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EC87-726 Mastitis Control Guidelines

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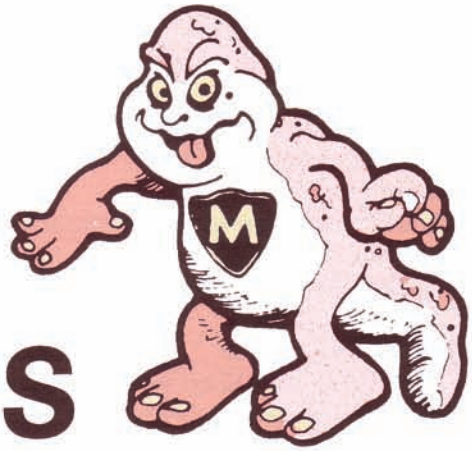
Nebraska Cooperative Extension Service EC 87-726

MASTITIS CONTROL GUIDELINES



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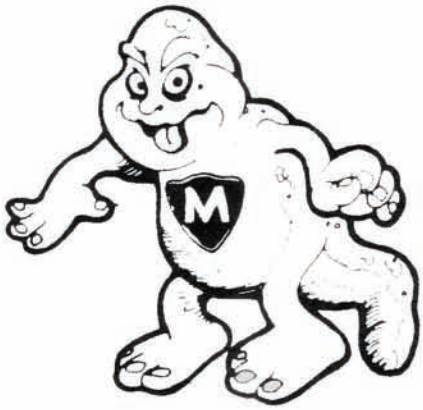

Mastitis Control Guidelines

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BASIC MASTITIS CONTROL PROGRAM REQUIREMENTS

Mastitis-free cow on cover courtesy of Mohr View Farms Omaha, Nebraska

USE OF MASTITIS CONTROL GUIDELINES

These mastitis control guidelines were prepared by UNL personnel based on current literature and experience with the Nebraska mastitis control program, the demonstration herds, and many on-site dairy farm evaluations. This information will help producers and others in the dairy industry to understand, establish, and maintain a comprehensive mastitis control program.

Since 1979, the UNL mastitis control team has conducted training sessions for producers and local support teams (veterinarians, fieldmen, and equipment dealers). Educational efforts directed toward these groups have continued emphasis on the necessary components and responsibilities of modern mastitis control procedures relative to their respective areas of expertise. The dairyman is the key member of the local team. The UNL team recommends working closely with your local team for help in your mastitis control efforts. Sources of additional help include:

1. Milk culture analysis by the UNL Veterinary Diagnostic Laboratory.
2. Individual cow somatic cell count (SCC) testing by the Nebraska Dairy Herd Improvement (DHI) Laboratory.
3. Recommendations relative to equipment design and function by UNL personnel. (Pre-check survey form required.)
4. Assistance to local teams by UNL personnel.
5. Current educational materials from the UNL team.

The origin of problems and the mastitis disease process is complex. To address the many factors affecting the level of mastitis in a given herd, these control guidelines are separated into specific problem areas. The problem areas are described in detail with information on how to recognize and correct or minimize the problem.

Recommendations and procedures presented in the guidelines will allow the producer to develop an effective mastitis control program. When the recommendations are coupled with a conscientious and dedicated attitude, the result will be less mastitis and more better-quality milk—at a lower production cost.

MILK PRODUCTION LAWS

Requirements & Rationale

Milk is often referred to as nature's most perfect food. This is undoubtedly true if the milk is produced by healthy cows under sanitary conditions by workers with clean equipment, clean clothes, and clean hands. The quality of milk **cannot** be improved once it leaves the cow! Many producers do not recognize the importance of on-farm cleanliness and sanitation in assuring a healthful product. This failure to recognize and accept the importance of cleanliness to safeguard public health has led to development of rules and regulations governing production of milk offered for sale.

In Nebraska the production of milk for re-sale is governed by state statutes passed by the Nebraska Legislature and enforced by the Nebraska Department of Agriculture, Bureau of Dairies and Foods. Milk offered for sale as Grade A, or for consumption as fluid milk, is governed by rules set forth in the Nebraska Pasteurized Milk Law. Requirements of the Nebraska law are identical with those developed by the U.S. Department of Health, Education and Welfare entitled Grade A Pasteurized Milk Ordinance. These rules are often referred to as the "PMO" and have special significance to milk involved in interstate commerce. Because the Nebraska "Milk Law" is identical to the Federal PMO, producers meeting the requirements of State law are assured compliance with Federal requirements.

Milk intended for use in manufacturing of dairy products is also governed by Nebraska law under regulations known as the Nebraska Manufacturing Milk Act. The requirements set forth in these regulations are similar to those for Grade A milk but are slightly less restrictive.

Regardless whether milk is produced for fluid consumption or for use in manufacturing, all producers should strive to produce milk of the highest possible quality. A high quality product helps assure public acceptance which means more consumption, greater demand and, ultimately, better milk prices. Good quality starts on the farm. Quality of milk cannot be improved once it is removed from the cow though some potential dangers to human health can be reduced through pasteurization and various manufacturing processes. The production of good quality milk requires healthy cows. Healthy cows are the result of many management factors including an effective mastitis control and herd health program. Compliance with milk production laws not only helps safeguard public health but also helps control the cost of production by keeping cows healthy. Basic PMO requirements are:

Milk Temperature

Requirements: Cooled to 45 °F or less within two hours after milking. The blend temperature in the bulk tank after first milking may not exceed 50 °F.

Reason: Control bacterial growth.

Bacterial Limits

Requirements: Bacterial concentrations or "bacteria counts" (raw or standard plate) may not exceed 100,000 per milliliter (1,000,000 for manufacturing milk).

Reason: Low bacteria counts indicate good cooling system function, clean and sanitary milk facilities and equipment, and good practices in preparing cows for milking.

Antibiotics

Requirements: Non-detectable.

Reason: Many people are allergic to some of the drugs used in treating illnesses in dairy cows. Even small amounts of antibiotics can cause serious allergic reactions and even death in people with allergy sensitivities.

Somatic Cell Counts

Requirements: Maximum concentration of 1,000,000 per milliliter.

Reason: Somatic cell counts over 300,000 indicate an unacceptable level of udder infection and are evidence of unhealthy cows or at least poor udder health.

Abnormal Milk

Requirements: Cows producing abnormal milk as proven by bacteriological, chemical, or physical examination must be milked last or with separate equipment. The milk must be discarded. The same requirements apply to treated cows. Equipment used for handling abnormal milk may not be used to handle milk offered for sale unless it is first cleaned and effectively sanitized.

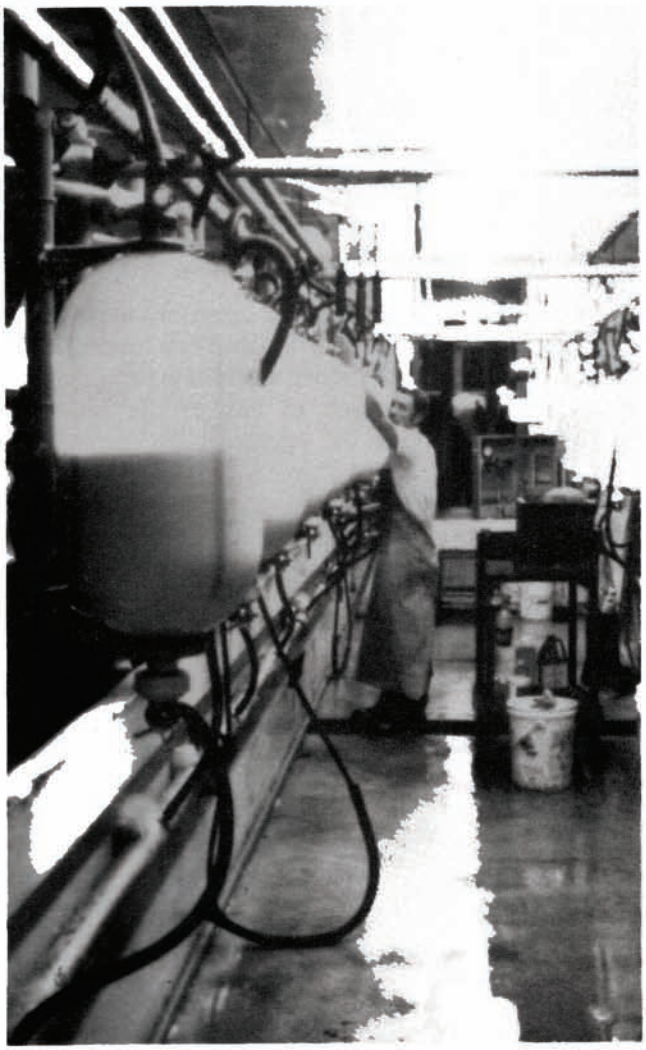
Herd somatic cell counts over 300,000 indicate a need for improved mastitis control management.

Rinsing by itself is not adequate. This applies to milklines, hoses, claws, weigh jars, etc.

Reason: Some diseases of cows are transmissable to humans. Some people are allergic to antibiotics used in treating cows. Milking infected or treated cows, or cows with abnormal milk, last also reduces the risk of cross-contamination between cows. A dirty milking area increases the risk of contaminating equipment, cows' teats, and the operator's hands as well as direct milk contamination. Good ventilation is necessary to reduce the risk of odors being absorbed by the milk and to make more pleasant working conditions which should result in operators doing a better job.

Milking Area Cleanliness

Requirements: Leftover feed must be removed to reduce the risk of mold growth and development of foul odors. Outer surfaces of the milking system must be clean. Other animals (non-dairy cows) must be kept out of the milking area.



Clean milking facilities are necessary to produce high quality milk and to control mastitis.

Reason: The risk of contamination of cows, equipment, milk and operators hands is greatly increased if the milking area is dirty. Other animals can carry diseases transmissible to humans. They also deposit manure at random locations thereby increasing the risk of contamination and development of slip hazards.

Cowyard

Requirements: The cow lot must be graded and drained to prevent development of pools of water and mud holes. Do not allow manure to accumulate to the extent that it results in dirty udders and flanks.

Reason: Sanitation is a primary requirement in the production of high quality milk while simultaneously controlling mastitis. Cows caked with manure are virtually impossible to clean properly before milking. Dirty cows in the parlor make milking unpleasant, increase the risk of udder and equipment contamination, and take excessive time during milking. Allowing cows to wade through mud, water, and manure increases the risk of udder infections from environmental organisms. Wet areas also contribute to increased insect problems. Piles of manure and feed increase problems in controlling rodents.

Milkroom Construction and Cleanliness

Requirements: The milkroom must be constructed with cleanable surfaces and must be kept clean and free of debris.

Reason: The milk room is the central work area for cleaning and sanitizing other parts of the milking system. Dirty conditions increase the risk of contamination of milk and equipment. Accumulated debris makes cleanliness more difficult to achieve, increases the risk of people tripping, slipping or falling, and provides a place for rodents to hide and multiply.

Toilet

Requirements: An easily accessible toilet must be provided and made available to all personnel.

Reason: Many human diseases are easily transmitted through human excrement. Insects, rodents, or other vectors can transmit such diseases to other people or cows.

Equipment Sanitation

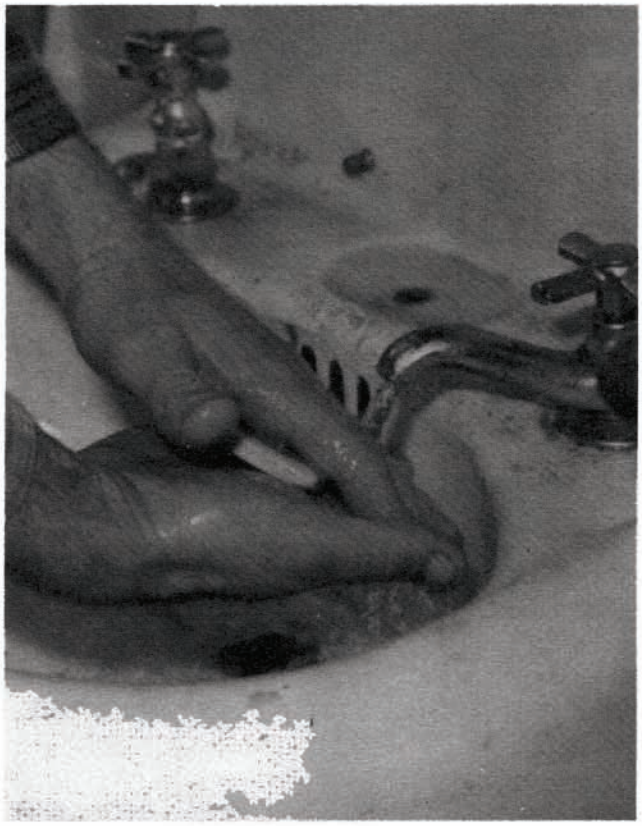
Requirements: All surfaces which come into contact with milk must be sanitized before each use.

Reason: Damp conditions in milking systems are excellent areas for bacterial growth. Even very small quantities of residual dirt or milk can lead to large numbers of bacteria developing between milkings.

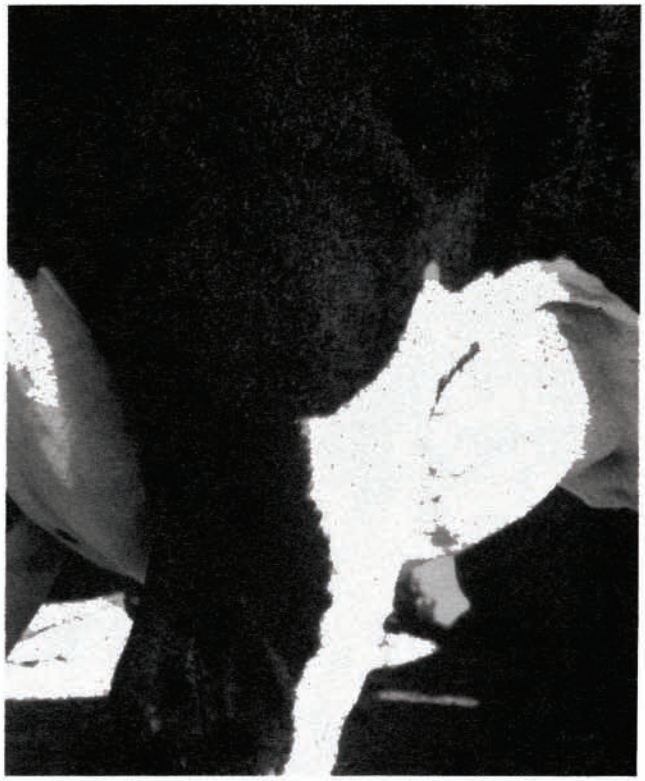
Cows Flanks, Udders and Teats

Requirements: The flanks, udders, bellies, and tails of all milking cows must be free of visible dirt. Udders and teats must be cleaned and treated with a sanitizing solution before milking. Teats and udders must be dry before milking. Clip the hindquarters of cows as frequently as necessary to facilitate cleaning. Clip udder hair short enough to prevent hair from being pulled into the teat cup assembly along with the teat during milking.

Reason: Clean cows are necessary to produce clean milk. Long hair and dirt increases the risk of dirt falling onto and being drawn into the milking system. Long hair on the udder is difficult to clean and dry. Wet teats provide a media for bacteria transport and increase the risk of liner slips or squawking (and new infections!). Wet teats and udders increase the risk of dirty water draining onto the top of the teat cup assembly and being drawn into the milking system and the milk supply during milking. Great care is necessary in wetting cows with a hose or prewash stall. Wetting excessive areas of the cow makes it impractical (if not impossible) to completely dry the cow before milking. Incomplete drying increases the risk of dirty water entering the milking system and the milk supply. Dirty water entering the milking system also increases the risk of teats becoming infected by environmental organisms.



Operator cleanliness is important in controlling the spread of mastitis-causing organisms.



Keeping udder hair trimmed helps cows stay cleaner, reduces labor during milking, helps assure high quality milk, and reduces the risk of udder infections.

Personnel Cleanliness and Handwashing

Requirements: Milking system operators must wash and dry their hands with individual towels immediately before milking, before handling any milking equipment, and after any interruption of any of the activities associated with milking. All operators are required to wear clean clothes while milking.

Reason: The hands of milkers are a primary means by which pathogens are spread from teat to teat, between cows and from the cows' environment to the cows. It is nearly impossible to prevent contamination of the milking system if the operator's hands and clothes are dirty. To prevent the spread of pathogens, hands should be thoroughly washed immediately after any part of the cow environment (parlor framework, holding area, or cow herself) has been touched, between cows, and after handling equipment used to collect abnormal milk.

Insects and Rodents

Requirements: The milking center must be kept free of insects and rodents.

Reason: Insects and rodents do not discriminate between clean and dirty areas. They are primary vectors of spreading dirt and bacterial or viral pathogens, and contaminating surfaces of the milking area and milking system.

BASIC MASTITIS CONTROL PROGRAM REQUIREMENTS

General

1. Monitor milk quality reports and strive to keep somatic cell counts below 300,000, raw plate bacteria counts below 5,000, and pre-incubated (PI) bacteria counts below 25,000.
2. Handle all cows gently and avoid practices which might cause stress or injury.
3. Feed for production using modern forage analysis and ration formulation technology.
4. Keep cows' udders clipped and feet well trimmed.

Milking Procedures

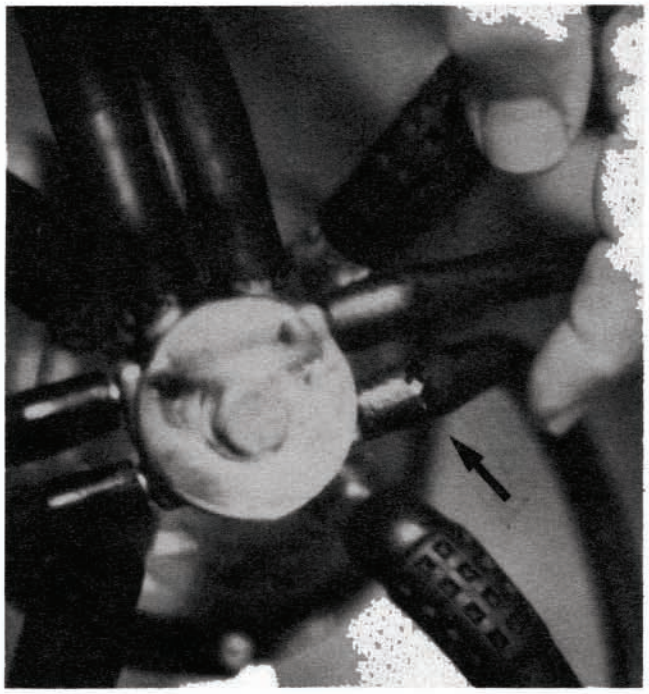
5. Wash hands thoroughly before handling udders or milking equipment to control spread of pathogens.
6. Milk first-calf heifers and clean cows first, followed by recuperating, treated, and infected cows.
7. Wash teats and udders thoroughly before milking.
8. Dry udders and teats completely using single-service towels before attaching milkers.
9. Check foremilk for indicators of infection or other abnormalities.
10. Stimulate for effective milk let-down.
11. Forbid the use of re-usable towels and cloths at any time during the milking operation.
12. Attach milkers with minimal air admission and within one minute from the time udder washing/stimulation is started.
13. Manage milking to minimize squawking (liner slips).
14. Respond promptly and attend to squawking and fall-offs.
15. Minimize machine stripping (not over 1 cow in 10 and not over 20 seconds).
16. Remove milkers promptly when milkflow stops.
17. Always turn off vacuum to claw before removing milker from cow.
18. Avoid removal of teat cups on a one-by-one basis except where absolutely necessary (not over 1 cow in 10).
19. Minimize air admission when attaching a bucket milker or other device to catch abnormal milk.
20. Rinse milkers, weigh jars, and hoses thoroughly after milking treated and/or infected cows.
21. Make sure teats are dry before turning cows out in cold, windy weather.
22. Keep all animals except cows out of the milking area.

Veterinary Practices

23. Work with veterinarian to determine proper treatment procedures and products for clinical mastitis.
24. Dip all teats after every milking with an approved product known to contain antibacterial ingredients.
25. Use CMT screening tests regularly to check questionable cows and all new milking animals.
26. Have milk cultures run on all cows with clinical mastitis and all purchased animals.
27. Use proper hygiene when treating—including use of an alcohol swab to clean teat end before making intramammary infusions.
28. Treat cows with clinical mastitis a minimum of three days with an approved product.
29. Dry-treat all quarters of all cows.
30. Double dry-treat Staph-infected quarters.
31. Dip teats of dry cows for one week after drying off and for two weeks before freshening.
32. Use a Vitamin A/D/E cream, or equivalent, to promote healing of injured teats.
33. Keep complete individual cow health and treatment records.
34. Cull chronic cows.

Milking Equipment

35. Check short air tubes (pulsation hoses) and inflation stems daily, replacing any with holes or cracks.
36. Have entire milking system thoroughly checked by equipment dealer at least once every six months.
37. Service milking equipment belts, filters, and oilers at least monthly.
38. Keep milking equipment and milking area clean.
39. Monitor washing system function to assure proper cleaning. Monitoring includes water temperature, cycle time, and chemical strength.



Air leaks cause poor milking and increase the risk of teat injury.

Cow Environment

40. Maintain cow yards and housing for maximum comfort and cleanliness.

41. Provide sanitary facilities for springing and fresh animals.

42. Provide large (12' x 12' minimum), dry, well-bedded, clean, well-ventilated maternity stalls for calving.

43. Provide dry, clean, well-ventilated resting areas for cows.

44. Protect cows from north and west winds.

45. Keep the cows' environment free of all debris and other physical hazards.

46. Eliminate mud and ledges from the cow area and prevent cow access to ponds, creeks, etc.

47. Keep feeders and waterers clean.

48. Maintain a good calf and heifer rearing program to reduce the risk of udder infection and injury before calving.

Extraneous Voltage

49. Maintain electrical system to minimize risk of extraneous voltage and safety hazards.

50. Have all alterations to electrical system performed by a licensed and qualified electrician in accordance with at least the minimum standards in the *National Electrical Code.*

Installing all on-farm wiring in accordance with the *National Electrical Code* (State law) eliminates most extraneous voltage problems.

51. Have all electrical work inspected by a representative of the Nebraska State Electrical Division as a means of assuring a safe installation in compliance with the *National Electrical Code* and as a means of identifying problems with existing wiring.

PROBLEM IDENTIFICATION

MONITORING HERD PROGRESS USING S.C.C. DATA

Mastitis causes more loss to the dairy industry than any other disease. The National Mastitis Council estimates $170/cow/yr. is lost to mastitis. Seventy percent (70%) of these losses are attributed to reduced milk production resulting from subclinical mastitis. Monthly individual cow somatic cell count (SCC) data through DHIA can be used to help minimize these losses.

Complete Figure 1 using your herd's somatic cell count. Fill in the first two years with previous herd data and keep the graph up-to-date on a monthly basis.

Answer the following questions about the herd:

Is the herd tested on a regular basis for SCC? _____

Percent of herd count contributed by cows over 600,000. _____

Is attention being given to problem cows?_____

Can problem areas (e.g., fresh cows) be identified?

_____

Has improvement been made during the last six months? _____

Estimated milk loss per cow per lactation (from graph)

_____ x _____ x $_____ = $_____.
#/cow # cows milk price your potential reward for SCC reduction

The dairy industry benefits from production of high quality milk. Most plants pay milk quality premiums for low somatic cell milk. Some producers miss out on this potential for increased income due to high levels of subclinical infection in their herds.

Does your dairy pay a premium for high quality milk? _____ If so, at what rates?_____ Does your herd qualify for this premium?_____ Calculate how much this premium does or could add to your milk check.

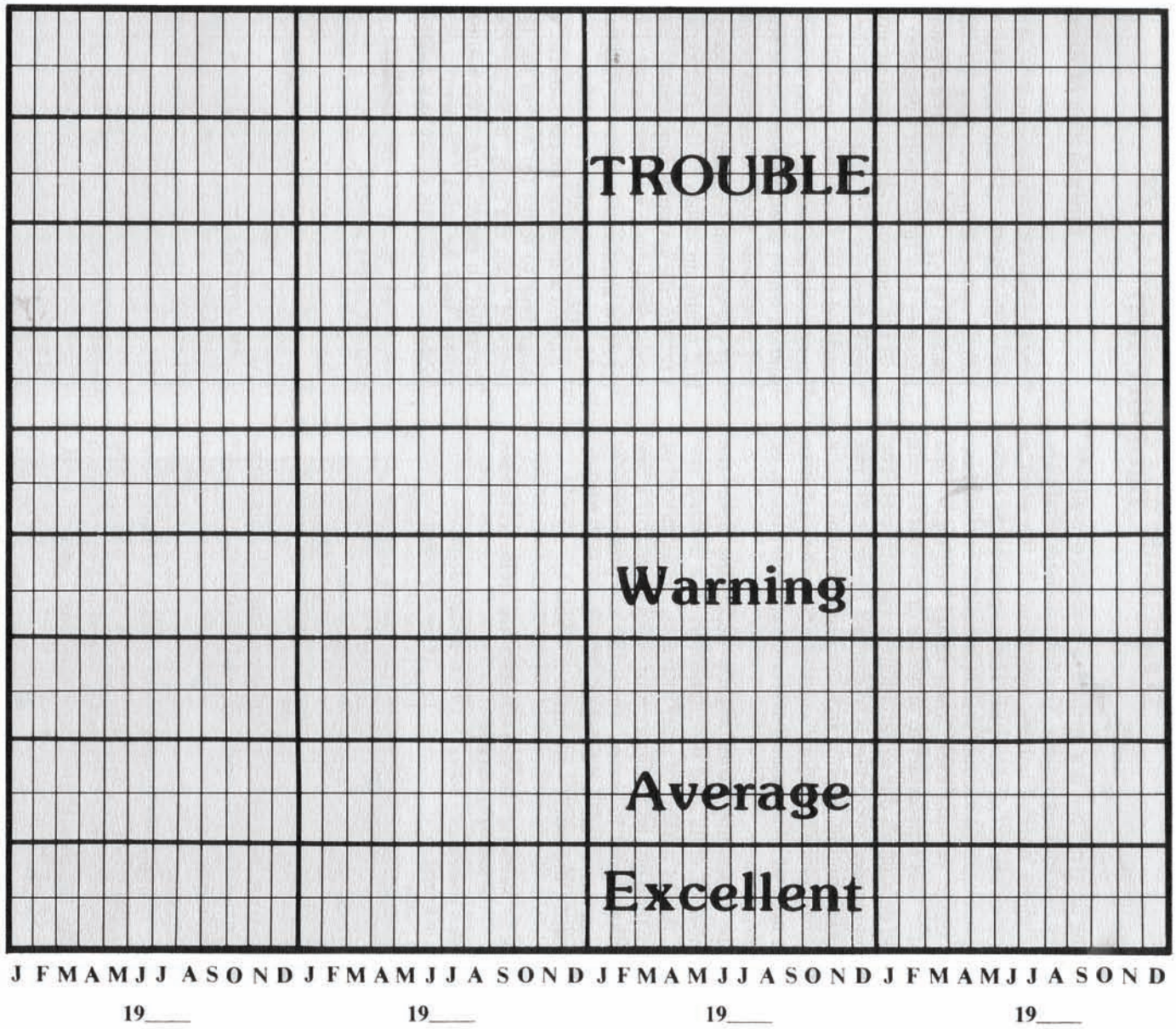
_____ x _____ x $_____ = $_____
cows RHA premium potential income

SCC and milk quality potential improvement

$_____ (Total)

HERD SOMATIC CELL AND BACTERIA INFORMATION

MILK LOSS (LBS/COW) Per Day	MILK LOSS (LBS/COW) Per Lactation	S.C.C. LINEAR SCORE	ACTUAL S.C.C.
			1000
			950
			900
			850
6	1600	6	800
			750
			700
			650
			600
			550
			500
			450
4½	1200	5	400
			350
			300
			250
3	800	4	200
			150
1½	400	3	100



DROP-OFF TEST

The drop-off test is a method to evaluate overall adequacy of a milking system. The test simulates what happens under normal milking operations in the event a unit is kicked off or dropped. The purpose of the test is to assure that the vacuum system is capable of maintaining stable vacuum even when things don't go "just right". This is necessary to minimize or prevent adverse stress on animals due to variations in vacuum level. The recommended procedure is to conduct the drop-off test at least monthly. Record and plot results to more easily visualize minor variations which indicate when a system is in need of more extensive servicing, maintenance, or repair.

The procedure varies slightly depending upon the number of units used simultaneously in a milking system. As the number of units increases, the likelihood of more than one unit falling off or being kicked off a cow simultaneously increases. Thus, the test procedures or the number of units "dropped off" varies too. Recommended "drop-offs" are listed in Table 1.

Table 1. Number of units used to conduct drop-off test as a function of milking system size.

No. units in milking system	No. units "dropped-off"
up to 8 units	1 (4 teat cup assemblies)
9-12 units	1 1/2 (6 teat cup assemblies)
more than 12 units	2 (8 teat cup assemblies)

Test Procedures

Procedures for the test are:

1. With the milking system operating, all units hanging in an "idle" condition, and all vacuum shutoff valves to the claws in a closed position, note and record the vacuum level.
2. With all but the number of units from Table 1 for the milking system size attached to cows and milking and the number of "drop-offs" listed in Table 1 closed against the claw ferrule, note and record vacuum level.
3. Using the number of "drop-off" units from Table 1, open and invert those inflations to allow full air admission. Note and record vacuum level.
4. With all units attached to the cows and milking, note and record vacuum level.

Drop-offs occasionally occur in all systems.

Interpretation of Results

Maximum allowable vacuum level variation between any of the tests is 0.5" mercury (Hg). Thus, if the maximum variation between any of the four preceding readings is 0.5" Hg or less, the system is considered satisfactory and functionally adequate.

If the vacuum level variation in any of the preceding tests is between 0.5" and 1.0" Hg the vacuum system is marginal in its functional capabilities. Caution must be exercised to minimize any other sources of vacuum fluctuation which could impose undue stress on cows' teats and predispose possible mastitis problems.

If the vacuum level variation between the maximum and minimum values on the preceding readings exceeds 1.0" Hg, the system is functionally inadequate and corrective procedures must be started. Failure to do so can result in unnecessary vacuum fluctuations and greater difficulty in controlling mastitis.

Should a situation be encountered where the vacuum gauge fails to move for any of the tests, with all units removed from the cows, open sufficient units to cause the gauge to move. This precaution is necessary since gauges may be stuck, "frozen", or corroded in one position. Failure to verify the operation of the gauge can result in erroneous readings and conclusions. Replace faulty gauges.

Possible Causes

Although the drop-off test gives an overall perception of milking system adequacy, it is not possible to determine the cause of vacuum level fluctuations based on this test alone. Further tests should be conducted (see section on Milking System Vacuum Tests). Possible causes of excessive vacuum fluctuations include:

Inadequate vacuum pump capacity (caused either by an undersized pump or by wear and associated decrease in performance capabilities).

Loose vacuum pump belts.

Undersized lines resulting in vacuum level drops due to airflow.

Dirty lines or line restrictions.

Dirty or insensitive vacuum regulator.

Leaks within the vacuum system.

Additional Tests

The drop-off test does not provide insight into the functional adequacy of the pulsation system. This component must be operating properly to achieve proper milking. The pulsator system must also be checked to assure proper operation (see section on Pulsator Tests).

EXTRANEOUS VOLTAGE PROBLEMS

Producer's Checklist

Terms like extraneous voltage, transient voltage, low voltage, stray voltage, and tingle voltage are used interchangeably to describe electricity present on "grounded" metal objects on the farm. They all refer to any "out of place" voltage on the farmstead.

Electricity present on "grounded" metal objects in **any** building, including houses, can be called extraneous electricity or extraneous voltage. The term voltage is often used to describe electricity because one of the ways to measure electricity is to measure its potential or voltage from some reference point—usually ground. Farms, and particularly dairy farms, are the places where extraneous voltage can become a problem because dairy farmers and cows are, at least twice each day, in contact with metal objects and surfaces such as stanchion pipes, milklines, vacuum lines, gutters and milk claws.

Extraneous voltage is sometimes difficult to eliminate because there are many possible sources. Faulty electrical equipment such as motor windings shorting to the frame of the motor, a bare pulsator wire touching the vacuum line, or a heating element in a water heater shorting to the tank are possible sources. Unbalanced 115 Volts alternating current (Vac) electrical loads on your 230 Vac service in the barn may cause the neutral voltage to be excessively high. One to 10 volts is considered high, especially if measured during milking.

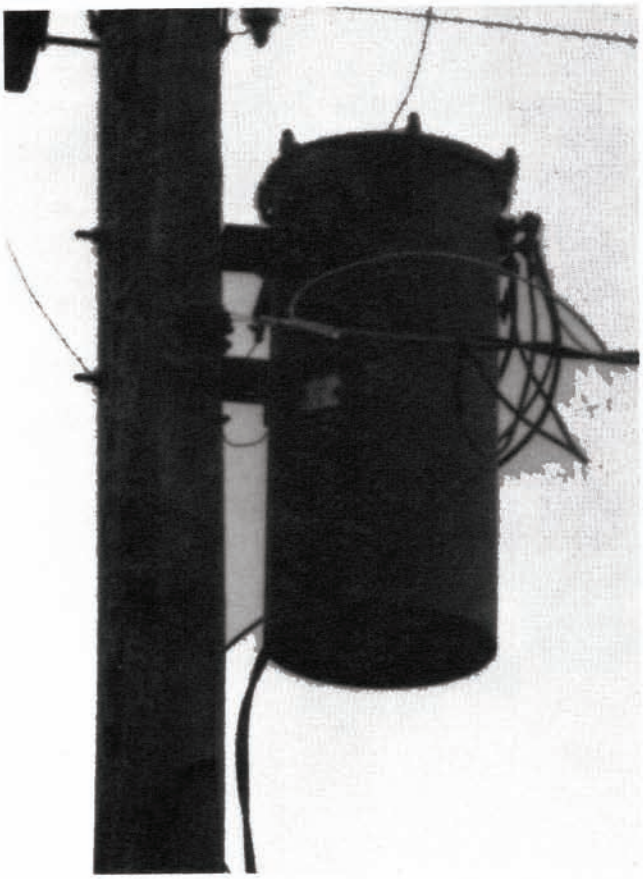
Insufficient or improper grounding of electrical boxes and equipment may be a source of extraneous voltage. Accumulations of dust and dirt in and around electrical equipment may become sources for extraneous voltage during rainy or high humidity weather.

With all of the possibilities for extraneous voltage, a dairy farmer needs help. Three main options for help:

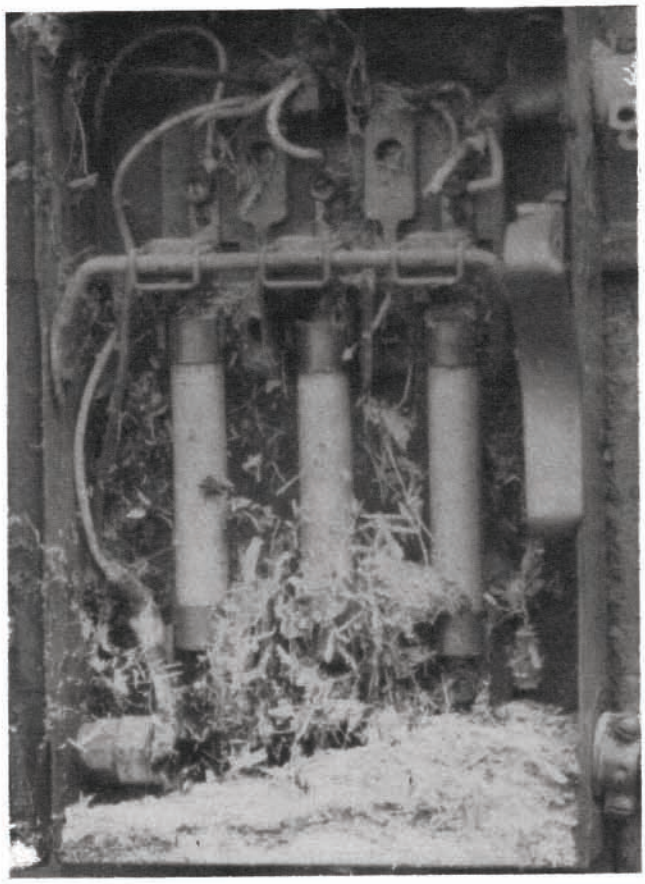
1. Call a qualified, licensed electrician.
2. Call the milking machine dealer.
3. Call the electric power supplier.

An electrician would be responsible for the distribution of ac power on the farm. Milking machine dealers are responsible for the equipment they install, and the power supplier usually accepts responsibility for its power distribution network up to the meter.

Electrical equipment must be properly installed and maintained to avoid problems. Follow the Producer's Checklist to determine if your electrical equipment needs service. A check in the "yes" column means some type of repair or service by a qualified, licensed electrician is required.



Good electrical system design and maintenance reduces the risk of extraneous voltage.



Debris in electrical boxes can cause extraneous voltage, especially during damp or humid weather.

Checklist

Farm Service Entrance - Power Pole	Yes*	No
Connection to the ground rod—loose, corroded	_____	_____
Covers loose	_____	_____
Excessive rust	_____	_____

Barn Service Entrance		
Ground rod missing at the service entrance	_____	_____
Connection to ground rod—loose, corroded	_____	_____
Covers loose	_____	_____
Excessive corrosion	_____	_____
Wet or damp areas	_____	_____
Accumulation of feed dust in or on service entrance box	_____	_____

Milkhouse		
Excessive corrosion — electrical boxes, conduit, etc.	_____	_____
Water on or in electrical boxes	_____	_____
Covers missing or open on electrical boxes	_____	_____
Wires laying in water	_____	_____

In the Parlor or Around-the-Barn		
Pulsator wiring - pinched wires	_____	_____
- loose, hanging wires	_____	_____
- scrapes, breaks or cracks in insulation exposing the conductors	_____	_____
- broken stall cocks	_____	_____
- wires taped to or wrapped around metal pipes, conduits, etc.	_____	_____
Badly corroded conduit or electrical boxes	_____	_____
Wires laying in damp or wet areas	_____	_____
Electrical boxes missing covers	_____	_____
Loose, hanging wires	_____	_____
Broken or bent conduit	_____	_____

A General Review of All Farm Electrical Equipment and Services		
Frequent fuse blowing (or circuit breakers tripping)	_____	_____
Ground rod missing or wire missing or loose at service entrance to **any** building	_____	_____
Lights dimming when motors start	_____	_____
Electrical shocks from any equipment	_____	_____
Badly corroded electrical boxes or conduit	_____	_____
Wires, electrical boxes, or motors in wet or damp areas	_____	_____
Accumulation of dust on or around electrical equipment	_____	_____
Bent or broken conduit	_____	_____
Scraped wire insulation exposing conductors	_____	_____
Insulated wires wrapped around metal pipes, conduits, etc.	_____	_____
Extension cords (cracked insulation, lamp cords)	_____	_____
Electrical boxes missing covers	_____	_____
Loose, hanging wires	_____	_____
Motors operating irregularly under load, sparking, etc.	_____	_____
Electrical outlets missing third hole for ground	_____	_____

* A 'yes' checkmark indicates a potential problem. In most instances, contact a qualified electrician for repair or replacement of electrical equipment.

EXTRANEOUS VOLTAGE — DATA SHEET FOR PROBLEM IDENTIFICATION

Extraneous Voltage Check

Entrance: size_____amps Location: _____

Grounding electrode: Material (ground rod, water pipe) _____

Location: _____ Condition: _____

Type connector (wire to electrode):_____Wire size: _____

Transformer: Location_____ Distance from milking center:_____ft

General condition of wiring and equipment (old, new, well done, corroded, professionally wired, piecemeal)

Describe: _____

_____

Voltage Check

	Milking System				
	Operating		Non-operating		Voltage w/
Checkpoints	mVac	mVdc	mVac	mVdc	100 Ω resistor**
Bulk tank to floor	_____	_____	_____	_____	_____
Bulk tank to floor drain	_____	_____	_____	_____	_____
Feeders to grates*	_____	_____	_____	_____	_____
Feeder to rear rail*	_____	_____	_____	_____	_____
Floor to rear rail*	_____	_____	_____	_____	_____
Grates to rear rail*	_____	_____	_____	_____	_____
Grates to claw*	_____	_____	_____	_____	_____

Claw to floor with milk in line_____mVac _____mVdc _____

Milk pump to floor: base_____mVac, peak _____mVdc _____

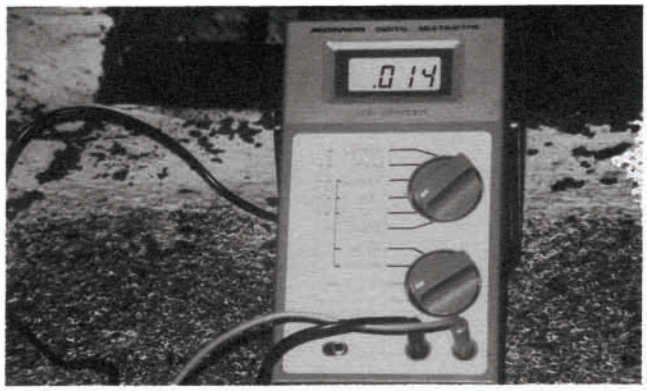
Waterer: Front feet support to tank _____mVac _____mVdc _____

Front feet support to water _____mVac _____mVdc _____

*Note location (e.g. north side, 2nd feeder from west)

**At any location where voltage exceeds 500 mV during initial check, re-check with 100 Ω resistor shunted across voltmeter leads.

Poor wiring practices and corroded electrical equipment are major causes of extraneous voltage.



A voltmeter which can tell the difference between ac and dc voltage is needed when checking for extraneous voltage.

COW CHECKLIST

	Yes	No*
Cows are clean (legs, flanks, bellies, etc.)?	_____	_____
Cows are in good condition (well fed but not overfed)?	_____	_____
Cows have good udder conformation (level base, no light or blind quarter, suspended above hock, etc.)?	_____	_____
Udders are clean (free of visible dirt)?	_____	_____
Udder hair is clipped (at least bottom half of udder)?	_____	_____
Feet and hooves are well trimmed (no long toes or "sled runners")?	_____	_____
Herd somatic cell count is less than 300,000?	_____	_____
Teats are in good condition (free of redness, scabs, warts, etc.)?	_____	_____
Teat injuries/lesions receive prompt attention and are medicated/treated with vitamin A/D/E ointment, or equivalent?	_____	_____

*Any question answered "no" indicates a weakness in a mastitis control program.

Failure to keep udder hair trimmed increases the risk of udder infections.

Untrimmed or sore feet cause discomfort and limit cow movement between feeding, resting, and milking areas and can limit milk production.

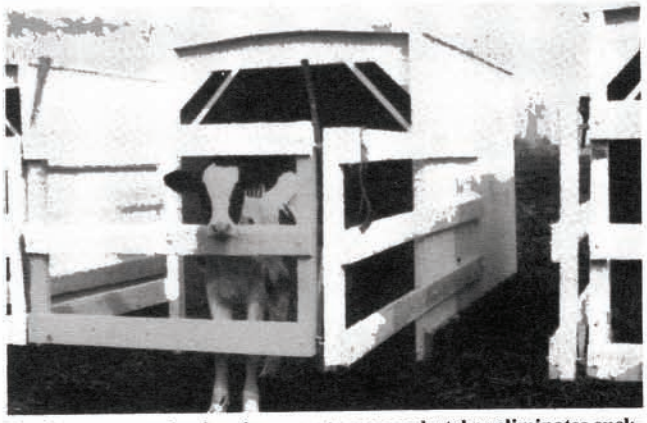
Teat injuries of all kinds make control of mastitis infections more difficult.

Dirty cows mean more labor during milking, increased risk of dirt entering the milk supply, and greater risk of udder infections.

COW ENVIRONMENT CHECKLIST

	Yes	No*
Lot: area is dry?	_____	_____
: area is clean (no more than a one-day accumulation of manure)?	_____	_____
: (and pasture, if applicable) is free of standing water?	_____	_____
: is free of depressions and mud?	_____	_____
: is free of ledges 6 inches or more in height?	_____	_____
: is free of debris and physical hazards such as boards, limbs, wire, etc.?	_____	_____
: (especially resting and feeding areas) is protected from north and west winds?	_____	_____
: is open to south for summer cooling?	_____	_____
Slopes in the cow environment (especially paved area) are 4% or less?	_____	_____
Lots are graded to promote good drainage?	_____	_____
"Flat" earthen lots are equipped with mounds?	_____	_____
Paved lot areas have a slip-resistant surface finish?	_____	_____
Cows are prohibited from entering creeks, ponds, etc.?	_____	_____
Cows are confined to concrete lot areas during adverse weather?	_____	_____
Waterers are provided at the rate of one cup or two linear feet of tank perimeter per 20 cows?	_____	_____
Watering devices are clean (water is clear, minimal debris in bottom, no algae)?	_____	_____
Feeding is done indoors or in a protected area (shaded, protected from north and west winds)?	_____	_____
Feed bunk: provides at least two linear feet of cow access length per cow?	_____	_____
: is clean (free of stones, moldy feed, etc.)?	_____	_____
: is in state of good repair (free of areas where cow injury might occur)?	_____	_____
Resting area is clean and dry?	_____	_____
Resting barn is adequately ventilated (open ridge, eaves and sidewall panels)?	_____	_____
Roof of resting barn (free-stalls or bedded-pack) has at least a 4:12 roof slope?	_____	_____
Bedded-pack provides at least 75 sq. ft. per cow (plus outside exercise area)?	_____	_____
A free-stall is available for each cow?	_____	_____
Free-stalls: (for Holsteins) are 4' wide?	_____	_____
: (for Holsteins) are at least 7' 6" long?	_____	_____
: are clean?	_____	_____
: are free of holes, hard lumps, etc.?	_____	_____
: are equipped with shoulder or back-up rails?	_____	_____
: contain a soft bedding material?	_____	_____
: are equipped with bedding boards?	_____	_____
: are in a state of good repair?	_____	_____
Dry cow facilities are of adequate size (75 ft^2 or one free-stall per dry cow)?	_____	_____

Allowing cows access to ponds is a violation of the Pasteurized Milk Ordinance and increases the risk of udder infections.



Keeping unweaned calves in separate pens or hutches eliminates sucking and reduces the risk of udder injury and infections.

Clean, dry, and well-ventilated housing helps assure cows' comfort and good production.

Unsanitary facilities can increase udder infections in first-calf heifers.

	Yes	No*
Dry cow facilities are clean, dry and well ventilated?	_____	_____
Heifer facilities are of adequate size?	_____	_____
Heifers are grouped according to size?	_____	_____
Heifer facilities are clean, dry and well ventilated?	_____	_____
Freshening facilities are clean, dry and well ventilated?	_____	_____
Freshening pens are at least 12' x 12'?	_____	_____
Freshening pens are cleaned after each use?	_____	_____
Freshening pen floor provides good footing for cow?	_____	_____
Calf housing is clean, dry and well ventilated?	_____	_____
Unweaned calves are housed in individual stalls, pens, hutches, etc.?	_____	_____
Calves and heifers are prevented from sucking each other?	_____	_____
Calves are protected from attack by predators?	_____	_____
Facilities are available to allow segregation of treated and infected cows?	_____	_____
Foot bath is available to aid in controlling foot problems?	_____	_____
Cow environment is free of rodents?	_____	_____

* A "no" answer indicates a potential weakness in the design of the animal environment which could contribute to health problems, including mastitis; or could limit feed intake and production; or might deprive you of valuable herd replacements.

MILKING SYSTEM CHECKLIST

	Yes	No*
Raw plate bacteria (SPC) counts are 5000 or less?	_____	_____
Pre-incubated bacteria (PI) counts are 25,000 or less?	_____	_____
Holding area is: clean?	_____	_____
: well ventilated?	_____	_____
: roofed?	_____	_____
: protected from north and west winds?	_____	_____
: sloped 1-4%	_____	_____
The maximum time any cow is held in the hold area is two hours (one hour is preferred maximum)?	_____	_____
Cows exit parlor to protected or sheltered area?	_____	_____
Milking area is clean?	_____	_____
Udder wash hoses are present, equipped with flow control nozzles, and installed to prevent nozzle lying on floor or in manure?	_____	_____
Milkline: is a maximum of 84'' above cow platform?	_____	_____
: is looped at end of parlor or milking area (except with weigh jars)?	_____	_____
: both ends enter receiver?	_____	_____
: slope is 1/4 - 5/16'' per 2 ft (1 1/2'' per 10 ft)?	_____	_____
: is free of vertical risers between cows and receiver?	_____	_____
: is free of low spots?	_____	_____
Milkhoses enter milkline in top half of milkline?	_____	_____
Milkhoses are long enough to allow proper positioning of units on cows?	_____	_____
Milkhose length prevents loop in hose below milkline during milking of most cows?	_____	_____
The number of milking units per milkline slope meets current standards (1 1/2'' = 2 units; 2'' = 4 units; 2 1/2 = 6 units; 3'' = 9 units—maximum)?	_____	_____
Vacuum shutoff valve is provided at claw, in milkhose, or as part of auto detacher system?	_____	_____
Air vents: are provided in claw, shells or short milk tube?	_____	_____
: are open and clean?	_____	_____
A transparent section is provided to observe milkflow (shell, hose, claw, etc.)?	_____	_____
Hoses and air tubes are free of cracks and holes?	_____	_____
Inflations are clean and smooth?	_____	_____
Exterior of milking system is clean?	_____	_____
Interior of milking system is clean?	_____	_____
Animals other than cows are kept out of milking area and milkroom?	_____	_____
A vacuum gauge is observable from milking area?	_____	_____
Vacuum gauge is in good operating condition?	_____	_____
Vacuum system is free of leaks?	_____	_____

An operating vacuum gauge assists in monitoring milking system performance. Be sure your gauge is working properly.

All line and pipe joints must be airtight. Do not use tape as a substitute for properly glued joints.

	Yes	No*
Milking system is sanitized before each use?	_____	_____
Milking system is cleaned (rinse, wash, rinse) after every use?	_____	_____
Wash cycle water temperatures, cycle times, cleanser concentrations, etc., comply with general guidelines (pages 42 to 46) or manufacturer's recommendations?	_____	_____
Vacuum pump airflow capacity meets minimum recommendations (page 26)?	_____	_____
All air lines or pipes are sized per recommendations (page 26)?	_____	_____
Vacuum level meets recommendations (low line = 11-13'' Hg; mid-height line = 12-14'' Hg; high line = 13-15'' Hg)?	_____	_____
Vacuum regulator is cleaned at least monthly?	_____	_____
Vacuum regulator is tested at least every six months to determine load sensitivity?	_____	_____
Vacuum regulator maintains vacuum level within 0.5'' Hg of set-point during all normal milking operations, including at least one "drop-off"?	_____	_____
Pulsator line is sized per standard recommendations (page 27)?	_____	_____
Pulsator line is clean?	_____	_____
Pulsator performance is checked (graphed) at least once per 500 hrs. of operation?	_____	_____
Pulsation rate is 50-60 cycles per minute?	_____	_____
Milk:rest ratio is between 50:50 and 70:30?	_____	_____
Complete vacuum system evaluation is performed at least once per 500 hrs. of operation or at least once per six months?	_____	_____
Pulsator line is looped with both ends attached to distribution tank?	_____	_____
Bulk tank compressors are clean?	_____	_____
Bulk tank compressors are in a cool location?	_____	_____
Maximum milk blend temperature is 50°F or less?	_____	_____

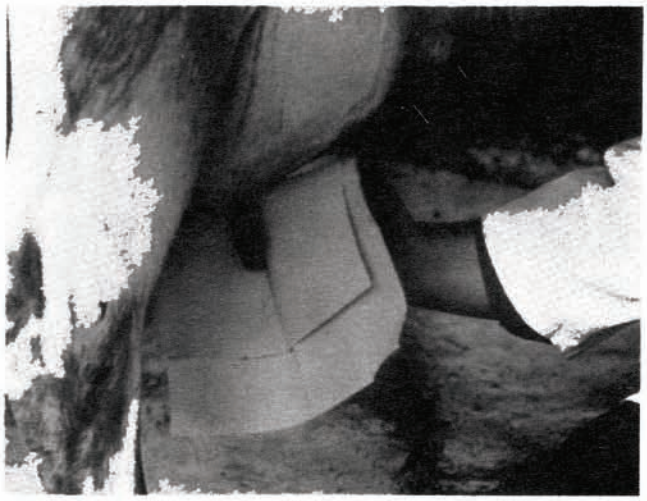
* A "no" answer to any question indicates a potential problem in producing high quality milk, controlling mastitis, and minimizing stress on the cow during milking.

MILKING PROCEDURES CHECKLIST

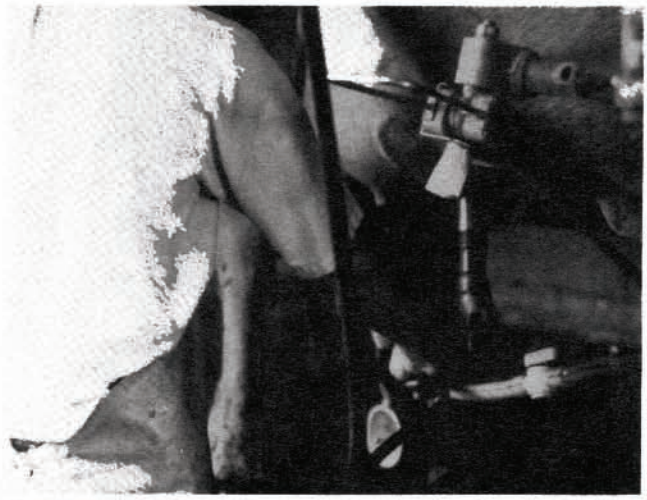
Who does the milking? _____

Cows are "pre-soaked" with "prep" stall? Yes_____No_____

	Yes	No*
Hands are washed before handling milking equipment or udders?	_____	_____
Udders/teats (including ends of teats) are thoroughly washed?	_____	_____
How? _____		
Wash water contains a sanitizer?	_____	_____
Product: _____		
Use of community or re-usable cloths and sponges is avoided?	_____	_____
Udders are thoroughly dried prior to unit attachment?	_____	_____
With single-service paper towels?	_____	_____
Ends of teats are clean?	_____	_____
Foremilk is stripped?	_____	_____
And examined for abnormalities?	_____	_____
Foremilking and washing are done independently?	_____	_____
Operator waits for "let-down" to occur (teats are flushed) before attaching units?	_____	_____
Unit is attached within one minute after starting udder washing/stimulation procedures?	_____	_____
Unit is attached with little or no air leakage?	_____	_____
Unit is kept aligned with udder—Parallel to base?	_____	_____
—Square under teats (not rotated)?	_____	_____
Milk hoses are supported by independent mechanism?	_____	_____
Claws are supported by independent mechanism?	_____	_____
Describe: _____		
Use of claw support (if applicable) to put forward or downward tension (excessive) on claw is avoided?	_____	_____
Squawking (slipping of liners) is prevented?	_____	_____
Visible means is provided to observe milkflow?	_____	_____
Squeezing of inflation stems to sense milkflow is avoided?	_____	_____
Most cows milk out in 5 to 7 minutes?	_____	_____
Cows are milked out adequately?	_____	_____
Machine stripping is limited to 15 to 20 seconds?	_____	_____
And to not more than 1 cow out of 10?	_____	_____
Units are removed promptly when milkflow ceases?	_____	_____
Vacuum to claw is shut off before removing units?	_____	_____
Removal of teat cups on a one-by-one basis is kept to an absolute minimum (not over 1 cup per 10 cows)?	_____	_____
Teats are dipped:_____sprayed:_____immediately after removing unit?	_____	_____
Product: _____		



Use single-service towels to assure udders are clean and dry before attaching milker.



Use hose support arms to position claw—parallel to base of udder and not twisted.

	Yes	No*
Units are rinsed after milking infected cows?	_____	_____
Manual:_____ Backflush:_____		
Inflations are discarded at appropriate intervals?	_____	_____
First-calf heifers and "clean" cows are milked first?	_____	_____
Mastitis/treated/infected cows are milked last?	_____	_____
Cows are fed immediately after milking?	_____	_____
Cows are treated gently?	_____	_____

Record of milking time: Start time:_____ End time: _____

No. cows milked per hour of parlor operation:_____ No. cows per man-hour:_____

or total time_____min. per_____cows. Pounds of milk:_____ Per man-hour:_____

Squawking: No. cows observed_____ No. squawks_____ No. drop-offs_____

Cow ID											Average
Position											XX
Lag-Time**											
Unit On-Time											

*Any question checked "no" indicates a potential problem area or weakness in the establishment of a mastitis control program.

**Lag-time is defined as time lapse from start of udder washing/stimulation to unit attachment. If pre-wash stalls are used, record time from start of pre-wash stall operation to start of manual washing separately.

Comments:

_____

_____

_____

_____

VETERINARY PROCEDURES CHECKLIST

	Yes	No*
Hands are washed before handling milking equipment and udders?	_____	_____
Foremilk is examined for abnormalities?	_____	_____
CMT, KMT or equivalent is used to check/screen questionable cows?	_____	_____
CMT, KMT or equivalent is used on entire herd at 6-week intervals?	_____	_____
Aseptic samples for culturing are taken from cows with clinical mastitis?	_____	_____
Complete records of cow-side tests and herd health are maintained?	_____	_____
Teats are dipped on all cows immediately after milking?	_____	_____
Teats of dry cows are dipped?	_____	_____
Teats are dry before cows exit milking area, especially in adverse weather?	_____	_____
Teat dip applicator is clean?	_____	_____
Teats are in good condition (free of erosions, blue color, scabs, etc.)	_____	_____
If no, describe: _____		
Vitamin A/D/E cream is used on injured teats to promote healing?	_____	_____
"Freeze preventative" ointment is used in adverse weather?	_____	_____ **
If yes, product: _____		
If yes, applied before:_____after:_____instead of:_____teat dip.		
Cows are infused (commercial dry cow treatment product) when they go dry?	_____	_____
% of herd treated?_____Product? _____		
Staph-infected quarters (confirmed by CMT and culturing) are "double dry treated"?	_____	_____

Describe handling of clinicals: _____

Describe procedures used in making intramammary infusions: _____

_____

*Any question answered "no" indicates a potential problem area or a deficiency in a mastitis control program.
**Not a requirement for mastitis control. These products are not a substitute for adequate shelter, teat dipping or good cow handling procedures.

Extract aseptic milk samples from all clinical quarters for culturing and identification of causative organism.

Dip all teats after every milking with an effective product to help control new infections.

SYSTEM PLANNING AND MAINTENANCE

DAIRY FARM PLANNING GUIDELINES

Overall Plan—Farmstead Layout

A good farmstead plan will provide for livestock, feed, manure, equipment, and personnel movement; give consideration to runoff, odors, security, dust, utilities, milk truck, etc.; and include options for future expansion.

System Components

Be mindful of facility investment and depreciation, labor, maintenance, and functional requirements. Give special attention to planning of multi-use areas to minimize conflicts.

Animal Housing

Characteristics of animal housing must include: well ventilated; no slopes over 4%; no ledges; and good finish on concrete to avoid slipping. Use high quality dividers for free-stalls. Provide a firm free-stall base with soft bedding overlay.

1. Calves - Warm or cold; must be well-designed and properly ventilated; provide space for one calf per 10-12 milk cows (minimum).
2. Heifers - Free-stalls (preferred, 1/heifer) or bedded-pack (at least 40 sq. ft. per head); provide space for one heifer per mature cow (lactating and dry) in herd.
3. Dry Cows - Free-stalls (1/cow; 4'-0'' or 7'-6'') or bedded-pack (75 sq. ft./cow minimum); shelter; provide space for one dry cow/5-6 lactating cows.
4. Lactating Cows - Free-stalls (preferred, 1/cow, 4'-0'' x 7'-6'' for Holstein cows) or bedded-pack (75 sq. ft./cow minimum); tie-stalls suitable for herds up to 60 cows; convenient for milking and observation; slip resistant alley surface; provide for grouping (minimum of two production groups); allow for separation of cows with mastitis; alley curbs at least 8'' high.
5. Treatment - Locate away from milking area (**Do not** use milking parlor for treatment); one space per 20 cows; stanchions to restrain cows for short-term treatment; box stall with restraint for long-term treatment; access to head and rear; should include head gate and foot bath; provide mechanism to lift ''downer'' cows in long-term treatment area.
6. Freshening - Box stalls 12' x 12' or larger, one per 20 cows; provide restraint device; vacuum line for milker operation; rough floor for footing with 6-10'' dust-free bedding to protect calf; provide support to lift ''downer'' cows; good accessibility for cleaning to help assure sanitation—area **must** be kept clean to reduce calf losses and reproductive tract infections.

Handling Facilities

1. Treatment - See item 5 under ''Animal Housing''; provide facilities for group as well as individual treatment for use in pregnancy checking, vaccinating, etc.; tilting table is a good accessory item for work on feet.
2. Loading - Accessible by trucks and/or trailer; solid sides on chute; good footing; provide catwalk along sides of chute for personnel.

Feed—Storage and Distribution

Bulk bins; tower or horizontal silos; hay; easily accessible for both loading and unloading; for planning, consider three replacements as equal to one cow; distribution by augers, conveyors or tractor and mixer wagon; blending of feeds before placement in bunk is recommended; provide scales to weigh feeds; provide at least 2' of bunk space per mature cow; provisions to allow feeding immediately after milking to keep cows standing for at least one hour; keep area clean to minimize rodent and insect breeding; storage capacity requirements dependent upon ration/feeding program.

1. Silage - Haylage; corn silage; typical storage requirements are in range of 7-10 tons capacity per cow per year.
2. Hay - Provide at least 2-3 lb per cow per day or 0.4-0.5 tons per cow per year; ground or bales; bunk or free-choice.
3. Grain - Concentrate; minerals; dry grain; high moisture—may require air-limiting storage; complete mixed ration; top-dressing; magnetic or computer feeder.

Milk Harvesting

Space must be maintained in sanitary condition; easy access by milk truck.

1. Holding area - 15 sq. ft. per cow in largest group; good footing; easily cleaned; protected from wind to minimize frost injury; cows should be held here maximum of 1 hour; well-ventilated.
2. Parlor or barn (including milking system) - Easily cleaned; adequate vacuum pump and regulator capacity; lines properly sized and sloped; well ventilated; well lighted. Install equipotential plane and voltage ramp.
3. Milkroom - Cleanable; adequate space; good drainage; ventilated.
4. Office/records - Storage/filing for production, health, and general records; convenient.
5. Storage - Refrigerator for perishables; sink for cleaning of utensils; freedom from temperature/moisture extremes; may be windowless; observe requirements for proper storage of chemicals, rubber goods, etc.; should **not** be in utility room.

Clean, dry calving facilities reduce the risk of infections.

Debris in the cow environment can cause injury and lead to infections.

Manure management should be part of all farmstead plans. Make it convenient to keep cow lots clean.

High producing cows require large quantities of high quality water. Keep cows away from contaminated water.

6. Utility room - Space for vacuum pumps, heat exchangers, water heaters/storage, compressors, etc.; make provisions for ventilation plus re-use of compressor heat; easy access to equipment for servicing; should be separate from storage room (ozone from motor operation destroys rubber).

Manure Management

Part of all installations; goal is to reduce costs; cannot be made a money-making part of operation regardless of design; production rate is about 1.4 cu. ft. per 1000 lb animal/day or 2.0 cu. ft. per mature Holstein/day.

1. Removal from barn - Tractor scrape; alley scrapers; slotted floor; flush; should be convenient so it gets done daily.

2. Storage - Deep pit under barn; slotted dam; earthen; above-ground (tub or tower); 2.0 cu. ft./cow/day minimum per mature Holstein; provide for precipitation in all open storages; freeboard required in all storages; recognize differences between total and usable storage volume; store as liquid, slurry, semi-solid or bedded-pack; provide usable storage capacity for at least 6-month or 200-day "duration of storage".

3. Land application - Provides best use of manure (crop nutrients, organic matter, etc.); rates should match crop needs; surface apply; injection; irrigation; nitrogen losses can be high unless incorporated promptly after application; provide for agitation in liquid and slurry systems.

Lots

Freedom from standing or running water; graded for drainage; concrete or earthen; limit access to earthen lots in wet weather unless lots are well graded and free of mud; no ledges; no manure accumulation; minimize areas for rodents and insects to hide/breed.

1. Pavement - Moderately rough surface for good footing; maximum slope of 4%.

2. Mounds - Soil or soil plus manure; See NebGuide G73-66 Mound Design for Feedlots; at least 50 sq. ft./cow.

3. Waterers - 1 water space (1 cup or 2 linear ft of tank) per 20 cows; kept clean; equipped with overflow and drain; easily accessible; 10' apron, minimum.

Traffic

Easy in/out; all-weather roads; consider dust around farm house.

1. Vehicle - Farm equipment, milk/feed trucks; at least 10' roadbed; wide turns; easily maintained.

2. Personnel - Safety for children; convenient.

3. Livestock - Use cattle guards and swing-away gates for control and easy access by equipment; do not mix with equipment if possible.

Utilities

Adequate for present plans plus immediate future.

1. Electrical - Properly sized; no undersized neutrals to help control extraneous voltage; properly grounded; installed by licensed electrician per minimum requirements of *National Electrical Code;* have inspection before acceptance.
2. Lighting - Security; working; general.
3. Water - Capacity of at least 50 gallon/day/cow, or equivalent; high quality.
4. Other - Natural gas; propane; telephone.

Construction

Use written contracts; consult with your attorney concerning contract requirements; request a bonding certificate or waiver of "mechanics lien" document.

Materials and Systems

Durability is prime requirement; compare on basis of roof design loads (25 psf minimum).

Pole

Usually most economical; use only pressure preservative treated lumber in contact with soil.

Concrete Block

Not a good choice; cleanable; must be insulated if used in milking center.

Frame Wall

Use pressure preservative treated sills; easily insulated.

Steel Frame

Not recommended for livestock unless painted before erection with epoxy paint; roof slope and deep purlins frequently limit ventilation by non-mechanical means.

Insulation

Necessary in milking center and calf facilities; protect from rodents and moisture; generally not required in housing for mature animals.

Ventilation

Required in all components of dairy installation; may be mechanical or non-mechanical—both require good design.

Mechanical

Uses fans; typical in milking center (except holding area), tie-stall barns and warm calf barns; requires carefully designed inlet system.

Non-mechanical

Also called "natural" ventilation; requires careful design—roof slope, ridge and eave openings, sidewall panels.

Extraneous Voltage

Present on approximately 50% of Nebraska dairy farms; most problems are due to poor on-farm wiring; can adversely affect cow movement, milk production, and mastitis control efforts.

Prevention

Best technique is good wiring and use of equipotential plane and voltage ramp.

Detection/Eradication

Usually time-consuming; requires proper equipment; follow safety rules; preferable to utilize services of licensed electrician.

Resources

Agricultural Engineering Plan Service

Plans; publications; general design information. (215 Chase Hall, Department of Agricultural Engineering, University of Nebraska, Lincoln, NE 68583-0727); request index.

Cooperative Extension Service

Part of USDA and UN-L; tax supported.

Agent - NebGuides; general planning.

Specialist - Detailed planning; plan evaluation by mail or office visit.

Soil Conservation Service

Part of USDA; tax supported; assistance with topographic work regarding lot drainage, manure management, etc.

Consultants

Provide services for a fee; services required for development of detailed plans, construction supervision/monitoring, etc.

Management

Regardless of the system installed, the key to success is you. Good design and preplanning can simplify management but cannot replace it. Do not build a system which requires management inputs beyond your abilities unless you plan to hire personnel with the required skills.

COW HOUSING AND ENVIRONMENT

General Recommendations

A clean, dry, comfortable and stress-free cow environment is essential to maintain an effective mastitis control program. Elimination of stress-inducing conditions within the cow's environment will reduce injuries and minimize the number of mastitis cases related to environmental factors.

The design of the cow environment must provide protection from cold and wind exposure during the winter and protection from direct sun and high temperatures during the summer. A clean, dry, well-ventilated resting area, absence of physical hazards, and provisions to prevent access to creeks, ponds, or muddy areas are also essential.

Geographic location, degree of exposure of site and operator preference determine the design of required shelter which might vary from a mature, well-planned tree shelter-belt with mounds in the lots to a totally enclosed mechanically ventilated tie-stall barn. For Nebraska, a cold, enclosed non-mechanically ventilated free-stall barn best meets year-round requirements. In all cases, the best technique to reduce the risk of frost injury to the udder is to provide housing facilities with dry bedding and protection from the wind in the holding and feeding areas. Protection from cold wind is especially critical for animals approaching freshening or that have freshened within the past two weeks.

Proper planning—whether for remodeling or a new installation—will pay dividends in reduced labor and lower the costs associated with mastitis treatment, early culling, and poor production.

A well-planned and effective environment for a dairy production enterprise must include:

1. Maternity facilities—capable of being maintained in a dry, sanitary condition; well-ventilated/equipped/lighted.
2. Calf housing—dry; clean; well-ventilated/equipped/lighted.
3. Holding area—protection from wind; covered; properly ventilated; sloped (up to 4%) with roughened concrete; capable of being kept clean; sized to keep time in holding area to two hours or less (1 hour preferred); 15 sq. ft. per cow.
4. Milking parlor—stress-free environment for milk harvest; meets needs of both cows and operator; well-lighted; properly ventilated; easy to keep clean; avoid steps and turns (especially at cow entrance) if possible.
5. Shelter (resting area)—clean; dry; well-bedded; properly ventilated; free of physical hazards; comfortable area to lie down.
6. Feeding area—protected from wind; clean; properly ventilated; covered and enclosed preferred.
7. Waterers—located for easy cow access; protected from wind; one bowl (cup) or 2 linear ft. of tank perimeter per 20 cows; 12 ft. concrete apron with no ledges; properly and safely wired if electrically heated; kept clean.
8. Lots—clean; properly sized for soil and slope conditions; well-drained; use mounds as necessary; no access to running or standing water; easily maintained.

Feeding Area

Protect cows during feeding by locating feeders and windbreaks to prevent direct wind exposure during winter weather. Feed the cows immediately after milking to keep them standing for at least one hour. Standing allows teat blood circulation to improve and provides time for the teat sphincter muscle to close the teat canal. Improved blood circulation reduces the risk of teat frost injury. Teat closure reduces the risk of pathogen entry.

Free-Stalls

The recommended practice is to provide one free-stall for each cow. Recommended free-stall dimensions for mature Holstein cows are 48" wide x 7'6" long. A good free-stall must be dry and comfortable and expose the cow to minimal injury risk. Use of bedding boards and back-up boards (shoulder rails) is recommended. Keep the free-stall base smooth, sloped toward the rear (2-4") and covered with a soft bedding material. Maintain on a daily basis; add bedding at least monthly.

Ventilation

Proper ventilation is critical to the cow's health. Most free-stall barns, bedded-pack barns, holding areas, and feeding areas can be properly ventilated by non-mechanical means. Recommendations can be found in the UNL Department of Agricultural Engineering publication entitled "Non-Mechanical Ventilation of Animal Housing Facilities."

Extraneous Voltage

Extraneous voltage can adversely affect milk production, cow behavior and the function of some equipment. To minimize the risk of extraneous voltages developing, all farmstead wiring and grounding must meet the minimum standards set forth in the *National Electrical Code* (NEC). The NEC is part of the Nebraska State Law. Use a licensed electrician familiar with the NEC when installing new wiring or trouble-shooting problems. Inspection of all new installations by a representative of the Nebraska State Electrical Division (402/554-2127) is recommended.

The UNL procedure is to check voltages at cow-contact points with a proper meter with milking equipment in both an operating and non-operating mode. Not all voltmeters will diagnose voltages properly. Locations with voltages exceeding the generally recognized "threshold of concern" of 500 millivolts (mV) should be identified. Initial diagnostic and corrective procedures can then be suggested. A set of fact sheets and reference materials on diagnosing extraneous voltage problems can be obtained from the UNL Department of Agricultural Engineering for $15.00. Make checks payable to the University of Nebraska.

Daily scraping of paved areas results in cleaner cows and lowers the risk of udder infections.

MILKING SYSTEM DESIGN

General Recommendations

Correct milking equipment function is basic for any successful mastitis control program. A good equipment dealer is an essential member of your mastitis control team. He should have the expertise to ensure proper installation and operation of your equipment.

Equipment manufacturers have developed preventive maintenance schedules and checklists to help keep the equipment operating continuously and correctly. Consult your dealer to develop a schedule for you. A preventive maintenance program, as a minimum, must include the following checks:

1. Belts (condition, tension, alignment).
2. Oil (level and flow).
3. Hose condition (free of cracks and breaks, not collapsed).
4. Filters (location, cleanliness).
5. Pump performance (within manufacturer's tolerances).
6. System capacity (locate and correct leaks and restrictions).
7. Regulator response (maintain vacuum level within 0.5" Hg of setpoint).
8. Washing/cleaning action (lines clean, bacteria counts low).
9. Pulsator operation (open/close, smooth consistent operation).

Preventive maintenance does not cost—it pays you back with better herd health. A complete check of the vacuum system should be conducted every 500 hours of operation. Procedures for performing the three basic tests along with allowable tolerances and interpretation of results are found in the section entitled, "Milking System Vacuum Tests".

Vacuum Pump

The airflow capacity of the vacuum pump should generally be within 5 cfm (New Zealand, NZ) or 2.5 cfm (American, ASME) of the manufacturer's specifications at a vacuum level of 15" Hg.

Vacuum System Capacity

Leaks, pipe restrictions, and vacuum losses associated with airflow through the pipes always result in system capacity being less than pump capacity. Acceptable losses range from 5% to 10% of pump capacity and vary with the size of the vacuum pump. Undersized or clogged lines, an excessive number of elbows, and leaks reduce the amount of air available for milking system operation and adversely affect vacuum stability.

Have your milking equipment dealer locate and correct all leaks in the system and replace damaged parts. While not essential to system operation, the vacuum pump exhaust should be equipped with a checkvalve to prevent backward pump rotation when the system is turned off, thereby reducing damage to the vanes. This device will also facilitate checking the system for leaks.

A minimum amount of airflow capacity is necessary for proper system function. Having excess airflow capacity does no harm except as it relates to vacuum pump operating cost. However, inadequate airflow capacity results in irregular vacuum fluctuations which can increase the incidence of new infections (see section on "Sizing Vacuum Systems" for detailed information).

Milkline Piping

Proper milkline sizing is necessary to minimize vacuum fluctuations at the teat. The maximum number of units per slope of milkline relative to pipeline size is: 1 1/2"—2 units; 2"—4 units; 2 1/2"—6 units; and 3"—9 units. Unless both ends of your milkline end at the receiver (double inlet receiver), your line is a "single slope" line even though it may slope in two directions and be "looped" across the end of the parlor. In a "single slope" line system, units on both sides of the parlor are counted to determine the number of units per

slope. For improved milking performance and more stable vacuum a looped, low line (below cow platform) double slope milkline with a double inlet receiver is recommended. The use of dead-ended milklines is not acceptable except in systems equipped with weigh jars. The slope of the milkline should be 1 1/4" - 1 1/2" per 10' of pipeline length (1/4" - 5/16" per 2'). Avoid low spots.

Pulsator Piping

Good pulsation and proper milking require properly sized lines. For best performance a looped line with both ends attached to the distribution or reserve tank is recommended. Minimum recommended line sizes for individual unit pulsation systems are: up to 7 units—1 1/4"; 8 to 12 units—1 1/2"; and 13 to 18 units—2". Increase all lines to the next larger size if only one end is attached to the distribution/reserve tank.

Regulator Response and Sensitivity

Stable vacuum at the receiver is necessary to minimize vacuum fluctuations at the teat which can cause teat end injury and predispose the cow to mastitis. A vacuum regulator is used to maintain vacuum at a pre-set level by varying the amount of air admitted as the system load changes. Recommended test procedures and allowable tolerances are set forth in the section on "Vacuum and Vacuum Regulators".

The regulator should be cleaned on a regular basis to ensure continued correct operation. The cleaning interval should be developed by you and your equipment dealer based on location and type of regulator. Most manufacturers recommend that the regulator be cleaned on a monthly basis; use this as a basic guideline. Regulator cleaning is an essential operation for correct milking system function. **Do it regularly.**

Vacuum Gauge

Every system should be equipped with at least one vacuum gauge to allow routine monitoring of system performance. In buying a replacement gauge, select one with built-in re-calibration capabilities. Install the vacuum gauge so it is easily visible from the milking area. Attach gauge to the main vacuum line leading from the vacuum pump to the sanitary trap. Avoid mounting on the pulsation line.

Vacuum Levels

To help assure proper equipment function, maintain vacuum at the correct level. Follow the recommendation of your equipment dealer. General recommendations are: low line (below cow platform)—11" to 13" Hg; mid-height line (up to 48" above cow platform)—12" to 14" Hg; and high line (over 48" above cow platform)—13" to 15" Hg. In determining proper vacuum level, consider the height at which milkflow is due to gravity instead of vacuum. For example, most systems with weigh jars are actually "mid-height" even though the milk transfer line is below the cow platform. Some automatic detacher sensors also result in "low milkline" installations actually functioning as mid-height systems. Never change vacuum levels more than 0.5" Hg per week. Sudden changes may cause severe teat stress and an increase in the number of clinical cases of mastitis.

Pulsators

Pulsators must operate smoothly and consistently for proper milking with minimum stress on the udder. Clean and maintain pulsators regularly. Follow manufacturer's recommendations. General guidelines and procedures are set forth in the section entitled "Pulsator Tests".

Inflations

Inflations deteriorate with age, use and exposure to cleaning chemicals. Replace them at regular intervals to assure good performance. Use inflations for no more than 1,200 individual cow milkings. Follow the manufacturer's recommendations.

Air Tubes

Inspect all air tubes daily. Replace cracked, soft, or broken tubes and hoses. Proper pulsation and milking require an air-tight system.

Drop-Off Test

This test should be performed at least monthly to check the overall adequacy of the vacuum system.

Improper selection or sizing of materials decreases system performance. Do not install PVC pipes within 3 ft of vacuum pumps. Excess heat damages plastic pipe.

MILKING SYSTEM DESIGN-RISK COMPARISON

Risk Comparison

A milking system is used at least twice each day to harvest the milk crop. This repeated and frequent contact with the cow increases the risk of teat or udder injury caused by a poorly designed, maintained, or operated system. Both field observations and research suggest that various system design features or details can influence the risk of injury to the cow.

Here is an overview of some factors to consider in selecting equipment and completing a milking system installation. The fact that a design feature is listed under the "higher risk" category does not make it wrong or bad. However, a higher level of management skill will probably be required. Similarly, the fact that a design feature is listed under the "generally safer" category does not mean good management is not important. In all cases, it is how all system components work together and how well the system is used and managed that determines the influence on the cow.

Milkline Location

Generally Safer

Low line (below cow platform)
- 11-13" Hg vacuum
- Less tissue trauma
- Reduced vacuum fluctuation

Higher Risk

High line (>4' above cow platform)
- 13-15" Hg vacuum
- Increased tissue trauma
- Greater vacuum fluctuation due to "lifting" of milk

Pulsation

Rate: 50-60/min.

Alternating front to back
- Less milkline and claw flooding tendency (volume)

Simultaneous front and back
- Eliminates hazards associated with hose reversal

Rate: <50 or >60/min.

Simultaneous front and back
- More milkline and claw flooding tendency (volume)

Alternating front to back
- Danger occurs as vacuum lines may get reversed.

Milk:Rest Ratios

Narrow

45 milk:55 rest

50:50 to 60:40 best for typical producer

Wide

70 milk:30 rest

Cows milk faster resulting in increased potential for over-milking

Operator limitations—milking occurs at a rate beyond operator's ability to "keep up"

Liners or Inflations

Soft

Stretch type (500-800 milkings)
- Frequent changing increases labor requirements

Careful economic appraisal required

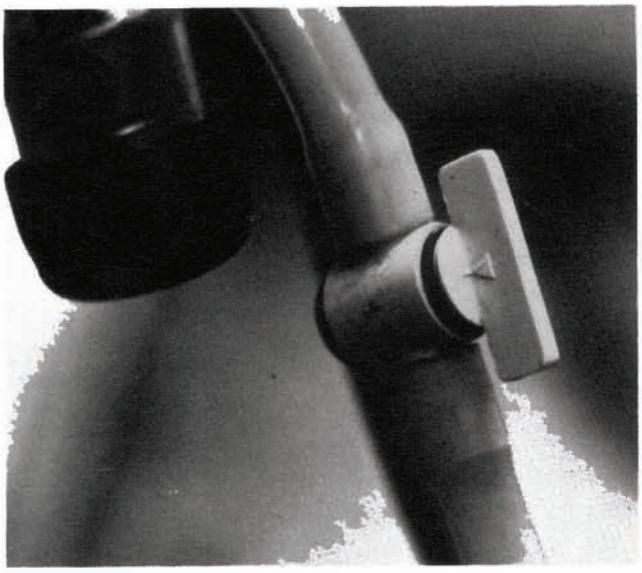
One piece (1,200 milkings)
- Generally best overall; numerous options available on market to obtain "best fit" of cows in a particular herd

Hard

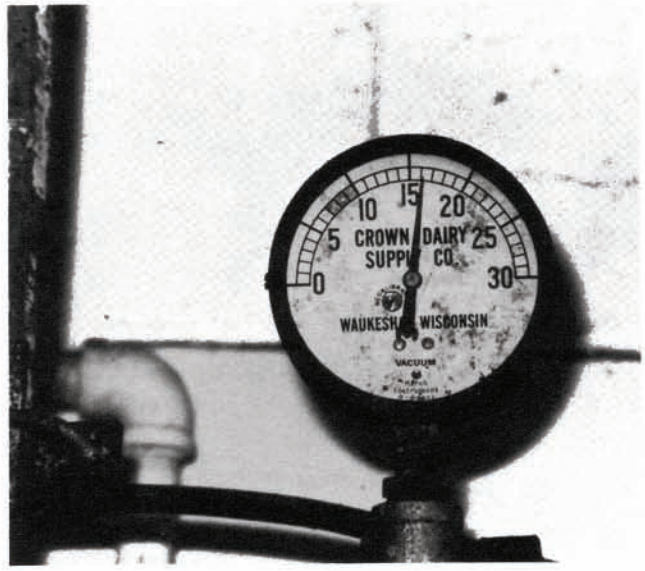
Many are one piece—up to 5000 milkings

Greater potential for squawking

Silicone liners: Teat extension may occur, resulting in continual exposure of teat ends to vacuum and resultant trauma; some herds probably OK



Use a positive closing valve to turn off vacuum before removing the claw.



Never operate any milking system with a vacuum level in excess of 15.0 inches mercury.

Generally Safer	Higher Risk
Claw Size	
Large Volume Type Reduces flooding, vacuum fluctuations and potential for impacting However, hose and claw support arms will be necessary for proper unit alignment	*Small Volume Type* Increases risk of flooding Large volume makes hose and/or claw support mechanism necessary to properly position claw for more uniform milkout and to control squawking
Air Bleed (Vents)	
Claw Less maintenance due to larger opening More uniform milk movement More stable vacuum	*Inflation Stem or Shell Base* Irrational air vectors within claw assembly Greater potential for vent blockage by debris due to small diameter openings
Vacuum Shutoff	
Positive Claw easily removed with minimal stress on teat	*None* Creates vacuum fluctuation when claw is removed Removal of claw under vacuum imposes unnecessary stress on teat tissue
System Airflow Capacity—CFM (Cubic Feet/Minute)	
At least 8-10 cfm (ASME) per unit at pump for systems with up to 10 units Reserve of at least 40 cfm (ASME) plus at least 2-3 cfm (ASME) per unit at receiver for systems with up to 8 units Systems with large numbers of units require more reserve	< 8 cfm (ASME) at pump or < 2 cfm (ASME) at receiver per unit—greater risk of squawking, fall-offs and vacuum fluctuations

Generally Safer	Higher Risk
Vacuum Regulator or Controller	
Highly Sensitive (Results in more stable vacuum) Spring loaded diaphragm Servo diaphragm	*Moderate or Poor Sensitivity* (Result is increased vacuum fluctuations) Weighted controller (lever or dead weight) Spring loaded sleeve
Hose-Claw Support Mechanisms	
Full Support Controllable pull on udder Better unit alignment	*Partial or No Support* Poor unit alignment Less uniform milkout Increased risk of squawking
Milklines	
Complete Loop, Double Inlet at Receiver Reduced vacuum fluctuation	*Dead-End Lines, Single Inlet at Receiver* Increased vacuum fluctuation
Liner or Inflation Barrel Length	
Long (5-6") Better teat massage	*Short* Teat exposed to continuous vacuum causing increased risk of teat irritation
Milkline - Slope/Size	
Slope: 1" - 1 1/2"/10' No. units per milkline slope 1 1/2" - 2 units (max) 2" - 4 units (max) 2 1/2" - 6 units (max) 3" - 9 units (max)	*Slope: < 1"/10' or >1 1/2"/10'* Low slope or too many units per slope = greater potential for flooding, resulting in vacuum fluctuations High slope = more foaming and associated increase in rancidity yielding reduced milk quality and shortened shelf life
System Maintenance	
1 - 1 1/2 Month Routine 500 Hr. or 6 Mo. complete	*Only When Trouble Develops*
Unit Removal	
Manual/Automatic Manual: Reduced vacuum fluctuation (2-3" Hg) Automatic: Reduced risk of over-milking Greater labor efficiency	*Automatic* Automatic: Milkflow sensors cause increased vacuum fluctuations (5-6" Hg) Higher management skill inputs required to assure system is functioning properly
Milk Yield Monitoring	
Weigh jars: More consistent milking on "test" day Milk meters: System performance only affected on "test" day	Automatic: Flow sensors cause greater vacuum fluctuations (5-6" Hg) Milk meters: "Test" day milking is different due to meter—greater vacuum drop and vacuum fluctuations Weigh jars: More equipment to work around

SIZING VACUUM SYSTEMS

Efficient, stress-free milking requires stable vacuum. To achieve these goals the vacuum supply system must be properly sized and carefully installed. Procedures presented are based on airflow rates in cubic feet per minute (cfm) New Zealand (NZ) standard. Airflow requirements based on the American (ASME) standard are one-half of the values given.

Estimating System Capacity

System airflow capacity must be sufficient to prevent an excessive drop in vacuum level should a unit be dropped or kicked off, allowing full airflow. The recommended base reserve airflow capacity is given in Table 1.

Table 1. Reserve airflow capacity as a function of milking system size.

Total number of units	Base reserve airflow capacity, cfm NZ
Less than 8	60- 90
9-12	90-135
Over 12	120-180

Most older claws (units) have a full open airflow capacity of 50-60 cfm NZ. Use the lower base airflow rates in Table 1 for systems having "standard" claws. New high capacity claws (e.g. Bou-Matic, Surge Orbit, Germania) have higher full-open airflow capacities. Use the higher reserve values in Table 1 for systems equipped with those claws.

The system must also have capacity to compensate for airflow through all components which require or admit air. Recommended component allowances are listed in Table 2.

Table 2. Component airflow requirements.

Component	Airflow allowance, cfm NZ
Unit operation (pulsator, vent, leakage)	6 per unit
Regulator leakage	6-18 per regulator*
Milk meters or weigh jars	2 per unit
Auto detachers	2 per unit
Milkline inlets	2 per 10 inlets
Pipeline couplings	2 per 20 couplings

*See later section for details on determining appropriate value.

Some companies estimate system airflow requirements by allowing a uniform airflow rate per unit. This procedure frequently results in small systems (4 or fewer units) having insufficient capacity for proper washing cycle function and large systems (more than 8 units) being oversized resulting in higher operational costs. The recommended procedure of providing a base airflow rate plus a smaller allowance for unit operation more closely matches system capacity to actual airflow requirements.

Vacuum Pump Capacity

The vacuum pump must provide sufficient airflow capacity under the full range of normal and expected operational regimes to maintain stable vacuum. Add 10% to the "estimated system capacity" to determine minimum vacuum pump capacity at milking vacuum level. This "extra" allows for system leaks, line losses, etc. Vacuum pump horsepower requirements can be estimated at 1 hp per 20 cfm NZ.

Vacuum Line Sizing

Vacuum system piping must be installed with tight joints and a minimum number of elbows and fittings. Any sudden change in air direction or velocity causes turbulence resulting in vacuum level variations. Eliminate indiscriminate use of bushings, reducers, and elbows. Never use street ells. Pipes should be sized for a maximum air velocity of 25 ft per second (1500 ft per minute) at maximum system flow rate. Recommended maximum airflow rates through common pipe sizes are given in Table 3. Use these values to size pipes from the vacuum pump to distribution tank and distribution tank to sanitary trap. In weigh jar systems size lines based on the divided airflow rate, since one line is used to provide vacuum to the weigh jars and thus to the milking units, and the second line is used to provide vacuum to the milk transfer line. Calculate airflow through each component of the system to determine proper line sizes.

Table 3. Maximum airflow rates through selected pipe sizes.

Pipe diameter, inches	Airflow rate, cfm NZ	
	PVC	Galvanized
1 1/4	25	20
1 1/2	40	30
2	65	50
2 1/2	100	75
3	150	115
4	260	195
5	410	310

Milkline Sizing

Milklines must be sized to allow space for both air and milkflow and to keep vacuum drops within an acceptable range. The maximum number of units recommended per slope of milkline installed with a slope of 1 1/2 in. per 10 ft. is given in Table 4. In a weigh jar system, the milkline serves as a transfer line only. Table 5 gives the recommended maximum number of weigh jars per milkline slope. Double entry receivers with looped milklines are recommended in all systems except those with weigh jars.

Table 4. Maximum number of units per milkline slope when milking is directly into the line.

Milkline diameter inches	No. units per slope (maximum)
1 1/2	2
2	4
2 1/2	6
3	9

Table 5. Maximum number of weigh jars per milkline slope.

Milkline diameter, inches	No. units per slope (maximum)
1 1/2	6
2	10

Pulsator Lines

Pulsator lines must be sized to provide instantaneous high airflow rates without appreciable drop in vacuum level. Although average airflow rates are only about 2 cfm NZ per pulsator, demand airflow rates can approach several hundred cfm. Sizing is especially critical in systems with a master pulsation control system where all pulsators operate simultaneously. The problem is further magnified with simultaneous pulsation of all four teat cup assemblies per claw. Minimum recommended pipe sizes for various numbers of pulsators are listed in Table 6. Both ends of the pulsator line should be looped back to the distribution tank. Where the pulsator line is looped within the milking area, but with a single line leading back to the distribution tank, the next size larger pipe should be used from the loop to the distribution tank.

Table 6. Minimum pulsator line sizes for individual unit pulsation systems.

	Minimum pipe diameter, inches	
No. units	Dead-end	Looped
Up to 5	1 1/4	1 1/4
5 to 7	1 1/2	1 1/4
8 to 12	2	1 1/2
13 to 18	3	2
Over 18	NR*	3

* NR = not recommended

Vacuum Regulator

The vacuum regulator is an essential component of a vacuum supply system. The regulator must respond to changes in airflow admission through system components and open or close to balance vacuum pump capacity with system airflow demands. A high level of sensitivity is required to allow prompt response to changes in system airflow requirements and minimize vacuum level variations.

With marginally- or under-sized lines, positioning of the vacuum regulator is critical. Where lines are sized in accordance with Table 3 and are of a reasonable length with a minimum number of elbows, reducers and bushings, greater flexibility is possible relative to vacuum regulator position. In general, the best procedure is to follow the manufacturer's recommendations.

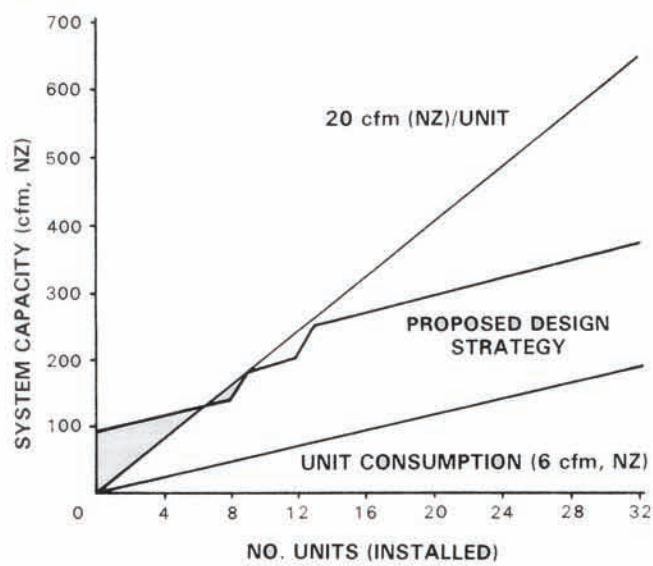
Most regulators admit a small amount of air even when in the "closed" position. To account for this "leakage", allow 6 cfm NZ per regulator except as follows: DeLaval—6 cfm NZ per VRM component; Sentinel 100—14 cfm NZ; Sentinel 350—18 cfm NZ.

Distribution Tank

The distribution tank is often referred to as a reserve or balance tank. The benefits and necessity of a distribution tank with properly sized lines is often debated. Its primary function is to allow interconnection of the various pipes in the system. Current recommendations are to provide a distribution tank with a capacity of at least 3-5 gallons per milking unit.

Piping Installation

All lines must be sloped and equipped with drains to allow automatic removal of condensed water, i.e., they must be self-draining. All installations must permit access to pipes for inspection and periodic cleaning. In particular, provisions **must** be made at the vacuum pump to allow disassembly of the vacuum line to check vacuum pump capacity. Lines should not be continuously glued from the vacuum pump into the milking area. A union or hose coupling should be provided near the vacuum pump. Special care in selecting piping is required where the vacuum piping connects directly to the vacuum pump and then leads to a remote distribution tank. **Under no circumstances** should PVC pipe be connected directly to the vacuum pump. Heat generated by the pump causes partial melting of the PVC threads with resultant leaks. At least 3 ft of iron pipe should be used between the vacuum pump and the changeover to PVC piping. All piping should be at least Schedule 40 PVC. Do not use ABS type drain/waste/vent (DWV) pipe.



Adequate vacuum pump capacity is necessary to properly operate a milking system but over-sized systems are wasteful of energy. Match vacuum pump size to system requirements.

In systems with multiple vacuum pumps, attach the pumps to a header line or distribution tank. Header lines should be at least as large as the main vacuum supply line (Table 3). Provide a valve between each pump and the header pipe or distribution tank. This provision allows independent checking of vacuum pumps and, under conditions of equipment failure, allows operation of the system at a reduced capacity while the faulty pump is being repaired.

Testing

A vacuum system should be tested after any changes and at least once every six months or after 500 hours of operation. Utilize the services of a knowledgable equipment dealer.

Example: What is the minimum airflow requirement for a double-four herringbone parlor with eight standard units and auto detachers? What size vacuum pipe is required? What is approximate pump horsepower requirement? A Sentinel 100 regulator will be used.

Estimated system airflow capacity:		
Reserve:		60 cfm NZ (30 cfm ASME)
Unit operation:	(8 @ 6 cfm NZ)	48 cfm NZ (24 cfm ASME)
Regulator:	(1 @ 14 cfm NZ)	14 cfm NZ (7 cfm ASME)
Milk meters:	(8 @ 2 cfm NZ)	16 cfm NZ (8 cfm ASME)
Auto detachers:	(8 @ 2 cfm NZ)	16 cfm NZ (8 cfm ASME)

Total (airflow required at receiver jar): 154 cfm NZ (77 cfm ASME)

Minimum pump capacity: 154 x 1.1 = 170 cfm NZ (85 cfm ASME)

Vacuum line from the vacuum pump to the sanitary trap: 4 in. (50' or less) (Table 3)

Pulsator line (minimum): 1 1/2" (looped) or 2" (dead-ended).

Vacuum pump motor horsepower (estimated): 170 ÷ 20 = 8.5

VACUUM AND VACUUM REGULATORS

A primary goal in the design and operation of a milking system is to minimize the variation of vacuum at the teat end. Stable vacuum reduces stress on the teats, thus reducing teat end damage that can ultimately lead to increased udder infection.

Cyclic Vacuum Fluctuations

Some vacuum variation is normal and necessary during operation of a milking system. As an inflation opens and closes, vacuum at the teat end varies. This variation in vacuum level is repetitious, occurs in a systematic, routine fashion, and is referred to as a cyclic vacuum fluctuation.

Another form of cyclic vacuum fluctuation is associated with milkflow. Air is admitted to the claw through vents to help move milk to the milkline. Once milk has entered the milkline, flow is primarily by gravity. Cyclic vacuum fluctuations occur because the quantity of milk in the hose leading from the claw to the milkline varies. Each 1 ft column of milk produces a 0.9" Hg vacuum change.

With a high-producing, fast-milking cow, the milkhose may be nearly full of milk. If the milkline is 5 ft above the cow's udder this column of milk will result in a 4.5" Hg decrease in vacuum at the teat end relative to the vacuum in the milkline. As milking is completed and milkflow through the milkhose decreases, the vacuum at the teat end will gradually increase until it is nearly the same as the vacuum level in the milkline.

With a milkline 2 ft below the udder, if the milkhose is full of milk, the vacuum at the teat end will be nearly 1.8" Hg higher than the milkline vacuum. Hence, teat end vacuum must be defined as a function of milkflow. In all cases, vacuum relief through the vent causes a decrease in claw vacuum compared to the milkline.

Another cause of normal cyclic vacuum fluctuation is friction due to the flow of air through a line. If the velocity of air doubles, vacuum losses increase fourfold. Therefore, limiting air velocities to a reasonable level is very important. A maximum air velocity of 25 ft/sec or 1500 ft/min provides an acceptable balance between vacuum losses due to friction and large pipe sizes. This criterion is used in sizing all lines leading from the vacuum pump to the sanitary trap and the regulator.

Irregular Vacuum Fluctuations

Irregular vacuum fluctuations are the result of nonroutine happenings within the milking system. Research has shown that new infections are markedly increased when irregular vacuum fluctuations are superimposed on cyclic vacuum fluctuations. Thus, elimination of irregular vacuum fluctuations is an essential part of a mastitis control program.

One cause of irregular vacuum fluctutations is operating too many milker units per milkline slope. As milkflow varies, the space between the milk and the top of the pipe also varies. Too many units per milkline slope results in a very small air space. Very high air velocities are thus necessary for operation of the milking unit. Since vacuum loss due to friction varies with the square of the air velocity, the consequence is excessive frictional losses and increased vacuum fluctuation at the teat. This source of irregular vacuum fluctuation can be eliminated by assuring that milklines are installed at the proper slope and by not attaching more units per milkline slope than 3-A recommendations (Table 4, page 32).

The performance of the milking system can usually be improved by changing from a single slope to a double slope milkline with half the units attached on each side. This change requires a double inlet receiver and modification of the washing system.

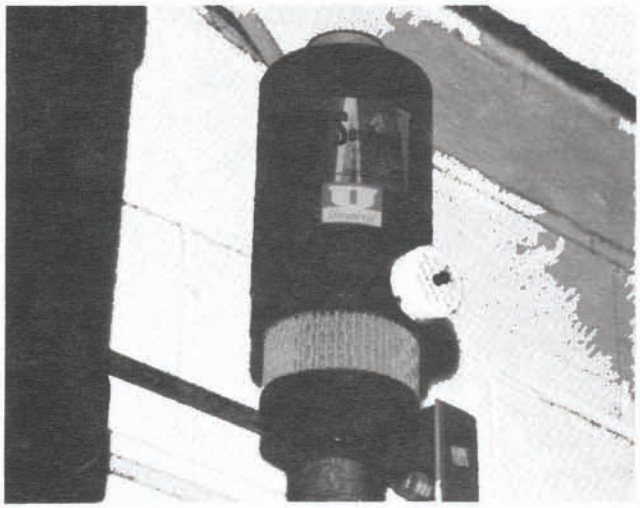
A more severe cause of irregular vacuum fluctuation is abrupt air admission to the system. A squawking liner is one example of how this occurs. **Inadequate vacuum system design** or function and **poor operator technique in attachment or removal** of milking units are two common causes of abrupt air admissions. Never remove the milking unit without first shutting off vacuum to the claw.

Maintaining Stable Vacuum

Simply having the vacuum pump start when the switch is thrown does not necessarily mean the system is operating properly. Routine maintenance is necessary to assure proper lubrication, clean filters, and tightness of belts. A complete system check should be made every six months or after 500 hours of system operation to check for leaks, line restrictions and worn parts.

The development of good milking techniques is equally as important as system design in eliminating irregular vacuum fluctuations. Any habit, such as squeezing inflation stems to sense milkflow, must be discontinued. Procedures which minimize the admission of air during the attachment and removal of units are essential. During unit attachment keep the inflation stem bent in a slight S-shaped turn against the claw ferrule until the cup assembly is in an upright position, ready to slide onto the teat. Use vacuum shutoff valves to allow complete release of vacuum before unit removal. See NebGuide G86-778.

Do not assume everything is operating correctly simply because a parlor is equipped with automatic detachers. Good performance requires the operator to learn proper equipment operational procedures. Routine maintenance is required to assure that vacuum shutoff valves, milk sensing devices, and similar components are functioning properly. A build-up of solids on valves and valve seats, damaged valves and clogged vents are frequently observed faults.



Select a regulator which limits vacuum drop to 0.5 inches Hg during system operation. Test all regulators after installation.

Vacuum Regulators

A vacuum regulator is used to maintain stable vacuum. Wide variations in performance exist between the various makes and styles of vacuum regulators. Careful selection and installation of the regulator are essential to good milking system function.

As the airflow through the various system components changes, the airflow through the regulator must change to balance vacuum pump capacity against air being admitted elsewhere in the system. During such occurrences as a unit drop-off or a sudden admission of air due to poor operator technique or squawking, the regulator must partially close to maintain a constant vacuum level within the system.

The ability of a regulator to accurately sense and control vacuum levels is closely associated with the design of the regulator. Direct-sensing style regulators in which vacuum levels are sensed at the point of air admission will nearly always provide less stable vacuum than servo-diaphragm style regulators. In servo-diaphragm regulators, the sensing of vacuum level takes place away from the point of actual air admission. This distance will range from several inches to as much as 25 ft depending upon regulator make and design. Examples of the various types of regulators are listed in Table 1.

Table 1. Regulator styles, in order of decreasing sensitivity.

Regulator style	Examples
Servo-diaphragm	Sentinel, DeLaval 2-50, Bou-Matic 180, Westfalia Vacurex
Spring-loaded sleeve	Surge Equalizer, Conde, Bou-Matic
Weighted sleeve	Surge oil-bath
Dead weight or weighted lever	Universal, DeLaval, Bou-Matic

Figure 1 shows "typical" response curves for different styles of regulators. The curves represent approximate average responses based on tests of over 250 regulators on a wide variety of systems and installations.

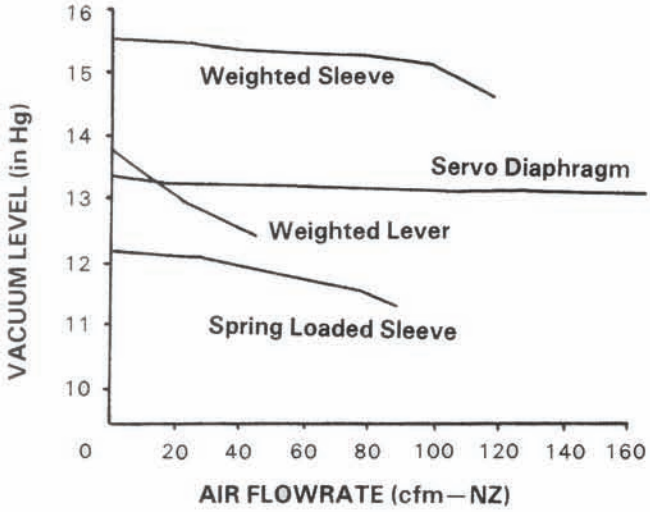


Figure 1. Typical sensitivity and response of different styles of vacuum regulators.

Current industry guidelines for vacuum regulator performance (3-A Accepted Practices, No. 606-02, Section 0) states: "The sensitivity of the regulator should be such that there will be not more than 1" of mercury fluctuation in vacuum under any operation condition." A similar statement can be found in *The Modern Way to Efficient Milking* published by the Milking Machine Manufacturers Council (1985 edition, page 30).

Based on our experience with many herds, the availability of more sensitive regulators and the importance of stable vacuum in controlling mastitis, current UNL guidelines for vacuum regulator performance state that the vacuum level should be maintained within 0.5" Hg of the regulator setpoint when the system loading airflow rate is varied from zero to within 90 percent of system capacity. The regulator setpoint is determined by allowing all air to enter the system through the regulator and reading the corresponding vacuum level. Regulator response is checked by loading the system by admitting air through a calibrated airflow meter positioned at the receiver. As the airflow rate through the meter increases, the airflow rate through the regulator decreases. The vacuum level is checked at each airflow rate through the meter across the full range from setpoint to 90 percent of system capacity. Vacuum levels should be checked with a mercury manometer.

The vacuum level of primary concern in a milking system is teat end vacuum. However, teat end vacuum levels must be defined in terms of the rate of milkflow and milk production from a given cow. At the same time, unless the regulator is performing properly and maintaining a stable vacuum level at the receiver, stable vacuum at the claw is an impossible goal.

Maintenance

Maintenance of the vacuum regulator is important for proper operation. All makes and models require periodic cleaning. Cleaning involves more than replacing the foam or paper filter which accompanies most regulators or cleaning the metal filter on some other styles. All vacuum regulators should be disassembled and thoroughly cleaned at least monthly. Use a mild detergent and water solution to clean all parts. Do not use solvents on any plastic component. A more powerful solvent can be used for most metallic-type regulators. After cleaning, all parts should be thoroughly rinsed, allowed to dry, and then re-assembled.

With some regulators the vacuum level adjustment screw must be loosened to allow disassembly. In such cases the vacuum level **must be reset** following reassembly. Vacuum levels must be returned to their previous level following cleaning.

Most manufacturers recommend that no lubricants be applied to the regulator. However, in some cases a light film of silicone or Teflon® spray will improve regulator response by allowing surfaces to slide more easily. Under no circumstances should oil be used because of changes in viscosity with temperature and because of the tendency to accumulate dirt. Where regulators routinely stick, polishing of moving parts with a piece of fine emery cloth will sometimes improve clearances sufficiently to allow better response and improved operation. A chronically non-responsive regulator should be replaced. A single regulator of adequate capacity for a given system is preferable to multiple regulators.

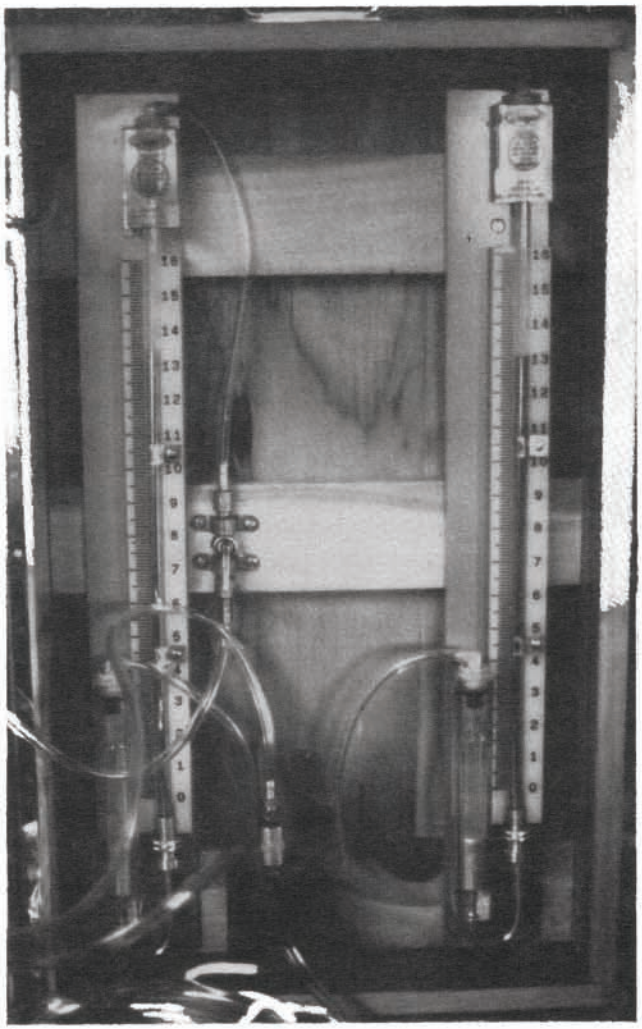
Always select the most responsive and sensitive type regulator which is available for systems of your size. Following installation, test the regulator to determine its response on your system. Do not assume any regulator is working right regardless of age or make. Test it! Only through good regulator performance and careful design of the entire system can the goal of eliminating irregular vacuum fluctuations be achieved.

Regulator response evaluation criteria:

0-0.5" Hg—OK

0.5-1.0" Hg—Caution! Regulator sensitivity is questionable.

>1.0" Hg—Danger! Clean and re-test regulator. If performance is not improved, replace regulator.



Accurate measurement of vacuum levels requires use of a mercury manometer.

AIR VENTS

Air vents within the claw assembly of a milking system are necessary to admit air to move milk from the claw into the milkline or weigh jar. Some companies recommend the use of small vents placed in the base of the shell or in the inflation stem or tail piece. Others use a vent in the claw itself. Research has not confirmed that one location is significantly better than the other; however, research has confirmed the importance of properly sized vents. Vents in the claw should be between 0.040 and 0.052 in. in diameter (#55-60 drill bit). Vents in the inflation stems should be sized so the combination of four inflation stem vents provide the same total cross-sectional area as individual claw vents. Since area is a function of the diameter squared, inflation stem vents should be about one-half the diameter of claw vents. With this small diameter, the potential for clogging due to dirt, debris, and milk solids build-up is increased. Routine maintenance to assure that vents stay open is essential.

Some producers have taken the attitude that if a little venting is good, a lot more is better. That is not true. Excessive air admission increases the potential for high bacteria counts. Increased agitation of milk through increased air bubbling can result in reduced shelf-life, increased rancidity, and in some cases, increased pre-incubated (PI) bacteria counts due to conditions more conducive to the growth of psychrotrophic bacteria. Limited field experience also suggests that excessive venting can result in uneven milk-out. As a rule, it will also result in slower milking since the difference in pressure between the udder and the milking system will be reduced due to relief of the vacuum in the claw through the vent opening. Under no circumstances should claw vent diameters exceed 0.052 in.

The use of vents in both the claw and the inflation stems should be avoided. If your system is equipped with vents in both locations, one or the other should be removed or otherwise closed.

The vent also serves a function during unit removal. When vacuum is shut off through a valve or automatic detacher unit, waiting a few seconds will allow vacuum to be relieved through the vent. After the relief of the vacuum, the claw assembly can be removed with minimal stress to the teats. Improperly adjusted claw removal devices can cause teat injury even if the vacuum is shut off. Thus, proper adjustment of the total system is essential.

HOSES—STORAGE and MAINTENANCE

Proper storage of all rubber goods, including inflations, is required to maintain them in good condition. High temperatures, sunlight, and ozone produced by electric motor operation are particularly detrimental to rubber materials. Inventories of inflations, air tubes, gaskets, and other rubber components of a milking system should **not** be stored within the utility room. The heat and ozone produced by compressor and vacuum pump motors causes accelerated deterioration.

Inventories of rubber goods should be stored in a separate, cool room, preferably in an operational refrigerator set at about 40°F. This protects the rubber from high temperatures, exposure to sunlight, and keeps them in a clean location. A refrigerator does not, however, prevent contact between the rubber and ozone which might be present in the air. Ventilation and separation distance are necessary to prevent deterioration from this source.

Proper pulsation requires that the small air tubes and pulsator hoses be maintained in good condition. Air leaks prevent complete opening of the inflations and premature closing, thereby resulting in decreased milking rates and non-uniform milk-out. Inspect air tubes at least once daily, and after any unit has been dropped or kicked off by an animal. Repair sharp corners and damaged claw ferrules to prevent cutting the inner surfaces of rubber products.

Cuts and cracks shorten the useful life of a rubber product. They can also result in an increase in bacteria counts due to development of an area that is difficult to clean and thus likely to enhance bacterial multiplication. Similarly, inflations which have become cracked and checked through age, use, or exposure to chlorine cleaning products can increase bacteria counts due to poor cleaning.

For optimum milking system performance, all rubber hoses and accessories must be kept clean and in good condition. Periodic replacement of all flexible milking system components (including those made of plastic) is a necessary part of producing milk.

Store extra rubber goods in a cool, dry area away from sunlight and electric motors.

INFLATIONS OR LINERS—SELECTION AND CARE

"The milking machine is the only piece of equipment on a modern-day dairy farm that routinely works on living tissue." That statement is often used to emphasize the importance of maintaining a milking system in a functional condition. The inflation or liner is part of the teat cup assembly and is the only part of a milking system that has direct contact with living tissue. Well-designed inflations in good condition are essential for good milking and to minimize stress or injury to the teat which can adversely affect the ability to control mastitis.

The inflation allows varying but cyclic levels of vacuum to be applied to the teat to achieve milking. By alternately opening and closing during the pulsation cycle, the inflation allows a differential pressure to exist between the udder (positive pressure, above zero) and the milking system (negative pressure or vacuum, below zero) across the end of the teat. During the closed or rest phase the inflation collapses due to a vacuum inside the inflation and atmospheric air pressure outside of the inflation (between the inflation and the shell), thereby shutting off vacuum to the teat and allowing increased circulation of blood within the teat. During the milking phase, vacuum is present in the teat chamber inside the inflation and in the space between the inflation and shell. The stretch or elasticity of the inflation causes it to open. The opening/closing action depends upon the maintenance of good elasticity within the inflation walls. Inflations which have become hardened through excessive use, contact with chlorine base cleaners, age, exposure to heat, or improper selection may not provide an adequate seal around the thick part of the teat near the end of the teat. Failure to obtain a good seal around the "end" of the teat results in an increased incidence of squawking.

As a cow milks, the length of the teat typically is increased by 30-40% within the teat cup assembly. The use of liners with a very low coefficient of friction can result in an increase in teat length that is perhaps 50-60% normal teat length. The extended teat or the use of inflations with a short body can result in the teat extending into the teat cup sufficiently far to be below the level at which inflation closure takes place. The result is teat injury due to continual exposure of the teat end to vacuum.

Similar difficulties have been reported by some producers who are using triangular and square inflations. The design of these inflations prevents complete closure under some operation modes. This can be particularly critical with animals having long teats. The reported result is irritation of a small area around the teat orifice. This irritation is significant since the teat end is the part of the cow's anatomy most directly responsible for the control of new infections. Producers who are experiencing difficulties with irritation around the teat orifice should try an alternative inflation design which might work better on their cows.

Another consideration in inflation selection is the diameter of the mouthpiece opening. Many producers perceive this opening as being the primary seal between the teat and the milking system. While it does serve the function of providing a mechanical seal to help reduce the entrance of dirt, contaminated water and other debris, it is not the primary vacuum seal. That responsibility lies within the inflation itself. Large mouthpiece diameters increase the risk of milk contamination. Undersize mouthpieces inhibit milking by compressing the teat and partially restricting the opening between the udder cistern and the teat. This same problem occurs if teat cups "creep" up too far on the teat.

Problems with variations in mouthpiece diameter have been observed on systems using two-piece shells and inflations which are field-formed around a metal ring. Variations in mouthpiece diameter of up to 1/4" have been measured on systems with just four units (16 inflations). Since all inflations start out being the same length, variations in mouthpiece diameter mean variations in liner stretch and milking characteristics. These problems appear to be the result of both poor inflation-forming technique and slippage around the metal mouthpiece ring as the inflation is used.

Inflations which are too stiff either by design or because of hardening through extended use or milk solids accumulation may fail to maintain an airtight seal around the teat and may close too slowly or incompletely to allow proper circulation of blood during the rest phase of the pulsation cycle. Similarly, inflations which have been used too long and have lost their elasticity may close prematurely or may not open completely, resulting in slower milking.

Using inflations for more milkings than recommended by the manufacturer is a common problem with some dairymen. The recommendation of most manufacturers is to use inflations for a maximum of 1,200 individual cow milkings. Although some manufacturers recommend longer time intervals, producers should look carefully at the actual cost per milking. In many cases, the longer inflation use intervals actually do not save money. In fact, the risk of decreased elasticity, increased hardness and other factors which affect milking may result in an increased cost of producing milk due to increased teat tissue injury and slower milking.

Inflations develop tiny hairline cracks and become rough with use and exposure to chlorine cleaning agents. Since the teat continually slides up and down within the inflation during milking, any increased roughness can cause irritation of the skin surface. Anything which adversely affects the health of the teat tissue will adversely affect the ability of a producer to maintain an effective mastitis control program. Hence, im-

properly selected, stored, or cleaned inflations can have a direct impact on teat health and infections. They can also cause unacceptably high bacteria counts due to poor cleaning.

Unfortunately, there is no technique available to determine which of the many inflations available on the market is best for a particular herd other than through trial and error. Any producer who is dissatisfied with the basic milking system function after having been assured that he has proper vacuum pump capacity, a sensitive regulator, proper line sizes and a properly functioning pulsation system should consider trying several different inflations until he finds one which works best on his herd with minimal squawking. Although it is generally best to stay with the inflations recommended by the manufacturer of a milking system, there are cases where variations in bore, body length, body diameter, hardness and stiffness of the inflation may justify use of a competitive brand. Once an inflation is identified that works well in your herd, write down the model number to assure that you continue to obtain the same one. Some manufacturers have up to five different inflations available for a given teat cup or shell design. Since outward appearance is very similar, only through observation of the model number can you be assured of getting the proper product. This is critical since not all dealers stock all model numbers of available inflations, even those provided by their company.

INFLATION CHANGE GUIDELINES

Inflations used on a milking system must be kept in a state of good repair for efficient harvesting of the milk crop. Using inflations for time intervals exceeding the manufacturer's recommendations can contribute to poor milking system performance due to loss of elasticity of the "rubber", lack of flexure due to hardening, and irritated teats caused by incomplete closure of the inflation. Excessive use can also lead to increased bacteria counts and associated decreases in milk quality as milk fats become absorbed in the rubber.

Recommended inflation change intervals are given in Table 1. This table was developed based on 1,200 individual cow milkings which is consistent with recommendations of most manufacturers.

An example of how to use the table: A 60-cow herd is milked in a double-4 herringbone parlor with 8 units. What is the maximum recommended number of days use on a set of inflations? In Table 1, read across from the 60-cow herd size until the column under 8 units is reached. The answer is 80 days.

Producers who milk three times per day (3X) can determine their inflation change interval by multiplying the numbers in the table by two-thirds. Thus, a producer on a 3X milking program should change inflations every 80 x 2/3 = 53 days.

Where the manufacturer's recommendations are different from 1,200 individual cow milkings, the proper inflation change interval can be determined by one of two methods:

A. Multiply the numbers in Table 1 by the ratio of the number of cow milkings recommended by the manufacturer, divided by 1,200. For example, if the manufacturer recommends that inflations be used for only 1,000 individual cow milkings, multiply the numbers in Table 1 by 1,000 ÷ 1,200 = 0.83. For the previous example that means inflations should be changed every 80 x 0.83 = 66 days.

B. Calculate the appropriate change interval from the following equation:

$$\text{Days} = \frac{\text{No. milkings per set of inflations x No. units}}{\text{No. cows x No. milkings per day}}$$

For the earlier example, the equation is worked as follows:

$$\text{Days} = \frac{1000 \times 8}{60 \times 2} = 66.7 = 67 \text{ or about every 9-10 weeks.}$$

Table 1. Recommended inflation change intervals in days (based on 1,200 individual cow milkings and 2X per day milking).

No. cows milked	Number of milking units											
	2	3	4	5	6	7	8	10	12	14	16	20
20	60	90	120	150	180	—	—	—	—	—	—	—
30	40	60	80	100	120	140	160	200	—	—	—	—
40	30	45	60	75	90	105	120	150	180	—	—	—
50	24	36	48	60	72	84	96	120	144	168	—	—
60	20	30	40	50	60	70	80	100	120	140	160	200
80	15	22	30	37	45	52	60	75	90	105	120	150
100	12	18	24	30	36	42	48	60	72	84	96	120
125	—	14	19	24	29	34	38	48	58	67	77	96
150	—	12	16	20	24	28	32	40	48	56	64	80
175	—	—	14	17	20	24	27	34	41	48	55	68
200	—	—	—	15	18	21	24	30	36	42	48	60
225	—	—	—	13	16	19	21	27	32	37	43	53
250	—	—	—	—	14	17	19	24	29	34	38	48
275	—	—	—	—	13	15	17	22	26	30	35	44
300	—	—	—	—	12	14	16	20	24	28	32	40

Chlorine cleaners accelerate the rate of deterioration of rubber components of a milking system. If strong cleaners (sometimes called "rubber cleaners") are used regularly, reduce the time between inflation changes by 10 to 20 percent. Always rinse a milking system thoroughly immediately after washing with chlorine-base cleaners.

A recommended practice for many years was to rotate inflations on a weekly basis. The inflations being "rested" were soaked in a lye solution to remove milk fats, rinsed, and allowed to dry. This practice was believed to extend the useful life of the inflations. Current recommendations do not include rotation of inflations. Even if inflations are rotated, do not extend the length of total use. Instead, accept as your compensation for the extra labor involved in changing inflations the fact that they are probably doing a better job of milking while they are used.

As with all rubber goods, the deterioration of inflations is accelerated by exposure to high temperatures, sunlight, and ozone. Consequently, rubber goods should not be stored on open shelves in a utility room housing vacuum pumps, compressors, etc. If you maintain an inventory of rubber goods on your farm, storage should be in an operational refrigerator set at about 40°F and away from motors.

MILKING SYSTEM VACUUM TESTS

A properly functioning milking system is an essential component of a mastitis control program. Three basic tests should be performed on all milking systems at least every six months or after 500 hours of operation and after any changes in the system, to assure functional adequacy. Run these tests on your equipment. A calibrated airflow meter equipped with a vacuum gauge is the only piece of equipment necessary. However, a mercury manometer increases accuracy of readings. Tests can be run using either New Zealand (NZ) or American (ASME) airflow standards. The calibration of the airflow meter will determine which standard is used.

Test No. 1—Vacuum pump capacity

Pump: Make:_____Model:_____

Motor Hp:_____

Manufacturer's rated airflow capacity:_____cfm,

(NZ_____ASME_____, check one)

This test will determine how the vacuum pump is performing under a given set of atmospheric conditions and provides a basis for tests 2 and 3. The test is always made at a vacuum level of 15" mercury (Hg), the standard at which pumps are rated. Locate the airflow meter as near the inlet of the pump as possible. Usually this means disconnecting the line between the vacuum pump and distribution or reserve tank. Start with the airflow meter open and gradually close it until a vacuum level of 15" Hg is registered on the gauge. Record the airflow rate and compare with the manufacturer's specifications.

Results: Airflow rate_____cfm @ 15" Hg

Check one: NZ_____ASME_____

Location of flowmeter for test: _____

A pump airflow capacity more than 3% below the manufacturer's rating suggests a pump problem. Possible problems include loose belts, leaking seals and chipped or broken pump vanes.

Test No. 2—Vacuum system capacity

Leaks, pipe restrictions, and vacuum losses associated with airflow through the pipes always result in system capacity—airflow available at the receiver jar to actually operate the milkers—being less than pump capacity. Acceptable losses as a percentage of pump capacity are: systems up to 100 cfm (NZ)—10%; systems between 100 and 150 cfm (NZ)—7-10%; and systems in excess of 150 cfm (NZ)—5-7%. Ideally, the test should be made with all milker units disconnected and nipples (including pulsators) capped. If this is not possible, add a consumption rate of 2 cfm (NZ) per milking unit (vents) and/or pulsator (if operating) to the measured system capacity before estimating losses. The airflow meter should be located at the receiver jar for this test. Usually the probe inlet can be used. Start with the airflow meter

A regular check of vacuum pump belts for proper tension will help assure adequate airflow.

open and gradually close it until a vacuum level of 15" Hg is reached. Record measured airflow. The vacuum regulator must be removed from the system for this test. Use a plug or cap to close the regulator mounting pipe.

Results: Measured airflow rate_____cfm @ 15" Hg

If units **or** pulsators are attached during test, add 2 cfm (NZ)/unit: + _____

If units and pulsators are attached during test, add 4 cfm (NZ)/unit: + _____

Estimated total system capacity_____cfm.

Subtract Test No. 2 results (total) from Test No. 1:_____cfm.

Divide preceding value by Test No. 1 results:

_____% difference.

Compare % difference with previously listed standards. If % difference is greater than standard values, check system for leaks or pipe restrictions.

Location during test: flowmeter:_____

vacuum gauge or manometer: _____

Test No. 3—Regulator response/sensitivity

Regulator: Make:_____Model:_____

Location:_____

Stable vacuum at the receiver helps assure minimal vacuum fluctuations at the teat which could predispose the cow to mastitis. A vacuum regulator is used to maintain vacuum at a pre-set level by varying the amount of air admitted as air admission through operational components varies. Increasing the airflow through the flowmeter (used to simulate milker units, milk meters, etc.) is called "loading" the system. The regulator should maintain vacuum levels within 0.5" Hg from the regulator setpoint (all air through regulator, or airflow meter closed and no units in use) to a loading rate equal to 90% of system capacity (Test No. 2 results). Allowance must be made for any leakage through the vacuum regulator. Replace the regulator (removed for Test No. 2). Insert the airflow meter into the system at the receiver jar or nearby. Determine the upper airflow rate (within 90% of Test 2 results, with consideration for regulator leakage) then divide the airflow into five or more approximately equal steps. For example, if the system capacity is 100 cfm (NZ), appropriate readings would be 0 (setpoint), 20, 40, 60, 80, and 90 cfm. Start with the airflow meter closed to determine regulator setpoint.

Results:

Air admission thru flowmeter, cfm	Vacuum level, Inches Hg
0	Setpoint:_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Erratic gauge behavior with changes in airflow suggests a dirty or sticky regulator. Clean regulator and rerun test. If erratic behavior still occurs it's a characteristic of the regulator or the regulator mounting location. If the change in vacuum level exceeds 0.5" Hg, the regulator may need to be re-located (re-tested, too), or replaced. A vacuum level variation of 0.5" to 1.0" Hg signals a "caution" condition. If the vacuum level variation exceeds 1.0" Hg, corrective action or replacement of the regulator is necessary.

Tests performed by: _____

Date:_____

PULSATOR TESTS

Proper pulsator action and pulsation system performance are essential to good milking. The precise characteristics of pulsator action varies between companies. Consequently, in any given milking system, the most important criterion is to assure consistency in operation between individual pulsators. This is necessary to assure that cows are milked very nearly the same regardless of the stall they happen to enter on successive milkings.

A routine daily inspection should be made to assure that all inflations, short air tubes and pulsator hoses are in good condition. Cracks in air tubes can result in improper opening and closing action of the inflations, thereby resulting in improper and inconsistent milking and increased risk of teat tissue trauma. Cracked inflations can result in high bacteria counts, poor milking, and, generally, poor udder health.

Another important check is to verify that the air inlet of the pulsator is open and clean. Restricted air inlets, whether due to insects, dust, manure, or other accumulated debris, result in the pulsator opening and closing improperly since atmospheric air pressure is not allowed into the system.

Quick Test

A simple and easy test of pulsator action is using a short length of milk hose equipped with a pipe fitting, an elbow, and a vacuum gauge (Figure 1). This device, when inserted into the shell end of the short air tube, can be observed and checked for smooth opening/closing action of the pulsators. The vacuum gauge should return to "0" as each pulsator admits atmospheric air and allows the inflation to close. During the "milking" phase the gauge reading should be the same as the overall system vacuum level. Vacuum variations exceeding 1" Hg or failure to close indicate a fault in the pulsator or leaks in the system. Since pulsator action will vary from company to company, the most important criterion is that the gauge moves in the same basic pattern between pulsators in a given system. Glitches, jerks, and similar erratic movement indicate that corrective procedures are necessary. In systems equipped for alternating front and back pulsation, be certain to check an air tube on both a front and a rear inflation teat cup assembly on each unit. The optimum test would be to check every air tube of every unit. This procedure would assure that the claw pulsation tee is not clogged or otherwise restricting airflow.

Pulsation Graphs

To more accurately evaluate pulsator performance, a recording should be made. Various types of recorders are available. Those which use straight air pressure or vacuum to activate a recording needle generally result in smoother curves, but may fail to indicate small errors in operation. At the other extreme are recorders which utilize electronic sensors or transducers to convert very slight vacuum level fluctuations into an electrical signal, which in turn drives the recording pen. Care must be exercised in interpreting these graphs since very small variations may be magnified and may lead to erroneous conclusions. The use of a recording is highly desirable whenever questions arise as to pulsator operation based on the preceding "quick test". Again, the consistency of operation should be evaluated. A pulsation graph allows quick and easy determination of proper opening and closing of pulsators, pulsation rate and milk:rest ratios.

Possible Causes

If either of the preceding tests indicates inconsistent pulsator operation, additional tests should be conducted to determine the reason for this inconsistency. Possible causes of problems include: cracked, worn or clogged air tubes, pulsation hoses or inflations; undersized or clogged pulsator lines; dead-ended pulsator lines (both ends of a pulsation line should be looped back to the distribution tank) (minimum pulsation line sizes are shown in Table 1); clogged pulsator vents; dirty or sticky pulsator plungers; worn, cracked, or hardened pulsator plunger seals or caps; worn or damaged pulsator valve seats; clogged inflation hose distribution tees or manifolds; broken or cracked inflation shells; and improper seals between the inflation and the inflation shell, either at the mouthpiece end or around the inflation stem.

Table 1. Minimum recommended line sizes for individual unit pulsation.

No. units	Minimum pipe diameter, inches	
	Dead-end	Looped*
Up to 5	1 1/4	1 1/4
5 to 7	1 1/2	1 1/4
8 to 12	2	1 1/2
13 to 18	3	2
Over 18	NR**	3

*If the pulsation line is dead-ended or if both ends of the pulsator line do not terminate at the distribution/reserve tank, use the next larger line size.
**NR = not recommended

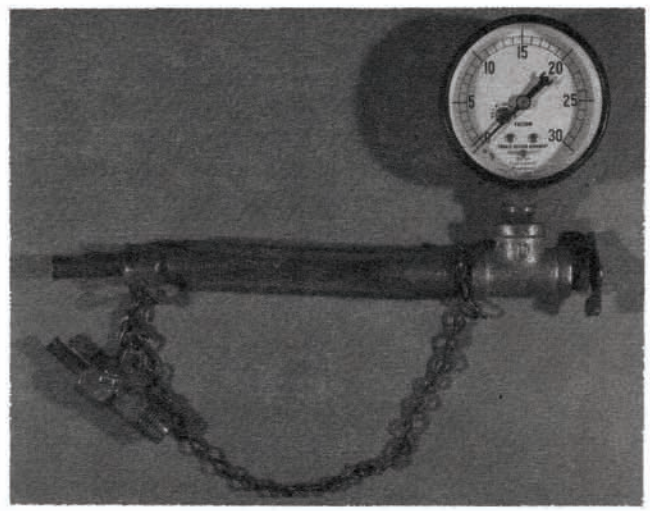
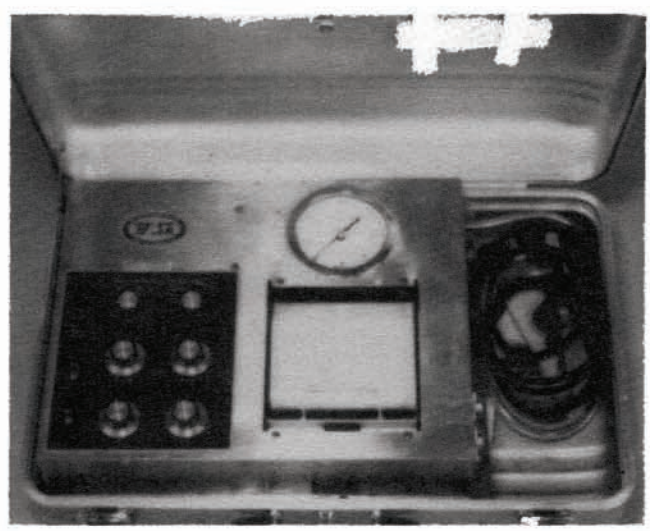


Figure 1. Vacuum gauge assembly to allow "quick test" of pulsator operation.



A vacuum recorder should be used at 90-day intervals to accurately evaluate pulsator operation and to check pulsators judged questionable with quick test.

MILKING SYSTEM CLEANING—BASIC PROCEDURES AND GUIDELINES

Production of high quality milk requires that all milk contact surfaces be kept clean. Failure to use good sanitation practices, failure to adequately prepare the cow for milking, lack of timely maintenance on milking system components and faulty milking system wash cycle function can result in high raw plate (SPC) and pre-incubated (PI) bacteria counts. The result is lower milk quality and in some cases, depending upon the milk market, reduced prices for milk sold. In extreme cases the right to market milk must be forfeited.

Manual cleaning of milking systems relies heavily on mechanical abrasion or brushing to clean milk contact surfaces. Clean-in-place (CIP) washing of milking systems relies primarily upon water velocity for the "scrubbing" action. In conjunction with specially developed chemicals, CIP cleaning is effective provided water volume, temperature, and velocity are appropriate. Cleaning solution concentration, contact time and system drainage are the other elements of good cleaning system function.

Proper cleaning begins with good system design and installation. Thus, your milking equipment dealer is a key element in assuring that a system is kept clean. **All** lines—whether or not they are classified as a "milk contact surface"—must be installed to assure drainage. Low spots must be avoided at all costs. All lines should be installed to allow inspection of interior surfaces. To the extent possible all lines should be installed to facilitate periodic cleaning.

Cleaning Procedures

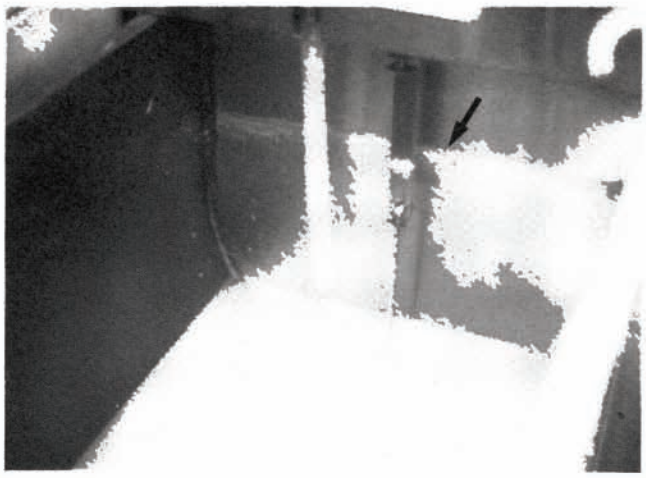
Federal and State milk production regulations (Pasteurized Milk Ordinance or PMO) require the milking system to be cleaned and sanitized after every milking. Rinsing after every milking and washing just once per day is not an approved or accepted practice. The recommended cleaning procedure is:

1. **Pre-rinse**—Immediately **after** every milking, circulate lukewarm water through the entire system, continuously discharging circulated water until discharged water runs clear. Rinse water should **not** be re-circulated through the milking system. Water temperature should be maintained between 95° and 110°F. Water temperatures below 95°F allow milk solids to solidify and be redeposited on the surface of the pipeline, weigh jars, claws, etc. At temperatures much above 160°F protein in the milk film will bake onto contact surfaces. Either situation makes subsequent cleaning much more difficult. Remember—water is a cheap cleaner! (see Table 1). Failure to thoroughly rinse milk solids out of the system increases the need for expensive detergents during the wash cycle to remove milk residue. Rinsing after each milking with just plain water removes approximately 70% of the milk residue from system surfaces. Residual milk film allows rapid bacterial growth.

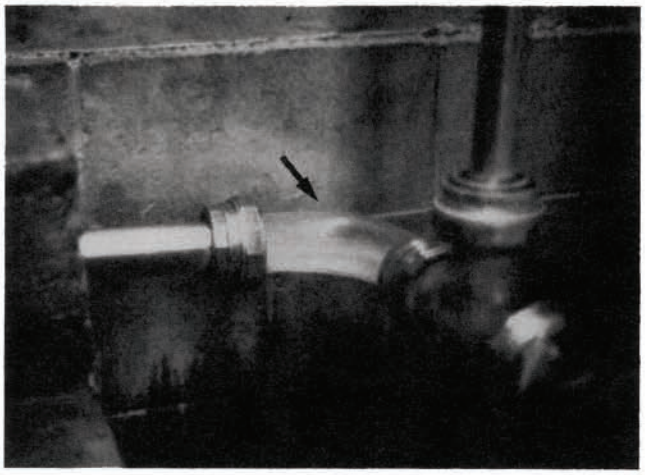
2. **Wash**—Following rinsing, the system should be washed with a chlorinated alkaline cleaner. The chlorine helps dissolve proteins and phosphates provide detergency and hold milk solids in suspension. Water temperatures should be maintained between 120° and 160°F. If necessary, use hot water circulated through a plate cooler or an auxiliary wash vat heater to maintain temperatures in this range (see Table 2). Lower temperatures require special cleaning chemicals. Wash cycle water should generally be re-circulated for at least 10 minutes.

3. **Rinse**—Chlorine shortens the useful life of rubber milking system components. An acid rinse lasting 3 to 5 minutes with a water temperature between 95° and 110°F should be used to remove residual chlorine. Avoid using hot water. Hot water causes the pipeline to dry too quickly, leaving behind a mineral film.

Note that an acid rinse uses different products than an acid wash. Acid wash products are used in extreme cases as a "shock treatment" to remove stubborn min-



Re-circulation of first rinse water after milking increases need for chemicals during wash cycle. Discharge rinse water. Do not re-circulate.



Improperly sloped lines increase vacuum fluctuations and make system washing difficult. All lines must be self-draining.

eral films. They contain a detergent. Proper washing and use of an acid rinse on a routine basis generally eliminates the need for use of acid wash products.

To reduce the growth of bacteria between milkings all components must drain completely. Complete drainage enhances drying of system surfaces which further inhibits bacterial growth. All hoses, including those servicing the claw wash manifold, must be installed to assure complete drainage or equipped with self-opening drains. Experience indicates that such devices have a fairly low level of dependability. Carefully observe all lines on a routine basis to assure that complete drainage is occurring. Some claw designs also require special attention to assure complete drainage.

4. **Sanitize**—The final step in milking system cleaning is to sanitize all surfaces. This step should be performed immediately **before** each milking (within 1 hour of milking). Use a solution temperature of 95° to 110°F and a cycle time of 3 to 5 minutes. Do not rinse the system after sanitizing but do allow time for excess water to drain from the system.

Water Quality

Good quality water is essential to good cleaning. Hard water (high in mineral content) requires more detergent to achieve proper cleaning. Have your equipment dealer or fieldman evaluate your water on a regular basis (at least every six months). Adjust cleaning chemical concentrations to assure proper solution strength per the manufacturer's recommendations. In some cases, a water softener or conditioner should be installed to remove excess minerals from water used to clean milking equipment. In many cases, the reduction in cleaning chemicals more than offsets the cost of the water softener.

Water Quantity

The amount of water necessary to achieve good cleaning varies with the size of milking system. Estimated minimum water requirements are listed in Table 1.

Table 1. Estimated minimum water requirements for efficient CIP cleaning of pipeline milking systems.

Milkline diameter, in.	Gal. of water per ft. of milkline
1 1/2	0.063
2	0.100
2 1/2	0.130
3	0.170

Plus: 2 gal. per receiver
2 gal. per milk pump and discharge pipe
1 gal. per weigh jar

Assure that wash vats are of adequate size to hold the required quantity of water. Undersized vats increase the required quantity of cleaning chemicals resulting in increased costs and may result in decreased milk quality.

Smaller milklines (1 1/2" and 2") can usually be washed satisfactorily with a suction line into the vat which is one size smaller. Larger lines (2 1/2" and 3") require a second wash cycle inlet pipe which leads from the vat directly to the milkline. The entry point should be within several feet of the receiver. A milk/wash valve is used to direct water in the proper direction. It is not possible to properly wash 2 1/2" and 3" milklines with water admitted through unit washers only. Systems equipped with weigh jars should include dead-ended washlines to assure that all water goes through the jars. A separate wash line for the jars and units is desirable. A special "splitter tee" should be used to divide the water flow. Do not "loop" the wash line around the parlor even if it is dead-ended.

Water Temperature

Proper washing solution temperature is essential. Although special low temperature cleaning chemicals are available, higher chemical costs frequently result in little or no net savings. Examples of minimum recommended water heater sizes are: double-4 parlor—80 gal. and double-8 parlor—120 gal.

A wash vat booster heater or a plate cooler with hot water circulated through the coils should be used to maintain water temperatures within the proper range throughout the cycle. Both initial and end-of-cycle temperatures are important. Estimated booster heater size requirements are listed in Table 2. Contact your equipment dealer for additional heater selection guidance and installation. For safety reasons, make certain the electrical system is installed in accordance with the *National Electrical Code.*

Table 2. Wash vat booster heater requirements to maintain minimum temperatures.

Milkline diameter, in.	Heater size, watts per ft. of milkline
1 1/2	50
2	70
2 1/2	90
3	110

Water Velocity

Air is used to increase the velocity of wash water. On 1 1/2" diameter milklines a continuous air bleed is satisfactory. Systems with 2" diameter or larger milklines must have an air injector. In addition to modifying the water velocity which increases "scrubbing" action, intermittent jets of air cause the water to "pile up". This slugging action is necessary to clean upper surfaces of the pipelines.

Cycle Time

The cycle time suggested under cleaning procedures are normal minimums. Follow recommendations of the manufacturer of your equipment.

Cleaning Chemicals

Use only specially formulated chemicals to wash your milking system. **Never** use household cleansers to clean any part of a milking system. Use a chemical concentration as recommended by the manufacturer for your quality water.

Source: Adapted from materials and information received from Babson Brothers Co. and DeLaval Agricultural Division of Alfa Laval Corp.

MILKING SYSTEM CLEANING—FILM DEPOSIT TROUBLESHOOTING

Evaluating the cause of cleaning problems in a clean-in-place (CIP) milking system is difficult. Raw plate (SPC) and pre-incubated (PI) bacteria counts provide an overview of the quality of washing. However, determination of the cause of problems still depends upon the ability to observe the nature of deposits on the milk contact surfaces. The following chart provides guidelines to aid in visually diagnosing cleaning system problems.

Description (appearance)	Film deposit	Probable cause[a]	Removal	Prevention
Blue-rainbow hue varnish like "applesauce"	Protein	Less than twice-a-day cleaning. Improper initial cleanup. Inadequate pre-rinse. Using non-chlorinated cleaner. Water temperature too high.	See "Pipeline Protein Film"	Twice-a-day wash. Adequate pre-rinse. Proper cleaning with proper strength wash solution. Chlorinated alkaline detergent. Use proper water temperatures.
White to yellow	Milkstone or waterstone	Mineral from milk. Mineral from water.	Initial cleaning. Acid wash.	Regular and proper cleaning procedure. Make detergent compatible with water. Acid rinse when necessary.
Hanging water droplets. Greasy (white) appearance. Oil.	Fat/grease	Same as protein. Low water temp. or weak detergent concentration. Using acids for washing instead of alkaline detergent. Pulsator oil on equipment surface.	Initial clean-up. Use "shock treatment" (see "Pipeline Protein Film")	Regular and proper cleaning procedures.
Red to brown/black.	Iron	Water supply. Iron from system components or source cleaning. Improper procedures. Too much chlorine.	Acid wash	Regular effective acid rinse. Proper selection of sanitizers. Water treatment.
White to gray glazed appearance.	Silica	Poor rinsing. Failure to manually clean outside surface of CIP equipment. Use of CIP where manual cleaning is needed. Water supply.	Special acid or, if necessary, special detergents for silicates.	Complete post-rinse. Regular acid wash. Manually clean outside surface of CIP equipment. Water treatment.
Black in rubber parts. Black residue	Inking (blacking) Black	Reaction between chlorine or chlorinated compound and rubber. Contact of dissimilar materials.	Thorough post rinse. Acid pre-wash. If not removed, replace.	Proper installation. Thorough post rinse. Acid pre-rinse. Proper dry storage.

Description (appearance)	Film deposit	Probable cause[a]	Removal	Prevention
Blue	Wetting agent	Inadequate rinsing.	Use "shock treatment" for initial cleanup. See "Pipeline Protein Film"	Proper rinsing. Proper detergent.
Grease, factory dirt, black deposit, rusting	Factory soil	Improper initial cleanup of new equipment.	Use "shock treatment" for initial cleanup. See "Pipeline Protein Film"	Thorough cleaning before new equipment is initially used.
Rust/pitting	Corrosion	Iron, tramp metal particles, improper detergent or sanitizer usage. Contact of dissimilar materials. Freezing of sanitizing solution on cooler.	Acid wash and abrasive action. Repolishing (buffing) if bad corrosion.	Proper procedures and passivating[b] acid rinse. For repassivation procedures, contact equipment dealer.
Pitted and white discoloration "embedded" in stainless steel surface	Etching	Improper use of detergent or sanitizer. Use of non-compatible chemicals.	Repolish-repassivation	(same as rust/pitting)
PLASTICS[c]—in addition to preceding problems				
Lack of transparency White-not clear	Opaque	Improper draining. Moisture absorption.	Exposure to heat and/or light (sunlight).	Good drainage. Blower or dryer. Ventilation.
		Mineral film.	Acid wash.	Regular & proper cleaning. Make detergent compatible with water. Acidified rinse when necessary.
		Protein film.	Acid wash with "shock treatment" See "Pipeline Protein Film"	Chlorinated alkaline detergent. Proper cleaning with proper strength wash solution. Adequate pre-rinse. Twice-a-day wash.
Yellow color	Yellow	Old age. Improper use of iodophor. Hand soil stain.	None	Proper product application. Replace periodically.

Description (appearance)	Film deposit	Probable cause[a]	Removal	Prevention
Brown discoloration	Brown-black	Rubber migration. Carbon from motors or dryers.	Acid wash—if not removed, replace.	Acid rinse. Proper filtration. Segregation of plastics & rubber. Replace periodically.
Red color-stain	Red	Serratia marcescens (a type of bacteria)	None	Proper procedures on **regular** basis.
Pink-purple color	Pink-purple	Streptococcus rubrireticuli (a type of bacteria)	Strong alkaline wash.	Proper procedures on **regular** basis.

[a]Causes for films and deposits are all in the realm of poor procedures (improper cleaning, rinsing, etc.) or incompatible products. In mechanical cleaning, problems may also be due to malfunction of the system, lack of proper solution strength, or improper water temperature.

[b]Conditioning process for stainless steel.

[c]After continuous use, periodic replacement of plastic materials is eventually necessary.

Pipeline Protein Film

The "applesauce" occasionally found in pipelines is the result of accumulated protein film. To ascertain whether or not a film is protein, brush a chlorinated cleaner on a small area. Film will be removed if it is protein.

Protein film accumulation is the result of one or both of the following:

1. Weak wash solution.
2. Pipelines being washed less than twice a day.

To remove protein film:

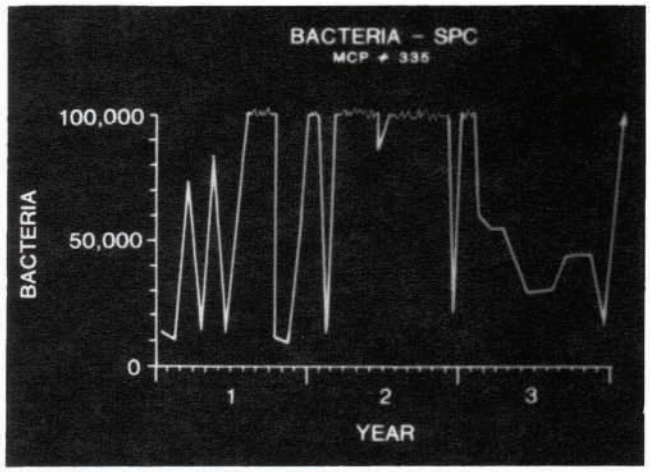
"Shock treatment"

1. Rinse equipment thoroughly with clean 100-115 °F water for 3-5 minutes.
2. Wash pipeline with 145-165 °F water containing acid cleaner at a concentration recommended by the manufacturer. Maintain water temperature.
3. Rinse pipeline thoroughly with clear, warm (100-115 °F) water to remove all traces of acid.
4. Mix a solution of chlorinated, alkaline pipeline wash solution per manufacturer's recommendations. To this, add one cupful (8 oz.) of rubber cleaner and one-half gallon of a concentrated chlorine sanitizer. Circulate this solution for 20 minutes.

!!!WARNING: THIS SUPER-STRENGTH SOLUTION IS HARMFUL TO EYES, SKIN AND CLOTHING!!!

5. Rinse thoroughly with clean, warm (100-115 °F) water for 3-5 minutes.
6. Check several sections or parts of the equipment to determine if cleaning is adequate. Occasionally this operation may have to be repeated where excessive contamination exists. Once the protein film has been removed, keep the pipeline free from further accumulation by using specially prepared pipeline cleaners at the proper strength after each operation of the pipeline system.

Source: Adapted from materials provided by DeLaval Agricultural Division—Alfa Laval Corporation.



Improper washing is a major cause of high bacteria counts.

MILKING PROCEDURES

MILKING PRACTICES

Udder Pre-Milking Stimulation and Cleaning

Effective mastitis control requires that you always milk only **clean, dry** udders.

The recommended procedure for pre-milking preparation and stimulation is:

1. Wash teats using the hand and hose-dispensed warm water (100° to 105°F) with sanitizer. Where a drop hose is not feasible (e.g., tie-stall barn), use single-use paper towels dipped in a bucket of warm water with sanitizer. Never dip a towel in the bucket after it has contacted a cow.
2. Dry the teats with single-use paper towels. No towel should be used on more than one cow. Use a new clean towel after drying a known infected quarter before drying another teat.
3. Strip and examine the foremilk for abnormalities indicative of clinical mastitis. Early detection—and treatment if appropriate—is important. Record observation and treatment used. Avoid trying to wash and check foremilk simultaneously.
4. Attach the milker unit with minimal air admission as soon as the teats become flushed indicating let-down has occurred. The entire procedure should require less than one minute from start to finish. Preparing one cow and attaching the milker before moving to the next animal can control lag-time and conserve labor by reducing the number of trips between cows.
5. Milker's hands should be thoroughly washed before milking and periodically during milking but especially after handling cows known to be infected.
6. The Pasteurized Milk Ordinance (PMO) requires that udders be sanitized before milking. The most practical method to meet this requirement is to dispense sanitizer into the udder wash water.
7. Excess water does not help clean—it only increases the chance of milk and teat contamination from water running down the udder and onto the teats or into the milker. Install hoses with directional nozzles and reduce the water pressure to a maximum of 30 psi. Results will be use of less water and sanitizer, and reduction of the wetted cow surface, thus minimizing the chance of milk contamination.

Foremilking

Examination of the foremilk by stripping onto the floor or into a strip cup will allow earlier detection of clinical mastitis. Avoid trying to wash and strip/examine foremilk simultaneously. Foremilking also aids in achieving good milk let-down.

Lag-Time

Lag-time is the elapsed time from the **start** of udder prepping until the unit is attached to the udder. Recommended lag-time is in the range of 45-60 seconds.

Attachment and Alignment of Milker Unit

Milker unit attachment with minimal air admission and correct milker unit alignment reduces stress on the teats. Reduce air admission during attachment by keeping the inflation stem bent into a slight "S" shape over the claw ferrule until the cup is ready to slide onto the teat. Keep the claw unit properly aligned with the base of the udder to provide minimal squawking. Use a hose support arm, if necessary, to support the weight of the hoses and hold them in a proper position to prevent twisting of the claw relative to the udder. Hose support arms are a good investment in nearly all systems.

Milker On-Time

Most cows will be milked-out in 5 to 7 minutes. Unit on-times will vary depending upon milking system operation (milk:rest ratio, pulsation rate and vacuum level), cow production level, and cow milkflow characteristics.

Squawking

Squawking causes irregular vacuum fluctuations. It is highly undesirable and detrimental to good udder health. Squawking may result in aerosol jets of milk being driven through the claw and into the other teats. If the milk from an infected quarter is driven into the teat of a previously uninfected quarter, a new mastitis infection could easily occur.

The cause of squawking may be: 1) insufficient or faulty vacuum system; 2) incorrect inflation size/hardness to match your herd; 3) improper unit support/alignment; 4) light quarters.

Check Milkflow

A visible means of checking milkflow is desirable. Transparent milkhoses or sections of the claw are common.

Do not squeeze the inflation stem to check milkflow. Doing so causes extreme vacuum fluctuations, increasing the risk of new infections.

Claw Removal

Remove the claw promptly when milkflow has ceased. **Never** remove the claw—or a teat cup—without first turning off the vacuum. Use a vacuum shutoff valve. If you do not have a vacuum shutoff valve, one should be installed. If individual teat cups must be removed, first shut off the vacuum by pressing the inflation stem against the claw ferrule and removing the teat cup with the other hand.

Units should be attached when teats become flushed, indicating let-down has occurred.

Incomplete drying of teats and udders increases the risk of infections and decreases milk quality. Note water droplets on ends of teats.

Teat Dipping

Teat dipping is a critical part of any mastitis control program. Teat dipping helps control new infections and should be continued throughout the year. In cold weather continue to dip. Wait 20-30 seconds, then blot excess dip from the end of the teats with a single-use paper towel. Allow the teats to dry before turning the cows out to minimize frostbite. If an ointment intended to reduce the risk of freeze injury is used, apply it **after** dipping and drying. Such products are not a substitute for teat dipping. Special care is necessary whenever the wind-chill is below 10 °F. The best prevention against frostbite is adequate housing.

The use of vitamin A/D/E cream is recommended on injured teats regardless of cause. Such products soften the teat to reduce cracking, help exclude dirt from the injury, and tend to stimulate healing.

Dip the teats on cows for the week following drying off and the week before freshening as this is a period of high incidence of new infections.

Cow-Side Test

The use of the California Mastitis Test (CMT), or equivalent, on a regular basis is helpful in identifying quarters harboring subclinical mastitis. Record test results. The information is valuable in determining trends and causes thereof which influence management decisions. This test is complementary to individual cow somatic cell count testing.

Rinse Teat Cups

Rinse teat cups, claws, milkhoses and weigh jars after milking treated or infected cows to reduce the chance of spreading mastitis and to minimize the possibility of antibiotic contamination of tank milk.

Milking Order

Reduce the transmission of mastitis pathogens via your hands and the milker unit by milking cows in the following order:

1. First-calf heifers and cows which are known to be clean (non-infected).
2. Cows known to be infected, or being treated.

Milk treated cows last to reduce the chance of getting antibiotic contaminated milk into the bulk tank. In some herds, maintaining a "clean" group and an "infected" group might be justified and feasible. Either grouping or severe culling is essential in herds with a high rate of infection.

Cow Cleanliness

Cow cleanliness plays an important role in overall herd health and mastitis control. It is also important in producing high quality milk and reducing labor requirements. Keeping udders clipped facilitates keeping cows clean. A clean, dry resting area is essential. Mud and manure clinging to the cow indicate cow lot and environment conditions are not acceptable. Dirty cows are a violation of the Federal and State Pasteurized Milk Ordinance.

Cow Condition

The feeding program will determine the condition of the cows and ensure a production response from a good mastitis control program. Effective mastitis control does not require special feeding, just a good overall nutritional program.

TEAT AND UDDER STIMULATION—TO GET THE MILK

To realize profit from any operation, maximizing the volume and quality of the salable product is necessary. Harvesting milk in the dairy business is no exception and certain procedures are recommended to provide maximum yield while preventing problems that reduce quality. Mastitis affects quality and when an infected cow is not milked-out properly the duration of infection can increase.

Although there is a small amount of milk stored in the teat—and the cistern above the teat—the majority of milk is retained in the alveoli close to where it is produced by the secretory cells. The anatomy of this portion of the mammary gland is structured so that when proper teat and udder stimulation occurs the myoepithelium (small muscle-like tissue) surrounding the cells of the alveoli will contract. The contraction of the myoepithelium causes a reduction in alveolar size (volume), thus causing milk ejection into the duct system of the udder. The stimulation of the teats before milking activates a neurohormonal chain of events that is called the milk "let-down" reflex. Gentle handling of the teats sends a nerve impulse to the cow's brain which triggers the pituitary gland to secrete the hormone oxytocin which circulates via the blood stream and, in turn, activates the alveolar myoepithelium.

Oxytocin is necessary to harvest all the milk but timing of its activity is critical. Within a minute of stimulation oxytocin is secreted. Its activity lasts only 5 to 8 minutes. As oxytocin is released, milk pressure in the udder is greatly increased which enhances milk harvest. Milk that is not removed from the alveoli is called residual milk and sometimes may amount to 20-25% of a cow's production.

It is important to not irritate or frighten the cow before or during milking as the "hold-up" hormone, adrenaline (from the adrenal gland) will be released, counteracting the oxytocin activity. It may take 15-20 minutes for the effects of adrenaline to subside. For these reasons timing and gentleness are important in harvesting the milk. Full cooperation from the cow is absolutely necessary. The relationship between time, milk pressure, and cow cooperation and its effect on milk harvest, is illustrated in Figures 1 and 2.

Milking at regular intervals utilizing gentle procedures for complete milk-out is recommended. Milking units should be attached to a clean, dry udder within one minute of initial teat stimulation and the cow should be milked completely out before 7 minutes have elapsed. It is critical to follow these guidelines as approximately half of the available oxytocin activity has disappeared within 7-8 minutes. Remember, poor stimulation, long lag-times, slow milking, pain, or fright in the cow may rob the producer of optimum production. Make the milking process a pleasant experience for both the cow and the operator!

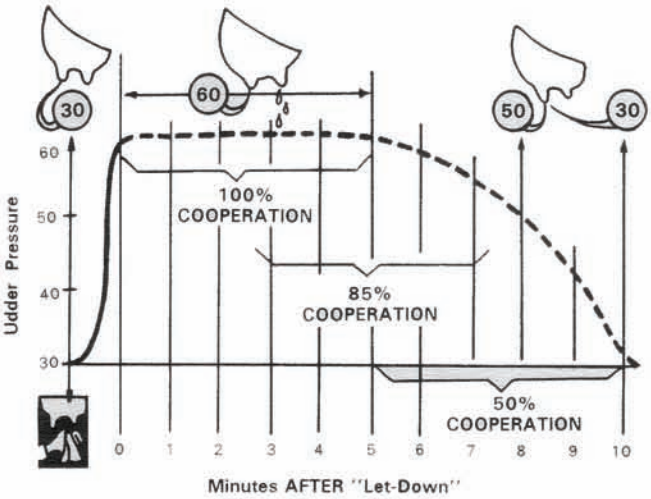


Figure 1. **Stimulation of the udder causes a release of oxytocin and an increase in udder pressure. Timing is critical for efficient milking. (Turner, Chas. W. "Harvesting Your Milk Crop". 1962, Revised 1981)**

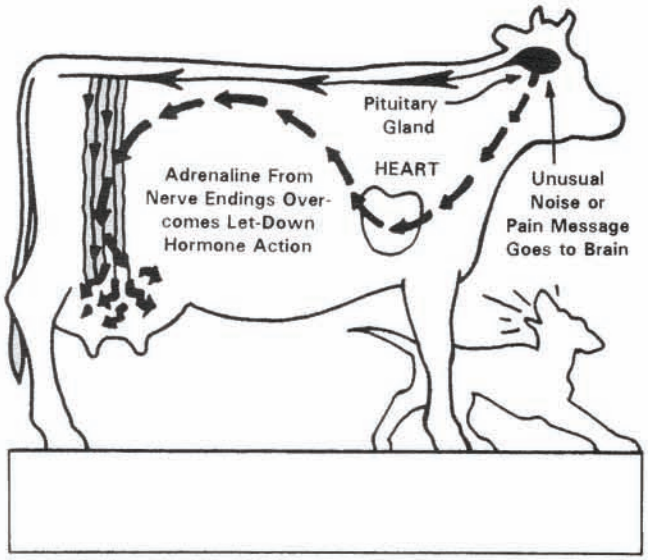


Figure 2. **The "hold-up" hormone (adrenaline) disturbs proper "let-down". (Turner, Chas. W. "Harvesting Your Milk Crop". 1962, Revised 1981)**

SQUAWKING—IMPORTANCE AND CONTROL

Squawking, or liner slips, is the inadvertent admission of air to a milking system between the teat and inflation. Researchers continue to identify it as the most detrimental of all outward indicators of poor milking procedures or poor milking system function. Direct adverse effects are evidenced by irritation of the teat on which squawking is taking place. Since the teat is the part of the cow's anatomy most directly responsible for controlling new infections, the undesirability of this action is obvious. Plainly stated, anything that adversely affects the condition and health of teat tissue will hinder efforts to establish and maintain an effective mastitis control program.

Squawking also increases the likelihood of tiny aerosols of milk (impacts) being driven by high velocity air (measured as high as several hundred miles per hour) into the orifice of other teats. This phenomenon is referred to as "reverse droplet impact". Should the aerosols contain mastitis pathogens, the potential for new infections to be established in otherwise clean quarters is greatly increased. Research at Cornell University has shown that during such extreme vacuum fluctuations, there is actually a higher pressure in the teat cup (liner) than in the teat, causing a force to move milk particles up into the teat canal.

All appropriate and necessary steps should be taken to minimize and eliminate squawking. Survey results indicate that a typical squawking rate is 1:4-6 cows milked. In contrast, one producer checked had no squawkings during milking of 12 cows. Any incidence of squawking which exceeds the ratio of 1:2 is absolutely inappropriate and immediate steps should be taken to remedy the situation. The National Mastitis Council recommends a maximum incidence of squawking of 1:20.

Among the possible causes (either individually or in any combination) of squawking are:

1. *Inappropriate inflation or liner selection.* Select an inflation having an appropriate hardness, bore, length, and mouthpiece diameter for your herd. Try different styles and models of inflations until you find one that works best on the majority of your cows.

2. *Inadequate vacuum pump capacity, line sizes, or excessive system leaks and dirty lines.* Be sure all components of your milking system are properly sized and well maintained.

3. *Poor regulator response.* An insensitive regulator can result in extreme vacuum fluctuations. Be sure your regulator responds properly to varying loads. Keep your regulator clean.

4. *Improper unit alignment.* Keep the claw assembly well aligned with the udder to ensure a good seal between the teat and inflation. The claw should set squarely under the udder. Do not allow the claw assembly to twist relative to the udder. Keep the claw adjusted so it sets parallel to the base of the udder.

5. *Improper use of unit support mechanism.* Some systems include independent claw support mechanisms to help keep the unit properly aligned with the udder. Avoid using such mechanisms to exert excessive forward or downward tension on the claw.

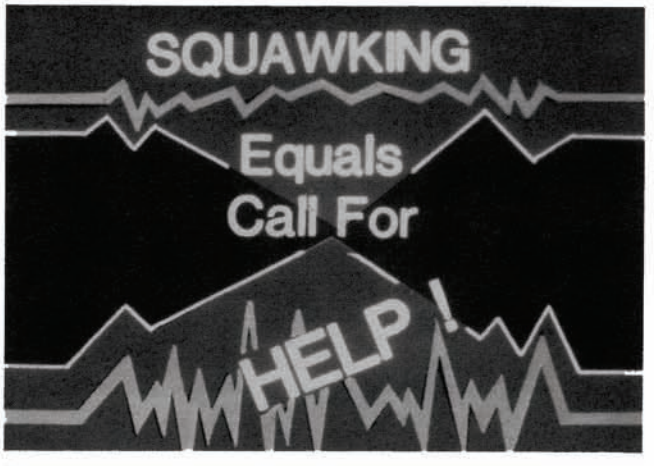
6. *Twisted inflations.* Inflations which are twisted inside the shell prevent the teat from being inserted properly, resulting in a poor vacuum seal. Be sure index marks on the inflation stem and mouthpiece are kept aligned.

7. *Poor milking procedures.* Be sure the udder and teats are clean and thoroughly dried before attaching the unit. Avoid attaching units before let-down occurs and teats become flushed. Remove units promptly when milkflow ceases. Avoid overmilking. Exercise extreme care in checking udders to verify end of milkflow.

8. *Light quarters.* Light quarters result in a poor seal between the teat and inflation. Since most light quarters are the result of previous mastitis problems in that quarter, the potential for infection being present is above average. Both factors increase the importance of preventing squawking on those quarters.

9. *Improper vacuum levels.* Maintain vacuum levels in the proper range for your milking system: Low line—11-13" Hg; mid-height line (includes most systems with weigh jars and detachers)—12-14" Hg; high line—13-15" Hg. Low vacuum levels can be the result of improper regulator adjustment or sensitivity; malfunctioning, improperly located or poorly calibrated vacuum gauge; or vacuum system deficiencies.

Although squawking is most likely to have detrimental effects on the cow on which squawking is occurring, the shock waves set up in the milking system can also cause stress on other cows being milked. Squeezing inflation stems to sense milkflow and removal of teat cups without first having turned off the vacuum can cause problems similar to those resulting from squawking. Both practices should be avoided.



Squawking, or liner slips, indicates problems, can cause teat irritation and increases new infections due to "reverse droplet" impact.

VETERINARY PROCEDURES

BASIC VETERINARY PRACTICES

Your veterinarian is trained and has the expertise to help you establish and maintain an effective mastitis control program. Realize that mastitis is a **herd problem** and mastitis control mandates that we identify and correct causes of the problem. Some types of mastitis cannot be treated effectively. In such cases, the cow should be culled. Modern control measures include such items as proper monitoring, sampling, interpretation of laboratory results and proper treatment selection. These are important parts of the program. Thorough understanding requires knowledge your veterinarian possesses.

Identification of Probable Infected Quarters (Cow-Side Test)

The California Mastitis Test (CMT), or equivalent, is a valuable tool to help identify subclinically infected quarters. We recommend daily sampling of problem cows and periodic (6-week intervals) herd CMT testing. This provides information concerning herd mastitis level and is accurate, easy, and rapid. It is also important to have the CMT results to correlate with cow composite milk sample cultures to determine the probable infected quarter. Record all test results on individual cow health charts. Your fieldman can help you procure a CMT test kit, and teach you proper technique.

Milk Sampling

Sampling of the entire herd, or a representative portion in some cases, will aid in identification of the bacteria (organism) causing mastitis. In addition, culturing of milk from clinically affected cows provides early information about new cases. Sampling of clinicals for culturing must be performed before treatment is started. Quality samples are necessary to identify organisms, therefore, the collection of samples without contamination is important. Have your veterinarian collect or teach you how to collect and properly ship aseptic samples to the laboratory. The laboratory report will be sent to you and your veterinarian. He will help you interpret results and advise corrective measures.

Herd Mastitis Recommendations

If you request it, interpretation, evaluation and recommendations in the area of veterinary medicine will immediately follow our receipt of the culture and CMT results from the UNL Veterinary Diagnostic Laboratory. To obtain this service, please specify on your sample submission form that a copy of the laboratory report be sent to Dr. Rice. Your veterinarian will receive a copy of this information.

Proper treatment of clinical cases should be administered using veterinary recommendations. As a general rule, administer treatment for at least one additional day after definite response is evident. That is, treat until the udder and milk appear to be normal, **plus one day!** A minimum of three days treatment should be used in all clinical cases.

Teat End Health

Regardless of mastitis type, teat ends are the first line of defense in mastitis prevention. Injury due to trauma, freezing, irritating teat dips, disease, and milking machine malfunction are common and must be prevented. Good, effective shelter and windbreaks are a must to prevent teat-end freezing when wind chills reach 10°F or lower. Teat freezing may occur even more easily and at warmer temperatures when the heifer or cow is near calving and the teats and udder are engorged causing poor circulation. High infection rates occur following any type of injury.

Complete Health Records

Records are essential in establishing and maintaining an effective program of preventive medicine and to obtain accurate, early diagnosis of health problems. A complete understanding of the entire herd and individual cow histories is essential and available only through reliable and up-to-date records. Establish a record system which is easy to maintain, conveniently located, and simple so interpretations can be made promptly and without confusion. An individual lifetime health record should be developed and maintained for each cow. Some of the most important information to be recorded includes date of birth, vaccinations, breeding, calvings, treatments, post-calving condition, past problems, and all mastitis and reproductive data. This is especially important to avoid antibiotic residue problems in meat or milk.

Records must be analyzed periodically to determine problem areas. Place emphasis where the greatest economic loss is occurring.

DHIA records—in conjunction with an individual cow health record—will meet the needs of this program. You and your veterinarian should develop a system best suited for your herd.

Records are of no value if they're not used! Learn how to maintain, interpret, and use all records, such as DHIA production and SCC data.

TEAT DIPS

Alphabetical List According to Active Ingredient

Active Ingredient	Manufacturer
Chlorhexidine	
A&L Hex Dip (0.5%)	National Purity Soap & Chemical
Anchor (0.5%)	North American Philips
Anchor Concentrate (2.0%)	North American Philips
BioGuard CHG (0.5%)	Bio-Lab, Inc.
Bou-Matic Super Dip (0.35% + 0.04% Quat)	Dairy Equipment Co.
Bou-Matic Super Dip	Dairy Equipment Co.
Chore-Boy Chlorhexidine Teat Dip #2522809	Chore-Boy
Darigard II (0.6%)	Ralston Purina
Della-Dip #1416694	DeLaval
Della-Dip (0.5%)	DeLaval
IBA Blue Ribbon (0.5%)	IBA, Inc.
IBA Chlorhexidine 4X (2.0%) Concentrate	IBA, Inc.
IBA FS 106 Teat Dip (0.75%)	IBA, Inc.
FRM-X (0.5%)	FRM Chemical, Inc.
Franklin Chlorasan (0.5%)	Fort Dodge Laboratories
Land-O-Lakes Proguard (0.5%)	A&L Laboratories, Inc.
Nolvasan Teat Dip (0.5%)	Fort Dodge Laboratories
Nu-X (0.5%)	FRM Chemical, Inc.
Protect (0.5%)	Enderon Chemical Company
Proteck (0.35%)	H. B. Fuller
Teatcare (0.425%)	Diversey Wyandotte Corp.
Universal Unidex (0.5%)	A&L Laboratories, Inc.
West Ag. Chloxidine (0.5%)	West Agro-Chemical Company
Iodine	
A&L Teat Dip (0.5%)	A&L Laboratories, Inc.
Bio-dip (0.5%)	Bio-Lab, Inc.
Bou-Matic Iodine Teat Dip (0.5%)	Dairy Equipment Co.
Bova-Dip (1.0%)	Beaulieu Chemical Company
Bovadine I (1.0%)	West Agro-Chemical Company
Bovadine II (0.25%)	West Agro-Chemical Company
Bovacide (1.0%)	Beaver Chemical Company
Chore Boy 1% Iodine Teat Dip	Chore Boy Division
Chore Boy Low Iodine Teat Dip	Chore Boy Division
Controlled Iodine Teat Dip (1.0%)	National Purity Soap & Chemical
DeLaval After Milking Teat Dip (0.5%)	Bonewitz Chemical Services—DeLaval
Della-Soft (0.5%)	Henkel Chemical Services, Inc.—DeLaval
Enderson Iodinal Teat Dip (1.0%)	Enderson Chemical Company
Farm/Dine (0.5%)	FRM Chemical Company
Full-Dip (1.0%)	H. B. Fuller (Monarch)
Hubbard Teat Dip (0.5%)	A&L Laboratories, Inc.
IBA FS 103 Teat Dip (0.5%)	IBA, Inc.
IBA FS 104 Teat Dip (0.5%)	IBA, Inc.
IBA FS 108 Teat Dip (0.10%)	IBA, Inc.
IBA FS 109 Teat Dip (0.25%)	IBA, Inc.
IBA Prevail (0.1%)	IBA, Inc.
ID-4 Kendall (0.35%)	Kendall Agricultural Products

Active Ingredient	Manufacturer
Iodine	
Iodip (1.0%)	Bio-Lab, Inc.
Io-dip (1.0%)	McKenzie & Rogers, Inc.
I-O-dip (1.0%)	Wesmar Company
Iocare (0.5%)	Fults Chemical, Inc.
Ioteat (1.0%)	Fults Chemical, Inc.
Lake-to-Lake (0.5%)	A&L Laboratories, Inc.
Land-O-Lakes (0.5%)	A&L Laboratories, Inc.
Liquid Udder Guard-ID-14 l(1.0%)	Klenzade
Master Mix - Master Dip (0.5%)	Bio-Lab, Inc.
Mastimin (1.0%)	Diversey Wyandotte Corp.
Medi-dip (0.5%)	Beaver Chemical Company
Mid Am Teat Dip (0.5%)	Henkel Chemical Services
Mid Am Teat Dip (0.5%)	A&L Laboratories, Inc.
Monarch-Full Dip (1.0%)	Monarch (Fuller)
Monarch Iodine Teat Dip (0.5%)	H. B. Fuller (Monarch)
Nu-dine (0.5%)	FRM Chemical Company
P3 Vetva 30	Henkel Chemical Services
Proclean (0.5%)	National Purity Soap & Chemical
Puridine I (1.0%)	Ralston Purina
Puridine II (0.5%)	Ralston Purina
Quarter Gard (0.25%)	Klenzade Products
Quartermate (0.1%)	West Agro-Chemical, Inc.
Sta-dip (0.5%)	A&L Laboratories, Inc.
Supersweet Dip-A-Dine (0.5%)	A&L Laboratories, Inc.
Teat Dip (0.5%)	Beaulieu Chemical Company
Teat Dip 1 (1.0%)	Beaver Chemical Company
Teat Dip 2 (0.5%)	Beaver Chemical Company
Teat Guard (1.0%)	Klenzade Products
Teat Kote (1.0%)	Babson Brothers Co.
Theratec	Babson Brothers Co.
Tilicon II (0.25%)	Diversey Wyandotte Corp.
Udder Guard (1.0%)	Klenzade Products
Universal UniDip (0.5%)	A&L Laboratories, Inc.
Latex	
Teat Shield - with Germicide (1.0% glyceromonolaurate)	Animal Care Products/3M
Seal Tite Teat Dip	Veterinary Concepts
Seal Tite II	Veterinary Concepts
Quaternary Ammonium Compounds	
Bou-Matic Quaternary Teat Dip (0.5% Blended Quats)	Dairy Equipment Co.
Farm Dip (0.5%)	FRM Chemical Company
IBA FS 105 Teat Dip (0.18%)	IBA, Inc.
Nu-dip (0.5%)	FRM Chemical, Inc.
Proclean (0.32%)	National Purity Soap & Chemical
Super Dip (0.35%)	Dairy Equipment Co.
Tegragon (.2% Active Quat)	Babson Brothers Co.
Universal Per Dip (0.32%)	A&L Laboratories, Inc.

Active Ingredient	Manufacturer
DodecylBenzene Sulfonic Acid (DDBSA liquids)	
AMPI Non-Iodine (1.94%)	Klenzade Products
Blugard (1.94%)	Klenzade Products
Blue Shield (1.4%) with barrier	Klenzade Products
Dairy-Mate Non-Iodine Barrier Teat Dip	Klenzade Products
Dairy-Mate Non-Iodine Teat Dip	Klenzade Products
IBA Tandem Teat Dip	IBA, Inc.
Per-Dip	Universal
Uni-Hex	Universal
West Agro Non-Iodine (1.94%) (linear DDBSA)	West Agro-Chemical Company
Miscellaneous Compounds (liquids)	
Before and After (1.0% capric & caprylic acid)	Diversey Wyandotte Corp.
Bio-Guard Teat Dip (0.18%)	Bio-Lab, Inc.
Chapless Teat Dip	Anchor Laboratories
Control (1.5% Septigon*)	Animal Care Products/3M
IBA Pova-Dip (.35% Povidone Iodine)	IBA, Inc.
TD 34 (bromine complex)	Babson Brothers Co.

*Septigon - dodocylamino propylglycine

PROCEDURES NECESSARY FOR TREATMENT AND/OR MILK SAMPLE COLLECTION FOR CULTURE

Intramammary treatment and aseptic milk sample collection require the same quality of teat end preparation. Absolute cleanliness is essential.

From the standpoint of mastitis control, it is imperative that subclinical infections be identified as they contribute to production loss and are the main source of infection for future clinical cases. The somatic cell tests, the Wisconsin Mastitis Test (WMT) and the California Mastitis Test (CMT), or equivalent, can be used to detect these quarters. The final test is identification of the bacteria involved in mastitis. Growth (culture), isolation, and identification of the infecting bacteria aid treatment and control measures. The laboratory work is wholly dependent upon **quality** of the milk sample submitted. For this reason, details of the sampling procedure will be stressed.

The objective in acquiring a milk sample for bacteriology is to obtain milk from the untreated quarter without contamination from outside sources, such as surface dirt and hair. Perform teat end clean-up in a clean, dry, well-lighted area comfortable for the cow and the operator. Samples are to be obtained before machine milking but after cleaning and foremilking. Treatment infusions are to be performed after milking. Sampling tubes should be conveniently arranged in a rack or wooden block by quarters and cow numbers. Sample before regular milking, that is, while the udder is full and **before any medication has been used.** Antibiotics in the milk will prevent growth of the organisms we are trying to grow and identify. Acute flareups should be sampled as soon as they are detected. As soon as the udder is prepared for milking, take cotton balls soaked in 70% alcohol and scrub the teat ends thoroughly to remove all traces of dirt and to disinfect. Use a fresh cotton swab for each teat. Swabs should be pre-soaked in alcohol and kept in a screw-capped jar. Disinfect and sample one teat at a time. Disinfecting all teats before extracting samples increases the risk of contamination. In preparing the teat end for intramammary infusion the same quality of teat clean-up is imperative. Do not touch the infusion tube "needle" during treatment.

Your veterinarian or the University of Nebraska Veterinary Diagnostic Centers can advise you where to obtain sterile sample vials. Do not use DHIA sample bottles or plastic "whirl packs." Remove the cap and carefully protect it from contamination. Discard two or three jets of milk, then fill the tube 1/2 full while it is held at a near horizontal position 1 to 2 inches from the teat end. Do not allow the cap or the lip of the tube to touch anything. This will minimize contamination. Immediately replace and tighten the cap without touching its inner surface. Be sure the tube is labeled with cow number and quarter. The samples must be refrigerated **immediately** and transported to the laboratory as soon as possible. A "styrofoam" box should be packed with coolant for adequate refrigeration during shipment. Frozen samples are acceptable when delays in delivery cannot be avoided.

The time for collection and shipment of milk samples to the Veterinary Diagnostic Center is also important. If the sampling day is Thursday or Friday, there is a risk of the specimens lying idle in the mail until deliveries resume on Monday; in this time the sample might spoil. For this reason, it is necessary to ensure the method of shipment does not incur delays through weekends or holidays. It would be preferable to retain the sample in a freezer until Monday rather than have it deteriorate due to loss of refrigeration in shipment. Samples collected as part of routine mastitis control programs should be shipped the day of collection and only between Sunday and Wednesday, avoiding holidays.

Attention to the preceding details will help maximize the quality of the sample and reduce waste of money and time. In the laboratory, each specimen will be examined for bacteria and an antibiotic susceptibility test will be performed when indicated.

It is essential that complete records be kept of each cow's medical history and test findings, especially those performed as cowside tests and laboratory tests so related data can be correlated. These procedures are tools used to diagnose mastitis in its broadest meaning and to help control the herd problem. Analysis of a group of factors, by the veterinarian, is necessary to yield information of greatest value. The analysis and, therefore, recommendations may vary from farm to farm.

Be sure teats are absolutely clean when collecting milk samples for culturing.

Regardless what laboratory you use to culture milk samples and identify causative organisms, insist that organisms be identified by both "first" and "last" names. Laboratory reports listing only "staph" or "strep" are of little value in determining the cause or source of infection.

COMMONLY OCCURRING MASTITIS-CAUSING BACTERIA AND THEIR CHARACTERISTICS

Mastitis can be caused by many different organisms. Injuries and severe bruises can also cause mastitis. The greatest risk from injuries is the increased likelihood of secondary infections. Infections are best prevented. Post-infection control of pathogens is expensive and not always successful. Despite more than 100 identified possible causes of mastitis, the specific bacteria listed account for an estimated 95% of all mastitis problems. Hence, adopting practices which lead to control of the listed bacteria is an essential part of any mastitis control program.

Streptococcus agalactiae: The source is generally from infected udders or contaminated milk. The infection tends to become chronic if not treated properly but response to treatment and eradication effort is favorable. Transmission occurs primarily during milking. Spreading is greater if udder cloths, sponges, or other poor milking procedures are used. Eradication requires good milking hygiene. Do not feed Strep ag. infected milk to calves.

Staphylococcus aureus: The source is generally from contaminated milk, teat sores, or operator's hands. The infection tends to become chronic and treatment response during lactation is poor. Staph infected cows pose a great risk of new infection to other cows. Good milking procedures, segregation of infected vs non-infected cows, proper machine function and maintaining healthy teats are very important. Infections caused by this organism are very contagious. Transmission is primarily during milking.

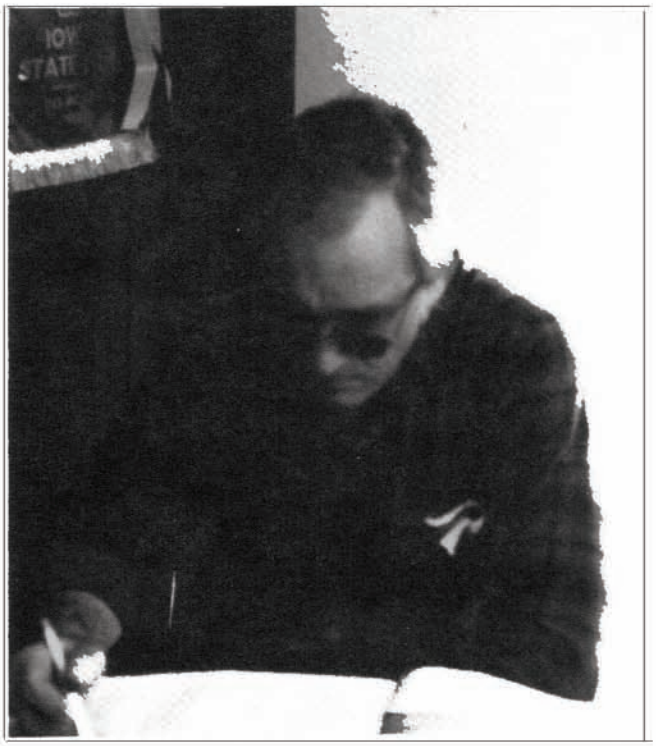
Streptococcus uberis and **dysgalactiae (Non-agalactiae streps):** The source is generally from the environment of the cow but most spreading occurs during milking. Infections may become chronic with variable response to treatment. Contributing factors related to incidence of infection include wet dirty cows, poor udder preparation techniques, milking wet udders, and management of the cow environment. The primary sources of Strep dysgalactiae are infected udders and skin lesions. Strep uberis is found on udder skin and is a major cause of infections prior to first-calving and during the dry period.

Escherichia-coli (E. coli): The source is usually the environment of the cow and/or fecal material. Most infections are self-limiting but occasionally infections are extremely acute and can cause death. Contributing factors related to incidence include wet, dirty cows; poor udder preparation practices; milking wet udders; and en-

vironmental management. Intense treatment procedures are necessary on clinicals. Treatment of subclinicals is generally not cost-effective.

Other Organisms: There are many other pathogenic organisms that can cause mastitis and create serious herd problems. Causative organisms must be cultured and identified to aid in determining probable source and establish procedures necessary to prevent further spread. It is not uncommon for transmission of some organisms to occur during careless or non-sterile treatment procedures. Contaminated medications, equipment and poor techniques are major factors associated with spread of yeast, mycoplasma, and various other pathogens.

Preventing new infections and eliminating existing infections are the basis of a total control program. All of the many types of organisms that cause mastitis can be controlled by proper implementation and maintenance of a total program. Various modifications may need to be utilized depending upon the circumstances. The basic plan requires properly functioning milking equipment, proper milking procedures, teat dipping and dry cow treatment, proper treatment of clinicals, culling of certain chronic cows, and maintenance of a healthful cow environment.



Accurate individual cow health records are an essential part of a mastitis control program.

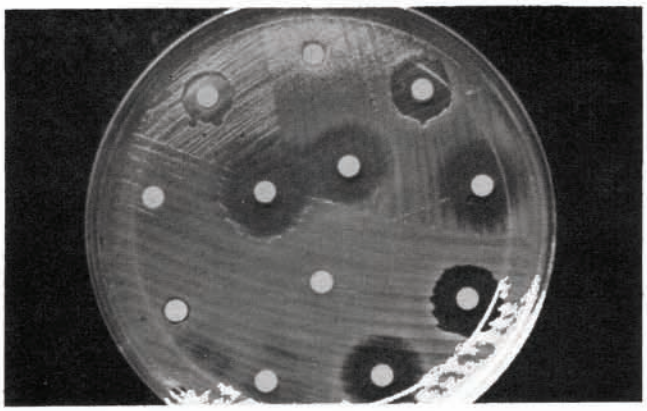
ANTIBIOTIC SUSCEPTIBILITY TESTING

Some confusion exists about antibiotic susceptibility or sensitivity tests. There is a lack of understanding about both their interpretation and the role such testing plays in a mastitis control program.

When a milk sample is examined for bacteria capable of causing mastitis, the bacteria found can be subjected to an antibiotic susceptibility test. In the laboratory the isolated bacteria are exposed to a variety of antibiotics. If the antibiotic slows or prevents organism growth that organism (bacteria) is assumed to be susceptible to that drug (antibiotic). If the organism continues to multiply it is assumed to be resistant to that antibiotic.

A single species of bacteria such as *Staphylococcus aureus* has many strains or types which may vary in their susceptibility to a given antibiotic. For this reason it is important to determine, in the laboratory, if a particular strain in a particular cow or herd is susceptible or resistant to various antibiotics. If an organism is resistant to a drug such as penicillin G, selection of penicillin for treatment of the cow would not be advised. Susceptibility to a specific antibiotic in the laboratory test **does not** necessarily mean that antibiotic will be effective in controlling the infection in the cow. This apparent contradiction is due to the many uncontrolled factors present in the live animal as opposed to the controlled conditions of the laboratory. Many of you have seen this happen in your own herds. The laboratory report indicates susceptibility, yet you are already administering that particular drug to no avail. In spite of this, standardized susceptibility testing is still the best estimate we have for predicting the effectiveness of an antibiotic. Over a period of time with individual animals or on a herd control program, antibiotic susceptibility testing is a valuable aid when it receives professional interpretation.

The point to be made is that a laboratory report indicating susceptibility of a bacterium to a particular antibiotic **does not** mean treatment with this antibiotic will guarantee elimination of the infection. For this reason selection of antibiotics based on correct laboratory data and subsequent modifications of treatment regimens are best managed by your veterinarian.



Susceptibility testing is helpful in selecting appropriate treatment products.

TREATMENT PROCEDURES, INCLUDING TESTING AND CULTURING

Mastitis is an inflammation of the udder. Frequently the inflammation is caused by pathogenic bacteria that gain entrance through the teat end. It is estimated that over 95% of all mastitis cases are caused by either Streptococcus or Staphylococcus organisms. In addition, there are a host of other microorganisms capable of causing mastitis, either in clinical or subclinical form.

Mastitis may manifest itself in various forms depending upon many factors. These factors include cow resistance, type of infective organism, timing and choice of treatment, and others. Due to these factors and their interrelationship, mastitis may become acute clinical (visible signs), clinical (some visible signs), or subclinical (no visible signs). These three types are all treated differently but if the clinical type is present, there will usually be many cases of subclinical mastitis present in the herd. (As a general rule, for each clinically infected cow there will be 15 to 40 cows with subclinical infections!) In the control of mastitis, a herd approach, in addition to individual and clinical treatment, is imperative as mastitis is indeed a herd problem.

Selection and Preparation of Individual Cows for Treatment

Acute clinical mastitis requires immediate treatment. This type of mastitis is serious and while it comprises a very small percentage of the total, death loss is common. Signs may include fever, depression, occasional lameness, swollen udder, abnormal and reduced milk secretion, and off-feed. It is imperative to obtain professional help immediately for cows with this type infection.

Clinical mastitis is recognized by flakes or clots in the milk with possible quarter swelling or soreness. Clinical mastitis should be treated promptly, preferably with veterinary consultation. Detection of cows with apparent mastitis is not difficult as clinical signs are evident. This is an important reason for foremilking. The strip cup helps in spotting the flakes and clots in milk and its use is recommended prior to each milking to assist in early mastitis detection.

Cows showing clinical signs should be treated with an **approved sterile intramammary** product as soon as clinical signs are seen. It is absolutely necessary to thoroughly clean and disinfect the teat ends with 70% alcohol and to maintain a sterile technique in the administration of the intramammary product. Failure to do this frequently results in a more serious mastitis problem due to mechanical introduction of new infectious agents during the treatment process. Treatment duration should be at least three days or prolonged one more day after clinical signs have completely disappeared. Systemic (muscle or intravenous) treatment may be used in conjunction with intramammary infusion when advised by your veterinarian.

Response to treatment varies considerably depending on the organism, duration of infection, cow's immune response, and other factors. Infections caused by *Staphylococcus aureus,* for example, **do not** respond well during lactation but might respond better to dry cow treatment. A decision to stop milking the cow before the end of a normal lactation might be necessary to allow more intense treatment and improved opportunity for a positive response.

Subclinical mastitis is the most common. The detection of subclinical mastitis requires the use of special tests as no signs other than lower production may be evident. The individual cow somatic cell count, Wisconsin Mastitis Test (WMT), and the cowside California Mastitis Test (CMT) can be used to identify high counts in infected quarters. While the CMT is an important tool in monitoring progress of the control program, treatment should not be based solely on this criterion.

Treatments Based on Cultures and Antibiotic Susceptibility

Many cows respond fairly well if treatment is administered early and long enough — if the organism is susceptible to drugs. To reduce guesswork it is desirable to sample infected clinical or CMT-positive quarters before any treatment to determine the specific pathogen present and its susceptibility to certain drugs. Although the culture information is valuable, do not wait to treat a clinical flare-up until sample analyses are received as early treatment is important. Culture and antibiotic data will provide information used on the herd problem as well as future clinical cases.

Available commercial treatments are formulated to be effective against the most common mastitis pathogens; however, treatment response in the cow does not always parallel results shown in laboratory susceptibility tests. Use only lactating cow products for cows in the milking line.

Dry Cow Treatment

It is highly recommended to dry-treat all quarters of all cows. Better response to some infections is possible with dry period treatment. By treating all quarters many unknown subclinical quarters also receive therapy.

Cows known to have quarters infected with *Staphylococcus aureus* should receive a repeat dry cow treatment in three weeks in known infected quarters. For cows treated with a second dry cow treatment, drug withholding times must be observed. If the cow freshens early, it may create a potential residue problem when milk is added to the tank as the dry cow infusions have longer withholding times.

APPENDIX

PRE-CHECK SURVEY

This pre-check survey of your milking system and equipment is an important part of analyzing your dairy operation. If you wish this service please send completed form to the address below—along with a check for $25 made out to the University of Nebraska. In return you will receive a completed analysis of your operation.

Return to:
Gerald R. Bodman, P.E.
Extension Agricultural Engineer—Livestock Systems
217 Chase Hall, University of Nebraska
Lincoln, NE 68583-0771

Producer: Name: _____ Phone: AC( )_____
Address: _____ County: _____

Directions to farm: [Please start from a definite intersection, highway milepost, etc.] _____

_____

_____

Milking times: AM—start to finish:_____ PM—start to finish:_____

Milk market: _____ Fieldman: _____

Equipment dealer: _____ Veterinarian: _____

Herd Background: No. cows _____ Breed: _____

Average somatic cell count: past year:_____past month:_____

Average bacteria counts: raw plate: past year:_____ past month: _____

pre-incubated (PI): past year:_____ past month: _____

Brief description of visible problems at present (for example, sore teats, warts, no. treated cases of mastitis, squawking, units fall-off, etc.)

_____

_____

Current Management Program

1. CMT, KMT or other cow-side test used to help identify cows with subclinical mastitis. No:_____ Yes:_____
2. Sanitizer used in udder wash water: No:_____ Yes:_____ Product: _____
3. Udders are washed using: hand & spray hose_____ cloth_____ sponge_____ other_____
4. Udders are dried before attaching units: No:_____ Yes:_____

   If yes, what technique is used? _____
5. Teats are dipped after milking: No:_____ Yes:_____ Product: _____
6. Dry cow treatment: % of herd treated_____ Product: _____
7. Is milking system sanitized **before** every milking? Yes:_____ No:_____
8. Is milking system rinsed and washed **after** every milking? Yes:_____ No:_____

Equipment

1. Describe parlor or milking barn (e.g. double 3 herringbone, double 4 sideopen, 3 in-line sideopen, 8-stall milking barn): _____
2. No. operators **usually** milking_____ Total no. people who milk **sometimes** _____
3. Total no. milking units used_____ No. units operated simultaneously_____ No. units per milkline slope_____
4. Milkline: diameter_____ Material: glass_____stainless steel_____

   distance: above/below (circle one) cow platform _____in.

   _____looped _____dead-ended

   slope:_____in. per 10' (or_____in. per 18" or_____in. per 24")
5. Receiver:_____double inlet_____single inlet (relative to milkline, do **not** count inlet for pipe from sanitary trap)
6. Do you use weigh jars: No_____ Yes_____ Height above cow platform_____in.
7. Do you use automatic take-offs: No_____ Yes_____ Make/Model: _____
8. Vacuum pump: Make:_____ Model:_____ Motor:_____hp
9. Vacuum line: from vacuum pump to sanitary trap: diameter_____in.

   material: _____plastic _____iron _____stainless
10. Pulsator line: material: _____plastic _____iron _____stainless

    size (diameter): _____in. _____looped _____dead-ended
11. Pulsators: make:_____ alternating:_____ simultaneous: _____
12. Brand and model of: claw_____ shells_____ liners _____
13. Vacuum regulator: make:_____ model:_____ location: _____
14. Are milk hoses or claw assemblies equipped with a vacuum shut-off valve: Yes_____ No_____
15. To help in evaluating your system, please conduct a "drop-off" test and record the results. Perform the test by:
    a) Record vacuum gauge reading with system operating "at rest" (no units on cows): _____in. mercury (Hg)
    b) Record vacuum gauge reading with all units milking (attached to cows) as in your normal milking routine: _____in. Hg.
    c) With one unit not milking (all other units on cows) turn on vacuum supply (milk hose) to this unit. Turn this unit over to admit air (all inflations open) such as would happen during a drop-off.

       What was the lowest vacuum level? _____in. Hg

       At what vacuum level did gauge stabilize with drop-off? _____in. Hg
    d) Record any other events which occurred while unit was turned over: _____

       _____
16. Additional comments, sketches or notes to aid us in evaluating your milking system (describe—attach additional sheet if necessary for comments).

Date pre-check survey completed:_____ by whom: _____