MEAT TECHNOLOGY – INFORMATION SHEET

Cutting edge technology for the meat processing industry

# Meat technology – information sheet

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# A guide to calibration and verification of accuracy for instruments for estimation of chemical lean content of meat for manufacturing

## Background

If a chemical lean (CL) statement is applied to the trade description of meat products, then CL must be determined by a method approved by AUS-MEAT Limited.

There are no instruments that determine CL directly. Estimates are made by:

i. methods that chemically determine the fat content of representative samples of the meat; or

ii. predictive methods that estimate CL indirectly from measurements of other properties of the meat such as water content or various electrical properties.

Before they can be accepted by AUS-MEAT as 'approved methods', methods must be assessed against a recognised reference chemical method. Methods approved by organisations such as Standards Australia, International Standards Organisation (ISO), Association of Official Analytical Chemists (AOAC), the Nordic Committee on Food Analysis (NMKL) are recognised reference methods. An outline of the approval process applied by AUS-MEAT is provided at Appendix 1.

## Scope of guideline

This guideline describes procedures for:

1. calibration and verification of accuracy for in-line or at-line instruments for estimating CL of meat in:
   - bulk-packed cartons;
   - meat before it is packed in cartons or bins;
   - size-reduced and ground meat (in pipes); and
2. calibration of off-line instruments for estimating CL in representative samples of meat

It also describes procedures for ongoing verification of calibration conformance.

## Basic procedure

The instrument shall be calibrated over the range of CL expected in the meat to be submitted to it. Calibration shall be done after installation prior to use; or when calibration conformance checks fail; or when any important instrument components or parameters are replaced or altered. Calibration may be done against any of the accepted reference methods listed below.

## Apparatus

### Configuration of system for calibration

The equipment will normally be installed in the location where it is to be used routinely. Alternatively, it can be located in an environment equivalent in terms of temperature, vibration etc. to the intended final location—provided that (for in-line or at-line instruments) rates of passage of cartons etc. are the same as they will be in the intended location.

***Grinders and other equipment*** for size reduction and preparation for analysis of small (approx. 200 g) samples representative of the unit (carton or other) passed through the instrument being calibrated must be in good physical condition and be operated under cool temperature conditions that avoid fat throw-out.

***The testing of samples by the reference method*** must be done by competent analysts, preferably, but not necessarily, in a NATA-accredited laboratory.

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## Procedure for in-line or at-line instruments

### 1. Bulk-packed cartons

The initial calibration should be based on data for at least 24 cartons of product.

Select cartons of manufacturing meat packed to specific weight (e.g. 27.2 kg nett) and nominal CL to cover the calibration range desired (e.g. 80–95; 60–90). If separate calibrations are performed for discrete CL ranges within the full range, it will be necessary to base them on data for at least 24 cartons of product in each case.

Pass each carton through/past the instrument at least three times and record the value displayed by the instrument after each pass.

NOTE 1. Values may be in CL units if an interim calibration has been programmed in, or they may be in other arbitrary units that will be used later to develop a calibration equation.

NOTE 2. Generate information that indicates whether any of the following influence the values given by the instrument:

- carton size, orientation;
- meat temperature;
- size of meat pieces in carton;
- air gaps between meat pieces in carton;
- (if 'catch weight' cartons), weight of meat in each carton.

***It is important that during preparation of small samples for analysis by the reference method, there be no loss of either fat or weep, and that the fat be evenly distributed.***

Transfer the test cartons to a cold room held at -2°C to 0°C. Once the meat has cooled to -1°C to 0°C (probably after 50–70 h), mix and grind repeatedly each carton of meat separately. The following procedure is suggested.

1. Grind the meat twice through a plate with 6 to10 mm holes, mixing it thoroughly after each pass.
2. Then either:
    i. Obtain a representative sample (weight 1-2 kg), by a coning-and-quartering technique (i.e. by forming the ground meat into a cone shape, dividing it into quadrants, selecting and mixing two diagonal quadrants; repeat until the weight of retained meat reaches 1-2 kg). Use a small mincer with a plate having 2 to 4 mm holes, or a food processor (Robot Coupe or similar) to twice comminute the sample, mixing it thoroughly after each pass; or
    ii. Grind the total (ground) contents of each carton twice through a plate with 2 to 4 mm holes, mixing thoroughly after each pass.
3. Withdraw a representative sub-sample (weight approximately 500 g).

It is recommended that duplicate or triplicate sub-samples be taken and sent for analysis so that a measure of the repeatability of the reference sampling and testing procedure is possible.

If possible, analyse the samples without delay. If that is not possible, carefully seal them in plastic bags of polythene or similar. If the samples cannot be tested within one working day of preparing them, freeze them and hold them frozen. When the frozen samples are thawed for testing, or when samples are held chilled overnight, check for any separation of weep from them. If there is visible weep, thoroughly mix each sample to incorporate the weep throughout the sample. Avoid loss of any weep.

Analyse each of the samples, in duplicate or triplicate, for water content (preferably by oven drying for 16 h at 103°C) and fat content (by exhaustive extraction with diethyl ether or similar solvent according to one of the procedures listed in 'Reference documents' below).

Calculate the CL as a percentage by subtracting the percentage fat content from 100. Calculate the water content as a percentage. The estimates of water content provide additional information about the homogeneity of the samples.

Analyse the relationships between the output values from the instrument being calibrated and the reference values for water content and CL using a suitable statistical package. Packages that generate regression equations and measures of the 'goodness-of-fit' of the equations to the data are suitable. Statistics that can be generated from recent versions of Microsoft Excel may be adequate. Those from a dedicated package such as Minitab are preferable. Because techniques will often estimate lean meat content from measurements related to the water content of the meat, the relationship between the instrument readings and water content provides valuable information about the performance of the instrument.

Regular verification of the calibration may be done either by:

- daily passage through the instrument of phantoms or test units; or
- comparison with daily test results from core sampling, desirably by plotting differences on control charts;

supported by periodic (initially two-monthly):

- chemical analysis of at least five cartons of meat, the nominal CL of which covers at least half of the CL range; or
- comparison of instrument results with test results provided by grinder customers.

### 2. Piles of meat on conveyors

The initial calibration should be based on data for at least 24 discrete 'piles' of product, each at least 3 kg.

Select piles of manufacturing meat according to visual estimates of nominal CL to cover the calibration range desired (e.g. 80–95; 60–90).

Pass each 'pile' through/past the instrument at least three times and record the value displayed by the instrument after each pass.

NOTE 1. Values may be in CL units if an interim calibration has been programmed in, or they may be in other arbitrary units that will be used later to develop a calibration equation.

NOTE 2. You should generate information that indicates whether any of the following influence the values given by the instrument:

- redistribution of the pile;
- meat temperature;
- meat piece size;
- weight of meat in pile;
- gaps between pieces;
- conveyor speed.

Seal the test piles of meat in plastic bags and transfer them to a cold room held at 0°C to -2°C. Once the meat has cooled to -1°C to 0°C (after 3–4 h or overnight), mix and grind repeatedly each pile of meat separately. The following procedure is suggested.

1. Grind the meat twice through a plate with 6 to10 mm holes, mixing it thoroughly after each pass.
2. Then either:
    i. Obtain a representative sample (weight 1-2 kg), by a coning-and-quartering technique (i.e. by forming the ground meat into a cone shape, dividing it into quadrants, selecting and mixing two diagonal quadrants; repeat until the weight of retained meat reaches 1-2 kg). Use a small mincer with a plate having 2 to 4 mm holes, or a food processor (Robot Coupe or similar) to twice comminute the sample, mixing it thoroughly after each pass; or
    ii. Grind the total (ground) contents of each carton twice through a plate with 2 to 4 mm holes, mixing thoroughly after each pass.
3. Obtain a representative sub-sample (weight approximately 500 g).

It is recommended that duplicate or triplicate sub-samples be taken and sent for analysis so that a measure of the repeatability of the reference sampling and testing procedure is possible.

If possible, analyse the samples without delay. If that is not possible, carefully seal them in plastic bags of polythene or similar. If the samples cannot be tested within one working day of preparing them, freeze them and hold them frozen. When the frozen samples are thawed for testing, or when samples are held chilled overnight, check for any separation of weep from them. If there is visible weep, thoroughly mix each sample to incorporate the weep throughout the sample. Avoid loss of any weep.

Analyse each of the samples, in duplicate or triplicate, for water content (preferably by oven drying for 16 h at 103°C) and fat content (by exhaustive extraction with diethyl ether or similar solvent according to one of the procedures listed in 'Reference documents' below).

Calculate the CL as a percentage by subtracting the percentage fat content from 100. Calculate the water content as a percentage. The estimates of water content provide additional information about the homogeneity of the samples.

Analyse the relationships between the output values from the instrument being calibrated and the reference values for CL using a suitable statistical package. Packages that generate regression equations and measures of the 'goodness-of-fit' of the equations to the data are suitable. Statistics that can be generated from recent versions of Microsoft Excel may be adequate. Those from a dedicated package such as Minitab are preferable. Because techniques will often estimate lean meat content from measurements related to the water content of the meat, the relationship between the instrument readings and water content provides valuable information about the performance of the instrument.

Regular verification of the calibration may be done either by:

- daily passage through the instrument of phantoms or test units; or
- comparison with daily test results from core sampling, desirably by plotting differences on control charts;

supported by periodic (initially two-monthly):

- chemical analysis of at least five piles of meat, the nominal CL of which covers at least half of the CL range; or
- comparison of instrument results with test results provided by grinder customers.

## 3. Size-reduced meat in pipelines

The initial calibration should be based on data for at least 24 pipeline samples of product, each at least 3 kg.

Select the samples of manufacturing meat according to visual estimates of nominal CL to cover the calibration range desired (e.g. 80–95; 60–90).

If possible, pass each sample through/past the instrument at least three times and record the value displayed by the instrument after each pass.

NOTE 1. Values may be in CL units if an interim calibration has been programmed in, or they may be in other arbitrary units that will be used later to develop a calibration equation.

NOTE 2. You should generate information that indicates whether any of the following influence the values given by the instrument:

- meat temperature;
- meat piece size;
- fat smearing in pipe near sensors;
- air gaps.

Seal the test samples of meat in plastic bags and transfer them to a cold room held at 0°C to -2°C. Once the meat has cooled to -1°C to 0°C (after 3-4 h or overnight), mix and grind repeatedly each sample of meat separately. The following procedure is suggested.

1. Grind the meat twice through a plate with 6 to 10 mm holes, mixing it thoroughly after each pass (NOTE: if the sample is already ground product, this step will not be necessary).
2. Then either:
    i. Obtain a representative sample, weight 1–2 kg, by a coning and quartering technique (i.e. by forming the ground meat into a cone shape, dividing it into quadrants, selecting and mixing two diagonal quadrants; repeat until the weight of retained meat reaches 1–2 kg). Use a small mincer with a plate having 2 to 4 mm holes, or a food processor (Robot Coupe or similar) to twice comminute the sample, mixing it thoroughly after each pass; or
    ii. Grind the total (ground) contents of each carton twice through a plate with 2 to 4 mm holes, mixing thoroughly after each pass.
3. Obtain a representative sub-sample (weight approximately 500 g).

It is recommended that duplicate or triplicate sub-samples be taken and sent for analysis so that a measure of the repeatability of the reference sampling and testing procedure is possible.

If possible, analyse the samples without delay. If that is not possible, carefully seal them in plastic bags of polythene or similar. If the samples cannot be tested within one working day of preparing them, freeze them and hold them frozen. When the frozen samples are thawed for testing, or when samples held chilled overnight, check for any separation of weep from them. If there is visible weep, thoroughly mix each sample

to incorporate the weep throughout the sample. Avoid loss of any weep.

Analyse the samples in duplicate or triplicate for water content (preferably by oven drying for 16 h at 103°C) and for fat content (by exhaustive extraction with diethyl ether or similar solvent according to one of the procedures listed in 'Reference documents' below).

Calculate the CL as a percentage by subtracting the percentage fat content from 100. Calculate the water content as a percentage. The estimates of water content provide additional information about the homogeneity of the samples.

Analyse the relationships between the output values from the instrument being calibrated and the reference values for CL using a suitable statistical package. Packages that generate regression equations and measures of the 'goodness-of-fit' of the equations to the data are suitable. Statistics that can be generated from recent versions of Microsoft Excel may be adequate. Those from a dedicated package such as Minitab are preferable. Because techniques will often estimate lean meat content from measurements related to the water content of the meat, the relationship between the instrument readings and water content provides valuable information about the performance of the instrument.

Regular verification of the calibration may be done either by:

- daily passage through the instrument of phantoms or test units; or
- comparison with daily test results from core sampling, desirably by plotting differences on a control chart;

supported by periodic (initially two-monthly):

- chemical analysis of at least five samples of meat, the nominal CL of which covers at least half of the CL range; or
- comparison of instrument results with test results provided by grinder customers.

## Procedure for off-line instruments

The initial calibration should be based on data for at least 24 samples of product.

The samples should be subjected to instrumental analysis without delay. For instance, if the intended use of the instrument is to test meat samples in boning rooms, the samples should be prepared and tested within the time normally expected during routine operations in boning rooms. If the instrument is one that measures the moisture content of the samples, its performance can be evaluated against a reference method for estimating moisture; otherwise a reference method for determination of fat should be used.

It is likely that the sample for off-line analysis will have been minced or chopped finely in preparing it for the test instrument. If not, use a small mincer with a plate having 2 to 4 mm holes, or a food processor (Robot Coupe or similar) to twice comminute the sample, mixing it thoroughly after each pass. Obtain a representative sub-sample, weight approximately 500 g, by following either a coning and quartering technique or a grab-sampling one. It is recommended that duplicate or triplicate sub-samples be taken and sent for analysis so that a measure of the repeatability of the reference sampling and testing procedure is possible.

If possible, analyse the samples without delay. If that is not possible, carefully seal them in plastic bags of polythene or similar. If the samples cannot be tested within one working day of preparing them, freeze them and hold them frozen. When the frozen samples are thawed for testing, or when samples are held chilled overnight, check for any separation of weep from them. If there is any visible weep, thoroughly mix each sample to incorporate the weep throughout the sample. Avoid loss of any weep.

Analyse the samples, in duplicate or triplicate, for water content (preferably by oven drying for 16 h at 103°C) or for fat content (by exhaustive extraction with diethyl ether or similar solvent according to one of the procedures listed in 'Reference documents' below).

Calculate the water content as a percentage; or calculate the fat content and calculate the CL as a percentage by subtracting the percentage fat content from 100.

Analyse the relationships between the output values from the instrument being calibrated and the reference values for CL or moisture content using a suitable statistical package. Packages that generate regression equations and measures of their 'goodness-of-fit to the data are suitable. Statistics that can be generated from recent versions of Microsoft Excel may be adequate. Those from a dedicated package such as Minitab are preferable.

For off-line procedures the application for approval should refer to recognised procedures for obtaining representative samples from cartons or other containers. For instruments that measure moisture content the application should refer to the nominated relationship between water content and CL and the publication describing that relationship.

## Reference documents

AOAC 39.1.02B: 2002, Meat and meat products—moisture in meat- air drying
AOAC 39.1.05: 2002, Meat and meat products—fat (crude) or ether extract in meat
AOAC 39.1.06: 2002, Meat and meat products—fat (crude) in meat; rapid
AOAC 39.1.05: 2002, Meat and meat products—fat (crude) or ether extract in meat
ISO 1442: 1997, Meat and meat products—Determination of moisture content (Reference method)
ISO 1443; 1973 Meat and meat products—Determination of total fat content
ISO 3100-1:1991 Meat and meat products—sampling and preparation of test samples. Part 1 Sampling
ISO 5725-1: 1994 Accuracy (trueness and precision) of measurement methods and results—Part 1 General principles and definitions
Meat Research Corporation, and Australian Meat Technology 1997. Sampling of cartoned meat and preparation for chemical lean determination.
Nordic Committee on Food Analysis (NMKL) 131: 1989 Fat determination according to SBR (Schmid-Bondzynski-Ratslaff) in meat and meat products

# Appendix 1

## Outline of AUS-MEAT Approval Process

Information in these guidelines is provided to assist equipment manufacturers and other interested parties to understand the process for submitting equipment for approval by AUS-MEAT. It should be noted that AUS-MEAT reserves the right to vary its procedures, or seek such information (as it deems necessary at the time), to ensure the accuracy of equipment to be used to measure elements of the Australian Meat Industry Classification System (AUS-MEAT Language) is maintained. Further information can be obtained by contacting AUS-MEAT on 07 3361 9200 or by visiting the website at www.ausmeat.com.au

Determinations on AUS-MEAT equipment approvals are made by the Australian Meat Industry Language and Standards Committee. The Committee takes into consideration the accuracy, repeatability and reproducibility of the equipment; and its ability to be easily calibrated and checked for accuracy during day-to-day use. Other factors in which the Committee may be interested are the safety of the equipment, and whether it has been manufactured in accordance with principles of sanitary design that are acceptable to relevant authorities in relation to cleaning, etc.

An AUS-MEAT equipment approval is normally sought by, and awarded to, the manufacturer of, or distribution agent for, the equipment. AUS-MEAT approval is normally for a specific brand, model and process application.

The applicant will normally be asked by AUS-MEAT to provide a detailed written plan for a trial to prove that the process is accurate. The trial design will depend on the equipment and its intended application, but should address the accuracy and repeatability of the test unit and reproducibility between separate units. This may entail the generation of test data in separate establishments for two different, but identical, units. In some cases the trial will be best conducted by third party contractors who are recognised as having expertise.

The trial design is normally agreed with AUS-MEAT before it can proceed. The trials should normally include internal audits for adherence to the trial protocol, but AUS-MEAT also reserves the right to conduct external audits.

The results of the trial submitted to AUS-MEAT should normally include the raw data and a competent statistical analysis. AUS-MEAT may require that the results be evaluated by an independent statistician nominated by AUS-MEAT Limited. Submissions should usually include the associated manual for the equipment, and the suggested QA procedures that will be used within enterprises to calibrate the equipment, and to confirm the accuracy of the results.

Where the equipment is used elsewhere in the world and has previously undergone trials, those results can be submitted as 'confirmatory data'.

Information required by AUS-MEAT includes, but is not limited to:

*Expression of intent to submit application*

1. Manufacturer/distributor
2. Nominated contact person and contact details
3. Brand, model
4. Principle of operation of equipment
5. Description of intended method of operation for estimation of CL and use of the information
6. Trial design in sufficient detail for AUS-MEAT to determine whether the intended evaluation is likely to generate appropriate data

*Formal application*

7. Results of the evaluation in a format that will permit an independent statistician to give an opinion on the performance of the equipment for the stated intended purpose
8. Other information from the trial that may assist the Committee makes its determination.

## AUS-MEAT minimum performance criteria

Performance criteria may be found at www.ausmeat.com.au



# Contact us for additional information

Meat Industry Services is supported by the Australian Meat Processor Corporation (AMPC) and Meat & Livestock Australia (MLA).

**Brisbane:**
Food Science Australia
PO Box 3312
Tingalpa DC QLD 4173

Ian Eustace
**T** +61 7 3214 2117
**F** +61 7 3214 2103
**M** 0414 336 724

Neil McPhail
**T** +61 7 3214 2119
**F** +61 7 3214 2103
**M** 0414 336 907

**Sydney:**
Bill Spooncer
PO Box 181
KURMOND NSW 2757

**T** +61 2 4567 7952
**F** +61 2 4567 8952
**M** 0414 648 387

**Adelaide:**
Chris Sentance
PO Box 178
FLAGSTAFF HILL SA 5159

**T** +61 8 8370 7466
**F** +61 8 8370 7566
**M** 0419 944 022