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Calibrating Meter-Type Feed Mills

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Meter-type feed mills (sometimes called automatic electric mills) are feed processing units which meter ingredients separately and blend them together in controlled flow rates. Blending takes place while the grain is ground and/or during conveying of the ration. Finer ingredients may bypass the grinding chamber. Each ingredient is supplied by a separate metering device.

Different brands of mills feature different types and locations of metering devices (Figs. 1 and 2). Meter types include:

- variable speed proportioning augers,
- adjustable gravity flowspouts above belts or rotating tables,
- fluted wheels with adjustable flow gates,
- vibrators with adjustable flow gates.

Ingredient meters measure material by volume while ration formulations are specified by weight. Calibration is the process of determining the meter settings that will produce the desired ratio of ingredient weights in the ration. Periodic calibration checks are used to determine if the original meter settings are still producing the desired ratio of ingredient weights.

This fact sheet is intended as a guide for calibrating meter-type feed mills. It also includes a discussion of factors affecting ration quality control.

Preparing for Calibration

Read the calibration section of the owner's manual. The manual describes the recommended calibration procedure for your mill and may contain charts and

tables as calibration aids. Some manufacturers also offer optional equipment, such as counters attached to ingredient meters, sampling chute assemblies and/or specially shaped sample containers for use in calibration.

A data sheet should be prepared for each ration before going to the feed center. An example of a Calibration Data Sheet is shown in Table 2, accompanied by an explanation of how the sheet is completed. The ratio of ingredients in the ration is calculated and recorded. The completed data sheet shows the date, times used in calibration, meter settings, and weights of ingredients delivered during the recorded time periods. The completed data sheet should be kept in the feed center for reference during calibration checks. Keeping a copy of the data sheet in your office is a good practice.

Calibration requires a container or set of containers to collect ingredients for weighing and an accurate scales. The timed method of calibration also requires a stop watch or a watch with a sweep second hand. A hand-held calculator will assist in making rapid calculations.

The Timed (Sequential) Method

The *timed method* of calibration, illustrated in Figure 3, can be applied to all meter-type mills. It is the easiest, most readily understood method. The flow rate of each ingredient is determined by weighing the amount of ingredient collected during a certain timed period. The flow rates (meter settings) of the individual in-

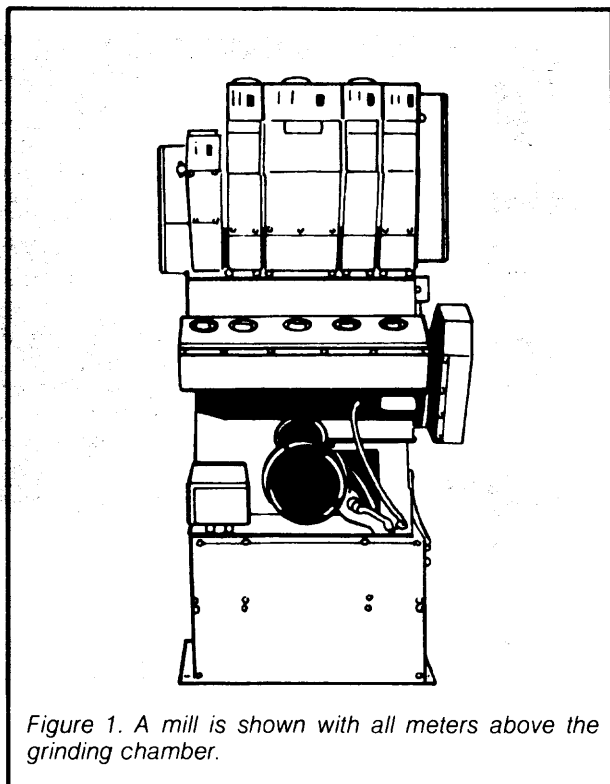


Figure 1. A mill is shown with all meters above the grinding chamber.

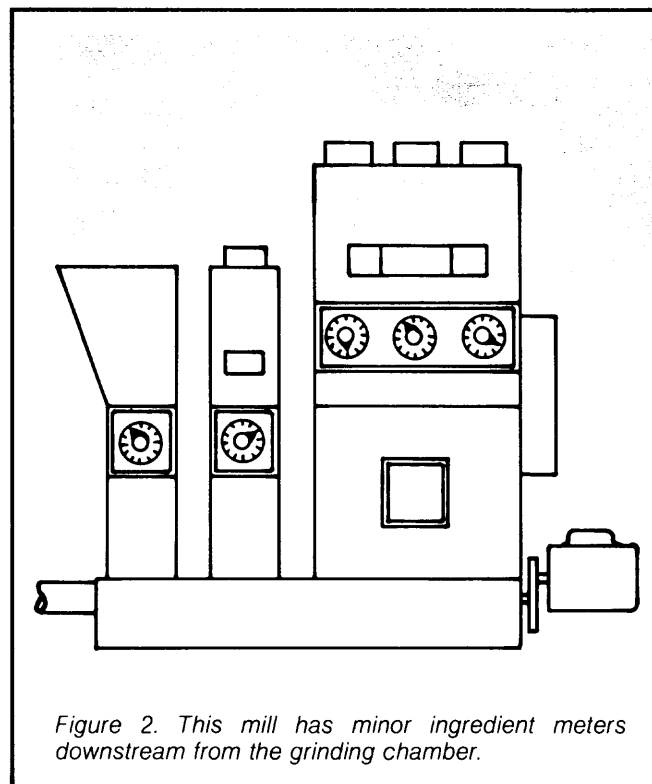


Figure 2. This mill has minor ingredient meters downstream from the grinding chamber.

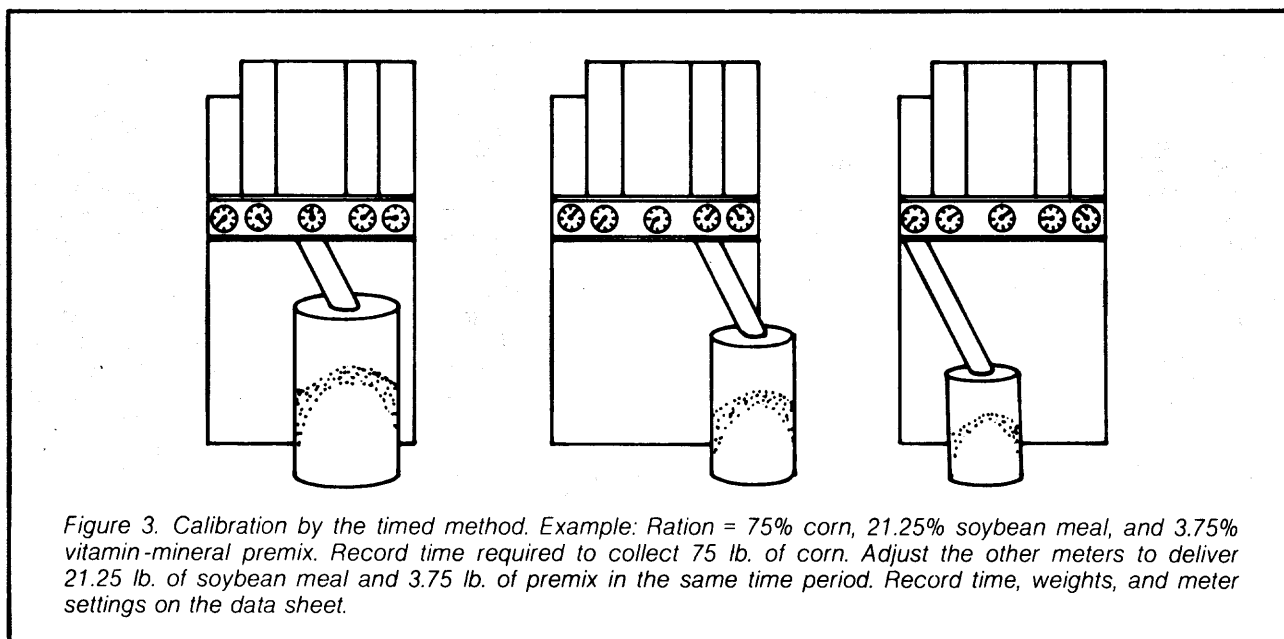


Figure 3. Calibration by the timed method. Example: Ration = 75% corn, 21.25% soybean meal, and 3.75% vitamin-mineral premix. Record time required to collect 75 lb. of corn. Adjust the other meters to deliver 21.25 lb. of soybean meal and 3.75 lb. of premix in the same time period. Record time, weights, and meter settings on the data sheet.

Ingredients are adjusted by trial and error until weights of the ingredients collected for the timed period chosen are in a ratio very close to that of the desired ration. Operator experience shortens the time required for trial and error adjustments.

Grain is the main ingredient in most rations. Therefore, a mill should be set to grind grain at about 90% of its grinding capacity and then other ingredients should be calibrated to match this grain flow rate.

Consider a ration that is 80% corn and 20% supplement. With a large drum set on a scale and the corn meter operating at about 90% of the grinding capacity of the mill, determine the length of time required to meter 80 lb. of corn. Adjust the supplement meter until it produces 20 lb. of supplement in the same time as was required to collect the 80 lb. of corn.

The Simultaneous Method

Some meter mills have a single variable speed drive controlling all the meters in addition to individual meter controls. After the mill is calibrated for a particular ration, the variable speed drive is increased until the mill is producing at near maximum capacity as indicated by an ammeter. These mills can be calibrated by the simultaneous method as illustrated in Figure 4.

The simultaneous method of calibration involves collecting each of the ingredients separately but simultaneously. The meter settings which control flow rates of the individual ingredients are adjusted by trial and error until the collected ingredient weights are in a ratio very near that of the desired ration. At this point the mill is "calibrated." The variable speed drive is then in-

creased until the mill is producing at near maximum capacity.

When ingredients are collected simultaneously, collection time is not important so long as there is an adequate amount of the smallest ingredient for accurate weighing. Collect at least 100 times the weight of the smallest scale division. For example, if the scales will weigh to the nearest $\frac{1}{4}$ lb., collect at least 25 lb. ($\frac{1}{4} \times 100 = 25$). If the scales will weigh to the nearest 1 oz., collect at least 6.25 lb. ($\frac{1}{16} \times 100 = 6.25$).

Combined calibration methods can be used. For example, a mill can be set to grind grain at near its grinding capacity with the simultaneous calibration method then used to match the correct flow rates of the other ingredients to that of grain. Calibration checks can be made by the simultaneous method, even for mills calibrated by the timed method.

Additional Methods

In addition to the two calibration methods detailed here, other methods can be used. Two manufacturers outline a "pounds per count" calibration procedure in their owner's manuals.

These manufacturers provide counters on each ingredient meter. Using the counters, a single collection of ingredient is made from each meter. Calculations involving weight of ingredient collected, meter counter reading, and the desired amount of ingredient per ton are used to determine the proper dial setting for each meter. The procedure given in the owner's manual should be followed carefully.

Another calibration method involves the development of calibration curves or tables. For each ingredient meter, a series of collections and weighings are used to determine the metered rate for dial settings over the full range of the meter dial. These results are plotted as curves or listed as tables. When a ration formulation is expressed as the desired lb./min. flow rate for each ingredient, the calibration curves or tables are consulted for a first estimate of each dial setting. Either the timed or simultaneous method is then used to verify that the intended ration formulation is being produced.

Quality Control

Most meter mills cannot adequately mix less than 25 lb. of an ingredient uniformly into a ton of feed. The 3-5 lb. micro-ingredient blends of additives, medications, vitamins, and trace minerals that are commonly added to each ton of feed should first be premixed with ground grain.

Light, fluffy ingredients, such as antibiotics, tend to flow unevenly. Premixing these additives with ground grain is required for accurate metering. Premixing is also required when fat is added. The quantity of carrier should be at least double the quantity of the ingredient it carries. A fine meal of grain (no finer than corn meal) is more suitable than flour as carrier.

Mixers specifically designed to uniformly mix ingredients that differ greatly in density and flow characteristics are required for preparing premixes. The minor ingredient should be poured into the carrier. Horizontal premixers are preferred to vertical units. Ribbon-types (Fig. 5) are preferred to paddle-types of units. Horizontal premixers featuring rotating mixing chambers also give good results.

When premixes are prepared with carriers, a small error is introduced unless the ration formulation is adjusted to account for the carrier. Table 1 contains an example showing how the ration is adjusted for the ground grain used as the carrier.

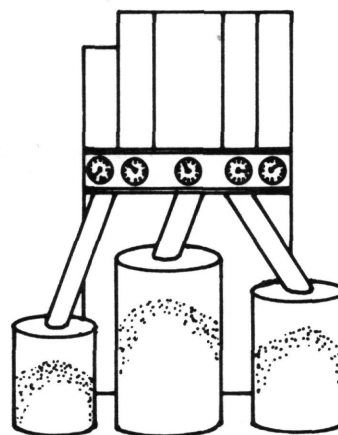


Figure 4. Simultaneous calibration—collecting all ingredients at the same time. Example: Ration = 75% corn, 21.25% soybean meal, and 3.75% vitamin-mineral premix. Ration ratio = 1 part vitamin-mineral premix to 5.67 parts soybean meal and 20 parts corn. Adjust meters until ingredient weights collected in any period equal this ratio: 1/5.67/20. Record meter settings on the data sheet.

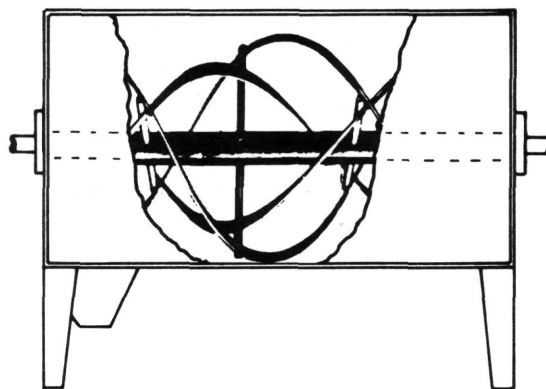


Figure 5. Horizontal, ribbon-type mixers are preferred for preparing vitamin, mineral, and antibiotic premixes.

Bulk density (test weight) is defined as the weight per unit volume. Since mill calibration is the process of setting volumetric flow rates to produce a ration formulated by weight, a significant change in the density of any ingredient will require recalibration.

The containers and scales used to calibrate the mill can also be used to detect changes in ingredient bulk density. Choose a container of convenient size ($\frac{1}{2}$ to 1 cu. ft.) and convenient shape (easily struck off with a straight edge). Changes in bulk density are easily and quickly detected by maintaining a record of the exact weight of each ingredient required to fill the container level full. When bulk density of any ingredient changes by 5%, recalibrate the mill for all rations containing that ingredient. It is a good practice to check bulk density before the first use of a new supply of any ingredient.

Meter-type mills require a continuous and uniform flow of ingredients. Changes in the characteristics of

Table 1. Adjusting ration formulation for the carrier. Example.

| Ingredient | Intended ration | | Adjusted formulation | |
|--------------------------|-----------------|-------|----------------------|-------|
| | lb./ton | % | lb./ton | % |
| Ground corn | 1595 | 79.75 | 1555 | 77.75 |
| Soybean meal | 320 | 16 | 320 | 16 |
| Vitamin-mineral mix | 80 | 4 | 80 | * |
| Antibiotic | 5 | 0.25 | 5 | 0.25 |
| Carrier (ground corn) | - | - | 40 | 20 |
| | 2000 | 100 | 2000 | 100 |

*The antibiotic should be poured into and thoroughly mixed with the ground corn before the vitamin-mineral mix is added to the premixer.

ingredients that affect their flow rates require recalibration of the mill. These changes are discovered during the regular calibration checks that are a part of quality control.

Some changes in ingredient flow characteristics can be anticipated. For example, a new mill will need to be recalibrated (or at least checked) after the spouts, bin surfaces, and metering chambers are polished by ingredient flow.

As grain becomes drier, it flows more freely and its test weight increases. Both factors increase the grain dry matter in the ration. Grain that is too dry (less than 10% moisture) is flinty and less palatable, while grain that is too damp (more than 15% moisture) is more subject to spoilage both before and after processing, especially during warm weather. Any grain moisture change of more than 3 percentage points calls for a calibration check.

The design and capacity of overhead surge bins can affect ingredient flow rate. Protein supplements in flour form give more bridging problems than those in meal or pellet forms. For minimum bridging, ideal overhead bins are nearly square in cross-section and have hoppers with two adjacent vertical sides (hoppered to one corner), while the two remaining sides slope at least 60° from horizontal. Spouts from overhead bins to gravity-fed mills should be large and steep enough to allow ingredients to flow freely. Spouts should not be larger than the metering device intake to avoid restrictions at this point. Spouts handling meal should be set at least 60° above horizontal (1¾:1 slope) while those handling grain may be set at least 45° above horizontal (1:1 slope).

High capacity, high speed augers should not be used to recharge the small surge bins on ground-level mills. Frequent on-off switching of the motors on these augers, under load, reduces their reliability and maintenance-free service life. In addition, fast filling of the surge bins may affect metering accuracy. Auger speed and delivery rate should be lowered to reduce starting torque and to avoid overwhelming the metering device and its surge bin.

Grain containing coarse foreign material, such as stems, stalks, and leaves can cause metering problems. These materials can partially block the grain flow through the metering device and/or prevent the automatic shut-off system from working properly. Be alert for coarse foreign material in any ingredient. Grain with excessive foreign material should be cleaned before storage for processing.

Avoid very finely ground rations. A high percentage of flour in the ration leads to separation and poor nutrient distribution. While some studies have shown slightly better feed efficiency with finely ground rations, dust problems are greater and pigs may develop ulcers. Flour in the ration tends to separate out in conveying systems, particularly in pneumatic conveyors.

Worn-out hammers must be replaced. With some mills, hammers can be reversed to extend service life. The expected life of reversible hammers in a 5 hp. mill is about 15,000 bu. of grain or about 500 tons of feed. Screens last much longer, at least 3,000 tons of feed, unless they are damaged by metal or stones.

Calibration checks should be made periodically. Suggested practices are to check calibration for each ration once each month or to check calibration for at least one ration each week. It is also a good practice to check mill calibration for each new batch of ingredients, such as a new delivery of soybean meal or a new grain supply. When in doubt, check calibration. And when the calibration check shows more than a 5% deviation from the intended metered rate of any ingredient—recalibrate.

An occasional laboratory analysis of your grain supply and/or your complete rations can be part of ration quality control. Your state department of agriculture laboratory or a private laboratory can provide this service. Consult your nutritionist to determine the usefulness of ingredient and ration analyses in your program. Your veterinarian may desire an occasional ration analysis as a diagnostic tool.

Summary

1. Make one person responsible for mill calibration and calibration checking.
2. Develop the simplest and most easily understood procedures for calibration and calibration checking to promote their frequent use.
3. For each ration, complete a calibration data sheet. Keep a duplicate in the feed center for easy reference.
4. Check calibration for each ration frequently—once each month is suggested.
5. A calibration check is suggested during first use of each new batch of grain or protein source or when the flow characteristics of any ingredient may have changed.
6. Determine and record the bulk densities of ingredients being used. When a 5% change in bulk density of any ingredient is found, recalibrate for all rations containing that ingredient.
7. Consider the use of ingredient and ration analyses. These analyses can provide important management and diagnostic information when studied with animal performance records.

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CALIBRATION PROCEDURES FOR RATION (EXPLANATION OF TABLE 2 ENTRIES)

- Step 1. Calculate the ratio of ingredients.
- a. Divide the percentage of each ingredient in the ration by the percentage of the smallest ingredient.
 Premix: 3.75 divided by 3.75 = **1**
 Soybean meal: 21.25 divided by 3.75 = **5.67**
 Corn: 75 divided by 3.75 = **20**
 - b. The ratio of ingredients is 20/5.67/1 for corn, soybean meal, and premix, respectively. Record these values on the data sheet.
- Step 2. Determine the grinding capacity of the mill.
- a. Set the mill to the "grind" setting.
 - b. Bypass all ingredients except the grain.
 - c. Increase the grain flow until the mill is grinding at capacity, as indicated by the ammeter, then reduce to about 90% capacity.
- Step 3. Calibrate by the timed method.
- a. Switch to "calibrate" setting.
 - b. Shut off all except the corn meter.

- c. Collect 75 lb. of corn, recording the time required.
 - d. Shut off all except the soybean meal meter.
 - e. Adjust the soybean meter to deliver 21.25 lb. of meal in the same time recorded for corn.
 - f. Shut off all but the premix meter.
 - g. Adjust the premix meter to deliver 3.75 lb. of premix in the same time recorded for corn.
 - h. Record the meter settings on the data sheet.
- Alternate Step 3. Calibrate by the simultaneous method.
- a. Switch to the "calibrate" setting.
 - b. Catch all ingredients simultaneously for the same period. Catch enough of the smallest ingredient to allow for accurate weighing.
 - c. By trial and error, determine meter settings that will provide a ratio of 20/5.67/1 for corn, soybean meal, and premix, respectively, for any timed period chosen.
 - d. Record the meter settings on the data sheet.

Table 2. Example Calibration Data Sheet
CALIBRATION DATA SHEET

| Fill out before calibration | | | | Fill out during calibration - Use either method | | | | | | | | | | | | Calibration Checks | |
|--|-------------------|-------------|--------------|---|---------------------------------------|----------------|--------------|-----------|------------|-------------|----------------|-------------|-------------|-----------|----------------|--------------------|--|
| Ration #1 <i>(Stanton)</i> Protein <i>16%</i> Date <i>1/1/84</i> | | | | Timed Method ‡ | Simultaneous or Uniform Time Method ‡ | | | | | | Meter Settings | | Date | OK | | | |
| Ingredient | lb/Ton | Percent | Ratio* | | Bin | Time | lb. | Trial 1 | | Trial 2 | | | | | Trial 3 | | |
| | | | | | | | lb. | Ratio† | lb. | Ratio† | lb. | Ratio† | | | | | |
| 1 | <i>Corn</i> | <i>1500</i> | <i>75.00</i> | <i>20</i> | <i>2</i> | <i>48 sec.</i> | <i>75</i> | <i>85</i> | <i>34</i> | <i>86</i> | <i>23.9</i> | <i>86</i> | <i>20.4</i> | <i>42</i> | <i>2/29/84</i> | ✓ | |
| 2 | <i>SOY (44)</i> | <i>425</i> | <i>21.25</i> | <i>5.67</i> | <i>3</i> | <i>"</i> | <i>21.25</i> | <i>18</i> | <i>7.2</i> | <i>20.4</i> | <i>5.7</i> | <i>23.6</i> | <i>5.6</i> | <i>29</i> | <i>4/2/84</i> | ✓ | |
| 3 | <i>STO Premix</i> | <i>75</i> | <i>3.75</i> | <i>1</i> | <i>5</i> | <i>"</i> | <i>3.75</i> | <i>29</i> | <i>1</i> | <i>3.6</i> | <i>1</i> | <i>4.2</i> | <i>1</i> | <i>10</i> | <i>6/15/84</i> | ✓ | |
| 4 | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | |

* Percent of each ingredient divided by the percent of the smallest ingredient.

† lb. of each ingredient divided by the lb. of the smallest ingredient.

‡ Samples collected for different time intervals can be mathematically converted to the same time interval and then ratios calculated the same as for either method of calibration.

| Oz/Lb. | Oz/Lb. | Oz/Lb. | Oz/Lb. |
|----------|----------|-----------|-----------|
| 1 = 0.06 | 5 = 0.31 | 9 = 0.56 | 13 = 0.81 |
| 2 = 0.13 | 6 = 0.38 | 10 = 0.63 | 14 = 0.88 |
| 3 = 0.19 | 7 = 0.44 | 11 = 0.69 | 15 = 0.94 |
| 4 = 0.25 | 8 = 0.50 | 12 = 0.75 | 16 = 1.00 |

CALIBRATION DATA SHEET

Fill out before calibration

Fill out during calibration - Use either method

| | | | | | | | | | | | | | | | |
|---|--------|---------|--------|-----------------------|--|--|------|---------|-----|---------|-----|-----------------------|--|---------------------------|--|
| Ration _____ Protein _____ Date _____ | | | | Timed Method ‡ | | Simultaneous or Uniform Time Method ‡ Time _____ | | | | | | Meter Settings | | Calibration Checks | |
| | | | | | | Trial 1 | | Trial 2 | | Trial 3 | | | | | |
| Ingredient | lb/Ton | Percent | Ratio* | | | Bin | Time | lb. | lb. | Ratio† | lb. | | | | |
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |

* Percent of each ingredient divided by the percent of the smallest ingredient.

† lb. of each ingredient divided by the lb of the smallest ingredient.

‡ Samples collected for different time intervals can be mathematically converted to the same time interval and then ratios calculated the same as for either method of calibration.

| | | | |
|---------------|---------------|---------------|---------------|
| <u>Oz/Lb.</u> | <u>Oz/Lb.</u> | <u>Oz/Lb.</u> | <u>Oz/Lb.</u> |
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