

# Milk Test Types - Interpretation & Troubleshooting

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**Cornell University**  
Animal Health Diagnostic Center



## Overall Goals

- We can never keep too many samples when bacteria counts are low or high – duplicate samples
- Understand there is a strategic approach that can be implemented to determine if cows or cleaning or incubation are the issue(s)
- Realize that most times the expertise of multiple parties is needed to permanently resolve the problem
- Use your knowledge along with new technology to help direct you to the area that is causing the issue



What does milk quality mean to  
you?

Are the expectations for milk quality  
different for the dairy producer,  
manufacturer and consumer?



# What drives milk quality?

Consumer demand

Government regulations

Processor regulations

Producer satisfaction



## Consumer expectations

- Quality milk, cheese, etc.
  - Free of pathogens-Safe to consume
- Animal husbandry/welfare
- Environmental stewards
- Health-Nutritional content
  - Does the nutrient content of milk fit into your daily routine/lifestyle
  - Free of “dirty” substances
    - antibiotics, hormones, pesticides, bacteria



## Bulk Tank Analysis

- Somatic Cell Count (SCC)
- Standard Plate Count (SPC)
- Laboratory Pasteurization Count (LPC)
- Coliform Count (CC)
- Preliminary Incubation Count (PI)
- General Identification (GID)
- Others



## Somatic Cells



- A measure of milk quality
- **Indicator of mastitis**
- A number that increases with poor udder health

**Somatic Cells:** Mainly white blood cells that increase in infected quarters.

**Uninfected quarters:**  
SCC << 200,000 cells/ml



## Standard Plate Count (SPC)

- Total aerobic bacteria in milk
- Milk plated for 48 hrs at 32°C (90°F)
  - bacterial colonies are then counted
- Regulatory limit is 100,000 cfu/ml
  - Industry standards are < 10,000 cfu/ml





## Lab Pasteurized Count (LPC)

- Bacteria than can survive pasteurization at 63°C (145°F) for 30 minutes
- Kills mastitis causing organisms
- Not a mandatory test
- Thermoduric-heat loving bacteria
  - Cause milk spoilage not mastitis causing organisms
- Bacteria not killed - counted by SPC method
- <250 cfu/ml goal
- > 250 cfu/ml usually related to milking system cleaning issues
  - Unclean milking equipment, improper sanitizing practices, leaky pumps, old rubber goods – gaskets, inflations, hoses and milkstone deposit (Murphy 1997)



## CC

- Milk plated on MacConkey's agar and incubated at 32°C (90°F) for 24 hours
- Determines bacteria from the environment
  - True reflection of sanitation and hygiene practices
- < 50 cfu/ml acceptable
- Low vs.. high levels
  - < 1,000 – cow contamination, units falling in manure, water
  - > 1,000 – dirty milking equipment



## CC

- Environmental microorganisms
  - bedding, manure, feed
- Poor milking techniques
- Poor sanitation/cleaning
  - Low wash temp
    - Start 120°F
    - End 100°F
  - NO sanitation at all
  - Improper draining after wash
- Contaminated water
- Cows with mastitis



## Preliminary Incubation Count (PI)

- Milk incubated at 13°C (55°F) for 18 hours
  - Bacteria counted by SPC method
  - Psychrotrophic – cold-loving bacteria
- Cooling, sanitation and duration of holding milk on the farm
- Should not exceed 100,000 cfu/ml
  - Usually < 25,000 cfu/ml
  - 10,000 cfu/ml is good
- Bacteria associated with:
  - off-flavors
  - milk spoilage
  - short shelf-life



## PI

- Reliability and repeatability of the test are concerns

“There is no scientific evidence of association of PI with product shelf-life, but the PI can be a tool used to troubleshoot faulty equipment.”

(Kathryn Boor-Cornell University, Food Science)

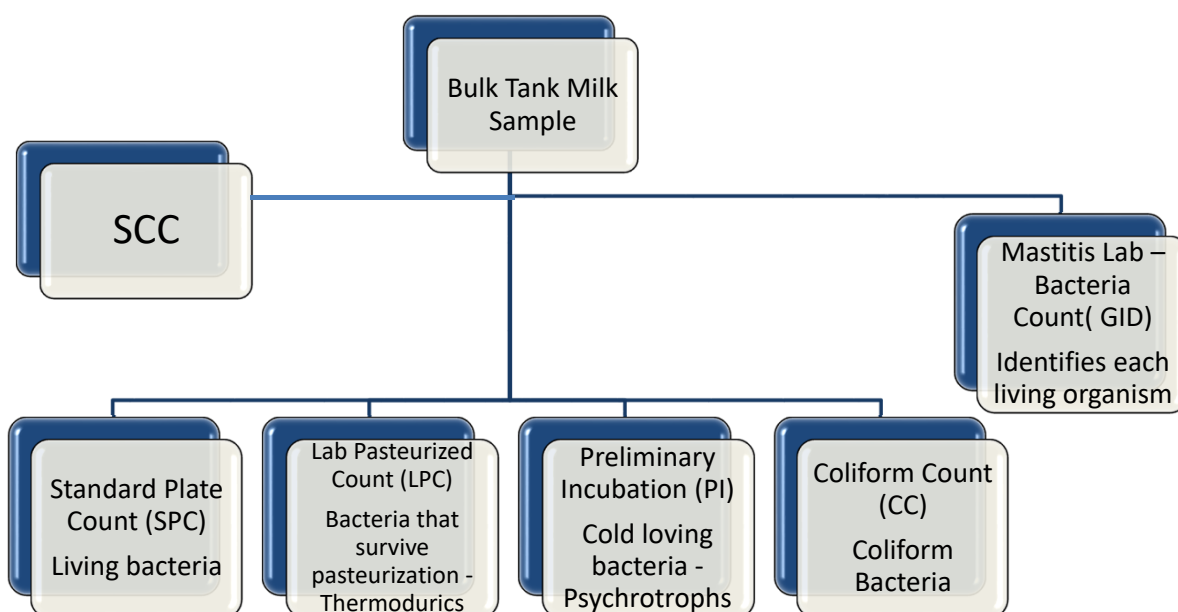


## Quantification of general identification (GID of QGID)

- Plate milk on blood agar
- Incubate at 95 – 100 F for 48 hours
- Identify and count each class of organisms`
  - Total Streps
  - Total Staph
  - Total E. coli
    - Count E. coli and Klebsiella
  - Identify (absence or presence)
    - Staph aureus, Pseudomonas, Prototheca, Yeast



## Bulk tank milk quality



- All bacteria counts are specific to the conditions that they are incubated under
  - Temperature, time, media, anaerobic, CO2 etc.
- How do the results from a SPC and GID differ?
- How can a SPC and GID be used to support each other?



## Milk quality comparison

Item	Goal	Legal	Method	Causes for elevated count	Possible organisms when elevated
<b>SPC</b>	< 10,000 cfu/ml	100,000	Incubate 48 h @ 90°F	Equip sanitation, cooling, unclean udders & teats	Usually environmental organisms
<b>LPC</b>	< 250 cfu/ml	NA	Incubate 30 min @ 145°F then SPC	Long-term equip sanitation, milk stone, old rubber goods, plate coolers, bacteria in H2O, extremely dirty cows	Streptococcus salivarius (biofilm)
<b>CC</b>	< 50 cfu/ml	NA	Incubate 24 h @ 90°F then SPC	<1,000 – cow contamination, units falling in manure, water >1,000 – dirty milking equipment	E. coli, Klebsiella
<b>PI</b>	< 10,000 cfu/ml	NA	Incubate 18 h @ 55°F then SPC	Equip and bulk tank sanitation, cooling, long time b/w milk pickups	Pseudomonas
<b>GID</b>	Organism specific	NA	Incubate 48 h @ 95 - 100°F	Cow, environment (dirty cows), dirty equipment	All organisms
<b>SCC</b>	< 200,000 cells/ml	750,000		Contagious transmission, improper milking routine, faulty milking equipment, overmilking, bacterial load on teat	Long-term elevated SCC = contagious Short-term elevated SCC = environmental



## Duplicate milk samples

- Keep a duplicate milk sample from every bulk tank load
  - Keep in freezer for two to three weeks
- When there is an elevated count then the duplicate sample can be tested
  - GID, SPC, LPC, CC, PI
- Why doesn't taking a bulk tank sample two or three days after an elevated bacteria count work when troubleshooting a bacteria count issue?



## Troubleshooting bacteria counts - Phases

- Phase 1: Elevated or high SPC
- Phase 2: Request differential counts – LPC, CC, PI, GID
- Phase 3: On-farm investigation
- Phase 4: NMC - Troubleshooting Cleaning Problems in Milking Systems
- Phase 5: New technology and methods



## What if the SPC is high following 2 consecutive tests?

- Examine the cleaning and sanitation system
  - usually improper cleaning and sanitation
- Milking procedures
  - Dirty cows, new milker
- Cooling
  - Cool to < 40°F quickly
- Mastitis & high bulk tank SCC (BTSCC)
  - *Strep, Staph and E. coli*
- Improper handling of sample
  - Milk hauler needs training
- During times of expansion
  - Be sure to test all animals for mastitis



# PI

- PI's are generally higher than SPC's
- 3-4 times higher PI than SPC may mean:
  - Similar issues as SPC
  - Failure to properly clean and sanitize equipment
  - Improper cooling
  - Debris buildup in plate coolers and chillers
    - Should you wash with a milk filter in?
  - Dirty hoses on buckets for fresh cows
  - Dirty and unclipped animals
  - *Strep ag.* or environmental *Streps*

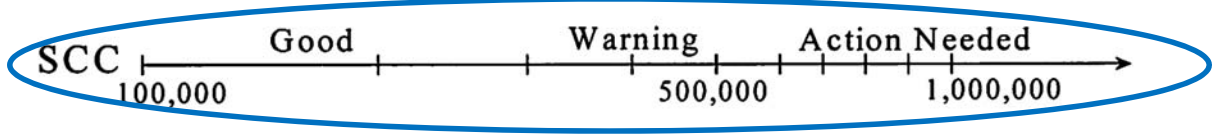
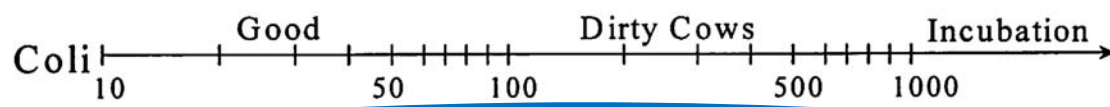
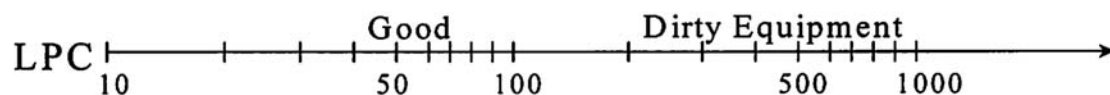
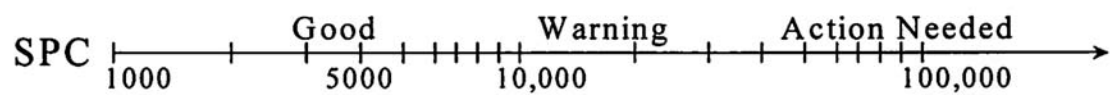


## Bacteria counts

- How can you use different bacteria count tests together to identify what is responsible for the elevated bacteria count?



## Milk quality – Troubleshooting Cleaning Problems in Milking Systems



When troubleshooting bacteria count issues don't forget to ask if SCC has increased at the same time



## SPC + GID + CC + LPC = greater chance to identify bacteria count issue

	SPC	CC	LPC
Milking dirty cows	5,000 - 20,000	100 - 1,000	LPC < CC
Milking system cleaning issues	5,000 - 20,000	CC < LPC	100 - 1,000
Incubation in cleaning system*	> 50,000	< 1,000	LPC < CC

\*There could be multiple sanitation issues when  
incubation is identified as the problem

– Strategic milk sample is required



## Visual inspection

- The bacteria counts are only one dimensional
  - You can only assume why the value is what it is if you don't visit the dairy
- Visit the dairy and look for what should be normal
  - Use of chemicals and concentration
  - Water temperature during wash – start and divert
  - Trapping our during wash – volume and timing
  - Sucking air during wash - volume
  - Slugging action – slug analysis





## Wash system analysis

- [NMC - Troubleshooting Cleaning Problems in Milking Systems](#)
  - Design of milking and wash system
  - Bulk tank milk quality analysis
  - Milk sampling
  - CIP procedures
  - Water quality and quantity
  - Water flow through unit
  - Slug analysis

### **Troubleshooting Cleaning Problems in Milking Systems**

From a Paper presented at the 1997 annual meeting of the National Mastitis Council by  
Douglas J. Reinemann, Ph.D. University of Wisconsin Milking Research and Instruction Lab

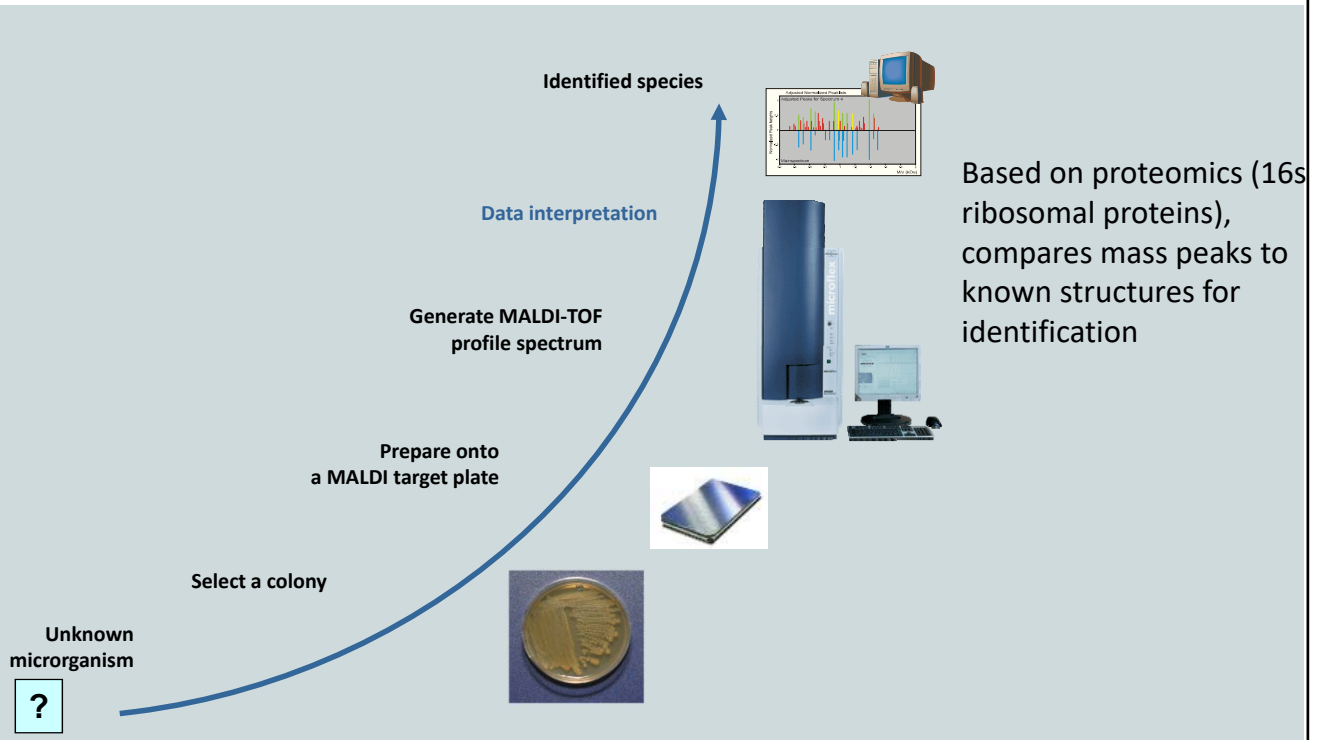


## Strategic milk sampling

<b>Location/Time</b>	<b>First activation of milk pump</b>	<b>4 hours</b>	<b>8 hours</b>	<b>End of milking</b>
<b>Time of sample</b>				
<b>Receiver 1</b>				
<b>Receiver 2</b>				
<b>Transfer line 1</b>				
<b>Transfer line 2</b>				
<b>Bulk tank 1</b>				
<b>Bulk tank 2</b>				



# MALDI-TOF MS microorganism identification



## MALDI-ToF

- Bulk tank results
- Swab sections of milking system
  - Near the same areas as strategic sampling
- Send swabs to lab with MALDI-ToF
  - Identify genus and species of organisms on swab
- Use MALDI-ToF on organisms from LPC
  - Identify the heat resistant bacteria



## Background on Case Example

- QMPS was contacted by the herd manager to assist in troubleshooting a long standing bacterial count problem
- Milking 1,050 cows
- D-14 parlor
- Milking 3x and washing 2x
- Farm has utilized multiple consultants



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## Bacteria results

- SPC > 10,000 cfu/ml
- LPC: 1,000
- CC: 40
- What does it mean?
  - LPC 100 -1000
  - CC < LPC
  - SPC 5,000 – 20,000



Persistent milking  
machine cleaning  
issue



## Information requested

- Requested
  - Slug analysis
  - Start and end wash water temperature
  - Chemical titration
  - Observation of entire wash cycle
    - Look and listen
  - Sanitize cycle – NO
  - SCC for last 12 months



## Further investigation

GID	
8/30/2016	Tank 2
Organism	Count (cfu/ml)
Strep spp	25,400
Staph spp	80
E. coli	40
Klebsiella	180
<b>Total</b>	<b>25,700</b>

- MALDI identified
  - *Streptococcus salivarius ssp. thermophilus*
  - Heat resistant bacteria
  - Environmental organism not necessarily associated with a faulty wash system





## Recommendations

- It was determined that the chemical pump was not dispensing the proper amount of chemicals during the wash and acid cycles
  - Determine how much chemical should be dispensed
  - Monitor how much chemical is being dispensed
- Hydrogen peroxide recommended to get rid of biofilm created by *Strep thermophilus*



- Maldi 1.903 *Strep thermophilus*

What can we tell from this bulk tank analysis?

	Milk, Bulk Tank
<b>Streptococcus</b>	
Streptococcus spp	<u>25,600</u>
<b>Staphylococcus</b>	
Staphylococcus spp	<u>not detected</u>
<b>Coliform Bacteria</b>	
E coli	<u>160</u>
Klebsiella spp	<u>60</u>
Other coliforms	<u>not detected</u>
<b>Other Bacteria</b>	
Gram negative bacillus	<u>not detected</u>
Gram positive bacillus	<u>not detected</u>
Corynebacterium spp	<u>not detected</u>
T pyogenes	<u>not detected</u>
Pseudomonas spp	<u>not detected</u>
<b>Other Organisms</b>	
Prototheca spp	<u>not detected</u>
Yeast	<u>not detected</u>
Mold	<u>not detected</u>
Other Fungus	<u>not detected</u>
<b>Total (CFU) Streptococcus spp</b>	<u>25,600</u>
<b>Total (CFU) Staphylococcus spp</b>	<u>not detected</u>
<b>Total (CFU) Coliforms</b>	<u>220</u>
<b>Total (CFU) Other Bacteria</b>	<u>not detected</u>
<b>Total (CFU) Other Organisms</b>	<u>not detected</u>
<b>Total Number (CFU)</b>	<b>25,820</b>
Streptococcus agalactiae	<u>not detected</u>
Staphylococcus aureus	<u>not detected</u>

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	Milk, Bulk Tank	Milk, Bulk Tank	Milk, Bulk Tank	Milk, Bulk Tank
<b>Streptococcus</b>				
Streptococcus spp	<u>360</u>	<u>240</u>	<u>960</u>	<u>540</u>
<b>Staphylococcus</b>				
Staphylococcus spp	<u>not detected</u>	<u>200</u>	<u>200</u>	<u>600</u>
<b>Coliform Bacteria</b>				
E coli	<u>28,000</u>	<u>20</u>	<u>not detected</u>	<u>not detected</u>
Klebsiella spp	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Other coliforms	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>20</u>
<b>Other Bacteria</b>				
Gram negative bacillus	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Gram positive bacillus	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Corynebacterium spp	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
T pyogenes	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Pseudomonas spp	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
<b>Other Organisms</b>				
Prototheca spp	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Yeast	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Mold	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Other Fungus	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
<b>Total (CFU) Streptococcus spp</b>	<u>360</u>	<u>240</u>	<u>960</u>	<u>540</u>
<b>Total (CFU) Staphylococcus spp</b>	<u>not detected</u>	<u>200</u>	<u>200</u>	<u>600</u>
<b>Total (CFU) Coliforms</b>	<u>28,000</u>	<u>20</u>	<u>not detected</u>	<u>20</u>
<b>Total (CFU) Other Bacteria</b>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
<b>Total (CFU) Other Organisms</b>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
<b>Total Number (CFU)</b>	<b>28,360</b>	<b>460</b>	<b>1,160</b>	<b>1,160</b>
Streptococcus agalactiae	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>	<u>not detected</u>
Staphylococcus aureus	<u>not detected</u>	<u>DETECTED</u>	<u>DETECTED</u>	<u>DETECTED</u>

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## Routine tasks

### Daily tasks

- Collect a duplicate bulk tank sample from every load of milk
- Check temperature recorder for...
  - Bulk tank cooling
  - Bulk tank wash
- Check water temperature for wash if recorded
  - Starting temp
  - Divert or end temp



### Weekly tasks

- Place a mark on the wash chemical barrels to make sure chemical is being used
- Check the marks on the wash chemical barrel to make sure chemical is being used for wash

### Annual tasks

- Have the wash system analyzed
  - Water temp
  - Chemical titration
  - **Slug analysis**
  - Water volume



# Chemical usage chart

## LELY ROBOT CHEMICAL USE

<b>Monthly Use - gallons</b>	<b>1 Robot</b>	<b>2 Robots</b>	<b>3 Robots</b>	<b>4 Robots</b>	<b>5 Robots</b>	<b>6 Robots</b>	<b>7 Robots</b>	<b>8 Robots</b>	<b>9 Robots</b>	<b>10 Robots</b>
Astri-L / Oxonia*	3	6	10	13	16	19	23	26	29	32
Astri-Lin	2	5	7	10	12	14	17	19	22	24
Astri-Cid	1	2	4	5	6	7	8	10	11	12
Post Spray	10	20	30	41	51	61	71	81	91	101
<b>Yearly Use - gallons</b>	<b>1 Robot</b>	<b>2 Robots</b>	<b>3 Robots</b>	<b>4 Robots</b>	<b>5 Robots</b>	<b>6 Robots</b>	<b>7 Robots</b>	<b>8 Robots</b>	<b>9 Robots</b>	<b>10 Robots</b>
Astri-L / Oxonia*	39	77	116	155	193	232	271	309	348	386
Astri-Lin	29	58	87	116	145	174	203	232	261	290
Astri-Cid	14	29	43	58	72	87	101	116	130	145
Post Spray	122	243	365	487	609	730	852	974	1096	1217
*USA PRE-TREAT X 2										

Source: Lely Vermont



## Discussion

- Duplicate tank sample from every load of milk that leaves the farm
  - freeze 2 to 3 weeks worth of samples
- Use all the tools at your disposal
  - SPC, LPC, CC, Mastitis lab quantitative, NMC Guidelines, MALDI
- Visually inspect the different aspects of the wash system
- Don't overlook the little things
  - Monitoring chemical usage, replacing wear items
- Collect milk samples at different locations from the milking system
  - strategic sampling
- Long-term issues or extreme cases use NMC Troubleshooting Cleaning Problems in Milking Systems Form as a guideline
- Use technology to help you identify the source of the issue



# Questions

