

## 11.1 Introduction

Animal milk recording is a basic prerequisite for herd/flock management purposes as it is also the basic element of herd improvement and breeding programs. To measure milk yield of animals many kinds of milk recording devices have been developed in the past.

Since 1984 ICAR has developed rules, standards and recommendations for testing, approval and periodic checking of milk recording devices. In this Section 11 standards for milk recording devices are described for cows, buffaloes, goats and sheep.

This section is a part of the International Agreement of Recording Practices of ICAR (Point 14 of the Agreement).

## 11.2 Definitions

A milk recording device has the function to:

Measure the milk yield per individual milking of an animal (whole udder or per quarter).

Provide a representative sample of this milk or perform an on-farm analysis of the milk on relevant parameters (at least fat and protein content).

without significantly affecting the normal milking procedure and the quality of the harvested milk.

Measuring principles in general are based on weighing principles or direct or indirect measuring of volume by volumetric principles or others like infrared principles. In most cases a milk recording device consists of a milk meter and a more or less integrated sampler. In some cases the sampler is a separate device more or less independent from the milk recording device. In all cases the approval is given to the milk recording system (device), meaning the combination of milk meter and sampler or the combination of milk meter and milk analyser.

Milk analysers in combination with milk meters can measure milk flow and milk components (for instance fat, protein, lactose and somatic cells) . Data generated by these devices can be used in daily management and in official milk recording. Other parameters which can be measured by the same equipment are for example measuring blood in milk, urea, hormones and so on. Such parameters are more related with farm management.

On farm analysers for the relevant parameters in the milk can be divided in:

In line analyser. An in line analyser is installed in the milk pipeline and performs the analysis during the milking process (real time) or at the end in a representative aliquot of the whole milking

At line analyser. An at line analyser is installed besides the production line and is used to analyse a representative sample of the whole milking. These devices are likely to be located near the milking unit but not exclusively.

In this document the term 'milk analyser' refers to an in line analyser only.

Note: Any combination of milk meter and sampler or milk analyser must be tested to achieve an ICAR approval.

Reference is made to standards for milking equipment. These standards are:

ISO 3918 Milking Machine Installations. Terms and definitions.

ISO 5707 Milking Machine Installations. Construction and performance.

ISO 6690 Milking Machine Installations. Mechanical testing.

ISO 20966 Automatic Milking Installations - Requirements and testing.

IDF Bulletin 265: Determination of FFA in milk and milk products.

ICAR Guidelines on On-farm Milk Analysis (under construction)

The following abbreviations are used in this document:

MRDs for a Milk Recording Device including a sampler

MRDa for a Milk Recording Device including a milk analyser

### **1 1.3 Requirements for milk recording devices and systems**

For the purposes of official milk recording only devices are valid which meet the definitions of ISO 3918. Milk recording devices are to be designed to operate under the normal conditions of machine milking as defined in ISO 5707 and ISO 20966. Materials used in the manufacturing of milk recording devices must comply with the requirements of ISO 5707 / 20966 and the legal provisions in the country of a member organization. Manufacturers shall specify the precise conditions under which a recording device is designed to operate properly within the scope of this guideline and provide written operating instructions.

The milk recording device should have a measuring and sampling capacity for a milk yield of at least:

40 kg for cattle.

15 kg for buffalo.

6 kg for goats.

3 kg for sheep.

### 11.3.1. Reading scale

The graduated scale of a jar or tube must be permanently fixed to the wall in a suitable dark color to contrast with the milk to be measured. It is required that the measuring tube of portable meters can be easily checked for verticality at reading (for example by continuous lines encircling the tube at 5 kg intervals).

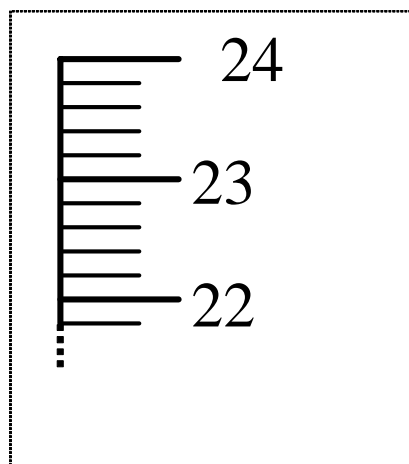
**Note.** In case of removable measuring tubes: only the approved type of tube may be used for recording.

The unit of measurement is mentioned in table 11.1 The scale shall consist of a vertical line of 1 mm wide the full height of the scale with horizontal lines to one side of the vertical line. The numerical value of each kilogram interval shall be indicated in figures of 5 mm minimum height, at the far end of the horizontal line mid-way down the line. Primary intervals shall be indicated by lines of 15 mm length and 0.5 to 1.0 mm thickness; secondary interval shall be indicated by lines of 10 mm length and 0.25 to 0.5 mm thickness. An example of the measuring scale is given in figure 11.1.

The graduations of the scale and the minimal scale representation (length of scale representing 1 kg milk) differ per animal species and shall be as reported in table 11.1.

*Table 11.1 Units of measurement for all species.*

Species	Interval	Minimal scale representation
Cattle	primary : 1.0 kg secondary: 0.2 kg	10 mm / kg
Buffalo	primary : 1.0 kg secondary: 0.2 kg	25 mm / kg
Goat & sheep	primary : 1.0 kg secondary: 0.1 kg	40 mm / kg or liter



*Figure 11.1 Example of a measuring scale for milk yield*

### 11.3.2. Yield display

In systems where the meter is connected to a computer system, and this device is used for official milk recording, a print or electronic file must be available. The file must include cow ID, amount of milk, time of milking and the position where the cow was milked. The printout or file must contain every milking on recording day. In case a display is used, it shall consist of easily legible figures at least 5mm in height, which can be read at any level of ambient light. The display shall indicate the milk yield in kilograms with increments depending on the species:

For cows and buffalos increments of no more than 0.2 kg; for preference increments of 0.1 kg.

For sheep and goat increments of no more than 0.1 kg; for preference increments of 0.05 kg.

### 11.3.3. Sampling

The sample shall be:

Representative for all the milk collected during that milking.

Sufficient amount for analyzing the milk composition.

A minimum volume of 25 ml shall be taken at the minimum recordable milk yield depending on the species: 2 kg for cattle and buffaloes and 0.3 kg for goat and sheep.

*Note. The sufficient amount for analyzing is depending on the country and varies between 25 ml and 50 ml. In cases samples of evening and morning milking are combined, 25 ml sample per milking is sufficient in all countries. When evening and morning milking are separately analyzed, in some countries a higher amount of sample can be prescribed.*

The sampler shall be easily accessible, sampling tubes or bottles (when used) shall be easy to place and remove. In parlors where jars are mounted below the cow standing level, consideration shall be given to the means of sampling. If sampling is to be done directly from a tap at the base of the jar, then:

The distance from the base of the tap nozzle to the operator's floor should be no less than 0.2 meters.

The operational conditions must comply with local and/or national health and safety requirements.

The tap shall be so located and or constructed that contamination of the air flow used for mixing the milk is avoided.

Where milk sampling is done by a remote sampling device, then it shall be designed and constructed so that:

The operational conditions must comply with local and/or national health and safety requirements.

It can be included in the washing circuit.

Carry-over of milk between animals is prevented (to be proven in a test procedure)

### **11.3.4. Jars**

Materials, construction and installation of a milk recording jar shall comply with the requirements of ISO 5707. The jars shall be installed so that the yield can be easily read and a sample can be taken without a risk for personal injury e.g. from animal kicks or trapping by moving parts of the installation. Recording jars shall be installed so that the distance between the operator's floor and the bottom of the graduated scale shall not exceed 1.60 m.

The milk release mechanism from the recording jar shall be milk tight and shall prevent milk from passing between the jar and the transfer pipe in either direction except when milk is deliberately released. The mechanism shall be as close to the jar as is practical. Where air admission is used as the means of mixing milk, then the air admission hole shall be adjacent to the milk release mechanism to eliminate the risk of some milk not being mixed with the bulk of the milk from the current animal.

### **11.3.5. Milk meters**

A milk meter shall be designed to permit easy reading and handling by the operator while it is attached to the milking equipment. In addition, it shall be resistant to all conditions encountered in its normal working environment (i.e. during milk measuring and sampling, washing, disinfecting and, when applicable, transport). All parts subject to wear and tear shall be easily replaceable. The conditions for assembling of electronic milk meters are given by the manufacturer of the meter. If a milk meter is fitted with a calibration device or calibration option, adequate precautions shall be taken to prevent unauthorized alteration of settings.

### **11.3.6. In-line milk analyser**

The milk analyser shall:

- Give a value for fat and protein, representative for all the milk collected during that milking

- Not effect the milk in any way

A milk analyser shall be designed to permit easy reading and handling by the operator while it is attached to the milking equipment. In addition, it shall be resistant to all conditions encountered in its normal working environment (i.e. during milking, washing, disinfecting and, when applicable, transport). All parts subject to wear and tear shall be easily replaceable. The conditions for assembling of milk analysers are given by the manufacturer of the device. If a milk analysers is fitted with a calibration device or calibration option, adequate precautions shall be taken to prevent unauthorized alteration of settings.

A milk analyser shall at least analyse fat and protein content, or as the total amount in that milking or as percentage of the milk. Other parameters as lactose, urea and somatic cells are

not obliged, but could be a part of the approval test on request of the manufacturer. In that case they have to fulfil the requirements also.

Note. Next to the parameters mentioned above, also parameters as for instance conductivity, blood and progesterone can be measured in milk. As for these parameters no accuracy limits are yet set, they are not a part of the requirements for milk recording devices.

Milk analysers can be used for different types of milk (cow, buffalo, goat, sheep). The requirements are (in first instance) based on cow milk. For other species the milk analysers have to fulfil the same requirements until specific requirements are set per species.

### 11.3.7. Limits of error for milk yield and milk composition

The limits of error for both milk yield and fat percentage (in case of a milk recording device with sampling) are presented in table 11.2 both for recording on the test day and daily recording of milk production. Moreover bias and standard deviation shall have an uniform distribution over the range of measured values using a test for homoscedasticity or heteroscedasticity. In case of daily recording of milk production, the milk production should be the average of at least 5 days.

*Table 11.2a. Limits of error for milk yield and fat percentage per species for milk recording devices with a sampler (both test day recording and daily recording)*

Species	Milk yield			Fat percentage		
	Range	Standard deviation <sup>1</sup>	Bias <sup>2</sup>	Range	Standard deviation	Bias
Cattle	2 - 10 kg	0.50kg	0.2 kg	2 – 7 %	0.10 % fat	0.05 % fat
	> 10 kg	5 %	2 %			
Buffalo	1 - 6 kg	0.30 kg	0.12 kg	3 – 15 %	0.30 % fat	0.10 % fat
	> 6 kg	5 %	2 %			
Goat and Sheep	0.3 - 0.8 kg > 0.8 kg	0.04kg 5 %	0.025 kg 3 %	2 – 12 %	0.20 % fat	0.10 % fat

<sup>1</sup>In kg or in percentage of mean reference yield.

<sup>2</sup>In kg or in percentage of the reference yield.

In case of a milk recording device with a milk analyzer, the requirements for milk yield as given in table 11.2a apply also for these devices.

The requirements for milk composition are given in table 11.2b for the compulsory elements fat and protein and in table 11.2c, for the elements which are not obliged. An approval for these elements can be achieved on request of the manufacturer.

The requirements in table 11.b and 11.2c are based on the ICAR-guidelines for On-farm Analysis

Table 11.2b. The accuracy limits for on-farm milk analyzers in milk recording for fat and protein (compulsory elements for approval of milk analyzers)

Accuracy	range	standard deviation	bias
Fat	2.0-6.0 g/100g	0.25 g/100g	0.13 g/100g
	5.0-14.0 g/100g	0.25 g/100g	0.25 g/100g
Protein	2.5-4.5 g/100g	0.25 g/100g	0.13 g/100g
	4.0-. /0 g/100g	0.25 g/100g	0.25 g/100g

Table 11.2c. The accuracy limits for on-farm milk analyzers in milk recording for lactose, urea and SCC (non-compulsory elements for approval of milk analyzers)

Accuracy	range	standard deviation	bias
Lactose	4.0-5.5 g/100g	0.25 g/100g	0.13 g/100g
Urea	10 – 7- mg/100g	15.0 mg/100 g	3.0 mg/100 g
SCC	0-2000	25 %	13 %

### 11.3.8. Effects on milking and milk quality

A milk recording device including a sampler or milk analyser shall:

Have none or a limited effect on the teat end vacuum as stated in ISO 5707 and measured according ISO 6690;

Have none or a limited effect on Free Fatty Acids in the milk, measured according appendix 11.2, where is stated that the effect of the milk recording device on FFA shall be less than the effect of a reference milk recording device;

Have none or a limited effect on the bacteriological quality of the milk. The milk recording device shall not accumulate milk soil and/or bacteria, using the cleaning procedure described by the manufacturer.

### 11.3.9. Automatic milk recording systems

Automatic milk recording systems record milk yield and a) take samples of milk or b) perform milk analysis without human supervision or interference. Automatic sampling systems are well-known in automatic milking systems, but could also be used in milking parlors. Systems for automatic milk recording shall fulfil all the requirements as stated in section 11.3 to 11.3.7 and shall:

Deliver electronic data. The file must include cow ID, amount of milk, time of milking and the position where the cow was milked. The file must contain every milking during the recording period.

Have no mismatches of animal identification with milking time, milk production and sample identification / results of the milk analyser;

Have a success rate in reading animal identification of at least 98 % (and must have the technical capability of 100% correct identification at recording);

Indicate if a milking is a complete milking (at least 80 % of the expected milk yield is collected) ;

Take samples each time an animal is milked and take care that samples are properly treated and/or stored to ensure the quality of the sample for analyses or perform milk analysis each time an animal is milked

Have a capacity to record and sample all the animal milkings within the intended sampling period;

Have a rate of sampling / milk analysing to ensure no or minimal delay of the milking of the next animal;

In case of sampling: the sampling unit shall meet with ergonomic demands (weight, construction, connectivity, accessibility of critical places, portability).

## 11.4 Procedures for approval

Only records from milk recording devices, including samples or milk analysers, approved by ICAR are accepted for official milk recording. A new milk recording device, milk recording system produced by a manufacturer or any other third party can be used for official milk recording only after it has been approved as defined in this Section 11. Member organizations can only approve the use of milk recording devices first approved by ICAR.

The following exceptions apply:

Cattle: Meters in use before 1 January 1992 that have been previously accepted by the ICAR member organization, can be used after this date.

Buffalo: Meters in use before 1 January 1997 that have been accepted by the ICAR member organization, can be used after this date.

Sheep and goats: Meters in use before 1 January 1995 that have been accepted by the ICAR member organization, can be used after this date.

### 11.4.1 Role of ICAR and the Test Centres

The bodies of ICAR involved in approval of milk recording devices are:

Secretary General of ICAR on behalf of ICAR Board.

Sub-Committee for Recording Devices.

Service-ICAR. ICAR has established Service-ICAR s.r.l. (a 100 % daughter of ICAR) to deal with the contractual and financial transactions between manufacturers, test centers and ICAR.

Test Centers. The approval tests are carried out by the ICAR approved test centers in different countries (See Appendix 11.1).

The procedure for an approval looks like follows:

1. The manufacturer or any other interested party must send a formal test application to ICAR / Service-ICAR secretariat by filling the related application form available on the ICAR website: [www.icar.org/pages/ICAR\\_approvals/RD\\_application\\_for\\_testing.htm](http://www.icar.org/pages/ICAR_approvals/RD_application_for_testing.htm).
2. Service-ICAR will consult the Chairman of the Sub-Committee for Recording Devices to establish the test procedure and select the test centre to perform the test.
3. The test centre prepares the test protocol describing the test procedure, time schedule and test budget. Service-ICAR will then issue the formal contracts both with the manufacturer/test applicant and the selected test centre.
4. The applicant of the test is obliged to pay Service-ICAR the fee for the test before the ICAR test starts.
5. The test centre conducts all the necessary test procedures, analyses the results and submits a confidential test report to Service-ICAR which sends a copy of the report to the test applicant and a copy to each member of the Sub-Committee for their comments and/or endorsements to the Chairman.
6. Within a month the Chairman will inform ICAR / Service-ICAR secretariat of the Sub-Committee's approval or non-approval of the device.
7. The Secretary General of ICAR will sign the ICAR approval letter and the accompanied approval certificate which are sent to the test applicant without delay..

## 11.4.2 Submission for approval

When a new milk recording device is to be submitted for an approval test, the test applicant must provide to Service-ICAR a list of devices with serial numbers, from which the required number of test devices can be randomly selected by the test centre. The number of serial numbers and devices to choose from and to be chosen, differs per species and type of milk recording device, see table 11.3a and 11.3b.

*Table 11.3a. Number of milk recording devices with samplers needed for an approval test.*

Species	Cattle	Buffalo	Goat and/or sheep
# on list with serial numbers	50	30	30
# of devices for laboratory test	2	2	2
# of devices for field test	8	8	4 / species
# of farms for the field test	2	2	1 / species
# of reserve devices	1 (optional)	1 (optional)	1 (optional)

In case of milk recording devices with a milk analyser, from a list of 50 serial numbers 2 devices will be chosen for the laboratory test and 6 devices for the field test, from which 4 devices will be installed in a milking parlor and two devices in automatic milking systems (robot), see table 11.3b.

Table 11.3b. Number of milk recording devices with milk analysers needed for an approval test

	laboratory	parlor	robot
# on list with serial numbers	50	50	50
# of devices for laboratory test	2		
# of devices for field test		4	2
# of farms for the field test		1	1
# of reserve devices		1 (optional)	

In case of permanently installed devices, they can be selected from already installed devices on two farms. In case of milk recording devices intended for both goat and sheep, 4 devices shall be installed on a goat farm and 4 devices (all out of the same batch), on a sheep farm. The use of a reserve device is optional. In case of a problem with a device the reserve meter can replace the faulty device (See 11.5.2.3). Results of the reserve meter are excluded from the final analysis if not needed as replacement. In case of automatic milk recording systems, a selection will be made out of 10 units by the test centre (See 11.4.4);

An operating manual of the device.

A calibration test procedure to test the device annually in the field (see 11.6.2). The validity of this procedure will be tested during the field test. It is preferred that this procedure can be conducted without milking cows; for instance by a test with water or whatever method is appropriate. The method

for testing has to be provided by the manufacturer, the test centre tests for validity and reproducibility of the proposed testing method.

The manufacturer/test applicant is responsible for the correct installation and calibration of the devices in the laboratory and on the farms. After installation the test centre will conduct the tests without representatives of the manufacturer/test applicant present.

### **11.4.3 Modified milk recording devices**

If approved milk recording devices are modified in hardware and/or software, influencing the measurement or the testing routine, the manufacturer is responsible to report the modification(s) to the Chairman of the Sub-Committee for Recording Devices. He will consult the test centre responsible for the original approval test. Based on the information gathered the Chairman of the Sub-Committee for Recording Devices will present to the manufacturer the plan of the required retest, if any, that has to be done to give an ICAR approval for the device modification. The manufacturer reports the device modification to ICAR on the normal test application form and in case a retest is required it is contractually then managed by Service-ICAR as done with the full tests.

### **11.4.4 Automatic milk recording systems**

An automatic milk recording system is a combination of automatic recording of milk production and automatic sampling / automatic milk analyses. In most cases the recording of milk production and automatic milk analyses is performed on daily basis and the automatic sampling is performed on the test day only. In case the automatic sampling system is combined with more types of milking systems and/or more types of milk meters, each combination has to be tested for approval.

The test procedure for approval of milk recording devices is adjusted to the situation with automatic milk recording systems on the following points:

In case the milk meter used in automatic milk recording is of an already approved type, the laboratory test is omitted.

The test will be carried out by testing 2 out of a series of at least 10 milk recording/sampling devices. Both devices should be tested in two milk recorded herds. The farms will be chosen by the ICAR test centre from a list of farms given by the manufacturer/test applicant or dealer.

In the case of automatic (voluntarily) milking systems, the device tests will be carried out as part of the normal daily milking routine of the chosen farms.

For each test herd, at least 50 valid recordings will be taken (milk yield + samples) from no less than 40 animals.

All readings will be checked for correct identification and combination of animal identification, milking time and milk production.

The test will check that correct identification of sample bottles can be maintained even in case the sampling procedure fails due to mechanical or software problems.

The manufacturer/test applicant provides the test centre with a user manual of the sampling device and gives instructions about handling of the sampling system (connection with the milking system, power-supply, tubes etc.). This user manual will be an integral part of the ICAR test. Following the user manual; the test centre connects the sampling system to the milking system and carries out the test procedure. The user manual must also give instructions to check the correct functionality and temperature of the sampling device.

## **11.5 Approval test**

A full device approval test has two main elements, the laboratory test and the field test.

### **11.5.1 Laboratory test**

The objective of this test is to evaluate the device under several field conditions in order to assure that the device will give sufficient results. Therefore in the laboratory test the performance of the milk recording device is measured under different circumstances of flow rate, vacuum level, air bleed and tilting. Also the influence of the milk recording device on FFA and claw vacuum level is recorded. Two devices have to be available for testing and depending on the test one or both devices are tested.

A test rig is used, consisting of an artificial udder and a standard cluster (see ISO 6690), a pulsation system and a vacuum level and air inlet in the cluster which can be set to the test demands.

#### **Test solution**

It is preferred that water, with an additive (salt or acid) to increase the conductivity as given by the manufacturer (mS/cm), is used instead of milk. However, depending on the measuring principle, it can be necessary to use fresh milk or artificial milk, as indicated by the manufacturer. In case of artificial milk the manufacturer is obliged to provide the artificial milk. In case water or artificial milk is used and the measurement principle of the milk meter is volumetric, a compensation for density should be calculated, based on the assumed density of milk of 1.030 for cows, 1.032 for goat and 1.036 for buffalos and sheep. For reference quantity the fluid is weighed with an accuracy of 0.01 kg for cattle and buffalo and 0.005 kg for goat and sheep.

For a number of tests (f.i. influence of free fatty acids) the use of fresh milk, direct from a milking installation, is necessary. The milk shall be kept on a temperature of  $30 \pm 2$  °C until used in the tests. The milk shall be of healthy animals and shall have a normal composition.

#### **Test conditions**

The minimum time per test shall be at least 2 minutes for each flow rate. The device is tested at the vacuum level recommended by the manufacturer or, when no vacuum level is recommended, by the intermediate vacuum level used in the test for influence of vacuum level (40 kPa for cattle and buffalo, 38 kPa for sheep and goat). A tolerance in the vacuum level of  $\pm 0.5$  kPa is acceptable. The air bleed in the cluster shall be 10 l free air/min for cattle and buffalo and 6 l free air/min for goat and sheep.

The device shall be mounted in a height relative to the cluster as is recommended by the manufacturer. The outlet of the milk recording device to the bucket or jar, used for reference, shall be mounted comparable to field circumstances. In any case blockage of the outlet must be avoided.

The following tests are performed:

#### **11.5.1.1. Influence of flow rate on accuracy and sampling**

Both devices are tested, with at least 20 measurements per device and, at least 3 measurements per flow rate. The different flow rates for testing are depending on species:

Cattle : 1.0, 2.0, 3.0, 6.0, 9.0 and 12.0 kg/min

Buffalo: 0.3, 0.6, 1.2, 2.5, 4.0 and 6.0 kg/min

Goat and sheep: 0.3, 0.6, 1.2, 2.0, 3.0 and 5.0 kg/min

Deviation (milk meter – reference, milk analyser - reference) and/or sample percentage are plotted against flow rate.

The milk meter should work properly for flow rates up to 9.0 kg for cattle, 4.0 kg/min for buffalo and 3.0 kg for goat and sheep; at higher flow rates the meter should still work. Properly in this regard means that repeatability and correlation are such that the device will give sufficient results under field conditions.

#### **11.5.1.2. Influence of vacuum level on accuracy and sampling**

One device is tested using the flow rates and number of repetitions mentioned in 11.5.1.1. at different vacuum levels depending on species:

Cattle and buffalo: 30, 40 and 50 kPa

Goat and sheep: 30, 38 and 45 kPa

Deviation (milk meter - reference) and sample percentage shall be plotted against flow rate and vacuum level.

Note. In case of testing a MRDa, this test on sample percentage is only needed when sampling is a part of the procedure (i.e. differed time analysis).

Note. If the test in 11.5.1.1 is performed at one of the vacuum levels stated in 11.5.1.2, the results of 11.5.1.1 can also be used for this test.

#### **11.5.1.3. Influence of air bleed**

One device is tested at one of the vacuum levels as stated in 11.5.1 with different air bleeds and a flow rate depending on species (See table 11.4)

*Table 11.4. Flow rate and air bleeds to be tested for influence of air bleed.*

Species	Flow rate (kg/min)	Air bleeds (l free air/min)
Cattle	5	0, 4, 12, 20, 30
Buffalo	2.5	0, 4, 12, 20, 30
Goat and sheep	2	0, 4, 8, 16, 30

Per air bleed at least 3 repetitions should be made. The deviation (milk meter – reference) and /or sample percentage shall be plotted against air bleed.

Note. In case of testing a MRDa, the test on sample percentage is only needed when sampling is a part of the procedure (i.e. differed time analysis).

#### **11.5.1.4. Influence of tilting the device**

One device is tested at the recommended vacuum level and standard air bleed at a flow rate depending on species and at inclinations as mentioned in table 11.5.

*Table 11.5. Flow rate and inclination to be tested for influence of tilting.*

Species	Flow rate (kg/min)	Positions
Cattle	5	Horizontal, 5 degrees to left, right, front and back
Buffalo	2.5	Horizontal, 5 degrees to left, right, front and back
Goat and sheep	2	Horizontal, 5 degrees to left, right, front and back

Per position air at least 3 repetitions should be made. The deviation (milk meter – reference, and sample percentage shall be plotted against position.

Note. In case of testing a MRDa, this test on sample percentage is only needed when sampling is a part of the procedure (i.e. differed time analysis).

#### **11.5.1.5. Effect of the milk recording device on teat end vacuum**

Milk recording devices shall meet the standards described in ISO 5707. The devices shall be tested by comparing the vacuum in the cluster with and without the milk recording device according to ISO 5707 and ISO 6690. However, if the manufacturer specifies a particular type of cluster assembly for use with the milk meter, then that type shall be used.

#### **11.5.1.6. Effect of the milk recording device on free fatty acids**

The effect of the milk recording device on FFA during the test (without milk sampling device or with sampling device when this is an integral part of the milk meter) shall not be more than

the effect of the reference milk meter (see Appendix 11.2). The test procedure is described in Appendix 11.2.

#### **11.5.1.7. Evaluation of method for Calibration Test**

The method of calibration testing, as given by the manufacturer, will be tested on two milk meters including the milk analysers when appropriate and evaluated for use in the field.

#### **11.5.1.8. Evaluation of cleaning properties**

A technical evaluation of the cleaning properties of the milk recording device (MRDs or MRDa) will be performed. The evaluation shall give information about:

- Design of the internal and external parts of the device (e.g. lack of dead ends, unreachable parts for cleaning fluid etc.).

- sufficient turbulence during cleaning of the milk recording device (device in cleaning mode).

- special needs for cleaning (e.g. extra cleaning fluid).

### **11.5.2 Field test**

Field tests have to be carried out to assess the performance of the milk recording device (MRDs and MRDa) under field conditions. These tests are to be carried out under normal milking conditions on farms with a, for the breed and country, representative level of production and a normal distribution of milk quantities, flow rates and fat percentages.

It is known that milking machine characteristics and milk flow rate have major effects on the accuracy of milk recording devices with samplers and milk analysers. The milking installations on the farms where the tests are conducted have to comply with ISO 5707.

#### **11.5.2.1. Test procedure**

Milk quantity given by the milk meters is compared with the milk quantity of the reference. For reference the whole amount of milk produced during the milking of a given animal is collected in a suitable bucket and the weight of that milk is measured using a scale with an accuracy of +/-0.02 kg for cows and buffalos and +/- 0.01 kg for goat and sheep. The amount of reference milk is corrected for the amount of samples taken for analysis of fat percentage.

In case of a MRDs duplicate samples are taken from the milk collected in the bucket (reference) and duplicate samples are taken from the milk collected by the sampler. In all cases milk in the bucket and sampler has to be mixed thoroughly before taken samples. When for any observation no duplicate sample is available (it is not possible to take two samples), this sample should be analyzed twice if possible and the results will be treated as duplicates. Samples are analyzed for fat percentage by an accredited laboratory.

In case of a MRDa, the results of the milk analyser are compared with the reference samples.

As flow rate could influence the accuracy for yield, sampling and milk components, it is advised to record average and maximum flow rate of each milking (or at least machine on time). These data could be used in the statistical analyses and the results could replace a part of the laboratory test (see 11.5.1.1).

In each test run at least 40 readings per device has to be done. If necessary, such a farm test may take one or more consecutive days. Valid readings have minimum and maximum values for quantity and fat percentage, depending on species, as specified in table 11.6.

*Table 11.6. Valid reading in the field test per species (minimum and maximum).*

Species	Milk production (reference)	Fat percentage (reference)	Protein percentage (reference) *)
Cattle	2 – 40 kg	2 – 7 %	2,5 - 5 %
Buffalo	1 – 15 kg	3 – 15 %	3 - 8 %
Goat	0.3 – 6 kg	2 – 8 %	3 - 7 %
Sheep	0.3 – 6 kg	2 - 12%	3 – 8 %

\*) Protein content is only needed for milk analysers

### **11.5.2.2. Cleaning and disinfection**

Tests of effectiveness of cleaning and disinfecting of the milk recording devices shall be carried out during the farm tests on all the devices under test by a visual inspection. In case of residues found, additional information shall be gathered from bulk milk quality and/or ATP measurements. With the ATP method, swabs will be taken on parts of the device where cleaning and disinfecting could be ineffective (or less effective than expected), e.g. on the top of the meter, in different chambers, in samplers or tubes.

The milk meter has passed the test if:

There are no visible residues on milk contact surfaces.

Bulk milk quality and/or ATP show no raise in number of bacteria/ATP levels.

### **11.5.2.3. Faulty device in test**

In case one milk recording device fails due to poor calibration or technical defect where the other devices pass the test, then:

The test centre may decide to replace the faulty device with the reserve device and have it installed and tested, or

The test centre may ask the manufacturer to repair and/or calibrate the device and then retest that device.

In the report to ICAR it will be stated which milk recording device is replaced or retested and why.

#### **11.5.2.4. Handling and operation**

In case relevant handling or operational problems occur in the first test run, the manufacturer shall be informed and allowed to solve the problem before the second run, without in any way affecting the accuracy of the milk recording device (MRDs or MRDAs). Any remarks about handling and operation of the milk recording device in the field, made by the people involved in testing (including the farmers), should be noted in the report, also the problems which are solved during the test period.

#### **11.5.3 Analysis (statistical)**

A software program performing the statistical analysis, graphics and conclusions is available for each species. The software is owned by ICAR and has been made available to the ICAR test centers.

All milk recording devices in test must fulfil both the standards for bias and standard deviation of accuracy for milk yield and fat content (See table 11.2). If the reference values for yield or fat percentage are outside the limits for valid readings (Table 11.6), these readings for yield or fat percentage will not be used in the analyses. If the values of duplicate samples for fat percentage differ with more than 0.10% these readings should be omitted. The average of the duplicates of the reference and of the milk recording device is calculated and used in the analyses.

The difference between the reference and the milk recording device is calculated for yield and for fat percentage and the difference is compared with the reference value. Even the extreme results for differences between reference and milk recording device should be used in calculations, unless there is a reason to assume an error has been made or the milk recording device has been broken. There shall be no fewer than 35 readings left for one milk recording device for both yield and fat percentage; otherwise a retest of that milk recording device will be necessary.

Statistical treatment is done to find out if outlier data exist in the remaining data and in what way the data may modify the assessment of the bias related to the milk recording device. The standards for bias should be fulfilled both with and without outlier data. The standards for reproducibility should be fulfilled with all data.

Both bias and reproducibility are also tested for homoscedasticity. There is homoscedasticity if the residuals of the regression of the differences between milk recording device yields and reference yields on these reference yields are identically and independently distributed. Homoscedasticity is tested by a chi-2 test that compares the matrix of variance covariance of the estimators of the coefficients of regression obtained under the assumption of heteroscedasticity, with the same matrix obtained under the assumption of homoscedasticity.

First, homoscedasticity of the residuals of the regression is tested. If there is homoscedasticity of the residuals, the current rule concerning calculation of the standard deviation of reproducibility and the conditions of acceptability of a milk recording device are maintained (See below paragraphs 11.5.3.1 and 11.5.3.2).

If homoscedasticity is not proven by the specific test it means that there is heteroscedasticity. Then the variance of residuals is not similar according to different classes of results and test of the standard deviation of reproducibility is done per class of reference yield for each milk recording device. Classes for yield and fat content are depending on the species. In each class a standard deviation of reproducibility is calculated and compared to a threshold value that depends on the average of the reference yields for the class. For each class the current procedure done for all data is applied (See below paragraphs 11.5.3.1 and 11.5.3.2). If the standard deviation of reproducibility according to ICAR's requirements fails for one (or more) class, the milk recording device is rejected. The minimum number of measurements for a class of reference yield is fixed as 10. The statistical analysis is also described in the flow chart - see Annex Flow Chart Statistical Analysis for dairy cows.

### **11.5.3.1. Milk yield**

Estimate the correlation between these differences and the reference yields.

If the correlation is not significant ( $P > 0.05$ ), it is assumed that the bias of the milk recording device is independent of the yield. Use the mean difference between the reference and milk recording device yields as the bias of the milk recording device, and use the standard deviation of the differences as the reproducibility of the milk recording device.

If the correlation is significant ( $P < 0.05$ ), it is assumed that the bias of the milk recording device is dependent on the yield. Calculate the regression of the differences on the reference yields, and use the residual standard deviation about the regression line as the reproducibility of the milk recording device.

In both instances, plot the observed differences, the expected bias and the maximum acceptable bias against yield. If the expected bias falls outside the acceptable limits at any point within the range of observed reference yield the milk recording device is rejected.

### **11.5.3.2. Fat percentage (valid for testing samplers)**

Estimate the correlation between the difference and reference.

If the correlation is not significant ( $P > 0.05$ ), it is assumed that the bias of the milk recording device is independent of the fat content of the milk. Use the mean difference between the reference and milk recording device samples as the bias of the milk recording device. Use the standard deviation of the differences between the means for the reference samples and the means for the milk recording device samples as an estimate of the accuracy of the milk recording device.

If the correlation is significant ( $P < 0.05$ ), it is assumed that the bias of the milk recording device is dependent on the fat content of the milk. Calculate the regression of the differences between reference samples and milk recording device samples on the overall mean fat content at each observation, and use the residual standard deviation about the regression line as an estimate of reproducibility of the milk recording device.

In both instances, plot the observed differences, the expected bias and the maximum acceptable bias against the overall mean fat content for each observation. If the expected bias

lies outside the acceptable limits at any point within the range of observed fat contents the milk recording device is rejected.

### **11.5.3.3. Milk components (valid for milk analysers only)**

For all milk components in the approval test of a milk analyser, the data will be analysed according to the procedure described in 'Guidelines on on-farm milk analyses'.

Remark: in contrast to the 'Guidelines on on-farm milk analyses' the number of farms and readings do differ. In stead of 5 farms and 100 readings, in the procedure described in this document 2 farms (1 automatic milking system, 1 milking parlor) are used with respectively 2 and 4 devices. For each device 40 valid readings are needed, as is usual for testing the accuracy for yield. So, in total 240 readings will be used for analyses on milk components.

## **11.5.4 Approval of recording devices/systems**

The Test Centre will compile a test report which will be send to the chairman of the Sub-Committee for Recording Devices. The Sub-Committee will discuss the results and will advice the Board of ICAR regarding the approval status. Finally the Board of ICAR will endorse the approval of the recording device/system.

Following the notification of the approval of a milk recording device / system from ICAR to the member organizations and the manufacturer they must comply with the following conditions:

1. The manufacturer will tag all the ICAR approved devices supplied to the market with a non-removable ICAR issued label which contains the name of the manufacturer, name and unique serial number of the device, year of approval, species identification and ICAR logo.
2. The manufacturer will supply ICAR and its member organizations with the description of the calibration procedure of the device and the instructions on how to use the milk recording device (milk meter and sampler or milk analyser). This information will be made available by ICAR on the ICAR website at: *[www.icar.org/Documents/Rules\\_and\\_regulations/Guidelines/Periodic\\_checking\\_of\\_milk\\_recording\\_devices.pdf](http://www.icar.org/Documents/Rules_and_regulations/Guidelines/Periodic_checking_of_milk_recording_devices.pdf)*.
3. The manufacturer will provide the member organizations with all the relevant technical information on the device.
4. Once a year each manufacturer is responsible to give ICAR a report as defined in 11.5.4.1.
5. Once a year each member organization will give ICAR a report as defined in 11.5.4.2.

### **11.5.4.1 Manufacturer annual report on ICAR approved devices in market**

ICAR will once a year (in January) contact the manufacturers of ICAR approved milk recording devices, and ask them to confirm which of the ICAR approved device models, listed on the ICAR

website are still in production and sold in various countries and report of any possible hard- or software modification/s made on the approved devices since the previous year report.

The manufacturer will in particular be responsible to declare:

Names and models of ICAR approved devices manufactured that year.

Modification/s, if any, made on an approved device in own production.

Other companies with right to use/manufacture their device, and under which name.

If yes, responsible to report any modification/s done by the other company.

List of countries the devices are in market.

The manufacturer signs the document and sends it to ICAR secretariat in Rome within one month from the date of the ICAR letter.

#### **11.5.4.2 Member Organization report on satisfaction with devices in use**

ICAR will once a year (in spring period) contact each member organization and request a report on milk recording devices in use in their member herds. In particular the report should include the following information:

Names and models of ICAR approved devices currently in use.

Field reports, if any, on devices which since the previous year report have not met calibration requirements described in 11.6.2 and 11.6.3.

Copies of written member complaints to manufacturer/dealer about device problems on member farms.

#### **11.5.4.3 Annual analysis by SC Recording Devices**

The Sub-Committee for Recording Devices analyses the annual reports from the manufacturers and member organizations. In case of sufficient evidence of problems with a given device the Sub-Committee will communicate the evidence to the manufacturer for its response and action. The Sub-Committee may withdraw/suspend the device approval if the manufacturer in the given time has not solved the problem.

In case of withdrawal/suspension of a device approval ICAR will inform its member organizations that from a given date new installations with that device will no more be ICAR approved and thus, recording data no more considered as official.

In case the approval of a milk recording device is withdrawn/suspended the devices already in use before the date of the suspension/ withdrawal may however be used for official milk recording after that date.

### **11.6 Installation and calibration test**

All scales, balance beams and spring scales used as reference should be calibrated at the beginning of a test and the accuracy should be at least within 0.02 kg.

## 11.6.1 Installation test

After installing milk recording devices in a new parlor or an extended parlor the performance of the device has to be tested by means of an installation test. This test is carried out in agreement with the member organization and/or in collaboration with the technician of the manufacturer or an authorized dealer. The manufacturer or the dealer is responsible for the installation, calibration and testing of the devices before the acceptance test is carried out. Before the acceptance test the devices have to be numbered according the numbers of the places in the parlor.

An installation test for a milk recording device consists of a milking test and, depending on the prescriptions for calibration testing, of a parameter check for the calibration. Only if results of the installation test are within the limits for this test, the device may be used for official milk recording.

### 11.6.1.1. Milking test

The yield according to the milk meter is compared with the yield for the reference during actual milking of animals. The testing procedure consists of one or more steps, depending on the results:

#### **Step 1**

Record three test observations with the milk meter and the reference and calculate the difference between the milk meter and the reference. The calibration of the milk meter is considered correct if the average difference is less than or equal to 150 % of the limits for bias according to table 11.2 and the average difference of all the devices on the farm shall be less than or equal to 100% of the limits for bias according to table 11.2. No further observations are necessary.

#### **Step 2**

If the difference is exceeding the test limits, the milk recording device(s) involved shall be recalibrated, 3 new readings per device shall be done and the calculation and checking mentioned in step 1 shall be repeated.

#### **Step 3**

If the difference is still larger than 150% of the limits, 3 more readings shall be done and the average difference of six readings will be calculated. The calibration of the milk meter is considered correct if the average difference is less than or equal to 150% of the limits for bias according to table 11.2. If not, the milk meter is not acceptable and readjustment, repair or replacement has to be done by the manufacturer, after which the above procedure has to be repeated.

Note: In some situations the milk recording device needs more than three observations for a correct milking test. In this case the procedure as given by the manufacturer and approved by ICAR has to be used.

### **11.6.1.2. Reference test**

In case each device has an individual calibration factor, this factor will be recorded before the milking test following the procedure of the manufacturer and the results of the reference method will be stored following the instructions of the Member Organization. In case the device is adjusted during the milking test, the reference test has to be redone after adjustment.

## **11.6.2 Calibration tests of on farm installed milk recording devices**

The calibration test has to be carried out at least once a year due to maintenance reasons (tear and wear) according to the manufacturer's requirements. The calibration test also includes check on accuracy. Different procedures can be followed to do the calibration test regarding accuracy:

1. The milk recording device can be tested according the procedure for calibration testing given by the manufacturer. The testing procedure and the limits of error can be found in the manual of the manufacturer and on the ICAR-website. In case the recording device includes a milk analyser, the accuracy for analysing fat and protein content shall be part of the calibration test.
2. An electronic computerized milk recording device / system can be subjected to an automatic check of errors as part of a milk recording program (this procedure can be given by a manufacturer, member organization or software suppliers). The procedure must be approved by ICAR.
3. The procedures under 1) and 2) can be extended by comparing milk yield and fat percentage and protein percentage (in case of milk analysers) of the bulk tank with the results of the recording day. If differences exceed 5% an investigation is necessary and a check of milk recording devices in accordance with 11.6.1.2. (or some other suitable method) may have to be carried out.

## **11.6.3 Calibration test of portable milk recording devices**

The calibration test has to be carried out at least once a year. The milk recording device shall be tested according the procedure for calibration testing as set by the manufacturer or other approved procedures as described in 11.6.2. The testing procedure and the limits of error can be found in the manual of the manufacturer and on the ICAR-website.

## **11.7. Quality assurance and control**

The approval of milk recording devices as described in this Section 11 is focused on the technical performance of milk meters and samplers. The validity of the data is also dependent on the whole procedure of sampling, handling of samples, relating data to animals, both in automatic systems and human operated systems.

To ensure proper data, checks should be made on:

Combining animal identification with milk production and sample identification.

Completeness of sampling (less than 1% samples missing).

Completeness of production recording (less than 1% of animals missing).

Completeness of animal recording (less than 2% missing in automatic recording systems, less than 1% missing in human operated systems) .

Sampling accuracy by comparing the fat content on the test day with the fat content of bulk milk.

Sampling and analysing accuracy by comparing the milk components given by the milk analyser on the test day with the milk components of the bulk milk (only in case of milk analysers).

Proper handling of samples (less than 1% samples that could not be analyzed).

Moreover the quality assurance certificate program of ICAR can be mentioned in this respect.