

## MANUFACTURING PRACTICE- MIXER PERFORMANCE TESTING PROCEDURES

### I Proposed Regulatory Text

14. (1) The performance of all mixers used in the making of medicated feed must be verified

(a) at the time of installation; and

(b) as frequently as necessary to ensure proper functioning, but not less than once a year.

(2) Every licensed operator must have written procedures to ensure that all mixers used in the making of medicated feed are maintained to ensure their proper functioning using

(a) the standard mixer test protocol set out in the American Society of Agricultural Engineers Standard ASAE S303.3, such that the coefficient of variation does not exceed the applicable coefficient of variation set out in the most recent Device Performance Verification List, published by the Canadian Food Inspection Agency; or

(b) a performance standard listed in the most recent Device Performance Verification List, published by the Canadian Food Inspection Agency.

### II Rationale For Regulatory Requirements

The mixing process is a critical step in the manufacture of medicated feeds. The performance of the mixing equipment is key to manufacturing quality feeds. With respect to medicated feed, proper mixing is critical to obtaining the correct drug level in the feed. The purpose of mixer performance testing (mixer validation) is to determine whether the mixing equipment is capable of producing feeds of uniform consistency.

### III Items to Consider When Developing Procedures to Meet Regulatory Objectives

#### Strategies

**A mixer performance test acceptable for the site must be developed and performed according to a regular schedule (at the time of installation for new equipment and at least once a year for all mixers)**

The licensed operator must have appropriate written procedures that describe how to test mixing uniformity. This is accomplished by testing the level of one or more substance in a pre-established number of feed samples from a batch of mixed product, and calculating the coefficient of variation (CV) for the batch. The CV is a calculation that is used to determine whether the mixer is capable of manufacturing uniform batches of feed. Individual differences in types of formulae produced in the facility and type of mixing equipment need to be considered in developing the protocol used, i.e., some particular aspects of the test will be site-specific.

The following principles should be considered when choosing the mixer performance test to be used in a particular facility:

### **1. The mixing protocol must be defined**

This protocol must specify the following, as a minimum:

- ▶ sequence of ingredient addition to the mixer
- ▶ mixing time
- ▶ batch size

The equipment manufacturer's recommendations should be used as a starting point to establish on-site guidelines for the operation of mixing equipment. Where possible these recommendations should be requested in writing at the time of purchasing the equipment. The test batch should be manufactured using the facility's current feed manufacturing practices.

### **2. Schedule of tests**

Mixer performance must be tested:

- ▶ at the time of the installation of the mixer (when installed after the Regulations have come into effect);
- ▶ after a major repair or modification that could impact on the functioning of the mixer;
- ▶ periodically, but at a minimum once a year

To allow for unforeseen circumstances, it is recommended that ongoing testing be conducted a minimum of 60 days before the deadline to allow time for corrective actions as required.

### **3. Test Protocol**

#### **Mixing operation settings**

Sequence of ingredient addition to the mixer, mixing time and batch size should be those used under normal conditions of operation.

#### **Selection of test substance**

The test substance is something that can be measured in a laboratory to evaluate mixer performance. For instance, if the level of salt present in the feed is used to assess uniformity, the laboratory would be asked to measure either sodium or chloride. Rather than being added as a single ingredient, the salt may be included in a premix or supplement which is mixed with other ingredients to produce another feed.

***The inclusion rate of the test substance should be similar to the inclusion rates for medicating ingredients in the feeds manufactured using that mixer. In addition, the inclusion rate of the ingredient which provides the test substance should be that typically used in the facility.***

## Choosing a Test Substance

The following criteria should be considered when choosing the test substance:

The lab method to determine the level of the substance should be highly reproducible and have a low analytical variation (e.g., less than the target CV for the mixer).

Only one ingredient should significantly contribute to the concentration of the test substance in the mix to avoid masking non-uniformity.

With respect to selection of the test substance, one or all of the following nutrients would appear to be suitable in most instances:

- ▶ sodium
- ▶ chloride
- ▶ zinc
- ▶ manganese
- ▶ copper

Other test substances may also be acceptable provided that they are indicative of product homogeneity.

## Sampling procedure

A minimum of nine spot samples should be taken after mixing is completed. These spot samples should represent the full batch. Samples should be taken at, or as near as possible to, the mixer discharge. Where this is impossible, another option may be to obtain probe samples from different locations in the mixer. If this method is used, for safety reasons, the power to the mixer should be disconnected prior to obtaining samples. When samples are taken at the discharge, they should be spaced evenly in time for the duration of the discharge. Alternatively, samples may be obtained at evenly spaced target weights during mixer discharge. In continuous proportioning systems, samples should be taken with the system running, at even, predetermined time intervals, and as close to the mixer discharge as possible. Take spot samples by holding a small box, cup or scoop in the stream of feed and collecting between 100 and 500 grams of feed (depending on the feed type). Place each sample in the appropriate sequentially numbered bag or container.

Three examples of this basic methodology for different types of equipment are described in Appendix 1.

## Critical limits

The mixer is considered to be producing homogenous feeds when the coefficient of variation for the test batch is:

- ▶ no greater than 5% for dilute drug premixes\*
- ▶ no greater than 10% for micro or macro premixes and supplements
- ▶ no greater than 15% for complete feeds and total mixed rations

\* dilute drug premix means a drug for veterinary use that results from mixing a drug premix with a feed as defined in section 2 of the *Feeds Act*, to such a level that at least 10 kg of the resulting mixture is required to medicate one tonne of complete feed, as defined in Section 2 of the *Feeds Regulations, 1983*, with the lowest approved dosage level of the drug

## Follow Up

Should the initial mixer test not meet the accepted standards, the laboratory results should be re-evaluated and original samples re-assayed if necessary. If the results of the original test are found to be correct, a second test must be performed following the same procedures. Should the second mixer test (or the re-test of the first samples) indicate that the mixing is adequate, these results will be taken as correct.

When the second mixer test verifies that mixing is not adequate, an immediate investigation must be made as to the cause. Continue corrective action and mixer efficiency testing until adequate mixing uniformity is achieved. For suggestions on potential causes of inadequate mixing/poor mixer validation results, refer to Appendix 2.

## Documentation and Records

The following documents and records are required:

- ▶ Mixer testing dates
- ▶ Verification records from mixing uniformity tests including a batch sheet for the test batch indicating ingredients added, amounts, mixing times, sampling procedures, laboratory analysis reports and the calculated CV
- ▶ Equipment maintenance records
- ▶ Record of corrective actions taken when unacceptable CVs are determined
- ▶ Notification of change of mixer

## Appendices

- ▶ Appendix 1: Mixer Performance Test Protocols
- ▶ Appendix 2: Troubleshooting
- ▶ Appendix 3: Checklist for Mixer Performance Testing
- ▶ Appendix 4: Mixer Test Performance Procedures and Records
- ▶ Appendix 5: References

**Appendix 1**

### **Mixer Performance Test Protocols**

Note: The following procedures are adapted from the Animal Nutrition Association of Canada's Mixer Validation protocol based on the "Test Procedure for Solids - Mixing Equipment for Animal Feeds," approved and adopted by the American Society of Agricultural Engineers.

A mixer validation shall be performed using one of the following three basic methodologies. The method chosen will depend on the type of mixer being used.

**1. *Batch-Type Mixers (except TMR Mixers)***

Batch Size: Mixers should be tested at their normal operating capacity.

Type of Feed to be Tested: Any batch in the production schedule can be tested. (Note: Ideally the type of feed chosen should be what is most frequently mixed in that mixer, and a feed that usually contains medications.)

Number of Samples to be Taken: A minimum of 9 samples per batch is required.

Procedure:

1. Accurately weigh the desired amount of the ingredient containing the test substance to be added to the mixer.
2. Prepare a minimum of 9 sequentially numbered sample bags or containers.
3. Calculate the sampling time interval as follows: Measure the time required for the mixer to fully discharge when filled to full capacity. Convert to seconds. For nine samples, divide by 10. Example: A five-minute or 300 second emptying cycle = one sample every 30 seconds starting after 30 seconds for a total of nine samples. An alternative is to sample at evenly spaced target weights during mixer discharge.
4. Add the feed ingredients to the mixer in their normal sequence.
5. Mix for the usual length of time, and record the actual mixing time.
6. After mixing is complete, take at least nine (9) spot samples as near the mixer discharge as possible.
  - a) Take the first sample from the first 10% of the batch as it is discharged and the last sample from the last 10% of the batch as it is discharged.
  - b) Take spot samples by holding a small box, cup or scoop in the stream of feed and collecting between 100 and 500 grams of feed. Place each sample in the appropriate sequentially numbered bag or container.
7. Submit samples to accredited laboratory for analysis for the level of selected test substance (e.g., sodium, zinc, manganese, copper, etc.) in each sample.
8. Calculate the mean, standard deviation and coefficient of variation of the mixer based on the assay results. (Note: Many labs will do this upon request.)

## 2. **TMR Batch Mixers**

Batch Size: Mixers should be tested at their normal operating capacity. (Note: Ideally the type of feed chosen should be what is most frequently mixed in that mixer, and a feed that usually contains medications. Given the large variation in particle size for TMRs, extra care must be taken to obtain representative spot samples.)

Number of Samples to be Taken: A minimum of 9 samples per batch is required.

Procedure:

1. Accurately weigh the desired amount of a ingredient containing the test substance to be added to the TMR mixer.
2. Prepare a minimum of 9 sequentially numbered containers (volume approximately one to two litres).
3. a) If sampling at mixer discharge: Calculate the sampling time interval by measuring the time required for the mixer to fully discharge when filled to normal operating capacity. Convert to seconds. For nine samples, divide by 10. Example: A five-minute or 300 second emptying cycle = one sample every 30 seconds starting after 30 seconds for a total of nine samples. An alternative is to sample at evenly spaced target weights during mixer discharge.  
  
b) If sampling from the feed bunk: Determine the length of the bunk filled with feed during mixer discharge, when the mixer is at normal operating capacity. If using containers, place the numbered containers at evenly spaced intervals along the empty feed bunk such that both the first and last portion of the mixer contents will be sampled.
4. Add the feed ingredients to the mixer in their normal sequence.
5. Mix for the usual length of time, and record the exact time
6. After mixing is complete:
  - a) If sampling at mixer discharge: Obtain at least nine (9) spot samples (sample size = 500 -1000 grams) as near the mixer discharge as possible by holding a container in the stream of feed until it is full. Take the first sample from the first 10% of the batch as it is discharged and the last sample from the last 10% of the batch as it is discharged.
  - b) If sampling from the feed bunk using sequentially numbered containers: Discharge the mixer contents into the bunk containing the sequentially numbered containers. Carefully remove the containers (which should contain at least 500-1000 grams of material) from the bunk and transfer samples to air tight containers.
  - c) If obtaining hand grab samples from the feed bunk: Discharge the mixer contents into the bunk. Carefully obtain representative spot samples, through the depth of the feed (500-1000 grams), at evenly spaced intervals along the length of the bunk.

7. As these samples have a high moisture content, place the entire contents of each container into an airtight bag (numbered as per the container). Submit samples to accredited laboratory for analysis for the level of selected test substance (e.g., sodium, zinc, manganese, copper, etc.) in each sample.
8. Calculate the mean, standard deviation and coefficient of variation of the mixer based on the assay results (on a 100% DM basis). (Note: Many labs will do this upon request.)

### **3. *Continuous Proportioning Systems*** (based on Quebec Provincial Regulations)

Type of Feed to be Tested: Any feed in the production schedule can be tested.

(Note: Ideally the type of feed chosen should be what is most frequently mixed in that mixer, and a feed that usually contains medications.)

#### Procedure:

1. Prepare 9 sequentially numbered containers.
2. Calculate the sampling time interval as follows: Measure the time required (in seconds) to manufacture a batch of feed (or a tonne of feed if the batch size exceeds one tonne). Divide by 10. Example: A five-minute or 300 second emptying cycle = one sample every 30 seconds.
3. While the system is running, take 9 spot samples, at the time intervals determined in Step 2, as close to the discharge of the continuous mixer as possible. Samples are obtained by holding the container in the stream of feed and collecting between 100 and 500 grams of feed. Place each sample in the appropriate sequentially numbered sample bag.
4. Submit samples to accredited laboratory for analysis for the level of selected test substance (e.g., sodium, zinc, manganese, copper, etc.) in each sample.
5. Calculate the mean, standard deviation and coefficient of variation of the mixing system based on the assay results. (Note: Most labs will do this upon request.)

## Troubleshooting

### Mixer Performance Validation Trouble Shooting (for batches tested)

1. Are ribbons/paddles worn and/or deformed?
2. Is there excessive feed build up on ribbons/paddles?
3. Have there been any mixer repairs, adjustments or new parts installed (e.g., ribbons, screws, paddles, different power motor, etc.) that might affect mixing function?
4. Have there been any procedural changes (e.g., change in mixing time, charging mixer beyond the manufacturers recommended specifications) that might affect mixing function?
5. Is the mixer running at the proper RPM and are ribbons rotating in the correct direction?
6. Were more than 5-8% of liquid ingredients added to the batches tested? How were liquids added, e.g., sprayed, atomised, etc.?
7. Was there a large variation in the particle size of the ingredients in the batches tested?
8. Did the ingredient containing the test substance have properties (e.g., electrostatic charge) which render it difficult to mix uniformly?
9. Was the mixer properly grounded?
10. Was the ingredient containing the test substance dusty so that it could have been lost via the dust collection system during mixing?
11. Was the degree of fill appropriate for the batches tested e.g., not above the mixer ribbon or below the mixer shaft?
12. Was the batch size appropriate, e.g., within manufacturer's recommendations? Too small or too large a batch may contribute to variability.
13. Was the sample size adequate? Larger samples may be required for TMR and liquid feed mixers or feeds which have higher degrees of particle size variation, e.g., multi-textured rations.
14. Was the size of the auger used to deliver the ingredient containing the test substance appropriate (e.g., was a premix auger used for macro premixes)?
15. Was the amount of the ingredient containing the test substance added to the batch appropriate?
16. Were the hammers/rollers and screens in good condition (particle size)?

## Checklist for Mixer Performance Testing

<b>Task 1</b>	<b>Assess adequacy of written procedures used to test mixer performance and records</b>
<b>Rating Type</b>	<b>Compliance Regulations Respecting the Making of Medicated Feeds Section 14</b>
	All unsatisfactory ratings require a record of compliance action taken and/or a signed action plan for correction of noncompliance.
<b>Standard</b>	<b>This task should be repeated for each mixer used in the manufacture of medicated feed</b>
<b>Standard</b>	To receive a satisfactory rating, the manufacturer must maintain mixer performance testing procedures and mixer records which contain the following information: <p style="margin-left: 20px;"><b>Mixer Performance Testing Records</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> the name or other information (e.g., model, serial number, etc.) which identifies the mixer to which the test record applies;</li> <li><input type="checkbox"/> the mixer performance testing date(s)</li> <li><input type="checkbox"/> details regarding the procedures that were used to assess the performance of mixing equipment (including information used to identify test feed (name, lot #), mixing sheet for test feed, the sequence of ingredient addition, batch size, mixing time, sampling procedures, etc.) <i>Please note, these procedures must describe an approved test, e.g., as indicated in the Regulations or listed on the Device Performance Verification List - see Appendix I for examples.</i>; and</li> <li><input type="checkbox"/> copies of mixer records must be kept for a period of at least three years from the date of testing.</li> </ul> <p style="margin-left: 20px;"><b>Mixer Performance Testing Procedures</b></p> <p>written mixer performance testing procedures must stipulate that at a minimum mixing equipment performance must be been tested at the time of installation (when installed after the Regulations have come into effect), after a major repair or modification and at least once/per year thereafter.</p>

**Task 2**                      **Evaluate performance of mixing equipment**

**Rating Type**              **Compliance**    **Regulations Respecting the Making of Medicated Feeds Section 14**

All unsatisfactory ratings require a record of compliance action taken and/or a signed action plan for correction of noncompliance.

**Standard**                      To receive a satisfactory rating, the establishment must have:

- evidence that the mixing equipment can produce feeds having a coefficient of variation within the critical limit for the particular type of feeds being manufactured using that mixer as defined in the *Feeds Regulations* (i.e., 5% for dilute drug premixes, 10% for micro or macro premixes and supplements and 15% for complete feeds and total mixed rations), including results of laboratory analysis for the level of selected test substance in test batches.

**Task 3**                      **Assess adequacy of investigations of out of tolerance mixer performance testing results**

**Rating Type**              **Compliance**    **Regulations Respecting the Making of Medicated Feeds Section 14**

All unsatisfactory ratings require a record of compliance action taken and/or a signed action plan for correction of noncompliance.

**Standard**                      To receive a satisfactory rating, the establishment must have:

- written procedures detailing follow up procedures and corrective actions to be taken when mixer performance is outside of critical limits; and
- the establishment must have evidence documenting that these procedures have been followed.

## Mixer Performance Testing Procedures

### 1. Identification of Mixer

These written procedures apply to the following mixer:

Name:  
Model:  
Serial #:

### 2. Testing Frequency:

This mixer shall be tested for performance at a frequency as per the manufacture's specifications (see operators manual) or at least once per year. In addition, this mixer shall be tested for performance after any major repair or modification is made.

### 3. Testing Procedures

Testing procedures shall be as follows:

#### 3.1 Type(s) of Feed to be Tested:

#### 3.2 Testing Procedure:

Insert appropriate Mixer Performance Test Protocol from Appendix 1

#### 3.3 Test Substance:

#### 3.4 Critical Limit:

The mixer performance will be deemed to be acceptable if the CV is within the lowest critical limit identified for feeds manufactured by this mixer, i.e.,:

- ▶ no greater than 5% for dilute drug premixes;
- ▶ no greater than 10% for micro or macro premixes and supplements; and
- ▶ no greater than 15% for complete feeds and total mixed rations.

## **Follow up procedures for CV results above Critical Limit**

Should the initial mixer test be above the critical limit, the laboratory results should be re-evaluated and original samples re-assayed if necessary. If the results of the original test are found to be correct, a second test must be performed following the same procedures. Should the second mixer test (or the re-test of the first samples) indicate that the mixing is adequate, these results will be taken as correct.

When the second mixer test verifies that mixing is not adequate, an immediate investigation must be made as to the cause. The following items should be checked and corrective actions taken and documented and test mixer efficiency until adequate mixing uniformity is achieved.

### **Mixer Performance Validation Trouble Shooting**

1. Have there been any mixer repairs, adjustments or new parts installed (e.g., screws, paddles, different power motor, etc.) that might affect mixing function?
2. Were more than 5-8% of liquid ingredients added to the batches tested? How were liquids added, e.g., sprayed, atomised, etc.?
3. Was there a large variation in the particle size of the ingredients in the batches tested?
4. Did the ingredient containing the test substance have properties (e.g., electrostatic charge) which render it difficult to mix uniformly?
5. Was the mixer properly grounded?
6. Was the ingredient containing the test substance dusty so that it could have been lost via the dust collection system during mixing?
7. Was the sample size adequate?
8. Was the size of the auger used to deliver the ingredient containing the test substance appropriate (e.g., was a premix auger used for macro premixes)?
9. Was the amount of the ingredient containing the test substance added to the batch appropriate?
10. Were the hammers/rollers and screens in good condition (particle size)?

**Mixer Performance Testing Procedures**

**1. Mixer Type**

- Batch Mixer (Mixer Performance Test Protocol - Appendix 1.1)**
- TMR Batch Mixer (Mixer Performance Test Protocol - Appendix 1.2)**
- Continuous Proportioning System (Mixer Performance Test Protocol - Appendix 1.3)**

**2. Identification of the Mixer (e.g., name, location, model, serial number, capacity, etc.)**

**c) Types of Feed Manufactured in the Mixer**

- Dilute Drug Premixes**
- Supplement**
- Total Mixed Ration**
- Micro/Macro Premix**
- Complete Feeds**

**d) Date of Mixer Installation**

**3. Initial Mixer Performance Testing**

Date of Initial Mixer Performance Testing:	Description of Initial Test Batch (Attach Mixing Sheet)					CV of Initial Test Batch	Test Substance
	Name of Test Batch	Name of Medication in Test Batch	Production of Test Feed as Percentage of Total Production	Sequence of Ingredient Addition Including Test Substance	Mixing Time		
37073	<i>Hog Grower # 2</i>	<i>Tylosin Phosphate</i>	25%	<i>Corn SBM Premix</i>	<i>3.5 minutes</i>	10%	<i>Sodium</i>

Mixer Performance Testing Procedures							

Mixer Performance Testing Procedures							

**Mixer Performance Testing Procedures**

**4. Major Repair/Modification**

Description of Major Repair/Modification	Date of Major Repair/Modification

**5. Ongoing Mixer Performance Testing**

Dates of Subsequent Mixer Performance Testing:	Description of Subsequent Test Batches (Attach Mixing Sheets)					CV of Subsequent Test Batch	Test Substance
	Name of Test Batch	Name of Medication in Test Batch	Production of Test Feed as Percentage of Total Production	Sequence of Ingredient Addition Including Test Substance	Mixing Time		

Attachments -        **Mixing Sheets for Test Batches**  
                           **Mixer Performance Test Protocol**  
                           **Results of Laboratory Analysis for Test Batches**

References

1. **Mixer Validation (personal communication), September 2000. Animal Nutrition Association of Canada.**
2. **American Society of Agricultural Engineers, 1990. Standards S303.2 and S380. In: Standards of the American Society of Agricultural Engineers, St. Joseph, MI.**
3. **Reglement sur les prémelanges médicamenteux et les aliments médicamenteux destinés aux animaux.**
4. **Hermann, Tim and Benke, Keith. 1994. Testing Mixer Performance MF-1172. Kansas State University Agricultural Experiment Station and Cooperative Extension Service.**

O:\FID\PPD\Food\GMP\MOP\Modules\mixer\Mixervp6.eng.wpd