an in-line heat exchanger can be used as a booster heater. A circulator pump to a hot water heater that has sufficient thermal mass to maintain the system wash temperature (generally at least the same volume of 145°F (62.8°C) water as the per cycle wash volume) can be hooked to the booster heater switch on the automatic washer timer. A time delay may be needed so the hot water does not reach the in-line heat exchanger before the wash solution. Check with the local regulatory authority to determine the proper way to protect the potable water supply from an improper interconnection with the recirculated cooling water.

Special Items

Backflushing can be an important milking parlor automatic procedure because teatcup liners can spread mastitis-causing bacteria. Automatic backflushing units disinfect the milking cluster between individual cow milkings. Backflushing with 15-25 ppm iodine solution will significantly reduce the bacteria on teatcup liners.

Protection - An intervening break to the atmosphere shall be provided between the water and/or chemical solution and the milk and/or milk contact surfaces at all times.

Water - All water used shall be from an approved supply complying with the PMO requirements for farm water supplies.

Air - Air must meet PMO requirements for sanitary air; refer to the compressed air paragraph below.

Milk meters are often used in milking parlors to electronically measure milk production. Weigh jars continue to be used to measure milk weights.

Heat exchangers are often used to cool milk and may be used also to keep wash solution temperatures high. They also require addition wash solution as they will be 100% filled during cleaning. Refer to DPC # 65 [Installing & Operating Milk Precoolers Properly On Dairy Farms](#) for more information.

Compressed air in contact with product or solution contact surfaces (for backflushing, etc.) should be filtered, and piped through smooth, non-absorbent, corrosion-resistant, and non-toxic air lines (including adhesives for joints). Provide at least one access point to check the cleanliness of air lines; a check valve may be required to prevent water and/or chemical solution from entering air lines. (Refer to "[3-A Accepted Practices for Supplying Air Under Pressure in Contact with Milk, Milk Products, and Product Contact Surfaces](#), No. 604-").

All water used should be from an approved supply. An intervening break to the atmosphere should be provided between the water and/or chemical solution and the milk and/or milk contact surfaces. Proper back flow preventers shall be installed where necessary to protect the farm water supply. (Refer to DPC #30, [Potable Water On Dairy Farms](#)). Adequate volumes of hot and cold water under pressure should be available and check valves on cold and hot water lines are recommended to reduce thermal losses. (Refer to DPC #58, [Sizing Dairy Farm Water Heater Systems](#)).

CLEANING AND SANITIZING MILKING EQUIPMENT

For more detail on cleaning and sanitizing refer to DPC # 9, [Guideline for the Fundamentals of Cleaning and Sanitizing Farm Milk Handling Equipment](#).

High bacteria counts in raw milk are often related to the condition of the milking system. The milk contact surfaces must be properly

cleaned and sanitized in order to prevent contamination of the milk.

Some milk handlers may pay premiums for high quality milk. Premium payments for quality milk have intensified the need to address cleaning and sanitizing problems. Farm operators should strive to produce milk with the following quality guidelines for bacteria counts.

1. Less than 5,000 Raw Standard Plate Count (SPC)
2. Less than 20,000 Preliminary Incubation Count (PIC)

All milking equipment, including fresh and treated cow equipment, must be thoroughly cleaned after each use and sanitized prior to the next use.

Current instructions for mechanical cleaning (CIP) and items requiring manual washing shall be posted in the milkroom by the dealer or chemical supplier.

Those responsible for the cleanliness of a milking system should thoroughly understand the proper cleaning procedure. An adequate supply of potable water is needed, ideally soft, with a low dissolved mineral content. The proper disposal of the waste water also reduces problems. (Refer to DPC #30, Potable Water on Dairy Farms).

An analysis of the water supply is needed to develop a proper cleaning program. When a water supply is changed, it should be analyzed to determine if adjustments of cleaner types and/or amounts are necessary. Checking the water quality each year is required in several states.

Cleaners must be compatible with the characteristics of the available water to prevent deposition of mineral films on milk contact surfaces. Test the water supply for hardness to select a compatible cleaning agent. Test kits are available and most suppliers of cleaning materials will perform this service for customers. Most cleaners are compatible with water that contains up to 10 grains per gallon of calcium/magnesium hardness. Specially formulated cleaners containing water-conditioning chemicals are necessary for water that contains 10 to 30 grains of hardness. Water softening treatment may be advisable when a water supply contains 20 or more grains of total hardness. Water containing other solids such as iron or sulfates can also create difficult cleaning problems. Water softeners or iron filtration systems may be required to treat these problem water supplies. (Refer to DPC #30, Potable Water on Dairy Farms).

Procedures To Mechanically Clean Pipeline Systems

The following is a cleaning procedure for milking systems which has been shown to give very satisfactory results.

Pre-Rinse: Flush the entire system with clean, tepid 110°-120°F (43.3°-48.9°C) water. This rinse should be discharged to the drain and continue until all clear water is discharged from the line. Tepid water removes soils more effectively than does cold water. Water in excess of 125°F (51.6°C) can "cook on" milk residues, if used as a pre-rinse.

Wash: Prepare chlorinated alkaline cleaner washing solution in 160°-170°F (71.1°-76.7°C) water at a concentration as determined by water quality tests and manufacturer's recommendations. Measure the cleaner and the water temperatures. The wash cycle should start at 160°-170°F (71.1°-76.7°C) and drain at a temperature above 120°F (48.9°C) to insure good cleaning efficiency. A minimum pH of 12.0, chlorine concentration of 120 ppm and an alkalinity of 1100 ppm should be used. If meters, sensors, weigh vessels, or other plastic parts are being used, cleaner concentrations should be increased. Generally an elevation in chlorine to 150 ppm and an elevation in alkalinity to 1300 ppm will be needed. Consult manufacturer for specifics for the meters or other components used.

Circulate the cleaning solution through the system for a minimum of 20 slugs, typically about 8 to 10 minutes. Actual circulation time will depend upon the complexity of the installation and to a large extent upon observations and experience encountered with a particular system. Brush-wash all parts not adequately cleaned by the circulating solution.

For systems with an automatic chemical dispenser, a test should be made on a regular basis to assure it is functioning properly.

Note: Hand brush the exterior of milker units prior to being automatically washed. This helps minimize foreign material from getting into the milking system.

Acid Rinse: Rinse the line with an ample volume of tepid acidified water to remove all traces of the cleaning solution. The pH of the acidified

rinse should be 3 as it is discharged at the end of the cycle. Test kits to determine the pH should be available from the installer.

After rinsing, allow the system to drain completely. Inspect the line and integral parts such as milker units, pump, receiver, weigh vessels, sanitary trap, etc. for proper cleaning. Milk contact surfaces should drain completely.

Sanitize: Just prior to milking, circulate an EPA registered dairy sanitizer solution through the pipeline, following directions supplied by the manufacturer. Allow the system to drain before milking is begun to keep sanitizer residues out of the milk.

Cleaning Pulsator Airlines

An important part of milking system sanitation is the cleaning of pulsator airlines on a regular basis. Condensation, milk droplets and airborne contaminants are frequently drawn into the vacuum line. Clean vacuum lines help to maintain optimum airflow within the milking system.

Vacuum systems should be designed to be easily cleaned. Pulsator lines should be installed with valves and tees provided for slug washing of the vacuum line. (Refer to Figures 2, 4 and 5). The wash solution must be able to flow through the entire pulsator airline.

The distribution tank should be designed and installed to prevent the wash solution from entering the vacuum pump. For example, do not install the outlet to the pump directly across from the inlet to the vacuum line. The tank should be able to hold a minimum of 15 gallons of solution without carryover to the vacuum pump. Tanks mounted overhead should be securely supported and have a drain that flows to a floor that is sloped to a drain or other method that does not create a sanitation problem from the drainage. The drain line must be protected from freezing .

Cleaning should be done as soon as practical after milking to allow for ample drainage time. Dispose of the solutions in a proper manner. Cows should not be in the parlor during the cleaning of the vacuum line to avoid exposing them to cleaning solutions. Care should also be taken to keep these solutions away from feed or bedding.

Vacuum lines need to be sloped to drain. All low spots should have automatic drain valves and clean-out plugs. Stall cocks should be located on the top of vacuum lines.

Cleaning Procedure:

1. Close Valve number 1. (Refer to Figures 4 and 5 below).
2. Prepare a wash solution as directed on the label of the product being used. A standard pipeline cleaner used monthly is adequate. Caustic cleaners are more dangerous and should only be used on severe buildups.
3. Start with the stall cock nearest the vacuum pump to clean the first section of pipe. Then progressively clean each section of the pipe. This should minimize the chance of plugging the pipe.
4. Shut off the vacuum pump and drain the system as necessary to empty the vacuum tank and lines. Check progress by progressively examining at the clean-out plugs. Make sure that the automatic drain valves do not become fouled.
5. Repeat steps 3 and 4 until the entire system has been washed.
6. Put the "Wash Pipe" into the tee. (Refer to Figures 4 and 5). Close both valves and turn on the vacuum pump. Allow vacuum to reach operating levels, then open valve 1 and draw in a minimum of 3 gallons of wash solution. Leave the valve open for 10 seconds. Then close the valve and allow the system to reach operating levels. Open the valve and allow it to remain open to clear the slug of wash solution through the line.
7. Repeat Step 4. If the system is still not clean, repeat Step 6.
8. Repeat Step 6 on other sections of the loop until all pipes have been washed.
9. Repeat Steps 3-8 using an acidified rinse following label directions for concentration.
10. Remove drain plugs to be sure the entire system is drained. If there are no drain plugs, open valves 1 and 2 and allow the pump to run at least 30 minutes to dry the pipes. (Refer to Figure 5).

Figure 4. Piping Schematic for Pulsator Airline Wash System

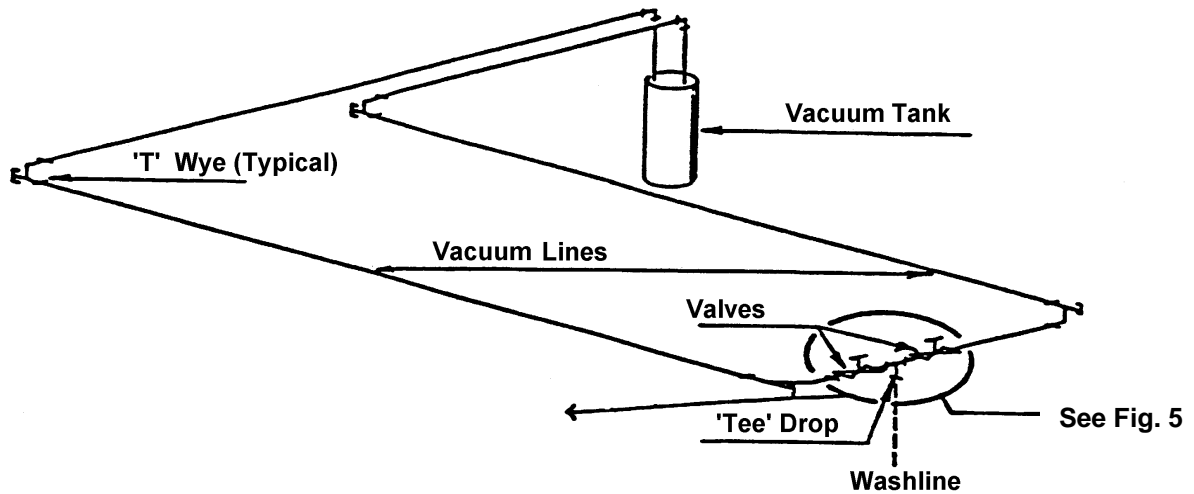
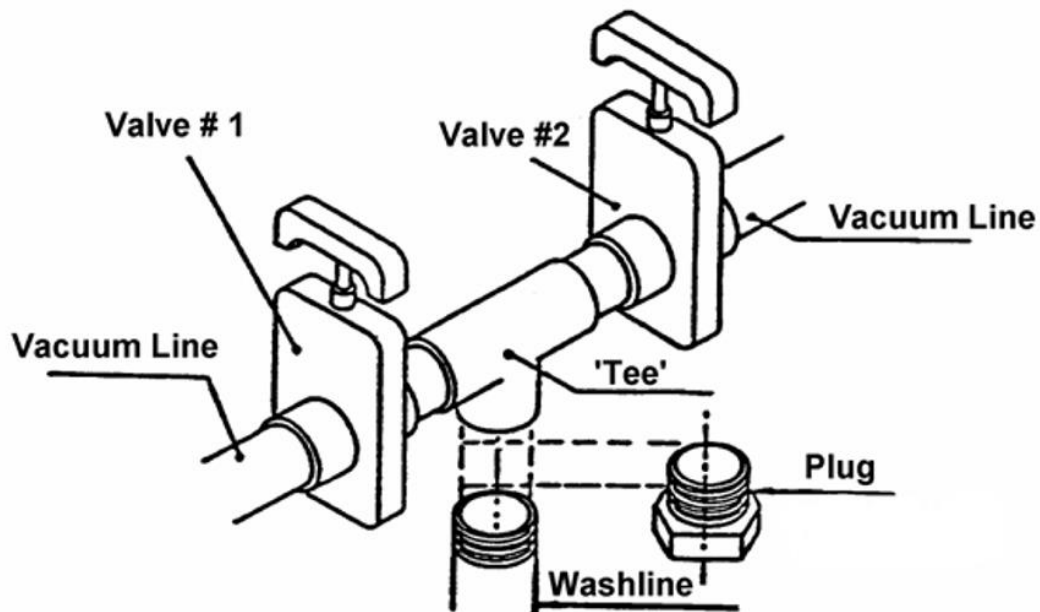


Figure 5. Inset of Pulsator Airline Wash System

Tee and valve may be located next to the distribution tank using only one valve. For airflow troubleshooting, the 2-valve system is more desirable. For more detail see Figure 2.



Cleaning Sanitary Trap Vacuum Line

The vacuum trap line should be cleaned on a monthly basis. To wash this line, the trap shutoff (ball) needs to be removed or disabled. The receiver should then be flooded, washing the trap. Note: Do not admit more solution than the

distribution tank can hold to prevent the solution from reaching the vacuum pump. The system must be allowed to drain between cycles. Use a hot detergent solution, followed by a warm, clear rinse, then hot acidified cleaning solution, followed by a clear, warm rinse.

TROUBLESHOOTING CLEANING PROBLEMS

Examination Areas

1. Examine the wash vat, tank or sink used to hold the rinsing and cleaning solutions. If it is not clean and films are present, this is an indication of inadequate cleaning.
2. Examine the rubber parts. If teatcup liners on milker units feel slippery or greasy and offer no resistance when the finger is rubbed over the surface, this is also an indication of inadequate cleaning.
3. Examine the probes in the receiver jar. If they appear soiled or are slippery to the touch, this is a further indication of a cleaning problem.
4. Examine the receiver jar. It should be free of film and water.
5. Examine the milk delivery line from the receiver group to the bulk tank. If the interior shows the presence of any film, the complete system may not be clean.
6. Examine the interior of the milklime, especially adjacent to the receiver. Frequently, water slugs will collapse and not clean the upper inner surface of the milklime. Also, look at the high point where slugs may not be maintained through the upward slope of the system.
7. Examine all weigh vessels for deposits.

Proper storage of cleaners and sanitizers will help prevent caking of dry chemicals and decomposition of various ingredients. The cleaning chemicals should be stored in a cool, dry area and out of the sunlight with caps and covers secured properly.

All chemicals must be stored in a secured area to prevent accidental mixing, skin contacts or the availability to children.

Causes of Cleaning Problems

1. Improper pre-rinsing temperatures. Too low a temperature will not remove milk soil adequately and may place a greater burden on the cleaning solution. Too high a

temperature will cook on milk solids, creating a proteinaceous film. The proper temperature is 110°-120°F (43.3°-48.9°C) tepid water.

2. Improper washing. This may result from such factors as:
 - a. Failure to dissolve all of the powder in the powder receptacle or the wash tank. Undissolved particles of powder lying in the tank may cause unsightly detergent burns on the metal surfaces.
 - b. Improper temperatures may arise from:
 - i. Hot water equipment capacities not adequate for the system. (Refer to DPC #58, Sizing Dairy Farm Water Heater Systems).
 - ii. Hot water heater problems arising from thermostat failures or burned-out heating elements.
 - iii. Insufficient total volume of hot water to cover demands. When detergent solutions drop below 120°F (48.9°C), milk soils start to redeposit on milk contact surfaces.
 - iv. Ambient temperature changes seasonally and wash volume may need to be adjusted to maintain adequate temperature or added thermal mass with the use of a heat exchanger.
 - v. Hoses on faucets that do not have proper check valves and allow for flow of cold water into the hot water system.
 - c. Failure of the diverter valve. If the diverter valve that dumps out the rinse water after one circuit is not working properly and milky water is being recirculated, problems can develop. Conversely, if the diverter valve malfunctions in the wash cycle, the wash solution may be diverted to drain too soon. The drain valve used with automatic washers may open before the cleaning cycle is over, or close before all the washing solution has drained out. If the latter occurs, neutralization of the acid rinse may occur.

- d. Low water volume in the wash tank. This may result from improperly adjusted levels when the system was installed, malfunctioning valves or electrical circuits within the cleaning unit or a sink that is too small after an update of the installation.
 - e. Failure of automatic washer systems to deliver proper amount of chemical at the proper time.
 - f. Improper alignment of spray device in the bulk milk tank or the improper location of spray ball in the tank. Tanks may need multiple spray balls to cover all areas, especially larger tanks. Be sure all areas of the tank are contacted with the wash solutions and that the agitator runs during the wash cycle.
 - g. Spray devices used for cleaning in the milk tanks must be free of foreign material.
 - h. Insufficient water pressure for the automatic washers that depend on water pressure for proper operation.
3. Improper treatment of the acid rinse water. This may result from the failure of the injector or pump to pick up sufficient product in the acid rinse.
 4. Lack of sanitizing prior to milking.
 5. Inadequate velocity and surface contact in the system. To maintain the velocity and surface contact, follow the manufacturer's recommendations for the system.
 6. Air leakage into the system. This may result in the development of excessive foam while milking and excessive cooling during the wash cycle.
 7. If the milk inlets on a pipeline are not being cleaned adequately, it is usually because of slug breakdown. If sliding milk valves, located on milk carrying pipelines, have units attached during washing, the valve covers will not be washed. Gaskets and "O" rings in sliding milk valves must be replaced according to the manufacturer's recommendations.

In automated CIP cleaning systems, the role of the operator is sometimes considered secondary compared to the person operating a manual cleaning system. However, the use of proper materials in directed amounts should be confirmed, as should the frequency of cleaning. Observing a complete cleaning cycle is essential because malfunctions may develop with automated systems.

High capacity complex systems may require a cleaning specialist consultation.

To identify residual films on milk lines see DPC #28, **Troubleshooting Residual Films on Dairy Farm Milk Handling Equipment.**

APPENDIX A. APPLICATION TO INSTALL OR REMODEL A MILKING SYSTEM

(Check with Regulatory Authority to see if your state has its own form and to determine the lead time before installation that this or an equivalent form must be submitted.. This form is for example purposes.)

Modification _____

New Installation _____

Fill In Appropriate Blanks

General

Name of Producer _____

Mailing Address _____

Shipping To _____ Estimated lbs. shipping daily _____ #cows _____

Estimated lbs. per hour flow rate _____

BTU Capacity of Bulk Tank _____ Gal. Capacity _____

Model & Make Unit _____ Date of Manufacture _____ Recording Thermometer (Y) (N)

Dealer Name _____ Proposed Installation Date _____

Dealer Telephone _____ Address _____

Configuration -

Parlor _____ Round-the-Barn _____ Highline _____ Lowline _____ Weigh Jars _____

Bucket _____ Dumping Station _____ (Vacuum)(Electric)

#of Units and Type _____

Vacuum System -

Pump 1 Make _____ Model _____ Size Motor _____

Pump 2 Make _____ Model _____ Size Motor _____

CFM Capacity _____ New _____ Used _____ Test Ports Installed? (y) (n)

Pulsation Line Size _____ Main Header: Diameter _____ Length _____

Location & Type of Vacuum controller _____

Distribution Tank: Size _____ Material _____

Pipeline-Location Receiver Group

Diameter Pipe _____ #of Slopes _____ Length _____ #Wash Loops _____

Height above Cow Platform _____ Estimated Pitch _____

Where Line Supported From _____

Type of Line Coupling: Plastic _____ Stainless Steel _____ Welded _____

Volume of Receiver _____

Trap Size _____ Main Vacuum Supply Line Size _____ Length _____

Miscellaneous - Pre-Cooler (y) (n) Type _____ Location _____

Automatic Take-Off? (y) (n) Digital Milk Wt. Recorder (y) (n)

Weigh Jars - Type _____ Capacity _____ lbs.

- Height of Milk Inlet Above Cow Platform _____

Wash System - Estimated Solution per Cycle _____ gal.

Size of Wash Sink _____ gal. Wash line material _____

Air Injector (y) (n) Automatic Washer (y) (n) Divert valve (y) (n)

Milk line position switch (y) (n) Soap and acid cycles (y) (n)

Main Water Heater Type _____ Capacity of Main Heater _____ gal.

Temperature Setting _____ F. Dedicated to Wash Cycle Only (y) (n)

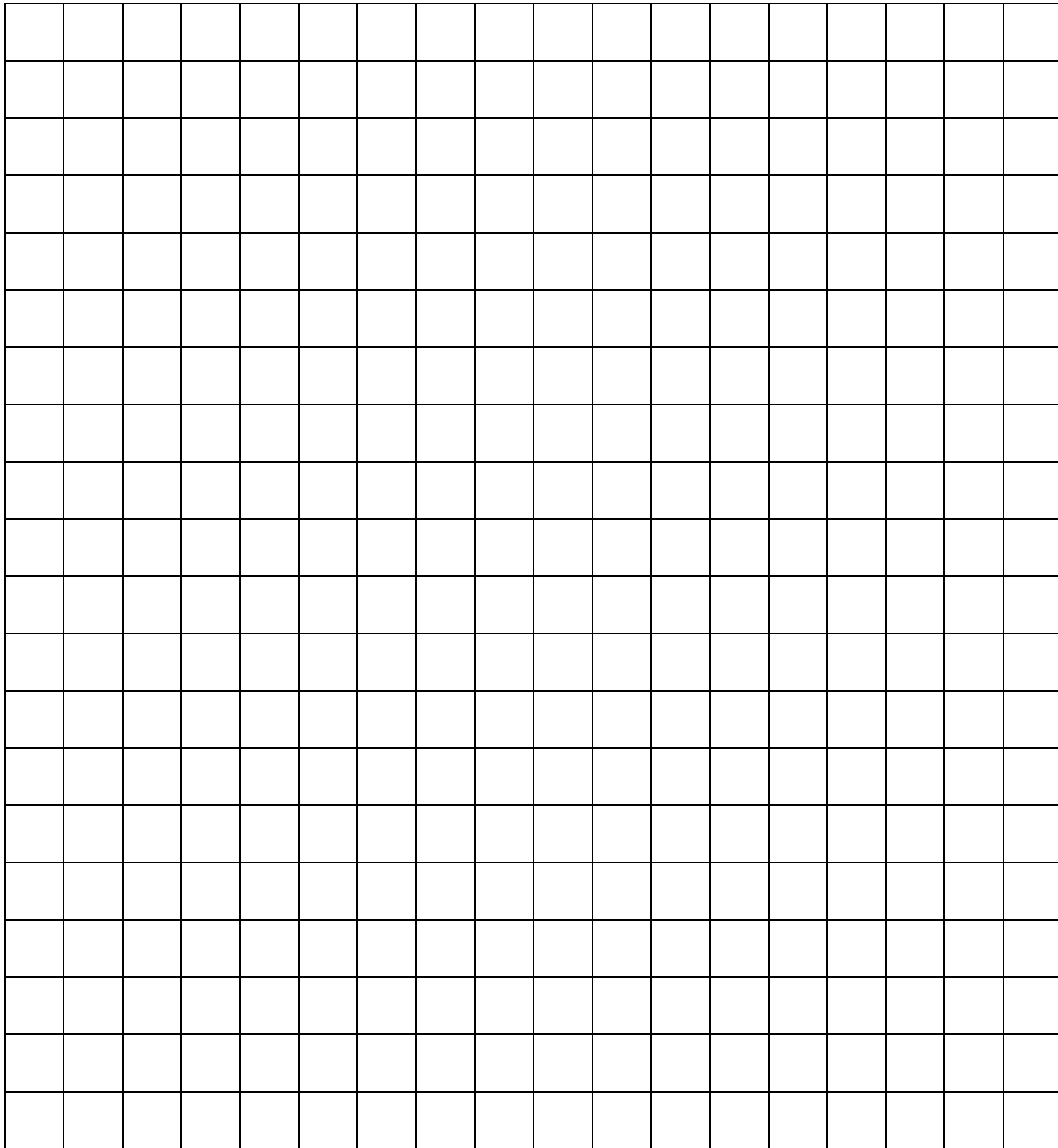
Heat reclaimer tank (y) (n) Capacity _____ gal. Estimated Temp. _____ F.

Cleaning -Minimum start at 160°F (71.1°C) _____ or maximum water temperature _____

Minimum water temperature _____ Manufacturer's recommendations for washing and water analysis must be posted in milkroom. Water temperature on wash cycle should remain over 120°F (48.9°C) through the entire wash cycle.

On the reverse side of this application, give a detailed drawing of vacuum, milk and wash systems showing: 1) High point(s); 2) Direction of milk flow and wash flow; 3) Location of major equipment; and 4) Inspection ports (welded only).

DIAGRAM OF MILKING SYSTEM



I certify that this milking system conforms to or exceeds 3-A sanitary standards and accepted practices for the design, fabrication and installation of milking and milk handling equipment.

Installer _____

Date _____

APPENDIX B. APPLICATION TO MODIFY OR INSTALL MILK-RELATED EQUIPMENT

(Check with Regulatory Authority to see if your state has its own form and to determine the lead time before installation that this or an equivalent form must be submitted.. This form is for example purposes only.)

Instructions:

1. All blanks that apply to this installation must be completed
2. This application is to be used for all equipment other than the basic pipeline and washing system.
3. Provide drawing on next page.

___ Bulk milk (cooling) tank	___ Automatic cluster removers
___ Pre-cooler (Tube or plate)	___ Backflush system
___ Heat recovery systems	___ Milker units
___ Detergent recovery systems	___ Other (explain below)

Make of Equipment	1 _____	Model _____
	2 _____	_____
	3 _____	_____

Capacity or Size	1 _____
	2 _____
	3 _____

Refrigeration:

Make of Equipment _____	Model _____
-------------------------	-------------

Hot water needed -

Prerinse: _____ gal.	_____ temp.	Wash: _____ gal.	_____ temp.
Postrinse: _____ gal.	_____ temp.	Hot Water needed _____ gal.	

Hot Water Heater:

_____ type _____ capacity (gal.) _____ recovery rate

Bulk Tank:

Gallons _____ Btu or H.R. rating _____ Recording Thermometer (Y) (N)

Estimated milk flow rate _____ Date of Manufacture _____

This application is to be accompanied by a detailed drawing showing the location of all doors, windows, other openings, location of all equipment including tank, outlet, compressor, water heater, and all other equipment

A cleaning program, including water hardness, detergent and sanitizer concentration must be posted in the milkroom.

Any future modification of this equipment must have prior written approval. Check with local regulatory authority for required lead time.

APPENDIX C. SCHEDULED MAINTENANCE FOR MILKING SYSTEMS

Not all items listed may apply to each milking and cooling system.
Consult a qualified dealer with questions.

	Each Milking	Daily	50 hrs. or Weekly	250 hrs. or Monthly	1500 hrs. or 6 mos.	3000 hrs. or Yearly
VACUUM SYSTEM						
1. Check vacuum pump oil supply	X					
2. Check vacuum level at gauge/manometer		X				
3. Check oil drip rate at pump oilers			X			
4. Check vacuum filter for cleanliness			X			
5. Check all drain valves for proper sealing			X			
6. Check sanitary trap check ball for effectiveness				X		
7. Clean vacuum controller filters				X		
8. Test vacuum controller sensitivity and overshoot				X		
9. Flush oil-seal vacuum pumps with flushing oil				X		
10. Check and adjust vacuum pump belt tension				X		
11. Drain moisture from oil reclaimers			X			
12. Flush and clean all vacuum lines and components						X
13. Replace vacuum filter screen						X
TRANSPORT SYSTEM (PIPELINE)						
1. Inspect all lines, gaskets and fittings for leaks				X		
2. Check milk pump check valve for leakage				X		
3. Inspect milkline for low spots and loose brackets				X		
4. Replace all rubber components(gaskets, check valves, etc.)					X	
MILKING UNITS						
1. Check for twisted teatcup liners	X					
2. Check claw/shell air vents for foreign materials	X					
3. Inspect milk tubes and pulse tubes for leaks		X				
4. Inspect inside of teatcup liners for cleanliness/roughness		X				
5. Pulsation hoses orientation		X				
6. Change liners based on manufacturer's recommendation						
PULSATION SYSTEM						
1. Check each pulsator for operation by observing milker action	X					
2. Clean pulsators				X		
3. Check pulsator airline connections				X		
4. Clean pulsator fresh air filter				X		
5. Have your dealer rebuild pulsators					X	
6. Have your dealer perform a complete system analysis					X	
7. Replace fresh air filter						X
CLEANING SYSTEM						
1. Visually check detergent/acid containers for chemical usage	X					
2. Check water temperature at tap		X				
3. Check water softener for salt usage/supply			X			

	Each Milking	Daily	50 hrs. or Weekly	250 hrs. or Monthly	1500 hrs. or 6 mos.	3000 hrs. or Yearly
4. Verify complete wash cycle and sink water level				X		
5. Inspect pipeline for cleanliness				X		
6. Wipe down exterior of pipeline and control panel				X		
7. Clean pipeline washer water input screens					X	
8. Change all drain valve diaphragms						X
9. Have water analysis performed						X
MILK COOLING SYSTEM						
1. Check cooler thermometer before and after milking	X					
2. Wash cooler exterior			X			
3. Inspect and clean condenser				X		
4. Clean cooler washer spray ball				X		
5. Inspect cooler interior for cleanliness				X		
6. Check accuracy of tank thermometer			X			
7. Inspect plate or tube cooler for cleanliness				X		
8. Check water level in chiller				X		
9. Replace all rubber components					X	
10. Test recirculated water in chiller for contamination/bacteria					X	
11. Have dealer inspect anodes in water storage tank						X
12. Have dealer check refrigerant charge						X
AUTOMATION SYSTEM						
1. Milk flow sensors						
a. Wash exterior				X		
b. Clean charger contacts and clean				X		
c. Inspect for buildup between rings					X	
d. Replace sliding milk valve gaskets						X
e. Replace battery			X			
2. Automatic cluster removers						
a. Drain moisture from air system					X	
b. Check sensor rings for buildup and clean			X			
c. Replace sensor shutoff hose				X		
3. Milk meters						
a. Inspect meters for cleanliness			X			
b. Lubricate O-rings				X		
c. Replace O-rings if worn					X	
d. Replace shutoff hose					X	
e. Replace rubber components					X	
f. Have dealer perform a complete tune-up						X

The maintenance information shown in Appendix C is used by permission from The Milking Machine Manufacturers Council, and is drawn from the Council's 1993 publication titled; Maximizing The Milk Harvest.

The dealer/technician should be qualified and follow manufacturer recommendations on the equipment installed at the dairy barn.