

## **Procedures for Evaluating Vacuum Levels and Air Flow in Milking Systems: 2005 Update**

Paper Presented at the 2005 NMC Annual Meeting by  
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Several years ago the Machine Milking Committee started the process to update and improve this guideline. The success of the original guideline, industry's use of Variable Speed Drives (VFD) for vacuum control and recognizing the opportunity to make the form more "User Friendly" were all reasons for updating this guideline.

Improving the already successful guideline would be simple since we had the original document and all the committee wanted was to include a few new procedures to cover the VFD's not addressed in the previous guideline. As one of the participants on the committee and the six years out of our lives, I learned the task was greater than expected. We struggled because we were trying to make the document an all-inclusive guideline incorporating everyone's suggestions and ideas. Finally recognizing that we were going beyond the scope of the guideline, we focused on the methods used in the evaluation of vacuum levels, pulsation systems and airflow in milking systems allowed us to accomplish our task.

The final document is published and available through the NMC and can be ordered by contacting the NMC either at this meeting or through the Web. The efforts of many committee members helps define the importance NMC has to the dairy industry through the diversity of its members. It is note worthy as we move forward to address the NMC as "**A global organization promoting mastitis control and milk quality**". We are not a "**Standards or Regulatory Organization**" as some often refer us as.

The Procedures for Evaluating Vacuum Levels and Air Flow in Milking Systems was originally published by the NMC in 1996. The main conceptual change in the document is to focus attention on the primary machine-related aspects of milking performance, namely:

- Average vacuum in the claw during milking
- Pulsator function

A third tier of detailed diagnostic testing will help determine causes of inadequacies in the primary performance parameters. The key elements of the document and a summary of the changes from the previous version follow.

### Purpose and Scope

*"This document presents methods for the evaluation of vacuum levels and airflows in milking systems. These methods are primarily for use in the evaluation of the adequacy of milking systems to maintain average vacuum in the claw within the intended range during milking and in the assessment of the ability of the pulsation system to operate within the manufacturer's specifications. This document should not be considered a comprehensive guide to the evaluation of all factors necessary for successful milking. For example, it does not address the operator of the machine nor their milking procedures."*

## Milking-Time Tests

*“Milking-time tests are the most direct method for determining the adequacy of the vacuum production and regulation of any milking system under its intended use conditions... Proper pulsator function is also critical to the success of the milking process... The third section will present more detailed diagnostic testing to determine causes of failure in vacuum regulation or pulsator performance. Accurate recordings of vacuum levels at various locations during milking provide the best means of demonstrating the adequacy of the vacuum production and regulation function of any milking system. The most useful sites for milking-time tests are in the claw, in the milkline, in or near the receiver (if necessary). Vacuum at these sites should be recorded while the system is under normal milk and air flow conditions; that is, while clusters are being attached, while all clusters are on cows, and while clusters are being detached. The regulator vacuum should be adjusted on each system to achieve the desired milking vacuum at the claw.”*

## Standards

This document IS NOT A STANDARD. The procedures presented in the NMC document are guidelines based on the ASAE and ISO standards. Both the American Society of Agricultural Engineers (ASAE) and International Standards Organization (ISO) standards for milking machine installation and performance are under review. Any revisions to these standards will have priority over the NMC guidelines.

## Table for the perplexed

A list of acronyms, units and abbreviations has been added to aid the user in deciphering the document.

## Receiver Vacuum Stability

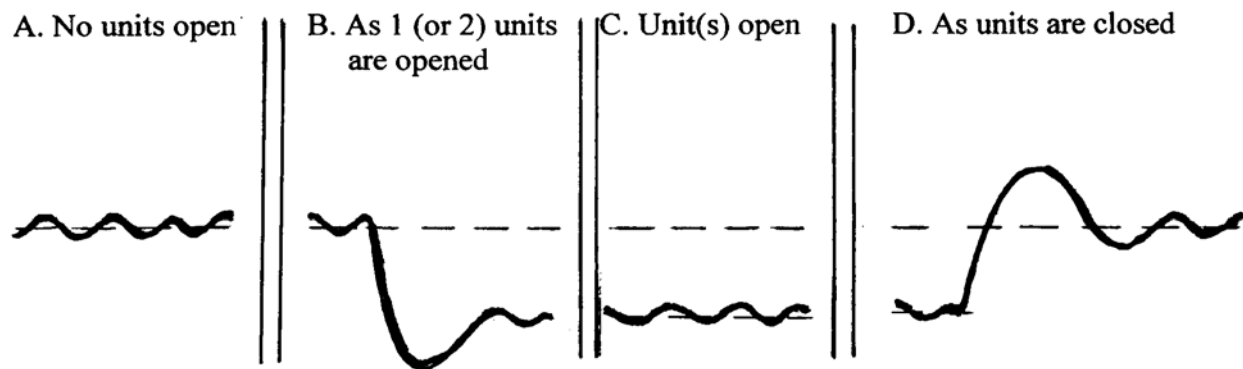
The fundamental performance requirement has not changed (-2 kPa vacuum drop), but the allowance for “overshoot” is now specifically stated (+2 kPa). *“The performance criteria for receiver vacuum stability is that vacuum in the receiver does not change by more than +/- 2 kPa (0.6”Hg) from the operating vacuum level during the course of normal milking, including teatcup attachment and removal, liner slips, and cluster fall-off.”* In the previous version only the vacuum drop was specified because of the characteristics of ‘conventional’ regulators usually results in the vacuum drop exceeding the overshoot. Details on methods to measure vacuum drop, undershoot and overshoot are presented below.

## Unit Fall-Off Test

Specificity has been added to the unit fall-off test to differentiate

- vacuum drop,
- undershoot and
- overshoot.

This more specific test, proposed by our distinguished Australian colleague, allows for more specific diagnosis of the elements contributing to vacuum changes at the receiver. Four separate vacuum recordings made with an electronic vacuum recorder or digital vacuum gauge that can display the maximum, average and minimum vacuum levels are required to calculate these three components of vacuum change.



- A. Record the Receiver Operating Vacuum (ROV) a 5 to 20 second AVERAGE vacuum in the receiver with the milking machine in an ‘as milking’ condition (teatcups plugged and pulsators operating).
- B. Record the MINIMUM vacuum AS THE UNIT IS OPENED. Start a 5 to 20 second vacuum recording then reopen the milking unit. The difference between the MINIMUM vacuum recorded during this test and the AVERAGE vacuum recorded in step C is the UNDERSHOOT.
- C. Record the AVERAGE vacuum when a unit is open. Open the milking unit to admit as much air as possible. Start a 5 to 20 second vacuum recording after the unit is opened and system vacuum has stabilized. The difference between ROV and the average vacuum in the receiver with the milking unit open is the VACUUM DROP.
- D. Record MAXIMUM vacuum AS THE UNIT IS CLOSED. Start a 5 to 20 second vacuum recording then close the milking unit. The MAXIMUM vacuum recorded during this test minus ROV is the OVERSHOOT.

The recommended limit for each of these vacuum differences is 2 kPa. Excessive vacuum drop is usually caused by restrictions in the air line between the receiver and the vacuum sensor. Excessive undershoot is usually the result of a conventional regulator that is sticking or has a plugged filter. Excessive overshoot is usually the result of an improperly adjusted Variable Frequency Drive (VFD) vacuum controller.

#### Testing Systems with VFD vacuum Controllers

The most important tests of milking machine performance:

- Vacuum in the claw
- Pulsator performance
- Unit falloff test
- Effective Reserve

are unchanged for systems using VFD controllers. Manual reserve is not measured and regulation efficiency is not calculated for systems with VFD controllers. The unit falloff test will

detect problems with VFD installation and adjustment. Systems with VFD controllers should be set to constant speed (60 Hz) for the series of component air admission tests.

### Air Admitted by System Components

Two new tests have been added to the series of air admission tests. The air admitted by a milking unit is measured so that a more accurate estimate of the required effective reserve can be made for milking units that have usually high air admission (large diameter short and/or long milk tubes) or low air admission (automatic shutoff valves). The air admitted by one teatcup has been added as an optional test to make a better estimate of the air used during unit attachment.

### System Leakage

An alternate method of estimating system leakage has been added. The air leaks in the system can be estimated by taking the difference between the vacuum pump capacity measured at the pump inlet and the AFM reading taken at the same location and same operating vacuum level with all components deactivated and the piping system connected (gate valve open).

### Conclusion

Typically, a milking system operates more hours per day; milk more cows per day with higher production/milk flow rates and is expected to perform under a wide variety of conditions. Milking systems have incorporated automation, data collection, labor savings, higher milk flows and other devices intended to save money and add value. NMC **“A global organization for mastitis control and milk quality”** must continue to provide the education forum required to raise expectations used in mastitis control and production of quality milk. This means we must incorporate other evaluation procedures that are just as important in successfully accomplishing the overall strategies and goals of our customers; the dairy producer and the consumers using dairy products. The NMC distinguishes itself by having diversity among its members and challenges the full membership to go beyond what has been successfully completed. This document demonstrates our membership’s ability to incorporate thoughts, expertise and successful practices into a simple and easy to use format. Each component of herd management, operator procedures, equipment function and environmental conditions should be evaluated and validated similarly.