Optimizing Automation in the Batching and Mixing System

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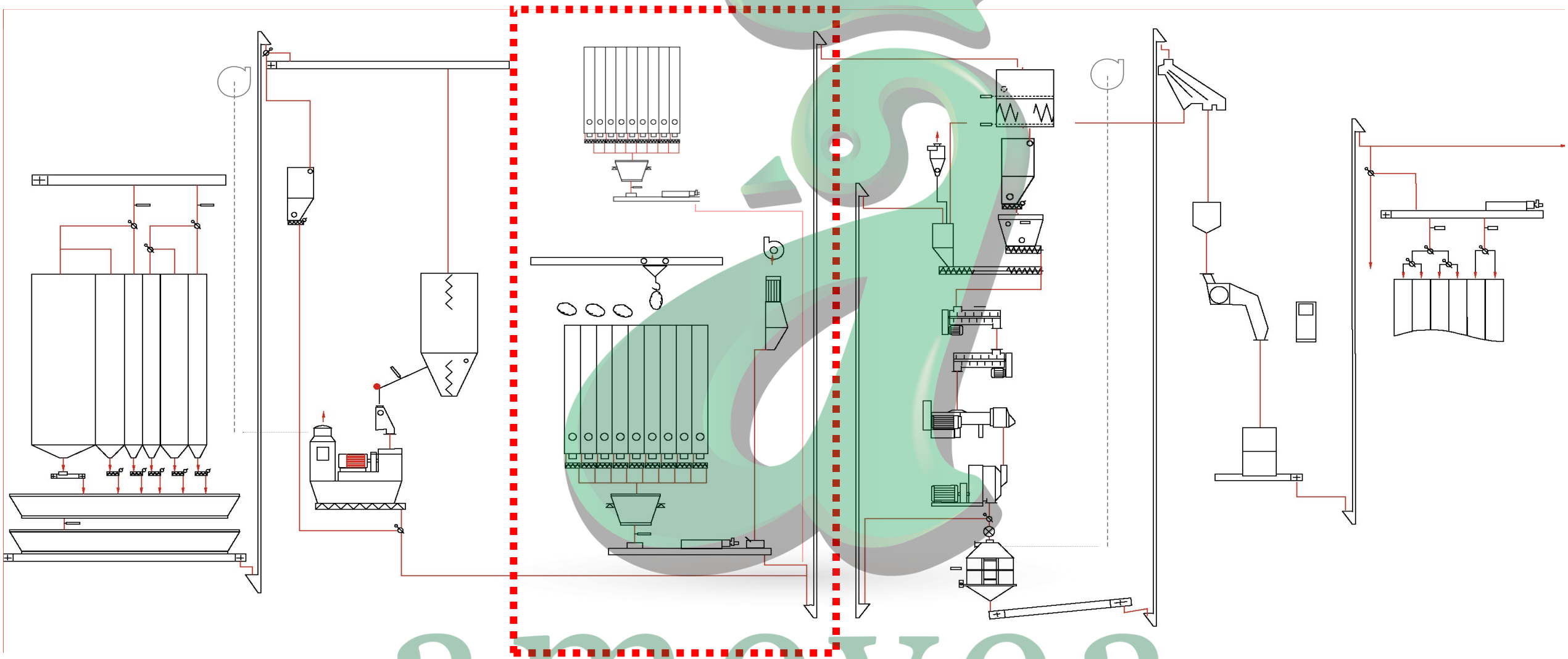
amevea

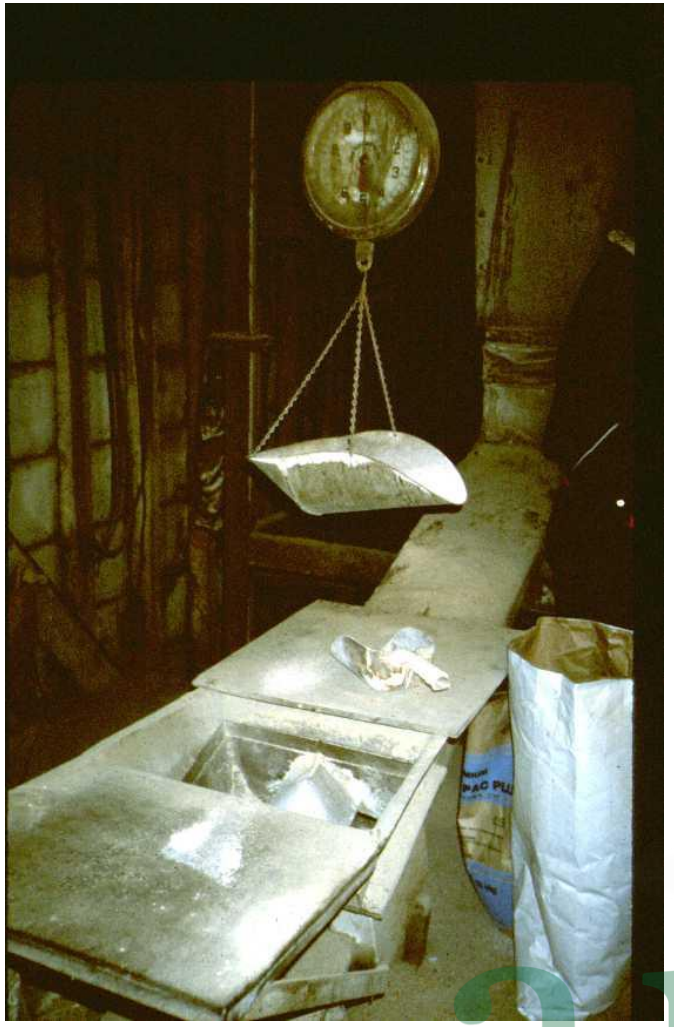
Batching and Mixing Overview

- Design
  - Pre-Batch Grind
  - Post-Batch Grind
- Equipment
  - Hoppers
  - Conveyors
  - Gates
  - Scales
  - Micro bin System(s)
  - Tote Bag System(s)
  - Mixer(s)

Batching and Mixing as a System



Batching System - Scales



- Every FeedMill Has Scales, However…
- Every scale has error
- 0.1% of the scales capacity
  - National Institute of Standards and Technology Handbook 44, scales with capacities greater than 500 lbs. can deviate up to 0.1% of the capacity.
- Misreading the scale
- **<u>Accepting under/over alarms</u>**

Load Cells

- Don’t operate load cells above the rated capacity
- Adequately protect the load cell cable and don’t carry the load cell by the cables
- Don’t allow build up of debris around the load cells and mounts
- Check for corrosion damage to load cell and mounting
- Don’t weld near the load cell

<u>Scale Considerations:</u>

Major Scale 80-90%

Minor Scale 10-15%

Micro Scale < 5%

Batching System – Medicated Feed

CFR Title 21 Chapter 1 Subchapter C Part 225
Subpart B 225.30 *Equipment*

(2) All equipment shall be maintained in a reasonably clean and orderly manner.

(3) All equipment, including scales and liquid metering devices, shall be of suitable size, design, construction, precision, and accuracy for its intended purpose.

Batching System – Medicated Feed

CFR Title 21 Chapter 1 Subchapter C Part 225
Subpart B 225.30 *Equipment*

(4) All scales and metering devices shall be tested for accuracy upon installation and at least once a year thereafter, or more frequently as may be necessary to insure their accuracy.

Mixer Design

- Ribbon
- Paddle
- Combination

  - Dimensions
  - Ribbon/Paddle Angle
  - Ribbon Tip Speed (shaft RPM)
  - Ribbon Width

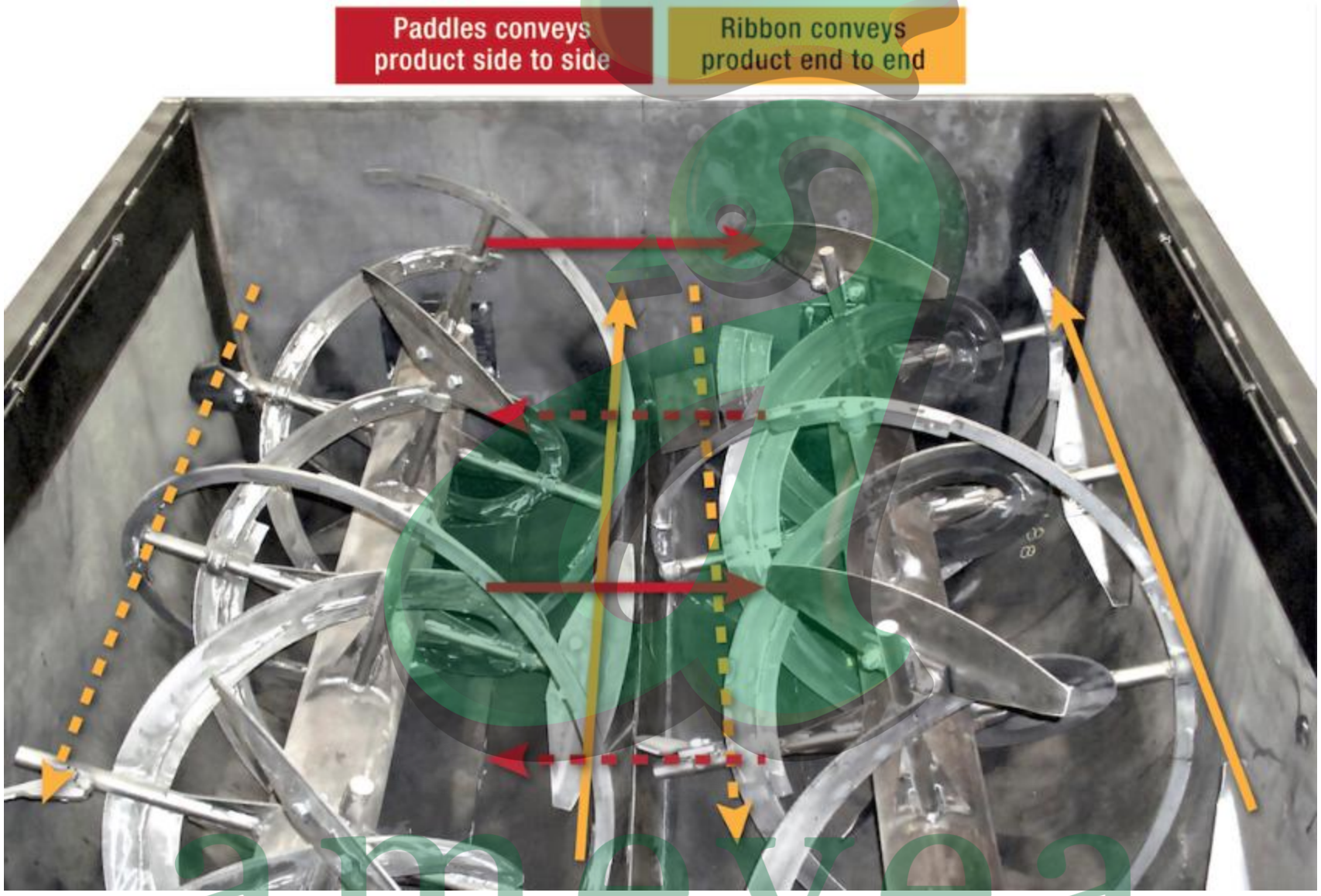
Ribbon Assembly

Hayes and Stolz

Paddle Assembly

Hayes and Stolz

Paddle/Ribbon Combination Assembly



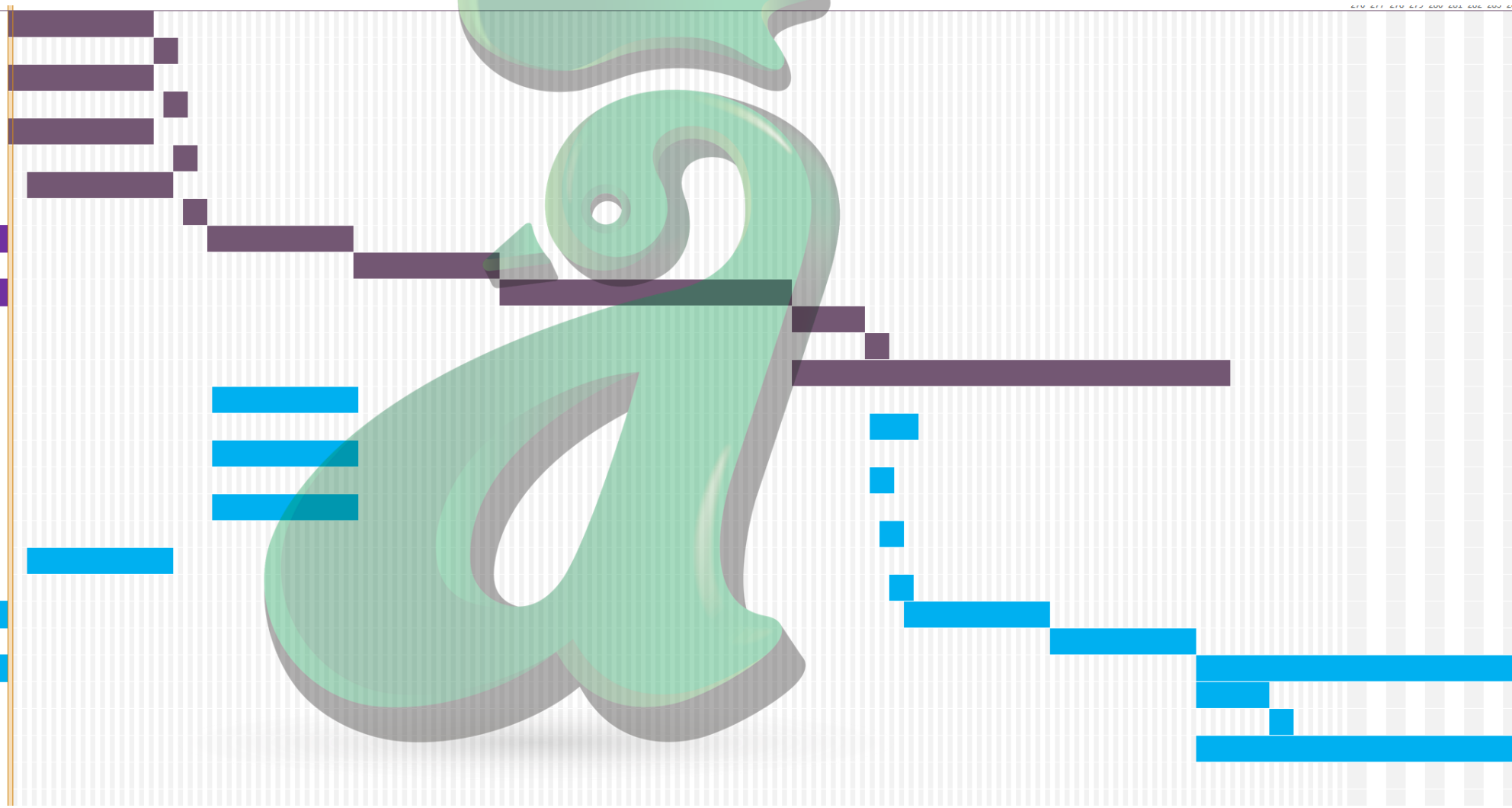
Scott Equipment Co.

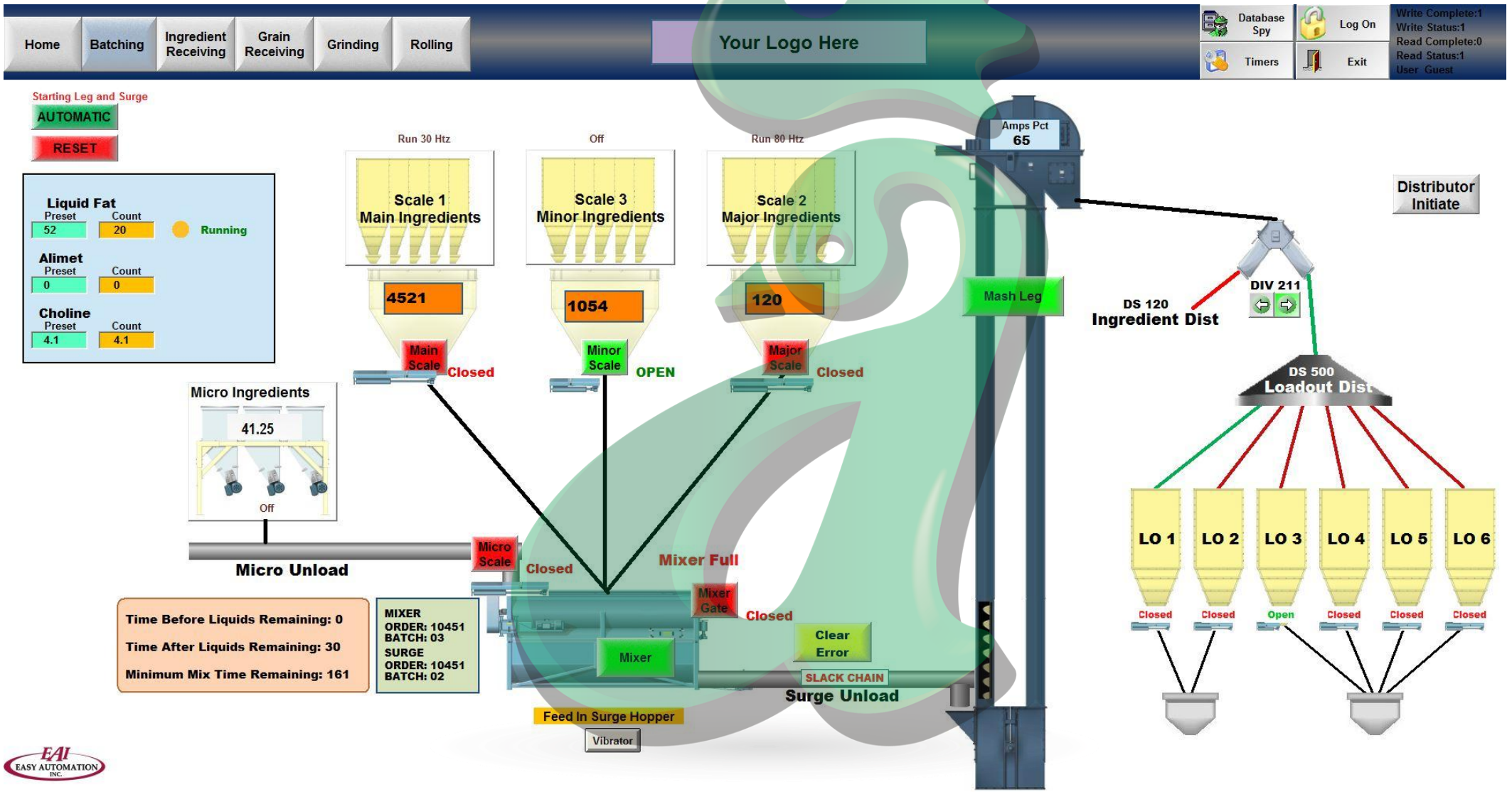
Batch Cycles

Operation	Time (sec)
Scaling	60
Scale Discharge	30
Dry Mix	60
Wet Mix	100
Mixer Discharge	10
Surge Discharge	100
TOTAL TIME	360 sec

Batch Cycles

MAJOR INGREDIENTS WEIGH UP	1	30	1	30
MAJOR INGREDIENTS SCALE DROP	31	5	31	5
MINOR INGREDIENTS WEIGH UP	1	30	1	30
MINOR INGREDIENTS SCALE DROP	33	5	33	5
MICRO INGREDIENTS WEIGH UP	1	30	1	30
MICRO INGREDIENTS SCALE DROP	35	5	35	5
HAND ADDS	5	30	5	30
HAND ADDS DROP	37	5	37	5
DRY MIX	42	30	42	30
LIQUID ADDITION	72	30	72	30
WET MIX	102	60	102	60
MIXER DISCHARGE	162	15	162	15
MIXER GATE CLOSED	177	5	177	5
SURGE HOPPER DISCHARGE	162	90	162	90
MAJOR INGREDIENTS WEIGH UP	43	30	43	30
MAJOR INGREDIENTS SCALE DROP	178	10	178	10
MINOR INGREDIENTS WEIGH UP	43	30	43	30
MINOR INGREDIENTS SCALE DROP	178	5	178	5
MICRO INGREDIENTS WEIGH UP	43	30	43	30
MICRO INGREDIENTS SCALE DROP	180	5	180	5
HAND ADDS	5	30	5	30
HAND ADDS DROP	182	5	182	5
DRY MIX	185	30	185	30
LIQUID ADDITION	215	30	215	30
WET MIX	245	60	245	60
MIXER DISCHARGE	245	15	245	15
MIXER GATE CLOSED	260	5	260	5
SURGE HOPPER DISCHARGE	245	90	245	90

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Rolling
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Database Spy
Log On
Timers
Exit
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Write Status:1
Read Complete:0
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User Guest
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AUTOMATIC
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Preset 52
Count 20
Running
Alimet
Preset 0
Count 0
Choline
Preset 4.1
Count 4.1
Run 30 Htz
Off
Run 80 Htz
Scale 1 Main Ingredients
Scale 3 Minor Ingredients
Scale 2 Major Ingredients
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1054
120
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Minor Scale
OPEN
Major Scale
Closed
Micro Ingredients
41.25
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Micro Unload
Micro Scale
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Mixer Full
Mixer Gate
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Mixer
Clear Error
SLACK CHAIN
Surge Unload
Feed In Surge Hopper
Vibrator
Time Before Liquids Remaining: 0
Time After Liquids Remaining: 30
Minimum Mix Time Remaining: 161
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BATCH: 03
SURGE
ORDER: 10451
BATCH: 02
Amps Pct
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Distributor Initiate
DIV 211
DS 120
Ingredient Dist
DS 500
Loadout Dist
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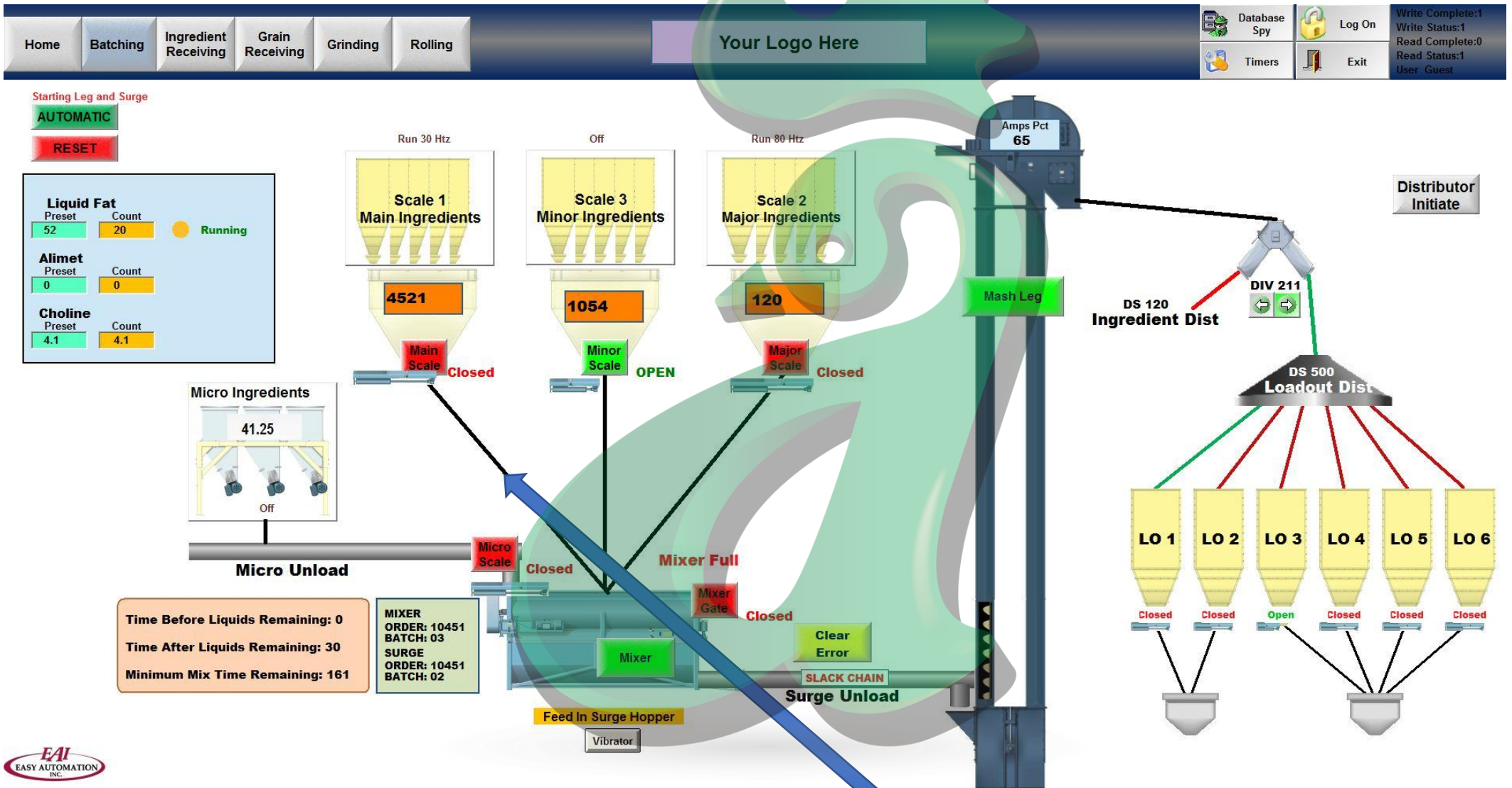
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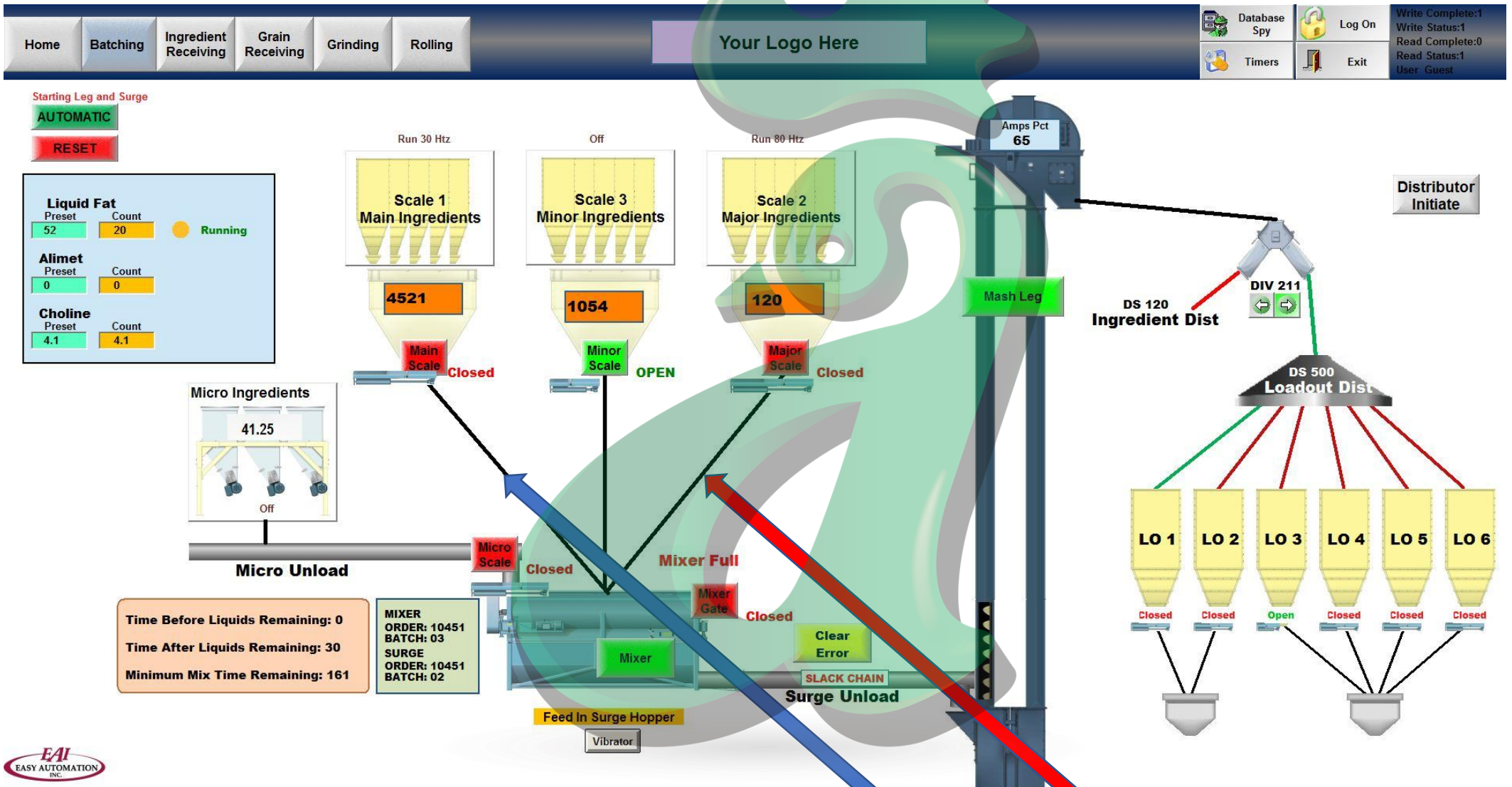
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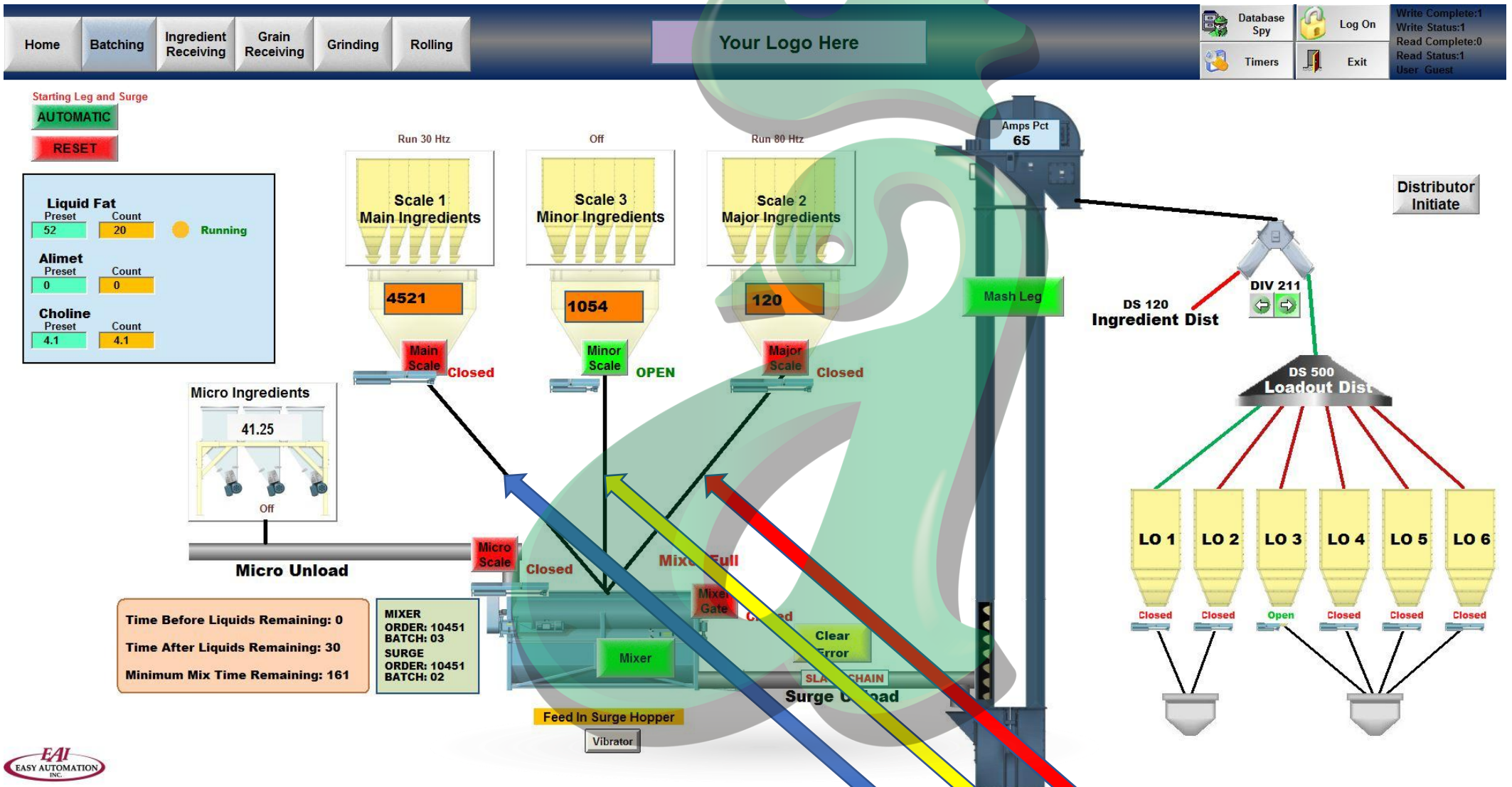
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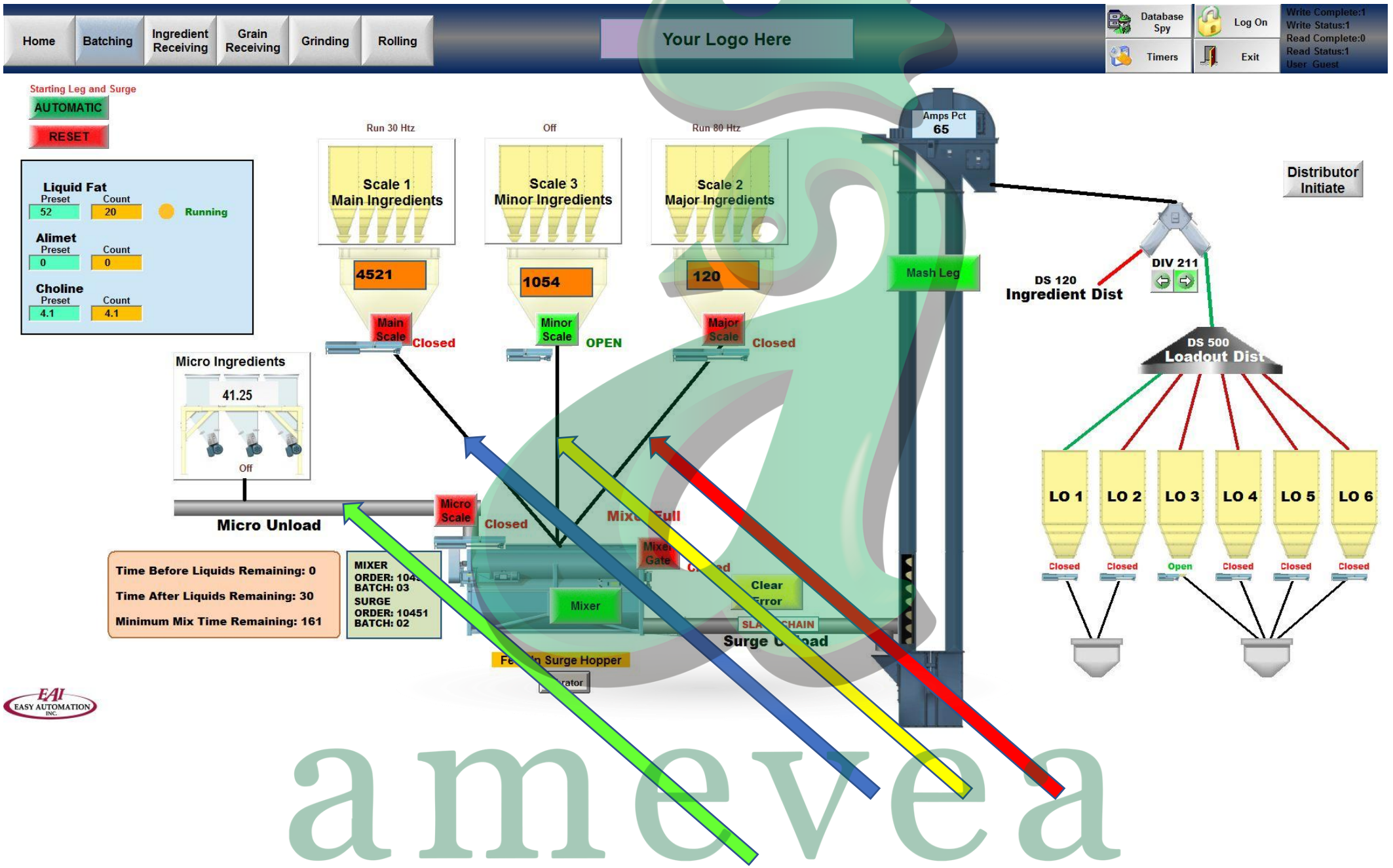
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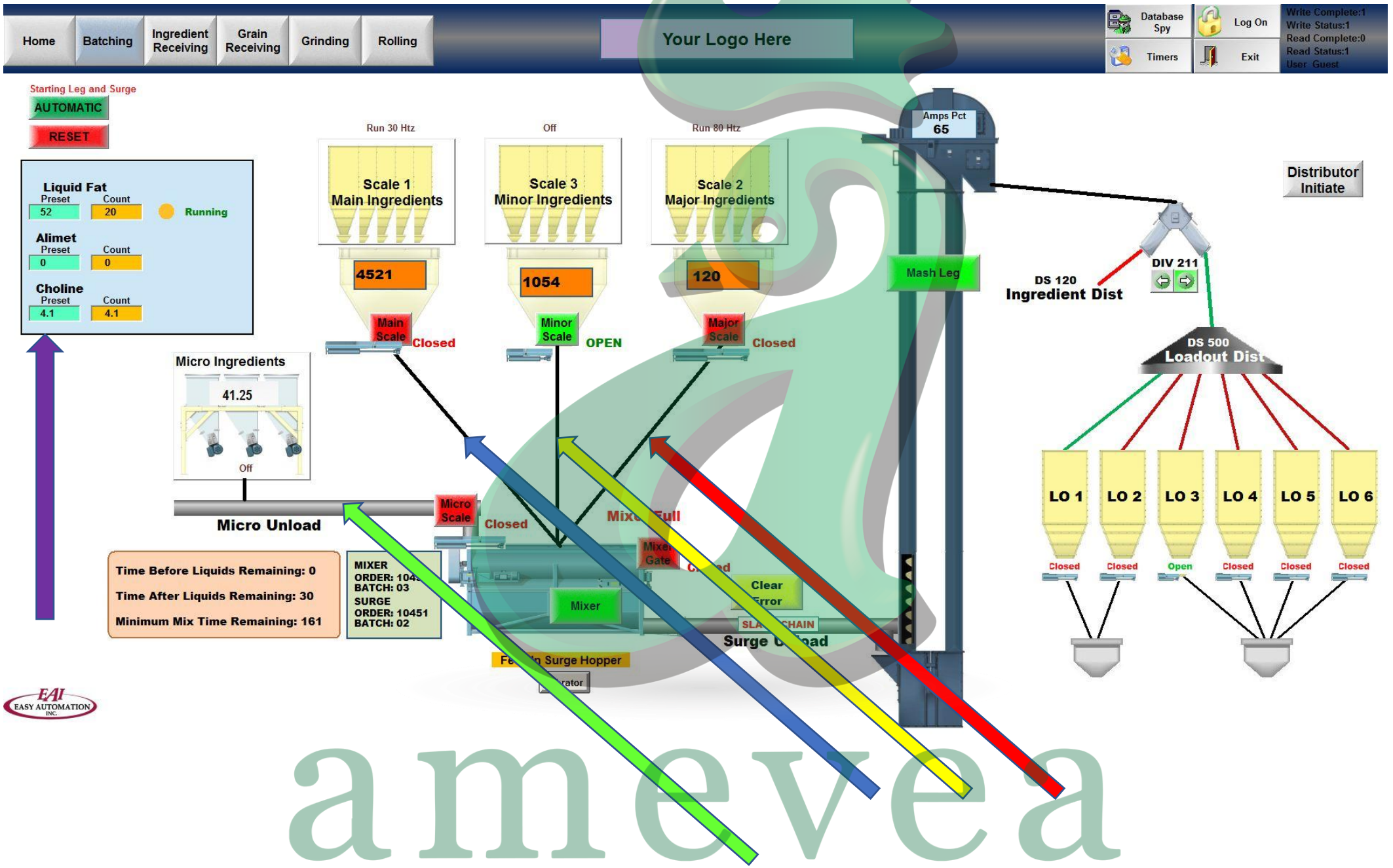
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Why Do We Mix?

What Is Mixer Uniformity?

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Mixer Uniformity

- Estimated by Coefficient of Variation (CV) of a specific nutrient or ingredient
- Measures the degree of dispersion of the ingredients in the batch of feed
- Typical Recommendation of a CV of 10% or less
- Generally, Mixer Uniformity increases with increased mixing time

Effects on Mixer Uniformity

- Particle Size
- Particle Shape
- Ingredient Density
- Ingredient Inclusion sequencing
- Formula Complexity
- Mixer Design
- Mixer Cleanliness
- Mixer Wear/Maintenance
- Over/Under Filling

Importance of Mix Uniformity

- Delivery of Medicated Feed Additives
- Species
- Age of animal
- Ingredient Potency
- Formula Complexity

- Regulations……

Calculation of Coefficient of Variation (CV)

- **%CV = s/m * 100**

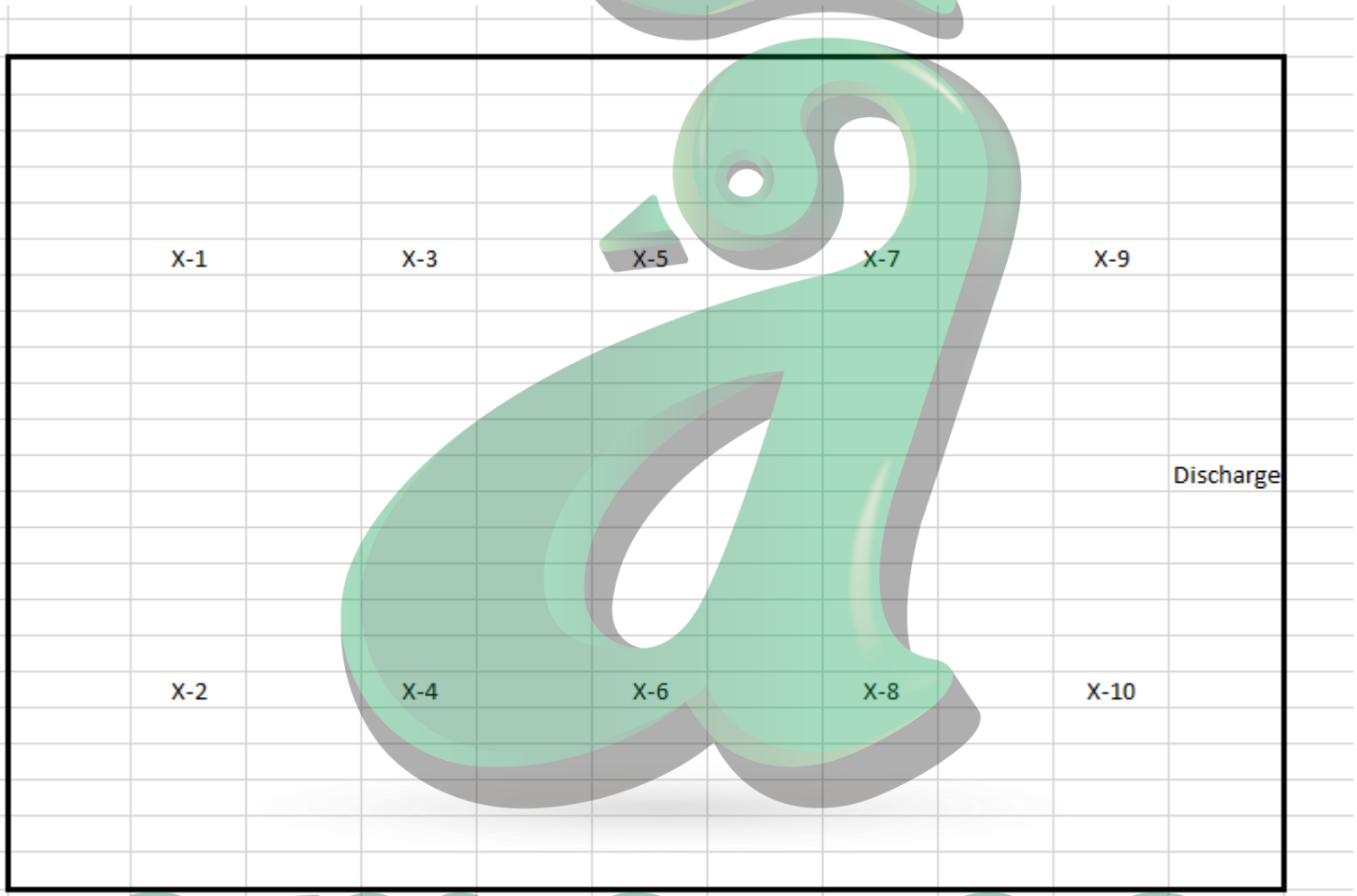
- $m = (\Sigma X_i)/n$
- $s^2 = (\Sigma(x_i^2)-nm^2)/n-1$

- Where:

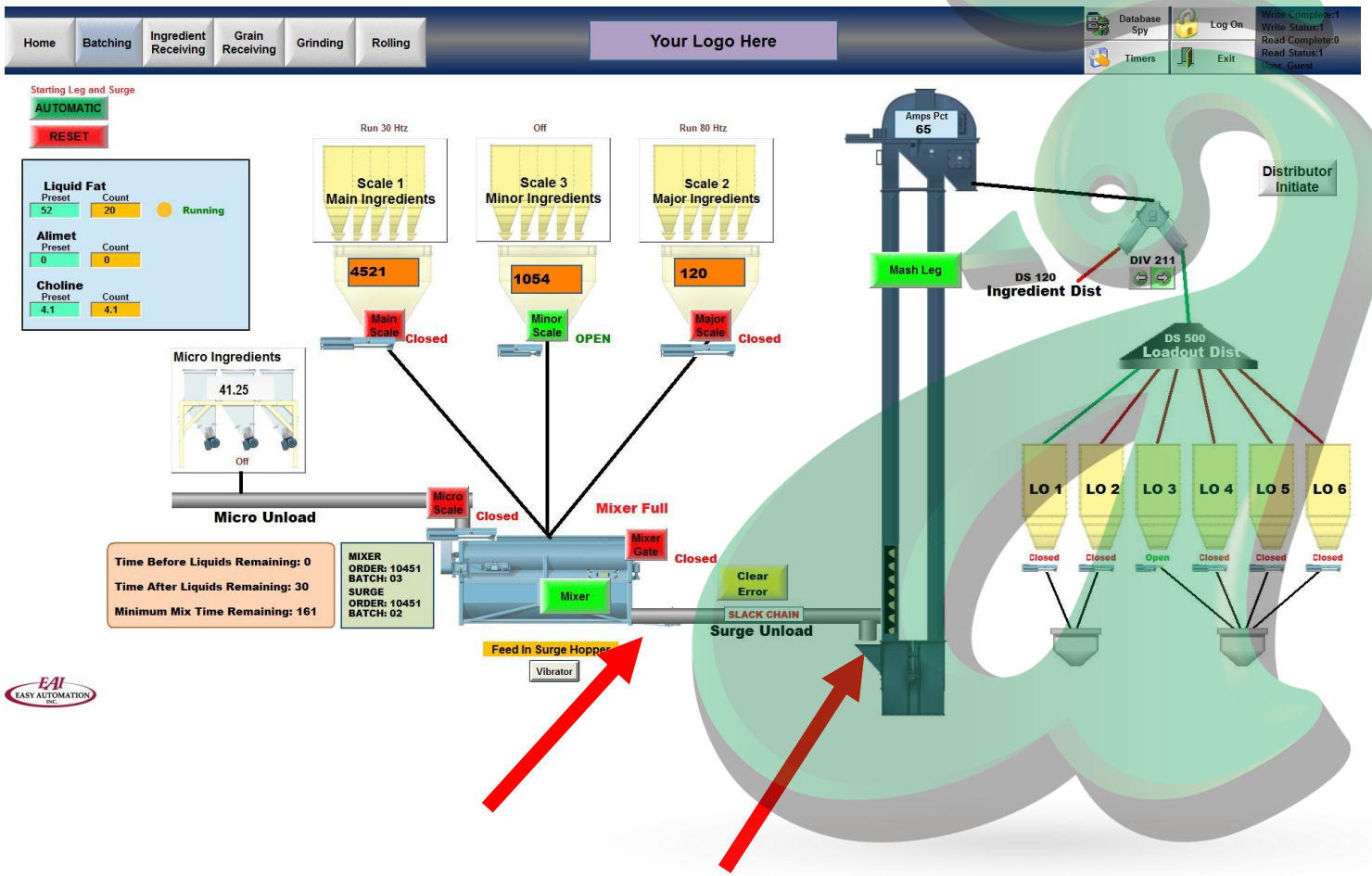
- %CV = Percent Coefficient of Variation
- s = Standard Deviation
- s^2 = Variance
- m = Mean
- n = number of samples assayed

	A	B	C
1	Date		
2	Location		
3	Personnel		
4			
5		**Sample**	**% Salt**
6		1	0.24
7		2	0.51
8		3	0.55
9		4	0.42
10		5	0.59
11		6	0.55
12		7	0.59
13		8	0.59
14		9	0.64
15		10	0.55
16		**Mean**	0.523
17		**Standard Deviation**	0.1156
18		**Coefficient of Variation**	22.10%
19			

Mixer Analysis Sample Sites



Mixer Analysis Sample Sites



Example:

Discharge Time is 120

Collect adequate samples starting at Time 0 and then every 12 seconds

Mix Uniformity - Marker Selection

- Cost
  - Time and Financial
- Ease of the Assay
  - Minimal sample preparation and assay steps
- Accuracy of the Assay
  - i.e. Synthetic (+/- 1%) or Biological (+/- 30%)
- On-Site Testing
  - Quick resolution if there are issues
- Single Source
  - Crude Protein is a poor selection.
  - Several ingredients have N in LECO test.

Marker Comparison

	Mix Time (min)		
Item,%	0.5	2.5	5.0
DL-Methionine	23.86	14.56	9.47
Lysine-HCl	19.75	16.00	8.70
Crude Protein	7.73	7.29	6.86
Chloride Ion (as sodium chloride)	20.26	12.75	15.08
Phosphorus	13.72	6.46	6.27
Manganese	36.25	20.80	17.59
Microtracer™ Red #40 (count)	21.77	11.72	15.08
Microtracer™ Red #40 (absorbance)	21.13	20.52	16.88
Microtracer™ RF-Blue Lake	32.49	20.09	18.64
Roxarsone (3-Nitro®)	30.24	25.15	25.54
Semduramicin (Aviax®)	27.40	16.11	11.23

Clark, 2006

Mixer Uniformity Analysis - Quantab™

Quantab® Chloride Titrator Procedure (Quantab®, Hach Co., Loveland, CO, 80539)

- Analysis for chloride ion.

- Weigh 10 g of sample into a cup.
- Add 90 mL of boiling distilled water; stir for 30-s; wait 60-s; stir another 30-s.
- Fold a circle of filter paper in half twice, open the cone-shaped cup and place the filter into the solution. Allow liquid to permeate filter paper.
- Place the titrator in the solution with the filter cone.
  - DO NOT PUNCTURE A HOLE INTO THE FILTER PAPER. The titrator capillary tube may become plugged with small feed particles.
- Leave titrator strip in the solution until the yellow indicator strip across the top has turned dark blue.
- Remove the titrator and record the reading to the nearest one-half division on the numbered scale.
- Convert the reading to percentage salt using calibration tables provided with the titrators.
- Multiply percentage of salt from the table by 10 to adjust for the dilution.

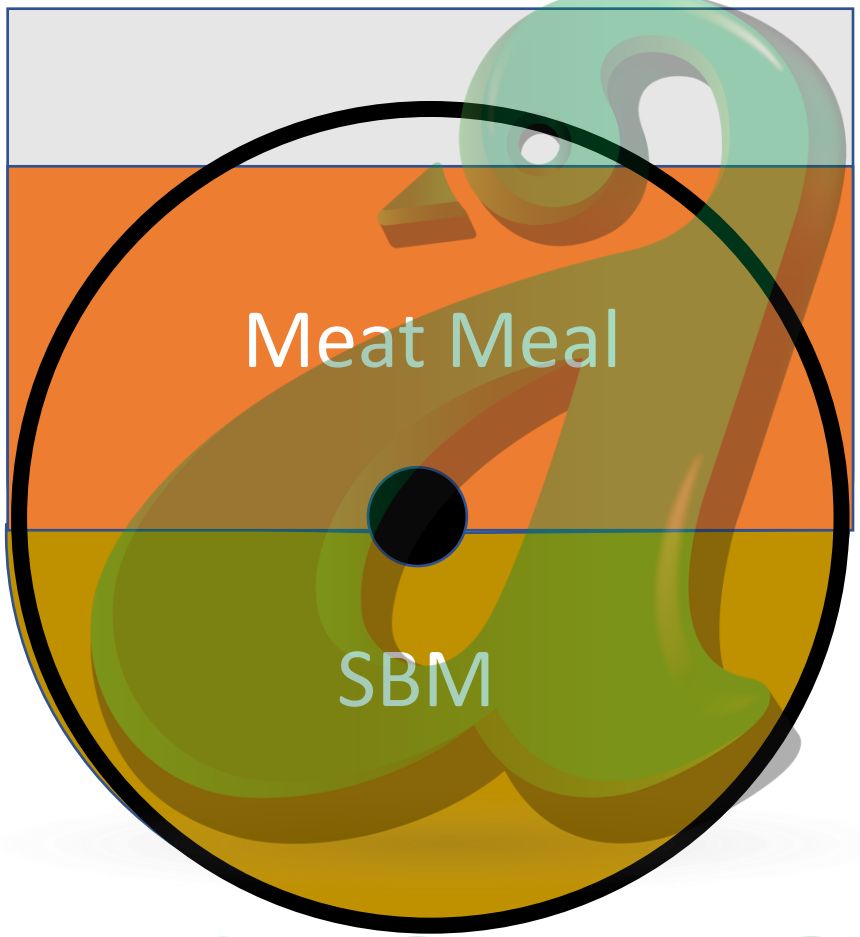
- **Calculate CV for each set of samples analyzed**

Interpreting Mixer Analysis

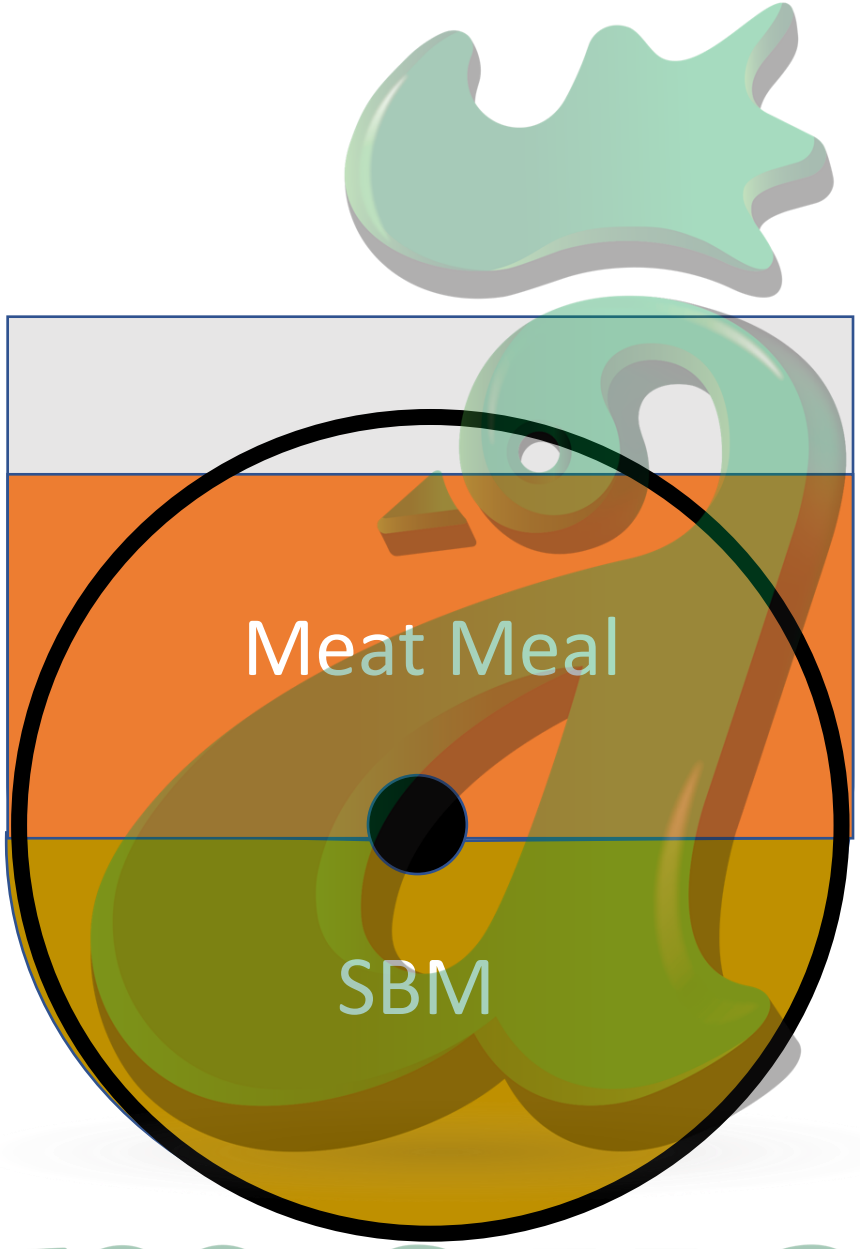
Percent Coefficient of Variation	Rating	Corrective Action
<10%	Excellent	None
10-20%	Good	Increase Mixing Time 25-30%
15-20%	Fair	Increase Mix Time 50% Look for worn equipment Overfilling Sequence of Ingredient Addition
> 20%	Poor	Combination of all of the above Consult Equipment Manufacturer

Hermann and Behnke, 1994

Protein As A Mixer Uniformity Marker

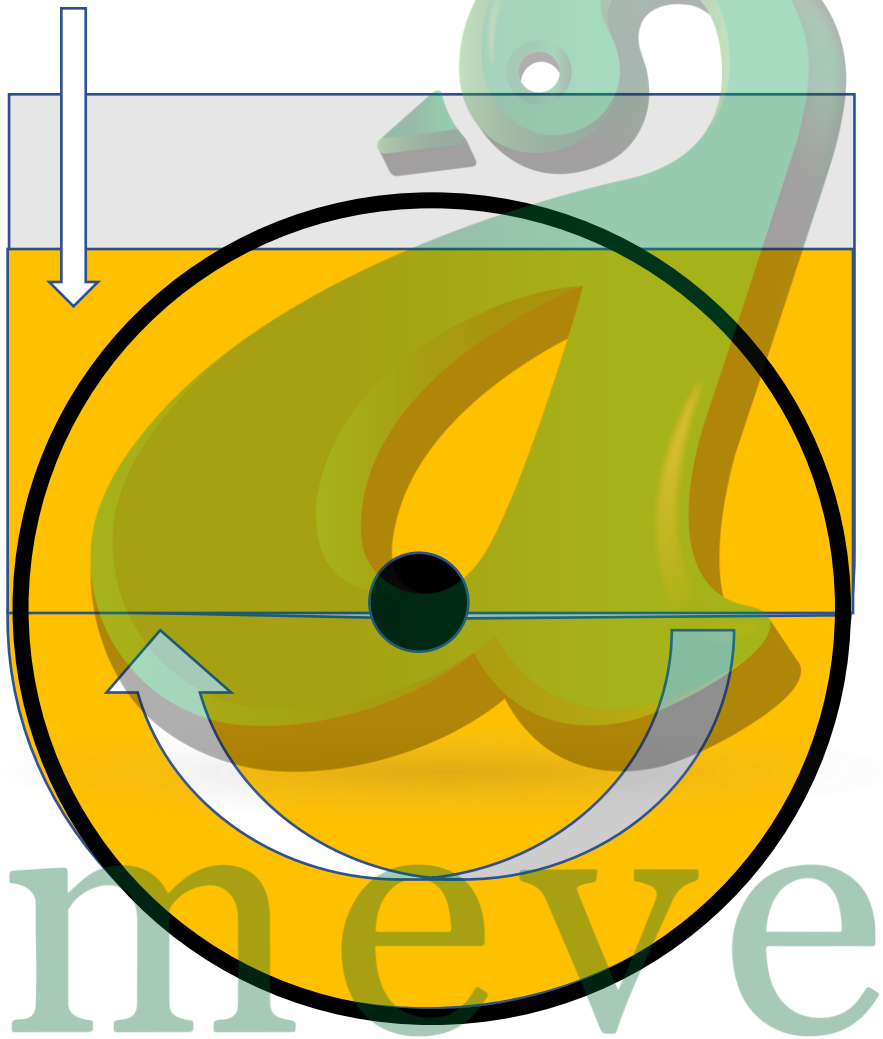


Assume a 6-ton mixer is filled with 3-tons of SBM (48%CP) and 3-tons of porcine meat meal (50% CP). If the mixer was not turned one revolution, but ten samples were taken for mixer analysis (and we assume no sampling error and exact nutrient profiles), 2.15% CV is the highest the coefficient of variation could be if evaluating Crude Protein.



Liquid Addition

- Spray liquids on the “upside”
- Insure that the nozzles are facing “down”



Mixer Volume Audit

			0.512 g/cc		0.561 g/cc	
Animal Feed						
Bulk Density(lb/cu ft)	32					
			32	32	35#	35#
Volume (Cubic Ft)	Width (in)	Length (in)	Capacity (#)	Capacity (Ton)	Capacity (#)	Capacity (Ton)
10	22	44	320	0.2	350	0.2
15	26	50	480	0.2	525	0.3
30	32	64	960	0.5	1050	0.5
42	36	72	1344	0.7	1470	0.7
58	40	80	1856	0.9	2030	1.0
86	46	92	2752	1.4	3010	1.5
114	50	100	3648	1.8	3990	2.0
128	52	104	4096	2.0	4480	2.2
196	60	120	6272	3.1	6860	3.4
238	64	128	7616	3.8	8330	4.2
286	68	136	9152	4.6	10010	5.0
339	72	144	10848	5.4	11865	5.9
398	78	144	12736	6.4	13930	7.0
464	78	168	14848	7.4	16240	8.1
571	86	172	18272	9.1	19985	10.0
662	90	180	21184	10.6	23170	11.6

Mixing Cycle Audit

Animal Feed						
Bulk Density(lb/cu	35					
			35	35	35#	35#
Volume (Cubic Ft)	Width (in)	Length (in)	Capacity (#)	Capacity (Ton)	Capacity (#)	Capacity (Ton)
10	22	44	350	0.2	350	0.2
15	26	50	525	0.3	525	0.3
30	32	64	1050	0.5	1050	0.5
42	36	72	1470	0.7	1470	0.7
58	40	80	2030	1.0	2030	1.0
86	46	92	3010	1.5	3010	1.5
114	50	100	3990	2.0	3990	2.0
128	52	104	4480	2.2	4480	2.2
196	60	120	6860	3.4	6860	3.4
238	64	128	8330	4.2	8330	4.2
286	68	136	10010	5.0	10010	5.0
339	72	144	11865	5.9	11865	5.9
398	78	144	13930	7.0	13930	7.0
464	78	168	16240	8.1	16240	8.1
571	86	172	19985	10.0	19985	10.0
662	90	180	23170	11.6	23170	11.6

	AS IS	15 Sec "Found"
Mixer Size	**5.0**	5.0
Hourly Capacity (TPH)	**100**	109.2
Batches/HR	**19.98**	21.82
Cycle Time (min)	**3.00**	2.75
Cycle Time (sec)	**180**	165
Assumptions		
Mixer Fill (Scale Discharge) (sec)	**15**	10
Mixer Discharge (sec)	**15**	10
Mixing Time	**150**	145
Dry Mix Time	**50**	50
Wet Mix Time	**100**	95
80 Hour Work Week @ 80%	**6400**	**6989**

Common Batching and Mixer Problems

- Improperly calibrated scales
- Broken, Dirty, or Bound load cells
- Poorly located liquid nozzles
- Clogged liquid nozzles
- Mixer Cleanliness
  - Build up of feed on paddles, ribbons, mixer liner
- Particle Size
  - Coursely ground grains and fine powder premixes
- Ingredient Density - Over/Under Filling
- Ingredient Inclusion sequencing
  - Minor or Micro scales not emptying last or completely
- Mixer Wear/Maintenance
  - Broken or worn paddles/ribbons
- HUMAN ERROR – INVOLVMENT …….