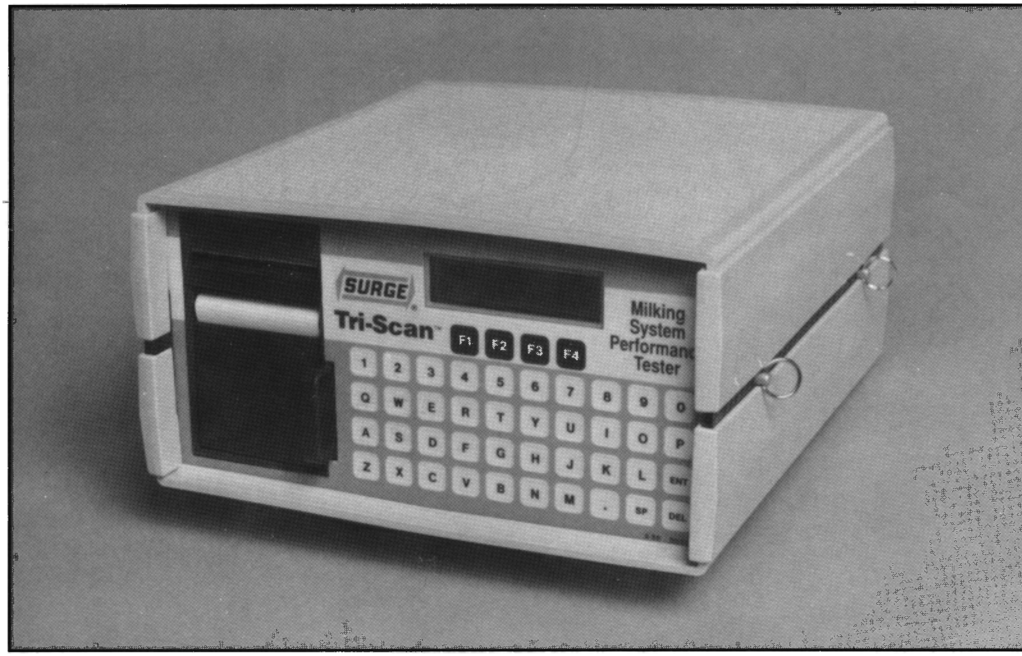

SURGE TRI-SCAN MILKING SYSTEM PERFORMANCE TESTER USER'S MANUAL

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INTRODUCTION

THE SURGE TRI-SCAN MILKING SYSTEM PERFORMANCE TESTER MANUALS

There are two Tri-Scan manuals. **The Owner's Manual** and the **User's Guide.**

Owner's

Owner's Manual

The Owner's Manual covers the technical aspects and machine operation of the Tri-Scan. The Owner's Manual includes:

- Nomenclature, parts list and specifications
- User controls and connections
- Power on and log on procedures
- The menu system
- Show display
- Set up Print Memory

Even though certain excerpts from the Owner's Manual are included in the this User's Guide, the Owner's Manual should be read and thoroughly understood before preceding to use the Surge Tri-Scan on a dairy.

User's

User's Guide

The User's Guide reviews milking machine operation. It details the procedures and rationale for milking system performance tests. These test are:

- Pulsation
- Milking vacuum
- Pulsed D C voltage
- D C voltage
- A C voltage

THE SURGE TRI-SCAN MILKING SYSTEM PERFORMANCE TESTER

Description

Description

The Surge Tri-Scan is a microcomputer, menu driven, triple channel, recording test instrument. It measures pressure (vacuum) and electric voltage magnitudes and lapse times.

The Surge Tri-Scan contains:

1. three programmable internal vacuum input channels with pressure transducers, for monitoring and recording: pulsation rates and ratios, and milking unit and milking system vacuum levels.

2. AC/DC voltage channel, for checking power supplier output, pulsation control output, neutral to earth voltage and other DC low voltage.

3. a two-channel thermal strip tape plotter for graphic presentation of pulsation wave-forms, unit and system vacuum levels, vacuum fluctuations, and AC/DC voltage levels.

4. three-channel data summary that lists pulsation wave form phase times in both percentages and milliseconds, and maximum, minimum and average vacuum or voltage levels.

5. a keyboard for inputting headers and notes on the strip tapes.

6. internal memory capacity for saving up to 32, 3-channel recordings of individual tests which can be recalled and printed later.

7. an RS232C connector for downloading test results from the Tri-Scan to a PC for word processor or spreadsheet manipulation.

PURPOSE

The purpose of the Surge Tri-Scan is to evaluate milking machine performance, based on Babson recommendations and industry standards.

The Surge Tri-Scan provides the technical and performance information needed for:

1. setting up milking machine systems so that they deliver maximum milking efficiency with minimum stress.
2. maintaining milking system efficiency.
3. closing sales.

The Surge Tri-Scan Milking System Performance Tester can be very instrumental in opening the way to greater professionalism and increased sales. For best results, use it as the key component of a program containing parameters and operating characteristics for specific milking machine functions.

MILKING MACHINE FUNCTION

Properly functioning and correctly operated milking machines, are of foremost importance to dairymen. They impact their milking herds, the quality and quantity of their milk and their overall financial well being.

Milk Removal and Massage

Milk removal and massage

The ultimate function of a milking machine is to remove the milk from a cow by applying vacuum to the teats, and to minimize the stress of body fluid congestion in the teat walls by applying massage.

The modern commercial milking machine utilizes milking units that consist of a claw or cup, teat cups with two chambers, short air tubes, a long air tube and pulsator to accomplish milk removal and massage. Milking vacuum is applied to the teats via the milk hose, claw and interior passage of the inflations. The massage is applied by a combination of the milking vacuum inside of the inflation and atmospheric pressure admitted into the pulsation chamber of the teat cup (between the shell and inflation), by the pulsator.

Rate and Ratio

Pulsation Rate and Ratio

The milk removal and the massage action is controlled by the pulsator. The number of pulsation cycles per minute is referred to as pulsation **rate**. The difference in the portion of the pulsation cycle devoted to milking and to massaging is called **ratio.**

Three of the most crucial functions of a milking machine are rate, ratio and milking vacuum level.

Benefits

Benefits of fast, complete milking

The benefits of fast and complete mechanical milking without undue stress to the teats, has been proven by:

1. controlled scientific research studies performed at a number of locations around the world.
2. on hundreds of thousands of dairy farms, over a period of more than fifty years.

The recognized benefits of fast and complete milkout, with minimum stress are:

1. increase milk yield.
2. fewer teat and udder problems.
3. quality milk.

MILKING MACHINE COMPONENTS AND SUB-SYSTEMS

A modern milking machine is a complex assembly of interdependent components. The function of each of these components depends upon the function of the total system. The components make up major sub-systems of the milking machine. These are:

Vacuum
Milk Handling
Pulsation
Milk Removal
Sanitation
Electrical

They are an integral part of the total system and must function correctly for the system to deliver optimum milking efficiency.

In order to install and maintain milking systems that provide maximum milking efficiency and minimum stress; it is necessary to understand the function and relationship of each of these components and sub-systems.

Vacuum

The role of vacuum

The vacuum system is the heart of a milking machine. Vacuum is the force that drives the system.

Vacuum, opens the inflations and creates the pressure differential that removes milk from the teats. It is also the force that closes the inflations and creates the compression load on the teats that relieves the congestion, of blood and lymph occurring within the teat walls, induced during milk removal.

Vacuum, lifts the milk into high mounted milk lines and provides the force that circulate cleaning and sanitizing solutions.

The capacity of a vacuum system should be sufficient to prevent abnormal fluctuations of the milking unit vacuum during milking. This requires that the vacuum pump, vacuum controller, distribution tank, milk and vacuum lines have ample capacity to handle the air flow demands of the system.

Maintaining a stable vacuum level of 12 inches Hg. (40.52 kPa), within the milking unit is paramount to fast, clean and safe milking.

The functions of the vacuum pump and vacuum controller are the most crucial of the vacuum system components, relative to optimum milking performance.

The vacuum pump must have the capability to move the cfm air flow required for operating all of the milking equipment, with a 50% reserve.

The performance of the vacuum controller is subject to more variation than any other vacuum system components. This is due to constant movement of the air flow control mechanism and the large volumes of contaminated air handled.

Milk Handling

Moving milk and air

The milk handling equipment of a pipeline milking system must do more than transport the milk. It must provide sufficient air moving capacity to prevent abnormal milk line vacuum fluctuations. Milk hoses, milk flow sensors, weigh jars and milk meters should be designed and installed in a manner that minimizes turbulence, restrictions, and drops in the vacuum level at the milking units.

Milk Removal

Compatible components

The milking equipment like the total milking machine system, is made up of a number of functioning components. The components are: the claw or cup, teat cup assemblies, milk hose, short air tubes, air divider, long air hose and pulsator. These components must be totally compatible in design and function, and work as unit, if optimum milking efficiency is to be achieved.

The cyclic action of inflation and pulsator are very critical to milk removal and teat massage. Inflations and pulsators are subject to more variation due to wear, than other components of the milk removal equipment. The performance of inflations and pulsators should be tested on a regularly scheduled basis to insure continuing optimum milking efficiency.

Sanitation

C.I.P. process and vacuum

Almost all pipe line milking machine systems used in North America, and many in other parts of the world, are CIP (cleaned in place) by circulating cleaning and sanitizing solutions with vacuum. Since vacuum is the force used in cleaning most pipeline milking systems, evaluating the effectiveness of the vacuum system can be an indirect measure of CIP efficiency.

Electrical

Low voltage AC, DC and pulsed DC currents

High voltage electric motors, magnetic starters, etc. have been a part of mechanical milking almost since the first practical on-arm applications. The use of low voltage AC, DC, and pulsed DC has become a prevalent part of the modern milking system. This has occurred as electronics have been employed in the control of more and more milking machine functions.

The Surge Tri-Scan Milking System Performance Tester, and test procedures contained in this manual will be of great assistance, in achieving the goal of being a part of the best milking machine dealership in your area of operation.

PULSATION

OVERVIEW

The teat cup is the focal point of a milking system. The inflation is the part of the milking machine that comes in contact with the live tissue of the cow's teats and is where the ultimate milking action occurs.

The purpose of the pulsator is to alternately introduce vacuum and atmospheric pressure into the pulsation chamber of the teat cup assembly. The alternation of vacuum and atmosphere within the pulsation chamber, working in conjunction with the vacuum inside the inflation, creates the milk and massage action within the teat cup.

The teat cup inflation action that removes the milk and relieves the stress of teat congestion is the cumulative result of the functions of all the milking machine components.

Benefit

The need for pulsation

The total benefit of pulsation, and the resulting inflation milk and massage action is not fully understood. It is known that when cows are milked with milking machines that provide pulsation they milk out faster, more completely and have fewer new infections of mastitis.

Congestion and edema can occur in the teat wall and apex as a consequence of vacuum being applied to the teat during milk removal. This problem has long been recognized as a need for pulsation. The frequency and amplitude of the massage are still the subject of much debate. The following is a review of research literature and reported field experiences that may help clarify some of the misunderstandings.

Research and Experience

Research studies have shown that one of the effects of congestion and edema within the teat, is that the diameter of the teat orifice can be reduced by as much as one third (1/3) its normal open size. The reduction occurs within one half (0.5) to one (1) second after the start of the milk phase of each pulsation cycle. This in turn reduces the rate of milk flow through the teat canal at a given pressure differential (vacuum level).

The occurrence of teat congestion and edema after .5 to 1 second (500 to 1000 mSec), of the beginning of the milk phase during each pulsation cycle, and the ensuing effect on milk flow, tends to verify the validity of recommending a pulsation range of 50 to 60 cycles per minute. If the inflation collapse and teat massage occurs within 500 to 720 mSec, after the beginning of the milk phase during each pulsation cycle, congestion and the possible accompanying edema will be prevented and maximum milk flow maintained. The number of pulsations per minute affects the afore mentioned time span in which the inflation collapse should occur as follows:

When should massage action begin?

mSec	PPM
600 - 720@	50
550 - 660@	55
500 - 600@	60

The rate of milk removal is in direct relation to the length of the massage or "D" phase of the pulsation cycle. If the D phase is longer than required, it reduces the milk flow time or "B" phase of the pulsation cycle unnecessarily and milk removal time is increased. On the other hand, as has just been presented, if the D phase is too short or commences too late in the pulsation cycle, congestion reduces the size of the teat orifice. This also increases the milk removal time. It is very important that the length of the D phase meet the minimums set forth below and in Tables 1,2,3,4,5, and 6.

How long should the massage phase last?

A number of research studies indicate that for the massage to be effective, the inflation wall must collapse against the teat surface with enough compression to force the accumulated fluids from the apex and vascular system of the teat. To accomplish this, the force must be great enough to overcome the diastolic arterial pressure, which is reported to be the equivalent of approximately 3 inches Hg of vacuum.

Both field experience and research studies indicate it is necessary that the pulsation chamber reaches atmospheric pressure (0 inHg) for a minimum of 150 mSec to assure massage efficiency. Some research studies also indicate that the incidence of new mastitis infections increase, when the pulsation chamber consistently fails to reach atmospheric pressure during massage phase.

If the pulsation chamber is not brought to atmospheric pressure for a predetermined length of time, the liner will not apply sufficient compression load to clear the teat, and congestion will be re-established more rapidly during the milk phase of the next pulsation cycle. Congestion remaining in the teats as a result of low compression is cumulative, and milk flow is further slowed as the milking progresses.

Complete massage

PULSATION TYPES

Two types of pulsation in common use are:

Simultaneous...where the cyclic pressure changes in all four teat cup pulsation chambers of a milking unit occurs at the same time.

Alternating...where the cyclic pressure curve in two of the teat cup pulsation chambers of a milking unit, alternates with the cyclic pressure curve in the other two teat cups.

Two types of pulsation

TRI-SCAN PULSATION TEST

Wave Form And Milking Vacuum

One of the primary functions of the Tri-Scan Milking System Performance Tester is measuring, recording and summarizing pulsation wave-forms, and milking unit vacuum level.

The precise presentation of the pulsation wave-form information by the Tri-Scan, allows the operator to compare the functional characteristics of a given pulsation system and teat cup assembly with established standards. The results of such comparisons will provide many of the details needed for setting up the pulsation system, to deliver maximum milking efficiency and provide minimum stress with a specific shell and inflation.

INFLATION/LINER ACTION

Phases

The pressure cycles within the pulsation chamber of the teat cups, cause the cyclic opening and closing of the inflations, which is referred to as the pulsation cycle. Each pressure cycle in a teat cup occurs in four phases:

a. increasing vacuum or opening phase;
b. maximum vacuum or open phase;
c. decreasing vacuum or closing phase; and
d. zero vacuum (atmospheric pressure) or closed phase.

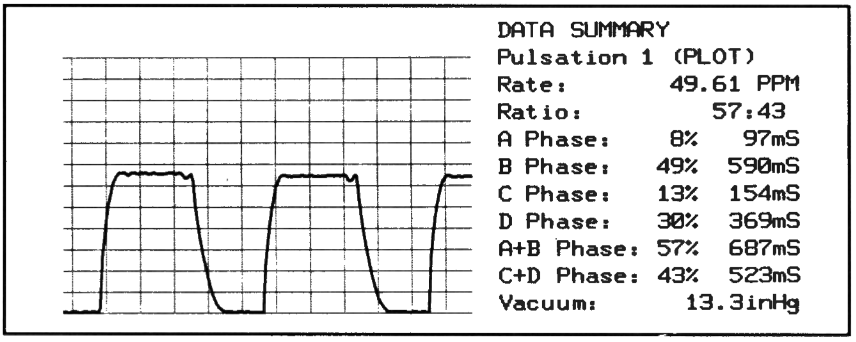
The pulsation cycle is generally described in terms of a milk to massage ratio, expressed as percentages, that occurs in two phases:

1. the milking phase, which is the duration of the of the a+b phases;
2. the massage phase, which is the duration of the c+d phases.

Pressure cycle wave- form graphs

The Surge Tri-Scan Milking System Performance Tester draws a picture of the wave-form created by this cyclic pressure. A Tri-Scan plot of a typical pulsation wave-form, shows the four phases of the pulsation cycle and provides an informational summary relative to each of the four phases (See Figure 1).

FIGURE 1 TYPICAL SURGE PULSATION WAVE-FORM WITH PHASES OF A COMPLETE PULSATION CYCLE INDICATED



Note 1 - The four phases of the pulsation cycle are identified as follows:

A Phase = increasing vacuum or opening phase
B Phase = maximum vacuum or milking phase
C Phase = decreasing vacuum or closing phase
D Phase = zero vacuum or massage phase

Note 2 - The Data Summary list:

Rate... in pulsation cycles per minute

Ratio... in percentage of milk to rest

A Phase... in percentage and milliseconds of the pulsation cycle

B Phase... in percentage and milliseconds of the pulsation cycle

C Phase... in percentage and milliseconds of the pulsation cycle

D Phase... in percentage and milliseconds of the pulsation cycle

A+B Phase... in percentage and milliseconds of the pulsation cycle

C+D Phase... in percentage and milliseconds of the pulsation cycle

Vacuum... maximum level within the pulsation chambers

Limp... a measurement of the difference in the two milking phases "A"+"B" when side-to-side alternating pulsation is employed (Limp is of no significance when front-to-back alternating pulsation is used)

Pulsation data summaries

ACCEPTED STANDARDS AND RECOMMENDATIONS

Industry Standards

ASAE & ISO standards

The ASAE (American Society Of Agricultural Engineers) Standard, Milking Machine Installation, Construction and Performance, and ISO (International Standards Organization) Standards numbers 6690, 5707 and 3918 agree as follows regarding milk to massage ratio:

1. The milk or "B" phase, should be a minimum of 30% of the total pulsation cycle.
2. The massage/rest or "D" phase, should be a minimum of 15% (150 ms) of the total pulsation cycle.
3. The limp, should be less than 5% where side-to-side alternating pulsation is used.

4. Changes in pulsation rate and ratio should not exceed +/- 5% when the pulsators are operated within the stated performance vacuum and temperature ranges.

Babson Recommendations

Babson recommendations

Babson Bros. Co.'s recommendations fall within the range of the various Industry Standards, especially with respect to the massage or rest phases.

The Tri-Scan Milking System Performance Tester's pulsation test summary presents the pulsation rate in cycles per-minute The milk to massage ratio phase data is presented in both % and mSec of the total pulsation cycle.

The Babson recommendation for pulsation rate is between 50 and 60 cycles per minute.

Since, a percentage of the total pulsation cycle equals different amounts of time at different pulsation rates, Babson Bros. Co.'s recommendations for the milk or "B" phase and massage or "D" phase of the pulsation ratio, are stated in minimum/maximum ranges of mSec. (See Tables 1 through 6)

TABLE 1

PULSATION RATIO, MINIMUM/MAXIMUM PHASE REQUIREMENTS AT 50 PPM.

Pulsation Type	Rate	Ratio	A %	A mSec	B %	B mSec	C %	C mSec	D %	D mSec	A+B %	A+B mSec	C+D %	C+D mSec
Simultaneous	50	50/50	9-15	115-175	33-44	381-557	13-21	175-240	25-38	293-472	49-53	556-672	47-51	533-647
Simultaneous	50	55/45	9-15	115-175	38-43	439-607	13-21	175-240	21-33	248-409	54-57	614-722	43-46	488-584
Simultaneous	50	60/40	9-15	115-175	43-53	496-670	13-21	175-240	16-28	190-346	59-62	671-785	38-41	430-521

TABLE 2

PULSATION RATIO, MINIMUM/MAXIMUM PHASE REQUIREMENTS AT 55 PPM.

Pulsation Type	Rate	Ratio	A %	A mSec	B %	B mSec	C %	C mSec	D %	D mSec	A+B %	A+B mSec	C+D %	C+D mSec
Simultaneous	55	50/50	10-17	115-175	31-43	332-494	15-23	175-240	23-36	247-411	49-53	507-609	47-51	487-586
Simultaneous	55	55/45	10-17	115-175	36-47	385-539	15-23	175-240	19-31	205-354	54-57	560-654	43-46	445-529
Simultaneous	55	60/40	10-17	115-175	41-52	437-596	15-23	175-240	14-26	152-297	59-62	612-711	38-41	392-472

TABLE 3

PULSATION RATIO, MINIMUM/MAXIMUM PHASE REQUIREMENTS AT 60 PPM.

Pulsation Type	Rate	Ratio	A %	A mSec	B %	B mSec	C %	C mSec	D %	D mSec	A+B %	A+B mSec	C+D %	C+D mSec
Simultaneous	60	50/50	11-18	115-175	30-42	291-442	16-25	175-240	21-35	207-361	49-53	466-557	47-51	447-536
Simultaneous	60	55/45	11-18	115-175	35-46	339-484	16-25	175-240	17-30	168-309	54-57	514-599	43-46	408-484
Simultaneous	60	60/40	11-18	115-175	40-51	387-536	16-25	175-240	12-25	120-257	59-62	562-651	38-41	360-432

TABLE 4

PULSATION RATIO, MINIMUM/MAXIMUM PHASE REQUIREMENTS AT 50 PPM.

Pulsation Type	Rate	Ratio	A %	A mSec	B %	B mSec	C %	C mSec	D %	D mSec	A+B %	A+B mSec	C+D %	C+D mSec
Alternating	50	50/50	6-11	70-120	38-48	436-602	9-15	115-170	31-42	363-532	49-53	556-672	47-51	533-647
Alternating	50	55/45	6-11	70-120	43-52	494-652	9-15	115-170	28-37	318-469	54-57	614-722	43-46	488-584
Alternating	50	60/40	6-11	70-120	48-57	551-715	9-15	115-170	23-32	260-406	59-62	671-785	38-41	430-521

TABLE 5

PULSATION RATIO, MINIMUM/MAXIMUM PHASE REQUIREMENTS AT 55 PPM.

Pulsation Type	Rate	Ratio	A %	A mSec	B %	B mSec	C %	C mSec	D %	D mSec	A+B %	A+B mSec	C+D %	C+D mSec
Alternating	55	50/50	6-11	70-120	37-47	387-539	10-16	115-170	30-41	317-471	49-53	507-609	47-51	487-586
Alternating	55	55/45	6-11	70-120	42-51	440-584	10-16	115-170	26-36	275-414	54-57	560-654	43-46	445-529
Alternating	55	60/40	6-11	70-120	47-56	492-641	10-16	115-170	21-31	222-357	59-62	612-711	38-41	392-472

TABLE 6

PULSATION RATIO, MINIMUM/MAXIMUM PHASE REQUIREMENTS AT 60 PPM.

Pulsation Type	Rate	Ratio	A %	A mSec	B %	B mSec	C %	C mSec	D %	D mSec	A+B %	A+B mSec	C+D %	C+D mSec
Alternating	60	50/50	7-12	70-120	36-47	346-487	11-18	115-170	29-40	277-421	49-53	466-557	47-51	447-536
Alternating	60	55/45	7-12	70-120	41-51	394-529	11-18	115-170	25-35	238-369	54-57	514-599	43-46	408-484
Alternating	60	60/40	7-12	70-120	46-56	442-581	11-18	115-170	20-30	190-317	59-62	562-651	38-41	360-432

Parameters for A & C phases range from a 4' pulsator hose at 12" Hg to a 9' pulsator hose at 15' Hg. The difference in a 4' to 9' pulsator hose is 25 to 30 mSec.

The airflow calculation factored in to the electronic parameter for B, D, A+B, and C+D is -1 to +2%.

Vacuum Saver shells will shorten the A and C phases.

PROCEDURE FOR PULSATION TEST

General Conditions

Before taking any measurement, connect all of the milking units and plug the teat cups to simulate actual milking conditions for **static testing**. All milking units should be attached to cows with milk flowing for **dynamic testing**.

Prior to testing

Visually inspect the milking system to ensure all controls are set according to specifications. Run the milking system for a minimum of five minutes or until all operating characteristic stabilize.

The main power switch of the Tri-Scan must be on and the diagnostic test completed before any input vacuum or electric connections are made.

Using the F and ENT keys

Even though, the Tri-Scan is equipped with a full keyboard, located on the front panel, all of the test programs can be initiated by a series of single key strokes, utilizing the four "F" function keys and the "ENT" key. The Tri-Scan's full keyboard provides flexibility and the advantage of adding personalized headers to the strip tape plots and ending notes, regarding the individual test.

Self-diagnotic test

Menu selection is started by turning on the Tri-Scan's main power switch located in the middle left side of the rear panel. The power up procedure includes an automatic self-diagnostic test (see section 3.2 of the Owner's Manual for details if error massages appear).

Upon completion of the diagnostic tests, the main menu will appear on the LCD screen near the top center of the front panel (See figure 4).

Hose Connections

The Tri-Scan be should be connected to the milking unit and pulsator in accordance with the ASAE Standard, EP445.

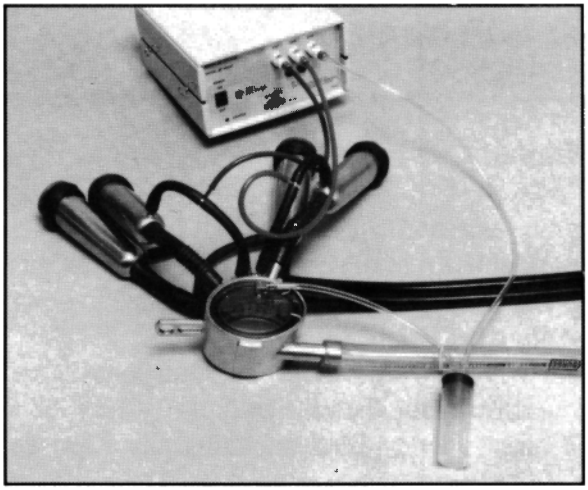


FIGURE 2
HOSE CONNECTIONS BETWEEN THE TRI-SCAN AND SHORT AIR TUBES; AND THE CLAW BODY FOR MEASURING RATE & RATIO, AND MILKING UNIT VACUUM.

Figure 2 shows the hose connections for measuring teat cup pulsation chamber, pulsation per minute rate, and milk to massage ratio.

Hose connections for pulsation wave-form testing are made , as shown in figure 2, between the vacuum ports marked CH1 and CH2 located in the upper right rear panel of the Tri-Scan, and the short air tubes on the milking unit. A third hose can be connected between CH3 and the milking unit for measuring milking vacuum.

The hose connection for a simultaneous pulsator is made between CH1 and the appropriate tee to any short air tube on the milking unit. A second hose can be connected between CH2 and a test lid or port on the milking unit being tested, for measuring milking vacuum along with the pulsation wave-form. Milking vacuum measurement and evaluation are discussed in Chapter III.

The hose connections for alternating pulsation are made between CH1 and a short air tube of one set of the alternating teat cups, between CH2 and the tee in a short air tube of the other set of alternating teat cups. As with simultaneous pulsation, CH3 may be connected between the Tri-Scan and a vacuum test port in the body of the claw, or properly inserted hypodermic in an inflation stem for measuring milking unit vacuum.

The length of the short air tubes should not be altered by the addition of tee or other approved hose connection adapters.

The Tri-Scan hose connections, for testing the pulsator are shown in Figure 3.

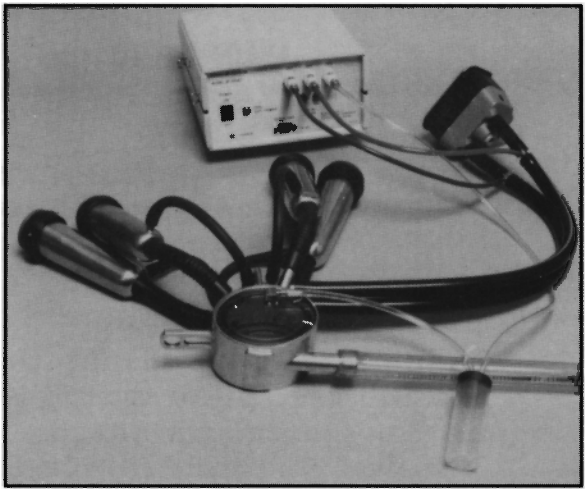


FIGURE 3
HOSE CONNECTIONS BETWEEN THE TRI-SCAN AND PULSATOR FOR MEASURING PULSATION RATE AND RATIO.

The hose connection for measuring the performance of simultaneous pulsators is made between CH1 and the long air tube as shown in figure 3 The connection to the long air tube should be made using the appropriate tee and within 2 inches of the end of the pulsator outlet nipple.

The hose connections for measuring the performance of alternating pulsator are made between CH1 and one conduit of the dual long air hose, and between CH2 and the second conduit of the same long air tube. The connections should be made within 2 inches of the end of the pulsator outlets using the appropriate tees.

FIGURE 4
CHOOSING A MENU

MAIN MENU

	SURGE		
Dis	Set	Prn	Mem
F1	F2	F3	F4

Main Menu options

The **Main Menu** offers four options.

1. Dis (Display)... Displays the **Show On Display Menu** for activating the real meter, checking the battery charge, and choosing recording from memory.
2. Set (Set Up)... Transfers control to the **Set Up Menu** for programming the input channels for types of recording, the channels to plot, and the record mode.
3. Prn (Print)... Activates the **Print Menu** for programming the printer.
4. Mem (Memory)... Transfers control to the **Memory Menu** for managing storage and recalling recordings.

Rate and ratio

The following procedure is used for setting up the Tri-Scan to measure pulsation rate and ratio as explained under **Hose Connections.**

Measuring rate & ratio

MAIN MENU

	SURGE		
Dis	Set	Prn	Mem
F1	F2	F3	F4

Pressing the **F2** function key under **Set** in the **Main Menu** shown on the LCD screen, displays the Set Up menu.

The **Set Up Menu** allows the operator to configure the Tri-Scan for performing a particular test, the type of recording, the channels to be plotted and if the information will be printed and/or saved to memory.

SET UP MENU

SET UP
Inp Plt Mod Exit

F1 F2 F3 F4

Set Up Menu options

The **Set Up Menu** offers options.

1. **Inp (Input)**... Allows the selection of the input channels to be recorded.
2. **Plt (Plotting)**... Selects the plotting of either wave-forms with data summaries or data summaries only.
3. **Mod (Mode)**... Permits the selection of either continuous or timed printing of a recording.
4. **Exit**... Returns control to the **Main Menu**

Pressing the **F1** function key, under Inp in the **Set Up Menu** shown on the LCD screen, displays the current **Input Selection Menu.**

INPUT SELECTION MENU

Current
OFF OFF OFF Exit

F1 F2 F3 F4

Pressing function keys while in the **Input Selection Menu** produces the following effect:

Pressing the **F1** function key repeatedly will cause the display for channel 1 to toggle between; **V1, P1, DCV, PDC, ACV** and **Off**.

Pressing the **F2** function key repeatedly will cause the display for channel 2 to toggle between; **V1, P1** and **Off**.

Pressing the **F3** function key repeatedly will cause the display for channel 3 to toggle between; **V1** and **Off**.

The Set Up Procedure For Pulsation Testing

Pulsation test set up

INPUT SELECTION MENU

Current			
OFF	OFF	OFF	Exit
F1	F2	F3	F4

1. Press the **F1** function key repeatedly until; **P1** is displayed in Channel 1.

2. Press the **F2** function key repeatedly until; **P2** is displayed in Channel 2, if alternating pulsation is to be recorded or to Off for simultaneous pulsation.

3. Press the **F3** function key repeatedly until; **V3** is displayed in Channel 3, if milking unit vacuum is to be recorded, or Off is displayed if only the pulsation wave-forms are to be recorded.

Upon completion of steps 1, 2 and 3 above, the **Input Selection Menu** will appear as shown, if the selection is for:

A. Simultaneous Pulsation without Unit Vacuum.

INPUT SELECTION MENU

Current			
P1	Off	Off	Exit
F1	F2	F3	F4

B. Simultaneous Pulsation and Milking Unit Vacuum.

INPUT SELECTION MENU

Current			
P1	V2	Off	Exit
F1	F2	F3	F4

C. Alternating Pulsation without Unit Vacuum.

INPUT SELECTION MENU

	Current		
P1	P2	Off	Exit
F1	F2	F3	F4

D. Alternating Pulsation with Milking Unit Vacuum.

INPUT SELECTION MENU

	Current		
P1	P2	V3	Exit
F1	F2	F3	F4

4. Upon completion of the input selections press the **F4** function key to return to the **Set Up Menu.**

SET UP MENU

	SET UP		
Inp	Plt	Mod	Exit
F1	F2	F3	F4

Pressing the **F2** function key under **Plt** transfers control of the Tri-Scan to the **Plotter Enable Menu** as displayed below.

PLOTTER ENABLE MENU

PLOT			(* = on)
P 1	P2	V3	Exit
F1	F2	F3	F4

Note: The **Plotter Enable Menu** screen will appear as it was configured in the **Set Up Menu**, even if power has been turned off and the Tri-Scan re-energized. The display above reflects the configuration shown in example "D" for Alternating Pulsation and Milking Unit Vacuum, which was the last screen displayed before this time.

Plotter Menu options

Any two of the channels appearing in the **Plotter Enable Menu** can be plot enabled, for plotting by the printer. This is accomplished by pressing the function key immediately beneath the desired channels. The enabled channels will be identified by an asterisk. The **Print Menu** can provide a plot of two enabled channels and a data summary of all three channels. See figure 2.

1. Press the **F1** function key to plot the pulsation chamber wave-form for the teat cup attached via hose to CH1.
2. Press the **F2** function key to plot the pulsation chamber wave-form from the teat cup attached via hose to CH2.

Following the above procedure will produce:

1. the display shown below.
2. a graph of the wave-form for alternating pulsation.
3. a printed data summary. Milking unit vacuum level will be summarized but not printed.

PLOTTER ENABLE MENU

```
PLOT                 ( * = on )
 P1 *   P2 *   V3      Exit

 F1      F2      F3      F4
```

To plot the pulsation chamber wave-form of one side of an alternating pulsator and milking unit vacuum level, use the following procedure:

1. Press the **F2** function key to remove the asterisk and disable P2
2. Press the **F3** function key to enable V3 for plotting.

Completing the above procedure will produce the menu shown below. A graph of the CH1 pulsation chamber wave-form, the milking unit vacuum level, and a data summary for all three channels are ready to print.

Plotting wave forms, unit vacuum level and data summary

PLOTTER ENABLE MENU

PLOT		(* = on)	
P1 *	P2	V3 *	Exit
F1	F2	F3	F4

Choosing not to plot enable any of the channels, will produce the following menu display and the Tri-Scan printer will print only a data summary for each of the three channels.

Data summary only

PLOTTER ENABLE MENU

PLOT		(* = on)	
P1	P2	V3	Exit
F1	F2	F3	F4

The same format is used for setting up the **Plotter Enable Menu** to plot pulsation wave-forms, when the Tri-Scan hose(s) are attached directly to or near the pulsator outlet nipple(s) for:

1. **Simultaneous and Alternating** pulsator systems pulsation wave-forms and milking unit vacuum levels.
2. **Simultaneous and Alternating** pulsator performance test only.

Plotting Speed

When plotting pulsation wave forms (P1 or P2), the plotter speed is one tape division (5mm) every .25 seconds.

Return to the **Set Up Menu**, once the plot selections have been made, by pressing the **F4** function key under the Exit in the **Plotter Enable Menu.**

SET UP MENU

SET UP
Inp Plt Mod Exit

F1 F2 F3 F4

Pressing the **F3** function key while in the **Set Up Menu** will transfer control to the **Mode Menu** and display the following:

RECORDING MODE MENU

RECORD MODE
Timed Exit

F1 F2 F3 F4

Selecting recording modes

There are two recording modes: **timed**; and **continuous.** Repeatedly pressing the **F1** function key toggles the display between **Timed** and **Cont (Continuous).**

1. Press the **F1** function key repeatedly until the word **Timed** appears in the LCD display as shown above. In the Timed Mode the Tri-Scan reads the inputs for a predetermined length of time. The number of functions recorded by the Tri-Scan is determined by the plot speed that has been selected. (See Appendix 3 Item 1 in the Owner's Manual regarding the number of pulsation wave-forms that are recorded in the Timed mode).

2. Pressing the **F1** function key a second time will display the word **Cont** in the LCD screen as shown below.

RECORDING MODE MENU

RECORD MODE
Cont Exit

F1 F2 F3 F4

Note: In the Continuous Mode the Tri-Scan records until stopped manually.

3. Pressing the **F4** function key, when the **Record Mode** configuration is completed, returns control of the Tri-Scan to the **Set Up Menu.**

SET UP MENU

SET UP			
Inp	Plt	Mod	Exit
F1	F2	F3	F4

The three configuration steps required in the **Set Up Menu** have been completed. Press the **F4** function key to exit the **Set Up Menu** and display the **Main Menu.**

MAIN MENU

SURGE			
Dis	Set	Prn	Men
F1	F2	F3	F4

The next step in the process is to move control of the Tri-Scan to the **Print Menu** by pressing the **F3** function key. The **Print Menu** display will appear as shown below.

Printing

PRINT MENU

PRINT			
Str	Hdr	Cap	Exit
F1	F2	F3	F4

The Print Menu provides four options:

1. **Str (Start)...** Starts the recording and printing.
2. **Hdr (Header)...** Activates the alpha numeric keyboard and allows the entry of a Header for individual printer tapes.

Print Menu options

3. **Cap (Capacity)...** Checks the capacity left in memory for storing individual recordings.
4. **Exit...** Returns control to the Main Menu

Pressing the **F1** function key when in the **Print Menu** will immediately start the recording process and transfer control of the Tri-Scan to the **Working Menu**.

Start recording

WORKING MENU

WORKING			
Halt	**Abort**		**Exit**
F1	**F2**	**F3**	**F4**

Note: The periods appearing after the word **working** is a graph that designates how far into the data recording process the Tri-Scan has progressed. Eight periods designate a complete recording. This graphing function is not displayed in the continuous mode.

Halt recording

1. Pressing the **F1** function key in the **WORKING MENU** halts both recording and printing, and displays the **HALTED MENU.**

HALTED MENU

HALTED			
Start	**Abort**		**Exit**
F1	**F2**	**F3**	**F4**

Halt Menu options

The Halted Menu provides three options:

1. **Start... F1** restarts the recording process and returns control of the Tri-Scan to the **Working Menu.**

2. **Abort... F2** Returns control of the Tri-Scan to the **Main Menu** and cancels further printing.
3. **Exit... F4** Halts plotting, returns an up-to-the-moment data summary of the recording, and transfers control to the **Enter Note Menu**

ENTER MENU

ENTER NOTE
XXXXXXXXXXXXXXX
XXXXXXXXXXXXXXX

< ENT >

Entering notes

Entering the **Note Menu** activates the alpha numeric keyboard and allows the operator to type in an ending note of up to two-fifteen character lines.

Pressing the **ENT** key enters the note for printing and transfers control to the **Save recording Menu.**

(The **ENT** key is located on the right side of the keyboard at end of the third row.)

SAVE RECORDING

SAVE RCDG ??	
Yes	No

F1 F2 F3 F4

Saving records

1. Pressing the **F1** function key saves the recording to memory and automatically assigns a number. The data can be recalled, manipulated for various plotting, and printed at a later date. Control of the Tri-Scan is returned to the **Print Menu.**
2. Pressing the **F4** function key disables the **Save Recording Menu** and returns control of the Tri-Scan the **Main Menu.**

PRINT MENU

PRINT
Str Hdr Cap Exit

F1 F2 F3 F4

Creating a header

Pressing the **F2** function key while in the **Print Menu** displays the **Header Menu**. This allows the operator to use the alpha numeric keyboard for inputting a two-line header consisting of up to fifteen characters on each line.

HEADER MENU

ENTER HEADER
XXXXXXXXXXXXXXX
XXXXXXXXXXXXXXX

< ENT >

Storing a header

Pressing the **ENT** key stores the header for printing on the tape and returns the Tri-Scan to the **Print Menu**.

PRINT MENU

SURGE
Str Hdr Cap Exit

F1 F2 F3 F4

Checking record storage capacity

Pressing the **F3** function key while in the **Print Menu** checks the capacity of the unused memory and displays the number of additional individual recordings that may be stored.

RECORDING CAPACITY MENU

RCDG CAP
XX

F1 F2 F3 F4

Once the capacity of the memory has been displayed, the control of the Tri-Scan is automatically returned to the **Print Menu.**

PRINT MENU

SURGE
Str Hdr Cap Exit

F1 F2 F3 F4

Pressing the **F4** function key returns control to the **Main Menu Memory.**

MAIN MENU

SURGE
Dis Set Prn Mem

F1 F2 F3 F4

Pressing the **F4** function key transfers control of the Tri-Scan to the **Memory Menu.**

MEMORY MENU

MEMORY
PLY CLR DMP EXIT

F1 F2 F3 F4

Memory Menu options

The Memory Menu offers four options:

1. **PLY (Play)**... Plays a recording from memory.
2. **CLR (Clear)**... Clears recordings from memory.
3. **DMP (Dump)**... Dumps recordings from memory into a personal computer.
4. **EXIT**.. Returns control of the Tri-Scan to the **Main Menu**.

Note: Any recording stored in memory can be view through the **Display Menu**.

See Section 4.4 and Appendix 2, Part 4 in the Owner's Manual for complete information relative to menu selections and the procedures for: recalling recordings from memory, reconfiguring plotting and printing; clearing recordings from the memory of the Tri-Scan; and dumping recordings from the Tri-Scan through the RS232Cport to a personal computer.

RUNNING TEAT CUP PULSATION CHAMBER PERFORMANCE TESTS

Input

Measuring vacuum level changes

Vacuum level changes are the inputs used by the Tri-Scan for teat cup pulsation chamber and pulsation performance testing. The magnitude of these pressure gradients are transmitted to the Tri-Scan via the 1/4 inch hoses with quick connects.

The hoses are connected between all, or a part of the vacuum input ports, CH1, CH2 and CH3, depending upon which of the various pulsation performance tests is to be conducted, and the appropriate connecting point on the milking machine.

Milking Machine

Testing milking units

Each milking unit should be tested individually, with all the other units connected to the system and running in a simulated or real milking situation.

Setting Up the Tri-Scan

1. Turn on the main power switch.

2. Access the **Set Up Menu.** Activate the **INP (INPUT) Menu** and select the appropriate combination of the input channels.

3. Move to the **PLOT (PLOTTER) Menu**. Select either wave-forms and data summaries, or data summaries to be printed.

4. Transfer control to the **MOD (MODE) Menu**. Select either continuous or timed recording. Timed are generally used for testing pulsation rates and ratios.

5. Access the **PRN (PRINT) Menu.** This initiated the printing sequence of the previously selected inputs. It allows an individualized header to be typed in, i.e. farm name, barn number, etc., and a note to be entered at the end of each recording.

6. Connect the hoses to the previously selected input channels and the appropriate connecting points, short air tube(s) with a 1/4 or 5/16 inch tee(s) and a similar size nipple in the claw body or lid of the milking unit.

7. Apply vacuum to the Tri-Scan by turning on the milking system or by attaching the milking unit and press the **F1** function key under **STR** in the **Print Menu**.

8. At the end of the timed cycle, or when the function key under **END** is pushed in the continuous cycle, the Tri-Scan automatically:

- **A.** Prints a tape, in the format previously selected from the **PLOT Menu**.
- **B.** Allows the entry of a note regarding the just completed test.
- **C.** Provides the opportunity to save the just completed recording to memory.

9. Repeat the test on all of the milking units, in the system being evaluated.

ANALYSIS AND INTERPRETATION

Types of Tests

Static or Dynamic tests?

Tests performed with the Tri-Scan Milking System Performance Tester fall into two major categories: 1) Static and 2) Dynamic.

1. **Static tests.** These are tests conducted with the all the milking units in a simulated milking position, with the teat cups plugged.
2. **Dynamic tests.** These are tests conducted with all the milking units attached in the prescribed manner and milking cows.

Static test

Static tests, are conducted to evaluate certain milking machine components, i.e. pulsators, milk and vacuums hose size and length, vacuum controls, teat cup shells; by comparing the Tri-Scan plots with predetermined standards.

Dynamic tests

Dynamic tests, are conducted to evaluate the adequacy of the milking system while operating under full load. A number of variable influences, i.e. number of milking units, milk flow rate, condition of pulsators, type and condition of inflations, air leaks, etc., may effect the results of a dynamic test.

Dynamic test results reflect the accumulated effect of these variables. The combination of these variables are infinite. It is, therefore, essential that each unit in a milking system be evaluated. The accumulated data from the tests should be used along with the rate and ratio data in TABLE 1 for making interpretations with respect to milking system functions. Using specific values form only one test will not provide an accurate picture of the system's efficiency.

Dynamic tests for pulsation should consider the following:

1. Teat cup pulsation chamber milk to massage ratio.
2. Pulsator milk to massage ratio.
3. Minimum massage "D" phase.
4. Average milking unit vacuum levels.
5. Minimum residual vacuum for massage.

Evaluating Pulsation Wave-Forms and Summary Output

Examine wave forms and data summary

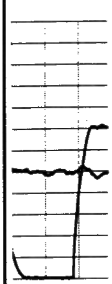
The evaluation of pulsation systems should include an examination of tapes showing both wave-forms plots and summary information.

The geometry of the wave-form plots should conform with that of a typical pulsation wave-form shown in Figure 1. (See appendix 1 for examples of tapes with wave-form graph depicting irregularities and explanation of the probable causes.)

The summary information on the tape, should be compared with the applicable corresponding information in TABLE 1. The time, for each of the four phases should fall within the range listed in the table for corresponding pulsation rate and ratio

The tape shown in figure 5 depicts a typical dynamic test recording of teat cup pulsation chamber wave-forms, milking unit vacuum level and data summaries for all three input channels.

FIGURE 5 TYPICAL TRI-SCAN RECORDING OF ALTERNATING PULSATION AND MILKING UNIT VACUUM SHOWING A PLOT OF PULSATION 1 AND VACUUM 3 WITH ALL SUMMARIES



DATA SUMMARY
Pulsation 1 (PLOT)

Rate:		49.52 PPM
Ratio:		51:49
A Phase:	9%	107mS
B Phase:	42%	508mS
C Phase:	14%	166mS
D Phase:	35%	430mS
A+B Phase:	51%	615mS
C+D Phase:	49%	596mS
Vacuum:		14.2inHg

DATA SUMMARY
Pulsation 2

Rate:		49.52 PPM
Ratio:		56:44
A Phase:	9%	104mS
B Phase:	47%	571mS
C Phase:	14%	169mS
D Phase:	30%	368mS
A+B Phase:	56%	675mS
C+D Phase:	44%	537mS
Vacuum:		14.3inHg
Limp:		5%

DATA SUMMARY
Vacuum 3 (PLOT)

Maximum Vac:	11.8inHg
Minimum Vac:	9.3inHg
Average Vac:	10.2inHg

In figure 5 the plot was set for P1 which in this case was for the front teat cups of an alternating pulsation system, and for V3 which was for the milking vacuum.

The wave-form plotted here is typical. The line variation in the B phase is due to a slight fluctuation in the pulsation line vacuum level. This level of fluctuation in the B phase has no effect on the open position of the inflation nor milk flow and is, therefore, completely acceptable.

Data Summary For Pulsation 1:

Typical data summaries

1. Rate: 49.61 PPM (Pulsations Per Minute) is within an accepted tolerance for 50 PPM.
2. Ratio: 50:50 (Milk to Massage/Rest) is one of the recommended ratios.
3. A Phase: 7% of the total pulsation cycle or 85mS are within the ranges set forth in table 1.
4. B Phase: 43% of the total pulsation phase or 524 mS are well above the 30% minimum requirement set by the industry and within the ranges listed in table 1.
5. C Phase: 12% of the total pulsation cycle or 144 mS are within the ranges listed in table 1.
6. D Phase: 38% of the total pulsation cycle or 456 mS are above the 15% minimum requirement set by the industry and within the ranges listed in tables 1.
7. A+B Phase: 50% of the total pulsation cycle and 609 mS are exactly on target.
8. C+D Phase: 50% of the total pulsation cycle and 609 mS are exactly on target.
9. Vacuum: 14.3 inches Hg is the vacuum level registered in the during the B phase. This vacuum level is indicative of that required for high mounted stanchion pipe line milking system and is within an acceptable range.

Data Summary For Pulsation 2:

1. Rate: 49.61 PPM (Pulsations Per Minute) is within an accepted tolerance for 50 PPM.
2. Ratio: 55:45 (Milk to Massage/Rest) is one of the recommended ratios.
3. A Phase: 7% of the total pulsation cycle or 85mS are within the ranges set forth in table 1.
4. B Phase: 48% of the total pulsation phase or 585 mS are well above the 30% minimum requirement set by the industry and within the ranges listed in table 1
5. C Phase: 12% of the total pulsation cycle or 148 mS are within the ranges listed in table 1.

6. D Phase: 33% of the total pulsation cycle or 391 mS are above the 15% minimum requirement set by the industry and within the ranges listed in tables 1.
7. A+B Phase: 55% of the total pulsation cycle and 670 mS are exactly on target.
8. C+D Phase: 45% of the total pulsation cycle and 539 mS are exactly on target.
9. Vacuum: 14.3 inches Hg is the vacuum level registered in the during the B phase. This vacuum level is indicative of that required for high mounted stanchion pipe line milking system and is within an acceptable range.
10. Limp: this measurement is not applicable when front-to-rear alternating pulsation is employed.

Data Summary for Vacuum 3

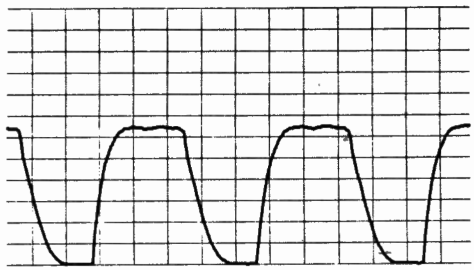
1. **Maximum Vac:** 12.1 inHg is the average maximum milking unit vacuum level registered during the recording.
2. **Minimum Vac:** 9.9 inHg is the minimum milking unit vacuum level throughout the recording. This indicates an average milking unit vacuum level fluctuation of 2.2inHg. This level of fluctuation is slightly above the accepted standard of 2inHg, but is within a range of acceptable tolerances.
3. **Average Vac:** 11.0 inHg this is below the milking unit vacuum level recommended by Babson. This is within the range of milking vacuum levels used in the industry, but is below 12.0 inHg recommended by Babson.

Typical Tri-Scan Tapes From Dynamic Pulsation Test

The tapes illustrated in figures 6 through 11 are recordings of dynamic tests. The waves-forms and data summaries conform to the standards from tables 1 through 6.

Typical Tri-Scan tape printouts

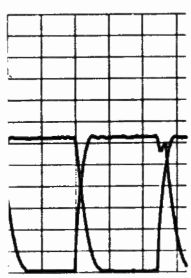
FIGURE 6.
SIMULTANEOUS WAVE-FORM AND DATA SUMMARY



DATA SUMMARY
Pulsation 1 (PLOT)

Rate:		49.52 PPM
Ratio:		56:44
A Phase:	13%	159mS
B Phase:	43%	516mS
C Phase:	18%	220mS
D Phase:	26%	317mS
A+B Phase:	56%	675mS
C+D Phase:	44%	537mS
Vacuum:		12.9inHg

FIGURE 7. ALTERNATING WAVE-FORMS AND DATA SUMMARY



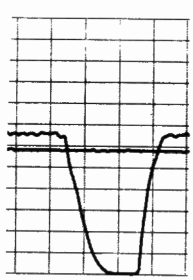
DATA SUMMARY
Pulsation 1 (PLOT)

Rate:		49.52 PPM
Ratio:		50:50
A Phase:	7%	79mS
B Phase:	43%	530mS
C Phase:	10%	125mS
D Phase:	40%	477mS
A+B Phase:	50%	609mS
C+D Phase:	50%	602mS
Vacuum:		12.5inHg

DATA SUMMARY
Pulsation 2 (PLOT)

Rate:		49.56 PPM
Ratio:		56:44
A Phase:	7%	80mS
B Phase:	49%	596mS
C Phase:	10%	121mS
D Phase:	34%	414mS
A+B Phase:	56%	676mS
C+D Phase:	44%	535mS
Vacuum:		12.6inHg
Limp:	6%	

FIGURE 8. SIMULTANEOUS WAVE-FORMS, MILKING VACUUM AND DATA SUMMARY



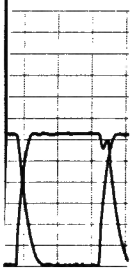
DATA SUMMARY
Pulsation 1 (PLOT)

Rate:		49.65 PPM
Ratio:		56:44
A Phase:	12%	144mS
B Phase:	44%	527mS
C Phase:	19%	224mS
D Phase:	25%	314mS
A+B Phase:	56%	671mS
C+D Phase:	44%	538mS
Vacuum:		13.2inHg

DATA SUMMARY
Vacuum 3 (PLOT)

Maximum Vac:	11.6inHg
Minimum Vac:	11.3inHg
Average Vac:	11.5inHg

FIGURE 9. ALTERNATING WAVE-FORMS, MILKING VACUUM AND DATA SUMMARY



DATA SUMMARY		
Pulsation 1 (PLOT)		
Rate:		49.52 PPM
Ratio:		50:50
A Phase:	7%	79mS
B Phase:	43%	529mS
C Phase:	10%	122mS
D Phase:	40%	481mS
A+B Phase:	50%	608mS
C+D Phase:	50%	603mS
Vacuum:		12.5inHg

DATA SUMMARY		
Pulsation 2 (PLOT)		
Rate:		49.52 PPM
Ratio:		56:44
A Phase:	7%	81mS
B Phase:	49%	595mS
C Phase:	10%	122mS
D Phase:	34%	414mS
A+B Phase:	56%	676mS
C+D Phase:	44%	536mS
Vacuum:		12.6inHg
Limp:	6%	

DATA SUMMARY	
Vacuum 3	
Maximum Vac:	12.2inHg
Minimum Vac:	11.9inHg
Average Vac:	12.1inHg

FIGURE 10. DATA SUMMARIES

DATA SUMMARY		
Pulsation 1 (PLOT)		
Rate:		49.65 PPM
Ratio:		51:49
A Phase:	10%	125mS
B Phase:	41%	493mS
C Phase:	16%	193mS
D Phase:	33%	398mS
A+B Phase:	51%	618mS
C+D Phase:	49%	591mS
Vacuum:		13.7inHg

DATA SUMMARY	
Vacuum 2 (PLOT)	
Maximum Vac:	13.8inHg
Minimum Vac:	11.5inHg
Average Vac:	12.6inHg

DATA SUMMARY	
Vacuum 3	
Maximum Vac:	13.9inHg
Minimum Vac:	13.1inHg
Average Vac:	13.6inHg

RECOMMENDATION

Rationale

Research studies and field experience agree, that maximum milking efficiency with minimum stress requires a balance between vacuum applied to the teats during the milk phase, and the compression applied for massage.

A logical deduction based on this information is that the massage, or D phase, of each pulsation cycle should commence within 500 to 700 mSec after the beginning of the A phase, and that it should have a minimum duration of 225 mSec and a maximum of 425 mSec.

Evaluation guidelines

The guidelines for meeting these parameters are:

1. Pulsation rate of 50 to 60 pulsations per minute.

2. Pulsation cycle duration of 1000 to 1200 mSec.

3. Milk B phase duration of 425 to 660 mSec.

4. Massage D phase duration of 225 to 425 mSec.

5. The milk to massage ratio percentage, for the A+B milking phase recorded in the teat cup pulsation chamber, should not be:

A. 1% less than the corresponding "On-time" percentage recorded during the pulsed DC voltage test run at the pulsator for the milking unit being checked.

B. More than two percent (2%) greater than the corresponding "On-time" percentage recorded during the pulsed DC voltage test run at the pulsator for the milking unit being checked.

MILKING VACUUM

OVERVIEW

What is meant by milking vacuum

Milking vacuum, as defined by 3-A, ASAE and ISO standards, is the reduced level of pressure within the milking unit. The milking unit vacuum is measured in inHg, mmHg or kPa and is applied to the teat ends during milking via the interior of the inflations.

Milking vacuum is the force that works in conjunction with internal udder pressure to move the milk from the teats into the milking machine. It is also the force that works in conjunction with the cyclic atmospheric pressure in the teat cup pulsation chambers to force the inflation closed and apply a massage force to the teats.

Milk Removal

Milk flows from the teats during the time the inflations are open. More specifically, milk flow begins at a point in the A phase of the pulsation cycle, when the inflations are approximately half open, throughout the B phase and during the C phase, until the inflations are approximately half closed.

As the inflation opens, the negative force of the milking vacuum beneath the teats and the positive force of the internal udder pressure within the teats produces a pressure differential across the teat end orifices. This difference in pressure stretches and expands the teat wall tissue and sphincter muscle, opens the streak canal, and forces the milk from the higher pressure area within the teat into the lower pressure of the milking machine.

At the same time the milk is being forced from the higher pressure area of the teat into the lower pressure of the milking machine; body fluids, blood and lymph, are drawn toward the end of the teat. As discussed in the previous chapter the accumulation of these fluids in the wall and apex of the teat will affect the rate of milk flow, if proper massage force is not applied at the appropriate time during each pulsation cycle.

Massage

The body fluids are massaged from the teats during the D phase of the pulsation cycle when the inflations close. The closing of the inflations must create sufficient compression against the teat ends to force the accumulated body fluids up and away from the teat apex and into the circulatory system.

The inflation closes when the pulsator admits air at atmospheric pressure into the teat cup pulsation chamber. The negative pressure of the milking vacuum inside the inflation, combined with the positive atmospheric pressure within the pulsation chamber, produces a pressure differential across the inflation wall. This pressure differential, causes the inflation wall to move away from the higher pressure in the teat cup pulsation chamber, toward the lower pressure on the inside of the inflation. The collapse of the inflation wall against the teat must provide the massage needed, to clear the body fluids congested within the teats, if fast complete and safe mechanical milking is to be accomplished.

Compression Load

What causes an inflation to collapse?

The strength of the force applied to the teats during the massage phase of the pulsation cycle, is referred to as compression load. The force is influenced by both the major and secondary factors listed below:

Major factors

1. The vacuum level inside the inflation.
2. Shape of the wave-form or length of the D phase
3. The resistance of the inflation to collapse.
4. The hardness of the material used in the inflation.

Secondary factors

1. The type and condition of the inflations.
2. The amount of air leakage between the teat and inflation mouthpiece during milking.
3. The condition of the pulsator.
4. The rate of milk flow.
5. The height milk is lifted from the claw to the milk line.

As was discussed in the previous chapter, the compression load against the teat during the D phase must be great enough to overcome the diastolic arterial pressure within the teat. The diastolic pressure is equal to a vacuum force of approximately 3 inches Hg, in most cows.

Another force that must be overcome in order to achieve proper massage, is the inflation's resistance to collapse. The level of this resistance varies from type of inflation to another. The variances are influenced by; the shape, bore size, hardness or firmness, the amount of stretch employed, etc.. The milking unit vacuum force, measured in inches Hg, must overcome the inflation's resistance to collapse plus the diastolic pressure within the teat's vascular system to be effective. The inHg value required to collapse specific Surge inflations is listed in Table 7.

How much force does it take to collapse an inflation?

TABLE 7.

PRESSURE REQUIRED TO COLLAPSE SURGE INFLATIONS

PART #	DESCRIPTION	INCHES Hg
10041	SURGE FAST-FLO	4.5
10048	SURGE FAST-FLO	4.5
10049	SURGE FAST-FLO	4.5
10050	SURGE FAST- FLO	3.5
10052	SURGE CUSH. DOME	4.0
10057	SURGE FLAT DOME	5.0
10058	SURGE FLAT DOME	5.5
10063	SURGE FLAT DOME	6.0
10080	SURGE JET-FLO	4.0
10081	SURGE JET-FLO	4.5
10094	SURGE B-2AA	3.0
10100	SURGE FLAT DOME	4.5
10134	SURGE FLAT DOME	4.0

Since, the massage force is influenced by a number of factors, the massage force value is not constant. It is a dynamic value, that changes with the varying interrelationships of influencing factors.

It is, therefore, highly ineffective to evaluate a given milking system, using generalities or a specific value. It is essential that tests be conducted which show the effects of these variables on milking vacuum characteristics. Interpretations should be made based upon mean values, from data accumulated during a series of tests of the system being evaluated.

The Tri-Scan Milking System Performance Tester, provides the capacity for achieving the above.

TRI-SCAN MILKING VACUUM TEST

Dynamic Tests

Five ways to test milking vacuum.

Data from dynamic testing of the milking vacuum, pulsation system, milk lines, etc. are used to evaluate the milking system while operating under full load.

Since, the combination of variables is infinite, it is necessary to run the milking vacuum test on all of the milking units in a system, and use mean values from these tests to make interpretations relative to the system.

Tests

There are five milking vacuum tests.

1. Milking vacuum level within the claw.
2. Milking vacuum relative to the pulsation wave-forms.
3. Milking vacuum fluctuation in the claw.
4. Milk line vacuum.
5. Milk line vacuum fluctuation.

ACCEPTED STANDARDS

Industry Standards

The Industry standards vary widely depending upon their origin. ASAE, ISO, UK and CANADIAN standard values are inconsistent in some areas. The following is composite minimum/maximum ranges from these standards.

1. Milking unit vacuum level is within a range of between 11 and 15 inHg (37.2 and 50.65 kPa).
2. Milking unit cyclic vacuum fluctuation is 2 to 3 inHg (6.75 and 10.13 kPa).

3. Milk line vacuum level range as low as 11.8 inHg (40 kPa) for low milk lines and up to 15 inHG (50.65 kPa) for high lines.
4. Milk line vacuum level fluctuation range of between .5 and 1 inHg (2.88 to 3.38 kPa).

Babson Recommendations

Milking vacuum standards

Babson Bros. Co's. recommendations for Surge systems fall within the general parameters set by the various Industry Standards.

Babson's recommendations for:

1. Milking unit vacuum level is 12 inHg. with a tolerance of + / - .5 inHg.
2. Milking unit vacuum level fluctuation is 3 inHg.
3. Minimum residual vacuum level is a minimum of 7 inHg.
4. Milk line vacuum level is a range of between 12 and 15 inHg, but should not exceed 15 inHg. The proper setting is dependent upon the vacuum drop across the milk hose, combined with that of any devices, i.e. milk meters, milk flow sensors, etc., that may be installed in the milk hose, between the milking unit and the milk line.
5. Milk line vacuum fluctuation is 1 inHg.

PROCEDURE FOR MILKING VACUUM TEST

General Requirements

Test procedure recommendations

Milking vacuum levels should be recorded during a normal milking, with all of the milking units attached to cows and milk flowing.

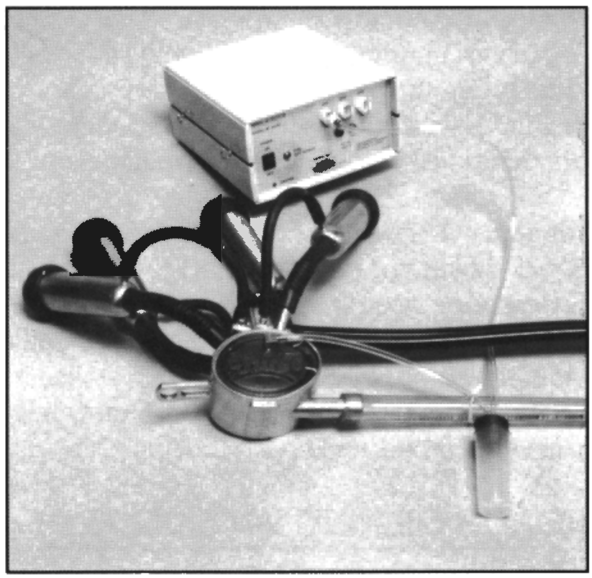
Tri-Scan recordings of milking unit vacuum should be run on all of the milking units used in a system. These recording should be made while the units are milking high producing cows.

Tri-Scan recordings of milking unit vacuum on high line milking systems should be made at or near the point in the system that requires maximum milk lift.

Hose Connections

The Tri-Scan hoses should be connected to the milking unit as described in the ASAE Engineering Practices: EP441, Test Equipment And Its Application For Measuring Milking Machine Operating Characteristics. Figure 11 shows the proper connections for recording milking unit vacuum level, and milking unit vacuum level in conjunction with teat cup pulsation chamber wave-form.

FIGURE 11



THE PROPER HOSE CONNECTION FOR RECORDING MILKING UNIT VACUUM ONLY.

Milking Unit vacuum

There are two alternatives for connecting hoses for recording milking unit vacuum level.

1. One is to connect the hose between the vacuum input port, marked CH3 on the back of Tri-Scan, and a nipple in a specially equipped test lid or claw window.

2. Is similar to one, except that a #12 gauge, three (3) inch hypodermic needle is inserted through the wall of one inflation stem, into the upper area of the claw the connection at the milking unit.

NOTE: The 1/4 X 5/8 inch milk hose tee, that is supplied with the Tri-Scan, should not be used for checking milking unit vacuum level. Measurements of milking vacuum utilizing a tee in the milk hose are not representative of the milking unit vacuum.

Pulsation Chamber and Milking Unit Vacuum

The same two alternatives apply, when connecting the hoses for the simultaneous measurement of milking unit vacuum and teat cup pulsation chamber wave-forms.

1. The hose connections for milking unit and pulsation chamber vacuum recording, where simultaneous pulsation is employed, should be made between:
   CH1 on the back of the Tri-Scan and the appropriate size tee, in the short air tube of the teat cup to be recorded.
   CH2 or CH3 and the milking unit using either a vacuum port in the claw, or a hypodermic needle as described above.
2. The hose connections for recording milking unit and pulsation chamber vacuum levels with alternating pulsation, should be made between:
   CH1 and the appropriate tee in an air tube of one of the teat cups operated by one side of the alternating pulsator,
   CH2 and the appropriate tee in a short air tube of a teat cup operated by the other side of the alternating pulsator,
   CH3 and the milking unit, attached to either a vacuum port in the claw or by a hypodermic needle as described under Milking Vacuum above.

Milking unit and milk line vacuum.

The hose connections for recording milking unit and milk line vacuums simultaneously are made between:

1. CH2 and the milk line. The connection to the milk line using the special milk valve inlet with 1/4 inch nipple

provided with the Tri-Scan.
2. CH3 and the milking unit as previously described.

Milk Hose Peripherals

The hose connections, for measuring the vacuum drop across peripherals placed in the milk hose, such as in line milk meters, milk flow sensors, etc., are make between:

1. CH2 and a 1/4 x 5/8 or 1/4 x 9/16 inch milk hose tee placed below the device.
2. CH3 and a 1/4 x 5/8 or 1/4 x 9/16 inch milk hose tee placed above the device.

Menu Selection

The Tri-Scan's full keyboard provides flexibility and the advantage of adding personalized headers and ending notes , to the strip tapes. All of the test programs can be initiated by a series of single key strokes, utilizing the four function "F" keys and the "ENT" key.

Menu selection is started by turning on the Tri-Scan's main power switch located in the middle left side of the rear panel. The power up procedure includes an automatic self-diagnostic test (see section 3.2 of the Owner's Manual for details if error massages appear).

Upon completion of the diagnostic tests, the main menu will appear on the LCD screen, which is located near the top center of the front panel (See figure 12).

**FIGURE 12
THE FRONT PANEL
WITH THE MAIN
MENU SHOWING.**

Milking Vacuum

Menu selections

Once the Main Menu has been displayed the following procedure is used for setting up the Tri-Scan to measure milking unit vacuum.

MAIN MENU

	SURGE		
Dis	Set	Prn	Men
F1	F2	F3	F4

1. Pressing the **F2** function key under **Set** in the **Main Menu** shown on the LCD screen, displays the **SET UP Menu.**

The **Set Up Menu** allows the operator to configure the Tri-Scan for:

1. performing a particular test,
2. the type of recording, and
3. data summary, and if the information will be printed and/or saved to memory.

SET UP MENU

	Set UP		
Inp	Plt	Mod	Exit
F1	F2	F3	F4

1. Pressing the **F1** function key, under **Inp** in the **Set UP Menu**, displays the **Input Selection Menu**.

INPUT SELECTION MENU

	Current		
OFF	OFF	OFF	Exit
F1	F2	F3	F4

Pressing function keys while in the **Input Selection Menu** produces the following effect:

Pressing the **F1** function key repeatedly will cause the display for channel 1 to toggle between **V1, P1, DCV, PDC, ACV** and **Off.**
Pressing the **F2** function key repeatedly will cause the display for channel 2 to toggle between **V1, P1** and **Off.**
Pressing the **F3** function key repeatedly will cause the display for channel 3 to toggle between **V1** and **Off.**

Recording milking unit vacuum

INPUT SELECTION MENU

	Current		
OFF	OFF	OFF	Exit
F1	F2	F3	F4

Recording data

1. Press the **F1** function key repeatedly until **OFF** is displayed in Channel 1.
2. Press the **F2** function key repeatedly until **OFF** is displayed in Channel 2
3. Press the **F3** function key repeatedly until **V3** is displayed in Channel 3.

Upon completion of steps 1, 2 and 3 above the **Input Selection Menu** will appear as shown below.

INPUT SELECTION MENU

	Current		
OFF	OFF	V3	Exit
F1	F2	F3	F4

Recording pulsation chamber and milking unit vacuum

INPUT SELECTION MENU

	Current		
OFF	OFF	Off	Exit
F1	F2	F3	F4

1. Press the **F1** function key repeatedly until **P1** is displayed in Channel 1.
2. Press the **F2** function key repeatedly, until **OFF** is displayed in Channel 2 if the recording is of a milking unit with simultaneous pulsation; or until **P2** is displayed if the recording is of a milking unit with alternating pulsation.
3. Press the **F3** function key repeatedly until **V3** is displayed in Channel 3.

Upon completion of steps 1, 2 and 3 above the **Input Selection Menu** will appear as shown, if the selection to be recorded is for:

A. Milking Unit Vacuum With Simultaneous Pulsation.

INPUT SELECTION MENU

	Current		
P1	Off	V3	Exit
F1	F2	F3	F4

B. Milking Unit Vacuum With Alternating Pulsation.

INPUT SELECTION MENU

	Current		
P1	P2	V3	Exit
F1	F2	F3	F4

C. Milking Unit And Milk line Vacuum.

INPUT SELECTION MENU

	Current		
OFF	V2	V3	Exit
F1	F2	F3	F4

D. Pulsation Chamber, Milk Line & Unit Vacuum

INPUT SELECTION MENU

	Current		
P1	V2	V3	Exit
F1	F2	F3	F4

4. Upon completion of the input selections press the **F4** function key to return to the **Set Up Menu.**

SET UP MENU

	Set UP		
Inp	Plt	Mod	Exit
F1	F2	F3	F4

1. Pressing the **F2** function key under **Plt** transfers control of the Tri-Scan to the **Plotter Enable Menu** as displayed below.

PLOTTER ENABLE MENU

PLOT		(* = on)	
P1	V2	V3	Exit
F1	F2	F3	F4

Note: The screen will appear as it was last configured in the **Set Up Menu**, even if power has been turned off and the Tri-Scan re-energized. The display above reflects the configuration shown in example "D" for Pulsation Chamber, Milk Line And Milking Unit Vacuum, which was the last screen displayed before this time.

Printing records

Any two of the channels appearing in the Plotter Enable Menu can be plotted by the printer. Printing is accomplished by pressing the function key immediately beneath the desired channels. The enabled channels will be identified by an asterisk. The Print Menu can provide a plot of two enabled channels and a data summary of all three channels.

1. Press the **F1** function key to plot the pulsation chamber wave-form for the teat cup attached via a hose to CH1.
2. Press the **F2** function key to plot the vacuum level in the milk lines attached via a hose to CH2.

Following the above procedure will produce the display shown below. A graph of the teat cup pulsation wave-form, the milk line vacuum level and a printed data summary of all channels will be provided.

PLOTTER ENABLE MENU

```
PLOT               ( * = on )
P1 *    V2 *    V3      Exit

F1      F2      F3      F4
```

To plot the teat cup pulsation chamber wave-form and the milking unit vacuum level, use the following procedure.

1. Press the **F2** function key to remove the asterisk and disable **V2**.
2. Press the **F3** function key to enable **V3** for plotting.

Completing the above procedure will produce:

1. the menu shown below,
2. a printed graph of the **P1** pulsation chamber wave-form and milking unit vacuum level, and

3. a data summary for all three channels.

PLOTTER ENABLE MENU

PLOT		(* = on)	
P1 *	V2	V3 *	Exit
F1	F2	F3	F4

Choosing not to plot enable any of the channels, will produce the following menu display and the Tri-Scan printer will print only a data summary for each of the three channels.

PLOTTER ENABLE MENU

PLOT		(* = on)	
P1	V2	V3	Exit
F1	F2	F3	F4

The same format is used for setting up the Plotter Enable Menu to plot only the milking unit vacuum, only the milk line vacuum or any combination of the three channels.

Plotting Speed

How to determine plotting speed.

The plotting speed of the printer is determined by the type of input chosen for channel 1 or 2.

1. To plot at 20 millimeters per second (1/4 sec. per div.), **P1** or **P2** must be used to monitored the pulsation wave-form. This is the required speed for recording a teat cup chamber wave-form and milking unit or milk line simultaneously.
2. To plot at the 5mm per second tape speed (1 sec. per div.), **V1** must be displayed.
3. To plot at the .5mm per second tape speed (10 sec. per div.), **V1** must be off and one or both of the two remaining channels, **V2** or **V3**, displayed.

Refer to Section 4.2.2 in the Owner's Manual, for additional information relative to choosing the various plot speeds.

Return to the **Set UP Menu**, once the plot selections have been completed, by pressing the **F4** function key under **Exit** in the Plotter Enable Menu

SET UP MENU

Set UP			
Inp	Plt	Mod	Exit
F1	F2	F3	F4

Pressing the **F3** function key while in the **Set Up Menu** will transfer control to the **Mode Menu** and display the following.

RECORDING MODE MENU

RECORD MODE			
Timed			Exit
F1	F2	F3	F4

How to select recording mode.

There are two recording modes: **1. Timed** and **2. Continuous.**

1. Pressing the **F1** function key toggles control and the display between **Timed** and **Cont**.
Press the **F1** function key repeatedly until the word **Timed** appears in the LCD display as shown above. In the **Timed Mode**, the Tri-Scan reads the inputs for a predetermined length of time. The number of samples recorded by the Tri-Scan is determined by the plot speed.
2. Pressing the **F1** function key a second time will display the word **Cont** in the LCD screen as shown below.

RECORDING MODE MENU

RECORD MODE			
Cont			Exit
F1	F2	F3	F4

Note: In the **Cont Mode** the Tri-Scan records until stopped manually.

3. Pressing the **F4** function key, when the **Record Mode** configuration is completed, returns control of the Tri-Scan to the **Set Up Menu.**

SET UP MENU

	Set UP		
Inp	Plt	Mod	Exit
F1	F2	F3	F4

Once in the **Set Up Menu** press the **F4** function key immediately to exit the **Set Up Menu** and display the **Main Menu.**

MAIN MENU

	SURGE		
Dis	Set	Prn	Men
F1	F2	F3	F4

The next step in the process is to move control of the Tri-Scan to the **Print Menu** will appear as shown below.

Printing

Printing options

PRINT MENU

	PRINT		
Str	Hdr	Cap	Exit
F1	F2	F3	F4

The **Print Menu** provides four options:

1. **Str...** Starts the recording and printing.
2. **Hdr...**Activates the alpha numeric keyboard and allows the entry of a Header for individual printer tapes.
3. **Cap...** Checks the capacity left in memory for storing individual recordings
4. **Exit...** Returns control to the Main Menu Memory.

MAIN MENU

	SURGE		
Dis	Set	Prn	Men
F1	F2	F3	F4

Pressing the **F4** function key transfers control of the Tri-Scan to the Memory Menu.

MEMORY MENU

	MEMORY		
PLY	CLR	DMP	EXIT
F1	F2	F3	F4

Memory options

The Memory Menu offers four options.

1. **PLY**... Plays a recording from memory.
2. **CLR**... Clears recordings from memory.
3. **DMP**... Dumps recordings from memory into a personal computer.
4. **Exit**.. Returns control of the Tri-Scan to the **Main Menu**.

The procedures for printing and memory management are common, regardless of the type of tests to be made or that have been conducted. Therefore, each step of the Memory Menu procedure has not been covered here. See pages 2.23 through 2.24 in the Pulsation Section of this manualfor details of these procedures.

Also, see Section 4.4 and Appendix 2 Part 4 in the Owner's Manual for complete information relative to menu selections and the procedures for:

recalling recordings from memory;
reconfiguring plotting and printing;
clearing recordings from the memory of the Tri-Scan;
and dumping recordings from the Tri-Scan through the RS232C port to a personal computer.

RUNNING MILKING VACUUM TEST

Vacuum is the input used by the Tri-Scan Milking System Performance Tester for milking vacuum testing. The vacuum level deviations are transmitted through the 1/4 inch hoses with quick connects to the vacuum input ports on the back of the Tri-Scan.

The hoses are connected between all or a part of the vacuum input ports, CH1, CH2 and CH3, and the appropriate connecting point(s) on the milking machine.

Milking Machine

Test every milking unit.

To insure a complete analysis, each milking unit should be tested individually during milking. The milking system should be under full load with all of the milking units in place and milking cows.

Setting Up the Tri-Scan

1. Turn on the main power switch.
2. Access the **Set Up Menu**. Activate the **INP (INPUT) Menu** and select the appropriate combination of the input channels.
3. Move to the **PLOT (PLOTTER) Menu**. Select the channels to be printed with either milking vacuum level wave-forms and data summaries, or data summaries only.
4. Transfer control to the **MOD (MODE) Menu**. Select either continuous or timed recording. The continuous mode should be used for recording the milking vacuum level in at least two milking machines in each system. The recording in continuous mode should run for the entire time it takes to milk the cow.
5. Access the **PRN (PRINT) Menu**. This initiates the printing sequence of the previously selected inputs. It allows an operator to type in individualized header, i.e. farm name, barn number, etc., and a note at the end of each recording.

6. Connect the hoses to the previously selected input channels and the appropriate connecting points on the milking machine. These connections should be made using the appropriate adapters supplied with Tri-Scan, for recording the milking unit, milk line and pulsation chamber vacuum levels.
7. Apply vacuum to the Tri-Scan and press the **F1** function key under **STR** in the **Print Menu**.
8. At the end of the timed cycle, or when **F4** under **END** is pressed in the continuous mode, the Tri-Scan automatically:

Prints a tape, in the format previously selected from the PLOT Menu.
Allows the entry of a note regarding the just completed test.
Provides the opportunity to save the just completed recording to memory.

Note: In order to perform a complete and accurate evaluation of a milking system, repeat the test procedure on all of the milking units. Average values should be developed from all the test data for interpretation of system performance.

ANALYSIS AND INTERPRETATION

Dynamic Tests

Milking vacuum performance tests must be conducted under dynamic conditions, with all the milking units attached and milking cows.

What does dynamic testing mean?

Dynamic tests of milking vacuum should consider the following:

1. Milking unit vacuum levels.
2. Milking unit vacuum level fluctuation.
3. Effect of milking vacuum on massage.
   - **A.** "D" phase.
   - **B.** Minimum residual vacuum level.
4. Milk line vacuum level.
5. Milk line vacuum fluctuation.

Evaluating Milking Vacuum Tapes and Data Summary Output

Dynamic tests of the milking vacuum are used to evaluate the milking system and individual components while operating under full load. There are a number of variable influences, (number of milking units, milk flow rate, air leaks, etc.) that may affect the results of a dynamic test.

Dynamic test results reflect the accumulated effect of the variable influences. Since, the combination of these variables are infinite, it is essential that the milking unit vacuum level of each unit be recorded. The accumulated data from these recordings should be used in making interpretations with respect to milking system functions. Using specific values from only one or two tests will not provide an accurate picture of the system's functional efficiency.

Average milking unit vacuum level.

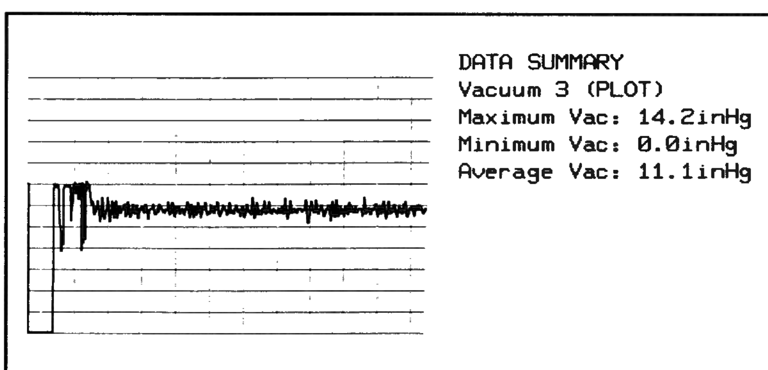
The milking unit is the closest point to the teat ends at which vacuum levels can be accurately measured. Therefore, ASAE, 3-A, ISO and Babson consider the milking unit vacuum level to be representative of vacuum conditions in the inflations near the teat end.

Milking unit vacuum level recommendation.

Babson's recommendation for milking unit vacuum level is 12, inHg + / - .5 inHg. measured with the units milking and the system under full load. See figure 13.

FIGURE 13

TAPE OF A TYPICAL MILKING UNIT VACUUM LEVEL RECORDING WITH A DATA SUMMARY OF VACUUM



The tape shown in figure 13 depicts a typical recording of milking unit vacuum under dynamic conditions. The plot line rises rapidly from 0 to the grid line representing 12 inHg at the point where vacuum was applied to the unit.

The effect of large volumes of air admitted into the claw as the teat cups were being attached, is reflected on the recording tape by a series of sharp depressions, with up to 7 inHg in magnitude at the beginning of the plot line. This type of vacuum drops in the milking unit vacuum level is referred to as an irregular fluctuation.

This graph shows very acceptable milking unit vacuum conditions. The plot line remains on a virtually horizontal plane of an average maximum vacuum level of 12.1 inHg throughout the entire milking.

Average milking unit vacuum level fluctuation.

The milking vacuum level plot on this tape is also a typical example of acceptable cycle vacuum level fluctuation within the milking unit.

These cyclic fluctuations are the consequence of a diaphragm pumping action created by the inflation's response to the pulsator.

In effect the volumetric area within the confines of the claw is reduced when the inflations are closed in the D phase. This action compresses the rarefied air within the claw, which is reflected on the tape by a sharp depression in the plot line of approximately two inches.

The volume within the claw is returned to its original size when the inflations are opened for the B phase. The rarefied air within the claw expands to fill the increased space . This action is reflected on the tape by a sharp upward movement of the plot line to the maximum milking unit vacuum level.

What is an acceptable level of milking vacuum fluctuation?

The magnitude of these cyclic depressions is greater near the beginning of the plot, when milk flow is at its highest, and decreases in the latter part of the plot as the flow subsides. The magnitude of the variations, however, never exceed 2 inHg, which is well within the 3 inHg maximum allowable cyclic fluctuation set forth in the accepted standards.

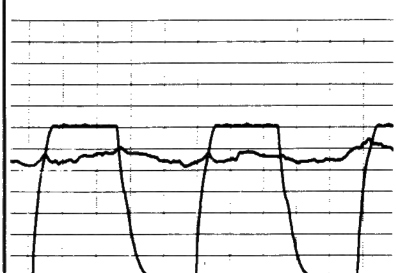
Data Summary for Vacuum 3

1. **Maximum Vac:** 14.2 inHg is the average maximum milking unit vacuum level registered during the recording.
2. **Minimum Vac:** 0 inHg is the average minimum milking unit vacuum level registered during the recording.
3. **Average Vac:** 11.1 inHg is the average vacuum recorded during milking.

The summary information on the tapes, should be used along with recordings from the other milking units, to develop mean values for comparison with the Babson recommendation.

A thorough evaluation of milking unit vacuum should be included in a review of recording tapes with simultaneous plots of pulsation chamber wave-forms and milking unit vacuum. See figure 14.

FIGURE 14
A SIMULTANEOUS PLOT OF PULSATION WAVE-FORM AND MILKING UNIT VACUUM.



```
DATA SUMMARY                        DATA SUMMARY
Pulsation 1 (PLOT)                  Vacuum 3 (PLOT)
Rate:          49.56 PPM            Maximum Vac:  12.8inHg
Ratio:              51:49           Minimum Vac:  10.2inHg
A Phase:      9%   106mS            Average Vac:  11.2inHg
B Phase:     42%   507mS
C Phase:     14%   165mS
D Phase:     35%   432mS
A+B Phase:   51%   613mS
C+D Phase:   49%   597mS
Vacuum:          14.2inHg
```

The wave-forms should be evaluated as discussed in under Pulsation. The milking unit vacuum level plot, which is recorded at the high tape speed will show the cyclic fluctuations as longer waves along the plot line. The data summary for the **V2** or **V3** channel, as the case may be, should comply with Babson recommendations.

Effect of Milking Vacuum on Massage

Milking unit vacuum inside the inflation is a crucial part of the equation that produces the force for teat massage. This vacuum level inside the inflation, coupled with atmospheric pressure admitted into the pulsation chamber, creates the pressure differential across the inflation wall that closes it for massage.

The milking vacuum on the inside of the inflation must be great enough to overcome the inflation's resistance to close, (see table 2), and have a residual or massage force equal to a minimum of 7 inHg. The residual vacuum level is calculated by subtracting the value of the inflation's resistance to close, expressed in inches Hg, from the value of the milking unit vacuum level, also expressed inches Hg. The remainder is the value of the residual vacuum or massage force expressed in inches Hg.

Residual vacuum needed after overcoming inflation collapse resistance

Example:

12.0 inHg = Milking unit vacuum level
<u>- 4.5 inHg</u> = Resistance to close of the 10048
7.5 inHg = Residual vacuum or massage force

Milk Line Vacuum

A Tri-Scan tape of the milk line vacuum, recorded under fully loaded conditions should be evaluated. See figure 15.

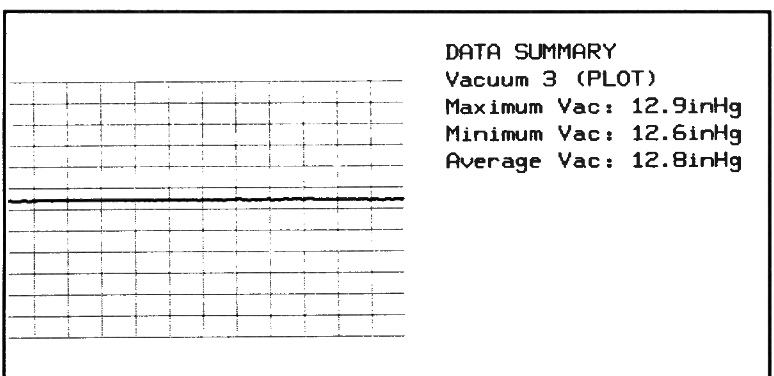


FIGURE 15
A TRI-SCAN TAPE SHOWING A TYPICAL MILK LINE VACUUM LEVEL RECORDING

The plot shown in figure 15 is a typical milk line vacuum level graph. The plot line of the vacuum level is stable at 13 inHg and the fluctuations are well within the 1inHg maximum set by Babson.

A simultaneous plot of the milking unit vacuum can be added to evaluate the effects of milk lift, resistance to flow, and vacuum drops created by the milk hose and optional milk flow sensors, milk meters, etc.. See figure 16.

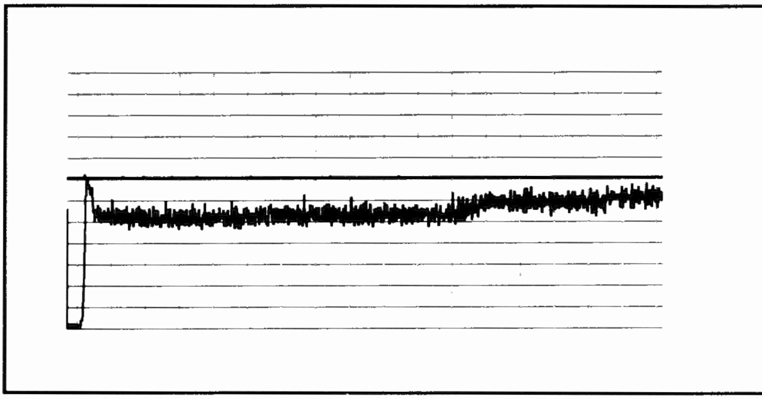


FIGURE 16
A TAPE OF A TYPICAL MILKING UNIT AND MILK LINE VACUUM LEVEL GRAPH OF A HIGH LINE SYSTEM

The tape shown in figure 16 was produced by setting the CH2 vacuum port to **V2** and CH3 to **V3** in using the **Set Up Menu** and enabling both channels for plotting, using **the Plot Menu**.

Acceptable fluctuation levels

The plots here are typical, with the milk line vacuum plot line starting at 15 inHg, and dropping approximately 3 inHg shortly after the milking unit was attached and milk began to flow. The milk line vacuum fluctuations due to irregular source never exceeds the 1 inHg fluctuation tolerance.

The variations in the plot line showing the milking unit vacuum level are due to the cycle pressure changes created by the inflations opening and closing. These are typical and within the maximum allowable variation of 3 inHg.

LOW VOLTAGE

OVERVIEW

Application

Electronics and low voltage circuitry continues to replace high voltage electric and mechanical devices, as milking machines have become more mechanized and automated. Integrated circuitry has replaced many items, such as the electro-mechanical milk pump and pulsator timers, end-of-milking sensor devices and the list continues.

Why is low voltage used?

The increased use of low voltage circuitry for controlling and monitoring various functions in modern milking systems, dictates performance testing of certain low voltage components as an essential part of a thorough milking system evaluation.

The primary reasons for using low voltage to control and monitor milking system functions are the size, flexibility, accuracy and reliability of the components. Plus the safety provided for both the people and animals involved.

Tri-Scan Low Voltage Test

The Tri-Scan Milking System Performance Tester provides the capability for conducting both DC and AC low voltage tests. The Tri-Scan can be used for making real time direct readings, or for recording and printing test results. These recordings can be printed with plots and data summary, or saved to memory, for later use.

Voltage ranges

The DC meter mode setting allows The Tri-Scan to monitor DC in a range of between 0 and 48 volts.

The AC meter mode setting allows The Tri-Scan to monitor AC in a range of between 0 and 2.5 volts.

Common tests

The low voltage tests most often performed in evaluating milking systems are:

1. Those that measure constant DC voltage output from power suppliers

2. The pulse DC voltage output at the pulsation controller and individual pulsators

3. The DC voltage levels at various points throughout the pulsation system
4. AC neutral to earth (stray) voltage

All of these tests can be run in the real time direct read-out mode or in the record mode.

The most important low voltage Tri-Scan tests, relative to milk removal are those of the pulsation control circuit boards and the pulsed voltage output.

Controlling pulsation

The Pulsation Control circuit board generates pulsed low voltage currents that control pulsation rates and ratios. The pulsed low voltage DC current is transmitted to electric pulsators by pulsation system conductor wires. The pulsed DC voltage initiates a cyclic electromagnetic field in the coil. This drives the plunger that controls the cyclic application of vacuum and air to the teat cup pulsation chamber. These cyclic pressure changes in the pulsation chamber translate into inflation movement for milk removal and massage.

Comparing measured values from Tri-Scan recordings of the pulse DC voltage at pulsator controller and at other points through out a system, with Babson recommended values can be exceedingly valuable in determining pulsation efficiency.

ACCEPTED STANDARDS

Industry Standards

Industry standards for low voltage components and circuitry, as they apply to milking machine performance are not available.

Babson Recommendations

Babson's requirements and recommendations for specific low voltage components and circuitry are given in the Maintenance Manuals.

Those pertaining to DC output voltage and pulse DC voltage rates and ratios are listed in tables 8 and 9.

TABLE 8
DC VOLTAGE OUTPUT FROM PULSATION CONTROL

Check Points	Acceptable Reading	Out of Range Reading/Possible Problem
Term 1 to Ground	0 VDC	Bad Ground Connection/Wire
Term 1 to Term 4	17 to 25 VDC	Power Supply
Term 2 to Term 1	17 to 25 VDC	Bad Pulsator/Poor Wiring
Term 3 to Term 1	17 to 25 VDC	Bad Pulsator Poor Wiring
(With Terminals 2 and 3 Disconnected)		
Term 2 to Term 1	17 to 25 VDC	Check Resonator/Bad Card
Term 3 to Term 1	17 to 25 VDC	Check Resonator/Bad Card

TABLE 9
PULSATION RATE AND RATIO AND TOLERANCE SETTING FOR PULSE DC VOLTAGE

Check Points	Rate	Ratio	Acceptable Reading Of Percent "On" Time	Out of Range Possible Problem
Term 2 to Ground	50PPM		48 to 52PPM	Bad Resonator
Term 3 to Ground		60:40	685- 757 mSec	Bad Card
		55:45	627 - 695 mSec	Bad Card
		50:50	570 - 632 mSec	Bad Card
	or 55PPM		53 to 57 PPM	Bad Resonator
		60:40	625 - 686 mSec	Bad Card
		55:45	572 - 629 mSec	Bad Card
		50:50	520 - 573 mSec	Bad Card
	or 60PPM		58 to 62 PPM	Bad Resonator
		60:40	573 - 628 mSec	Bad Card
		55:45	525 - 576 mSec	Bad Card
		50:50	477 - 525 mSec	Bad Card

Calculation for actual PPM Acceptable Reading: 60,000 ÷ actual PPM x (% on-time) = proper mSec +/- 7mSec

Example: 60,000 ÷ 50PPM = 1,200
1,200 x 50% = 600 mSec

PROCEDURE FOR LOW VOLTAGE TEST

Static tests are performed without system loading and are used for measuring low voltage drops across component and output.

Dynamic tests are performed with the system operating under full load, and are used to evaluate component functional characteristics and performance.

Tri-Scan Input Connections

The electric lead wires must be connected between the AC/DC volt input jacks marked - and +. These are located in the mid-right rear panel of the Tri-Scan as shown in figure 2. The other ends of the lead wires are connected to the terminals as described in tables 3 and 4, and as shown in figure 17. To check components without clearly marked terminals, connect between the positive (hot) wire and ground. Polarity must be observed in the DC mode.

Positive or negative grounding

Surge DC voltage systems utilize positive grounds. Some of the other milking machine companies also use positive DC grounds. However, some of the milking machine companies use negative DC grounds.

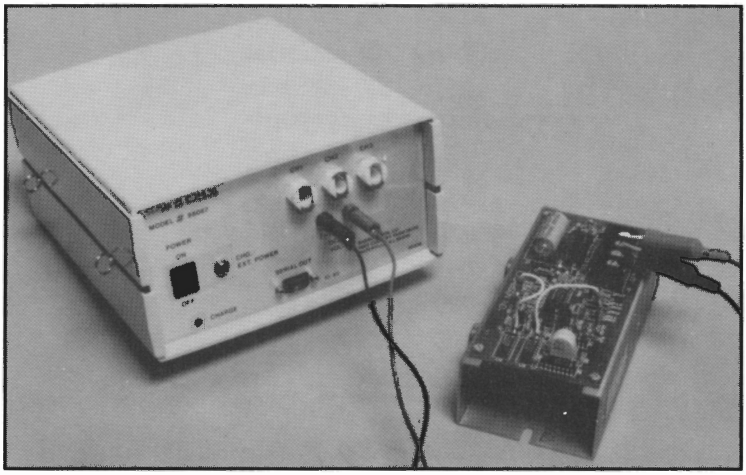


FIGURE 17
LEAD WIRE CONNECTIONS BETWEEN THE TRI-SCAN AND POINTS FOR CHECKING A PULSATION CONTROL CIRCUIT BOARD

The lead wire connections for recording pulsed DC voltage at the pulsators are made between the AC/DC input jacks on the back of the Tri-Scan, and the terminals on the pulsator as shown in figure 18.

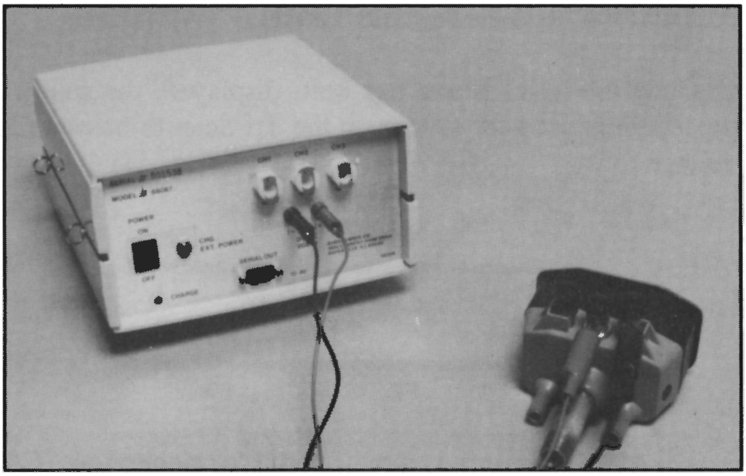


FIGURE 18
LEAD WIRE CONNECTIONS BETWEEN THE TRI-SCAN AND POINTS AT THE PULSATORS FOR RECORDING THE PULSE DC VOLTAGE

Checking alternating pulse DC requires testing of both the pulsed wave-forms from both sides of the pulsator.

Menu Selection

As with other test procedures, the full keyboard of the Tri-Scan simplifies labeling recordings and placing notes on tapes. The menu selections for setting up the Tri-Scan to record low voltage, are accomplish with a series of single key strokes utilizing the four function "F" keys and the "ENT" keys.

The **Main Menu** appears on the LCD screen, located near the top center of the front panel, it is displayed upon completion of the power-up diagnostic test. See figure 19.

FIGURE 19
FRONT PANEL WITH THE MAIN MENU SHOWING.

AC/ DC Voltage Real Time Tests

Once the Main Menu has been displayed, the following procedure is used for setting up the Tri-Scan to measure low voltage.

MAIN MENU

	SURGE		
Dis	Set	Prn	Men
F1	F2	F3	F4

Menu options

The Main Menu provides two options for monitoring AC/DC voltage.

1. Real time metering with direct read out on the LCD screen.

2. Recording voltage over a period of time for printing immediately upon completion of the test, or for storing in memory.

Pressing the **F1** function key under the **Dis** in the **Main Menu** moves control of the Tri-Scan to the **Show On Display Menu.**

SHOW ON DISPLAY MENU

	Show On Display		
Mtr	Bat	Rgd	Exit
F1	F2	F3	F4

Pressing the **F1** function key enables the real meter and displays the **Meter Menu.**

METER MENU

	Meter		
Vac	DCV	ACV	Exit
F1	F2	F3	F4

1. Pressing the **F2** function key under **DCV** configures the Tri-Scan to monitor and display DC voltages from 0 to 48 volts in real time.

```
DCV          X.XX V
Vac        ACV   Exit
```

2. Pressing the **F3** function key under **ACV** configures the Tri-Scan to monitor and display AC voltage from 0 to 2.5 volts in real time.

```
ACV          X.XX V
Vac   DCV        Exit
```

3. Pressing the **F4** function key, when monitoring either DCV or ACV returns control of the Tri-Scan to the **Main Menu**

DC And Pulsed DC Tests

MAIN MENU

```
          SURGE
Dis    Set    Prn    Men
```

F1 F2 F3 F4

Pressing the **F2** function key under the **Set** in the **Main Menu** shown on the LCD screen, displays the **SET UP Menu.**

The **Set Up Menu** allows the operator to configure the Tri-Scan for:

1. Performing a particular test,
2. The channels to be plotted,
3. For the recording to printed or saved to memory.

SET UP MENU

	SET UP		
Inp	Plt	Mod	Exit
F1	F2	F3	F4

Pressing the **F1** function key, under **Inp** in the **Set UP Menu,** displays the **Input Selection Menu.**

INPUT SELECTION MENU

	Current		
OFF	OFF	OFF	Exit
F1	F2	F3	F 4

Pressing function keys while in the **Input Selection Menu** produces the following effect:

Pressing the **F1** function key repeatedly will cause the display for channel 1 to toggle between; **V1., P1., DCV., PDC.,ACV.** and **Off.**

Selecting any voltage: **DCV, PDC or ACV** for CH1; disables CH2 and CH3

Recording DC Voltage

INPUT SELECTION MENU

	Current		
OFF	OFF	OFF	Exit
F1	F2	F3	F4

Press the **F1** function key repeatedly until; **DCV** , is displayed in Channel 1.

Upon completing the selection of **DCV** for CH1 the **Input Selection Menu** will appear as shown.

INPUT SELECTION MENU

	Current		
DCV			Exit
F1	F2	F3	F4

Recording Pulse DC

INPUT SELECTION MENU

	Current		
OFF	OFF	Off	Exit
F1	F2	F3	F4

Press the **F1** function key repeatedly until **PDC** is displayed in Channel 1.

Upon completing the selection of **PDC** for CH1 the **Input Selection Menu** will appear as shown below.

INPUT SELECTION MENU

	Current		
PDC			Exit
F1	F2	F3	F4

Pressing the **F4** function key under **Exit** returns control of the Tri-Scan to the **Set Up Menu** as shown below.

SET UP MENU

	Set UP		
Inp	Plt	Mod	Exit
F1	F2	F3	F4

Pressing the **F2** function key under **Plt** transfers control of the Tri-Scan to the **Plotter Enable Menu** as displayed below.

PLOTTER ENABLE MENU

```
PLOT              ( * = on )
PDC                     Exit

F1      F2      F3      F4
```

Note: The **Plotter Enable Menu** screen will appear as it was last configured in the **Set Up Menu**, even if power has been turned off and the Tri-Scan re-energized.

The channel appearing in the **Plotter Enable Menu** can be plotted by the printer. Printing is accomplished by pressing the function key immediately beneath the desired channel. The enabled channel will be identified by an asterisk. If the plotter is not enabled, a data summary will be provided.

Press the **F1** function key to plot the Pulse DC voltage.

Following the above procedure will produce the display shown below. A graph of the pulse DC voltage wave form, and a printed data summary.

PLOTTER ENABLE MENU

```
PLOT              ( * = on )
PDC*                    Exit

F1      F2      F3      F4
```

The same format is used for setting up the **Plotter Enable Menu** to plot DC and AC voltage reading.

Plotting Speed

The plotting speed of the printer tape is automatically set at 20mm per second for pulse DC voltage recording.

The plotting speed of the printer tape will be .5mm per second for DC and AC voltage recording.

Refer to Section 4.2.2 in the Owner's Manual, for additional information relative to choosing the various plot speeds

Return to the **Set UP Menu**, once the plot selections have been completed, by pressing the **F4** function key under **Exit** in the **Plotter Enable Menu**.

SET UP MENU

SET UP
Inp Plt Mod Exit

F1 F2 F3 F4

Pressing the **F3** function key while in the **Set Up Menu** will transfer control to the **Mode Menu** and display the following.

RECORDING MODE MENU

RECORD MODE
Timed Exit

F1 F2 F3 F4

Two recording modes

There are two recording modes: **1. Timed**; and **2. Continuous.**

Pressing the **F1** function key toggles control and the display between **Timed** and **Cont**.

1. Press the **F1** function key repeatedly until **Timed** appears in the LCD screen as shown above. In the **Timed Mode** the Tri-Scan reads the inputs for a predetermined length of time. The number of functions recorded by the Tri-Scan is determined by the plot speed.

2. Pressing the **F1** function key a second time will display the word **Cont** in the LCD screen as shown below.

RECORDING MODE MENU

RECORD MODE
Cont Exit

F1 F2 F3 F4

Note: In the **Cont Mode** the Tri-Scan records until stopped manually.

3. Pressing the **F4** function key, when the **Record Mode** configuration is completed, returns control of the Tri-Scan to the **Set Up Menu.**

SET UP MENU

SET UP			
Inp	Plt	Mod	Exit
F1	F2	F3	F4

Once in the **Set Up Menu** press the **F4** function key immediately to exit the **Set Up Menu** and display the **Main Menu.**

MAIN MENU

SURGE			
Dis	Set	Prn	Men
F1	F2	F3	F4

The next step in the process is to move control of the Tri-Scan to the **Print Menu** by pressing the **F3** function key. The **Print Menu** display will appear as shown below.

Printing

PRINT MENU

PRINT			
Str	Hdr	Cap	Exit
F1	F2	F3	F4

Print options

The **Print Menu** provides four options

1. **Str**... Starts the recording and printing.
2. **Hdr**... Activates the alpha numeric keyboard and allows the entry of a Header for individual printer tapes.

3. **Cap**... Checks the capacity left in memory for storing individual recordings.
4. **Exit**... Returns control to the **Main Menu**

Memory

MAIN MENU

SURGE			
Dis	Set	Prn	Mem

Pressing the **F4** function key transfers control of the Tri-Scan to the **Memory Menu.**

MEMORY MENU

MEMORY			
PLY	CLR	DMP	EXIT
F1	F2	F3	F4

Memory options

The **Memory Menu** offers four options.

1. **PLY**... Plays a recording from memory.
2. **CLR**... Clears recordings from memory.
3. **DMP**... Dumps recordings from memory into a personal computer.
4. **Exit**.. Returns control of the Tri-Scan to the **Main Menu.**

The procedures for printing and memory management are common, regardless of the type of tests. Therefore, each step of these procedures has not been given here. See pages 2.23 through 2.24 in the Pulsation Section of this manual for details of these procedures.

See Section 4.4 and Appendix 2 Part 4 in the Owner's Manual for information relative to menu selection and the procedure for: recalling recordings from memory, plot reconfiguration and printing; clearing recordings from memory; and dumping recordings from the Tri-Scan through the RS232c port to a personal computer.

RUNNING LOW VOLTAGE TEST

Electrical input is used by the Tri-Scan milking System Performance Tester for low voltage performance testing.

Tests of power suppliers, controllers and pulsators should be conducted while operating under full load.

Setting Up the Tri-Scan

1. Turn on the main power switch.
2. Access the **Set Up Menu**. Activate the **INP (INPUT) Menu** and select the appropriate combination of the input channels.
3. Move to the **PLOT Menu.** Plot enables the channels to be printed with voltage level plots and data summaries, or none of the channels if tape display data summaries only are desired.
4. Transfer control to the **MOD (MODE) Menu**.
Select either continuous or timed recording mode. The timed mode should be selected for pulsed DC voltage recording. The continuous mode is usually selected for recording constant low voltage output.
5. Access the **PRN (PRINT) Menu**. This initiates the printing sequence of the previously selected inputs. It allows an operator to type in individualized header, i.e. farm name, barn number, etc., and a note at the end of each recording.
6. Connect the lead wires to the AC/DC input channel on the back of the Tri-Scan and the appropriate connecting points on the low voltage system. Polarity must be maintained for DC recordings.
7. Press the **F1** function key under **STR** in the **Print Menu** after voltage is applied to the Tri-Scan.
8. At the end of the timed cycle or when **F4** under **END** is pressed in the continuous mode, the Tri-Scan automatically:

> **1.** Prints a tape, in the format previously selected from the **PLOT Menu**.
> **2.** Allows the entry of a note regarding the just completed test.
> **3.** Provides the opportunity to save the just completed timed recording (last 176 secs.) to memory.

Note: In order to perform a complete and accurate evaluation of a low voltage system, it is recommended that each unit in the system be tested.

ANALYSIS AND INTERPRETATION

Test Categories

Low voltage performance testing falls into two categories:

1. Real time direct read out tests
2. Recorded tests.

Evaluating Real Time Low Voltage tests.

Real time direct read measurements are taken to determine a voltage level at a specific place in the system. The analytical process is to compare the Tri-Scan meter reading with:

1. A known specification, such as those given in Table 1.
2. Other readings from measurements taken at similar points throughout the system.

Evaluating Low Voltage Test Recordings.

AC Voltage

AC voltage range

The AC voltage recording capability of the Tri-Scan Milking System Performance Tester, was design specifically for recording AC neutral to earth (stray) voltage.

Researchers generally agree that AC neutral to earth voltages readings above .5 volts on dairy farms are of concern. Thus the Tri-Scan's AC voltage range of 0 to 2.5 voltage.

The procedure for evaluating AC neutral to earth voltage on a dairy farm are well documented, in other publications and will not be covered in this manual. Refer to The Surge Maintenance Manual Section 1, pages 14 through 16 and the Minnesota Extension Booklet, Stray Voltage Problem With Dairy Cows, (Babson part number 89673) for details.

DC Voltage

Tri-Scan recordings of DC low voltage are plots of voltage levels over a period time. Recordings of DC voltage can be taken at any component or point through out the DC voltage system.

Their primary use is to observe the effects of various operating conditions; on the DC low voltage supplier output, at a specific place within the system.

The two tests are:

1. recording continuous voltage output of DC power suppliers
2. pulsed DC voltage output at the pulsation controller or at a slave component such as a pulsator.

1. The recordings of continuous DC output voltage from power suppliers should show variations in the plot line as the load changes due to slave component operation, i.e. pulsator coils activation. The plot line should remain within the range specified by Babson. See figure 20.

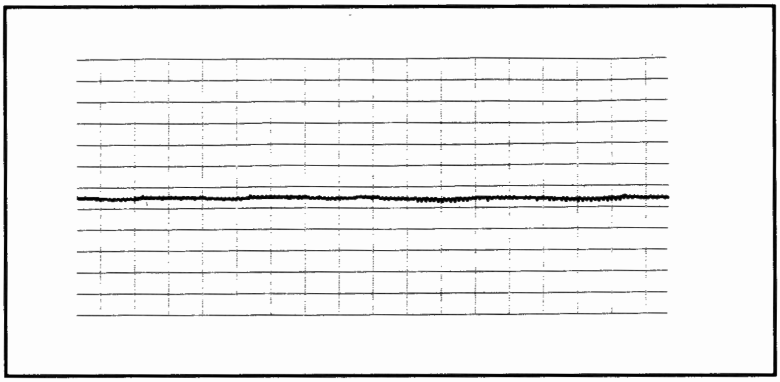


FIGURE 20 TRI-SCAN PLOT OF THE OUTPUT VOLTAGE FROM A PULSATOR CONTROL DC POWER SUPPLY.

The recording shown in figure 20 is of continuous DC voltage output from a pulsation control power supplier. This particular power supplier is performing within the specified voltage range of 20 to 25.5 volts. The data summary shows the maximum, average and minimum voltage levels and provides digital conformation of the plot graph visual observation.

2. Pulsed DC voltage recordings produce a wave-form plot which in appearance is very much like that produced by recording the pulsation chamber vacuum. See figure 21.

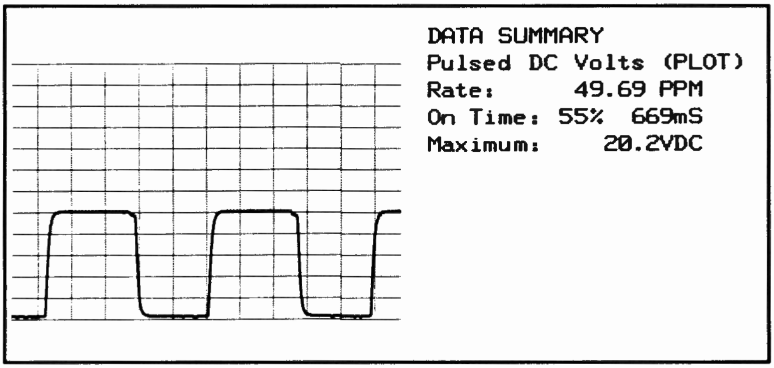


FIGURE 21
PLOT OF PULSED DC VOLTAGE WITH DATA SUMMARY.

Milk, massage ratio differences

Recordings of pulsed DC voltage are of significant value in evaluating the accuracy of the pulse rate and ratio generated by the pulsator control pulsor module, and the performance of the pulsators. The pulsed recordings are also used as a measure for determining the efficiency, in air transport between the pulsator and the teat cup for generating the cyclic pressure changes that drive the inflations. The standard for this evaluation is that the difference between the milk to massage ratio percentage, for the A+B milking phase recorded in a teat pulsation chamber, should never be:

1. Less than the corresponding A+B phase "On Time" percentage recorded during the pulsed DC voltage test run at the pulsator for the milking unit being checked.

2. More than two percent (2%) greater than the corresponding A+B phase "On Time" percentage recorded during the pulsed DC voltage test run at the pulsator for the milking unit being checked.

REFERENCES

1. ASAE EP445, Engineering Practice: TEST EQUIP MENT AND ITS APPLICATION MEASURING MILKING MA CHINE OPERATING CHARACTERISTICS. American Society Of Agricultural Engineers.

2. ASAE S300, Engineering Standard: TERMINOLOGY FOR MILKING MACHINE SYSTEMS. American Society Of Agricultural Engineers.

3. ASAE S518, Engineering Standard: MILKING MACHINE INSTALLATION, CONSTRUCTION AND PERFOR MANCE. American Society Of Agricultural Engineers.

4. 3-A Practice number 606-03, 3-A ACCEPTED PRACTICE FOR THE DESIGN, FABRICATION AND INSTALLA TION OF MILKING AND MILK HANDLING EQUIP MENT. International Association of Milk, Food and Envi ronmental Sanitarians; United States Public Health Service and The Dairy Industry.

5. ISO Standard 3918: MILKING MACHINE INSTALLA TION - VOCABULARY. International Standards Organi zation.

6. ISO Standard 5707: MILKING MACHINE INSTALLA TION - CONSTRUCTION AND PERFORMANCE.

7. ISO Standard: ISO 6690: MILKING MACHINE INSTAL LATION - MECHANICAL TESTING. International Stan dards Organization.

8. GUIDELINES THE INSTALLATION AND OPERATION OF MILK AND MILK HANDLING EQUIPMENT. Cana dian National Liaison Group On Milk Quality. International Standards Organization.

9. LINER MASSAGE AND TEAT CONDITION. Graeme Mein and David Williams.

10. MODERN WAY TO EFFICIENT MILKING. Milking Machine Manufacturers' Council.

11. SURGE MAINTENANCE MANUAL, SECTIONS 1, 2 & 3. Babson Bros. Co.

PERFORMANCE STANDARDS AND RECOMMENDATIONS

	INDUSTRY STANDARD	BABSON REC.	PAGE
MILKING VACUUM LEVEL		12"	1.5
VACUUM RESERVE	50%	SAME	1.5
MILK PHASE (SIDE TO SIDE PULSATION)	MIN. OF 30% OF TOTAL	SAME	2.5
MASSAGE PHASE(PULSATION)	MIN. OF 15% OF TOTAL	SAME	2.5
LIMP (PULSATION)	<THAN 5% OF TOTAL	N/A	2.5
PULSATION RATE VARIANCE	+/- 5%	SAME	2.6
PULSATION RATE	45 - 65	BETWEEN 50 - 60 CYCLES	2.6
MILKING UNIT VACUUM LEVEL	11 TO 15"	12" +/-.5	3.4
MILKING UNIT CYCLIC FLUCTUATION	2 TO 3"	3"	3.4
MILKLINE VACUUM LEVEL (LOW LINE) " " " (HIGH LINE)	MIN. 11.8" MAX. 15"	12 TO 15"	3.5
MILKLINE VACUUM LEVEL FLUCTUATION	.5 TO 3"	1"	3.5
MINIMUM RESIDUAL VACUUM LEVEL		7"	3.5
A.C. VOLTAGE NEUTRAL TO EARTH		<THAN .5	4.15