ICAR Recording Guidelines

approved by the General Assembly held in Berlin, Germany, on May 2014
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**International Agreement of Recording Practices**

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INTERNATIONAL AGREEMENT ON RECORDING PRACTICES
INTRODUCTION

What is ICAR?

The International Committee for Animal Recording (ICAR) is the world-wide organization for the standardization of identification, performance recording and evaluation of farm animals. Its aim is to promote improvement of farm animal recording and evaluation through the formulation of definitions and standards for the measurement of traits of economic importance. Together with the definitions and standards ICAR establishes specific guidelines for the purpose of identifying animals, the registration of their parentage, recording their performance and their evaluation, and publish the findings (www.icar.org).

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Updated versions of the Guidelines can be downloaded from the web site at [www.icar.org/pages/recording_guidelines.htm](http://www.icar.org/pages/recording_guidelines.htm).
INTERNATIONAL AGREEMENT ON IDENTIFICATION, RECORDING AND EVALUATION OF FARM ANIMALS

Article 1 Preamble

1. The International Committee for Animal Recording (hereinafter referred to as ICAR) is a worldwide organisation for the improvement of farm animal identification, recording and genetic evaluation. It develops rules, standards and guidelines for animal identification, recording and genetic evaluation. ICAR is registered as an international non-governmental and non-profit organisation. Its objects and functions are detailed in its Statutes.

2. In recognition of national and international legislation affecting its members, ICAR will incorporate legal agreements into its rules, standards and guidelines.

3. The rules, standards and guidelines laid down in this agreement are regarded as the minimum requirements for satisfactory recording within the aims of ICAR.

4. The agreement is designed to allow member organisations a degree of choice and flexibility within the rules and standards, while ensuring that there is a satisfactory degree of uniformity within the record-keeping and evaluation methods among member organisations.

5. Rules, standards and guidelines may be supplemented from time to time by additional provisions approved by the General Assembly of ICAR.

Article 2. General rules

1. Any new member organisation shall adopt and satisfy the Agreement within two years of taking up membership.

2. Each member organisation shall submit its recording rules in one of the official languages and its Annual Report to the Secretariat.

3. Any Member or Associate Member wishing to withdraw from the agreement, or withdrawing its recognition of a recording organisation, shall notify the Board in advance of the date of its planned withdrawal. The Board will then immediately notify all other member organisations of that fact and of the date of withdrawal.

4. The Board may revoke the recognition of a member organisation if the latter ceases to satisfy this agreement.

Article 3. Registration of results and authentication of records

1. Official records shall be calculated by one of the methods defined in this Agreement.

2. The recording organisations report to the ICAR Secretariat the data items that are recorded, together with the recording methods and the calculation methods used as defined in this Agreement.

Article 4. Certificates

1. Certificates containing recording results may only be issued by a Member Organisation.
2. An official certificate should contain the latest information.
3. Information described in the ICAR Rules on Individual Animal Certificates should be printed on the certificates.

**Article 5. Recording: basic principles**

1. Records should be a true indication of the identity, sex, breed, ancestry and date of birth of the animal. Only information recorded in the manner and to the standards of the Agreement shall be presented as the official record.
2. The recorded animal must be identified in accordance with the animal identity regulations pertaining in the country where animal reside.
3. Parentage, production traits and other characteristics including health traits shall be recorded in accordance with the Agreement. Recording standards for each trait are given in the ICAR rules.

**Article 6. Organisation of recording**

1. Organisations carrying out recordings are free to determine their particular recording methodologies provided these are in agreement with the ICAR rules.
2. Recording can be undertaken by any of the approved ICAR methods contained in the ICAR Rules, Standards and Guidelines.

**Article 7. The recorded herd**

1. Any group of animals kept for the same purpose and at the same location shall be regarded as a whole herd. For a record to be considered an official record, the whole herd as defined above must be recorded.
2. The recorded herd can be divided into separately recorded groups of animals, provided that those groups of animals are of clearly distinct breeds or crosses or are managed in significantly different ways at different locations.

**Article 8. Recording of parentage**

1. The parentage of an animal shall be recorded by identifying and recording the service sire and the served animal at the time of service. The identity, sex and date of birth of an animal, shall be recorded as soon after parturition of the dam as possible.
2. Rules for parentage recording are given in the ICAR Rules on Parentage Recording.

**Article 9. Recording milk and milk constituents**

1. The A4/2 milkings method is the ICAR standard reference recording. Any other approved method of recording as given in the ICAR Rules on Methods of Recording Performance may be used.
2. Milk recording can be done at one or more milkings.
3. Relevant symbols describe the method of recording and are given in the ICAR Rules on Recording Intervals.

4. ICAR Members are expected to observe the ICAR Rules, Standards and Guidelines on Recording Milk and Milk Constituents.

**Article 10. Recording of other traits and other species**

1. The traits of other farm animal species shall be recorded in the manner defined in the respective ICAR rules.

2. Other traits of bovine species shall be recorded in accordance with ICAR rules.

**Article 11. Genetic and other evaluations**

Genetic and other evaluations shall be estimated using one of the methods detailed in the ICAR Rules, Standards and Guidelines on Methods of Genetic Evaluation.

**Article 12. Supervision and quality assurance**

1. All Members involved in recording and/or evaluation related activities shall establish a system of supervision.

2. Associate Members involved in production of identification, recording and analytical devices should establish the system of quality control and quality assurance.

3. For the purpose of this Agreement, the recognized quality assurance systems are ICAR Certificate of Quality and ISO accreditation.

**Article 13. Publication of results**

1. Published records should furnish a true indication of an animal's performance, parentage and genetic merit. Official records and certificates may be issued only by member organisations and by organisations approved by them.

2. All published official records should be to a standardized basis as described in the ICAR Rules.

   2.1. In all cases the publication of the official record should indicate the methods used as given in the Sections of this Agreement.

   2.2. Where the record includes estimates of missing data, it must so state.

   2.3. The breed, sex and unique identity of the animal and the sire and dam of the animal and of their sires and dams and the animal's date of birth, should be shown on the official records, where these are known to the Recording Organization.

   2.4. Where the record has been significantly affected by the health of the animal, the record should so state.

   2.5. Where the record has been significantly affected by an unusual management practice and/or environmental conditions, the record should so state.

3. Details for the publication of records are given in the ICAR Rules on Individual Animal Certificate.
SECTION 1. GENERAL RULES

SECTION 1.1 - ICAR RULES, STANDARDS AND GUIDELINES ON METHODS OF IDENTIFICATION

1.1.1 ICAR general rules on animal identification

1. The recorded animal identity must be the animal's official identity in the member country and must be unique to that animal.

2. Where the identity of an individual animal is not unique, the record must so state (e.g. flock identities for goats/sheep). The identity number used for a flock or herd must be unique for that flock or herd.

3. The animal's identity must be visible.

4. The animal's identity should be unique and never be re-used.

5. The animal's identification device/method, must comply with legislative requirements.

6. Animals, which lose their identity device must be re-identified and, wherever possible, with their original number, provided that there is evidence that the animal is being correctly identified (where this is not possible, a cross reference to the original number must be maintained).

1.1.2 ICAR standard methods of animal identification

1. The animal's identity number may be attached to the animal by a tag, tattoo, sketch, photo, brand or electronic device.
Section 1 - General rules

2. Animals moving from one member country to another should, wherever possible, continue to be identified using their original identity number and name.

3. In the case of imported animals, where the number has to be changed, the official records should also show the original number and name. The original number and name must be reported in Export Certificates, AI Catalogues and in catalogues of important shows and sales. Where an animal is identified using an implanted 'electronic device', the animal must be marked in a way which indicates the presence of an "electronic identification" device.

1.1.3 Record of identification methods

1. The member organisation must maintain a record of the approved identification methods used in the country in which it operates.

2. The member organisation must determine, within the constraints of the member country legislation, the identification methods to be used on recorded animals and herds or flocks.

1.1.4 ICAR Standards for animal Identitites

1. The animal identity number will be a maximum of 12 digits (including check digits where used) and the three digit numeric code representing the name of the country in accordance with ISO 3166 shall be added to identify the country of origin. Three digit numeric ISO codes must be used for data transfer and storage. In printed documents the ISO alpha country code should be used.

2. For Electronic Identification Standards see Appendices to this Section.
SECTION 1.2 - ICAR GENERAL RULES AND GUIDELINES FOR PARENTAGE RECORDING METHODS

1.2.1 ICAR Rules on recording of parentage information

1. The identity of the animal served and the service sire must be recorded on the farm on the day of the service.

2. The insemination records issued by the AI Organisation (or the records kept by the DIY AI user) must include the date, the official identity and if available the name of the served animal and the identity and name of the service sire.

3. The recording organisation should record the service information, as soon as possible but no later than four months after the animal has been served.

4. The sex and identity of the progeny should be recorded on the day of birth and notified to the responsible organisation no later than the first recording visit after their occurrence.

5. In the case of embryo transfer the records must show the genetic dam and the recipient dam as well as the service sire.

1.2.2 ICAR rules on verification of parentage

The following checks must be carried out before a parentage record can be considered official.

a) That the served animal is properly identified.

b) That the service sire is properly identified.

c) That the Date of Birth is within ±6% of the average gestation length for the recorded service date for the breed of service sire.

d) That the progeny of the served animal is properly identified.

e) That the service sire is verified either by an AI record or by evidence that the service sire was on farm on the day of service, or by a declaration by a Veterinary Surgeon (e.g. in the case of Embryo transfer).

1.2.3 ICAR guidelines for supervision of parentage

1.2.3.1 Scope

The present guideline aims to provide guidelines for the relevant matters which must be undertaken to enable an organisation to use genomic data for parentage verification.
1.2.3.2 Blood typing

The use of blood typing for determining parentage verification may still be used nationally, but it is not recommended when exchanging parentage data. As there are no comparable ring tests between laboratories we therefore cannot assume consistency of results. When in doubt of any parentage, a DNA-test should be done. If no material is available from both parents, the animal should be excluded/not allowed for semen production or embryo production.

1.2.3.3 Microsatellite or SNP parentage analysis.

Following advances in molecular biology later described in Section 4 of this document, further information to enable organisations to utilise SNP parentage analysis is required.

Genomic parentage verification may be completed using microsatellites or SNPs. To absolutely verify the parentage, both parent's DNA is required, however verification of only the Dam may be acceptable if sire genetics are unavailable.

Historically, many animals’ DNA has been analysed using microsatellites, but increasingly animals are being genotyped on SNP chips. SNP chips may range in size from those that solely contain parentage SNPs to the high density chips used for genomic evaluation. The important thing is that they must contain the ICAR recognised parentage SNPS and that the analysis is completed at an ICAR accredited laboratory. This standard ensures that the parentage SNPs are exchangeable between organisations. If an animal has been genotyped for genomic evaluation using a chip which has these SNPs, it should be possible to request the parentage SNPs.

The transition from the microsatellite to the SNP method of parentage verification is problematical. Parentage microsatellites can be imputed from additional high density SNPs specifically chosen for that purpose and available on some SNP chips. Using higher density SNP chips gives the organization more information about the animal; it can aid sire identification, help identify the maternal grandsire, be used for genomic evaluation and can be used to check for genetic disease and traits. Alternatively organisations may decide to request the 120 parentage SNP and microsatellite genotypes

A list of ICAR accredited labs, for either microsatellite or SNP parentage verification, is available on the ICAR website (www.icar.org/pages/working_groups/wg_GA_laboratories.htm). The laboratory accreditation process is explained in full in Section 4.2 of this document.

1.2.3.4 Parentage verification procedure

To be able to use genotypes for parentage verification, an organisation must have in place a system that documents the requesting, sampling, processing, analysis and reporting of samples of DNA.

To obtain a good DNA analysis, a good sample of DNA is required. Samples may be of blood, semen, mucus, tissue or hair follicle, etc. The important criteria are that there is sufficient good quality DNA in the sample.

When collected, samples must be clearly identified, so that upon receipt at the laboratory they can be recorded accurately as belonging to a particular animal. Once the sample is analysed, the Parentage SNPs/Microsatellites from the calf must be compared with those from its sire and dam to decide whether the calf is related to the two parents. This interpretation may be completed by the laboratory as a service, or by the requesting organisation.
The organisation which has interpreted the DNA results will issue upon request a parentage certificate for the animal.
If the interpreted DNA results do not verify the alleged parents, additional sampling may be required.

1.2.3.5 Reconstruction of microsatellites for missing parents
Reconstruction of a parents' genotype for parentage verification should not be used except when there is no other option available, for example, when a parent is deceased and no DNA sample is available.
Where there is no other option, it is recommended that the microsatellite loci from five offspring are used to reconstruct the missing parent; otherwise there may not be enough data to correctly determine the parentage, particularly if the animal is inbred. Where ever possible the microsatellite genotypes used should be from direct genotyping of the offspring not reconstructed or imputed microsatellite genotypes.
There should be a flag on the reconstructed genotype to indicate that the genotype was imputed and, therefore, the parentage verification was from a derived genotype.
As an additional tool, grandparents' genotypes may be used to verify the parentage.
The reliability of the parentage verification is also determined by genetic diversity that is available within the progeny as well as the qualified parent.
Guidelines for imputing parentage SNPs and for using microsatellite and SNP verification to verify parentage will follow at a later release of these guidelines.

1.2.3.6 Visual inspection of the progeny.
Visual inspection cannot be used alone to verify parentage but can be used as a rough indicator of parentage where the sire can be easily identified by the type of calf that is born.
Visual inspection is better for exclusion rather than for verification.
a) Blood typing, Micro satellite, or SNP parentage analysis.
b) Visual inspection of the progeny.

1.2.4 Recommendation for recording and validation of AI data
1.2.4.1 Object of the recommendation
The purpose of this recommendation is to improve quality of data in Artificial Insemination of cattle (AI) by harmonising and improving data collection for guaranty high level of exchanges at international level. It recommends the minimum items that should be recorded for using AI data and the minimum of controls that data must undergo for being declared as valid. Annex 1 describes the minimum requirements for purposes other than genetic.

1.2.4.2 Field of application of the recommendation
The recommendation applies usage of AI data for genetic purposes such as:
1. Using AI data to establish parentage of bovines prior to registration in the herd-book and/or in files used for genetic evaluations for any trait.

2. Printing AI on pedigrees of pregnant females.

3. Genetic evaluation fertility of bulls, daughter fertility and establishment of Non-Return-Rates.

It applies to bovine populations for which parentage is systematically recorded such as herds on performance recording (milk and beef) and/or herds registered in the herd-book.

It's applies to countries were bodies are approved to enter AI data in the genetic data processing system for the above mentioned purposes.

It non applies to non genetic purpose.

1.2.4.3 Definitions

First AI: first insemination to breed a heifer or after the end of each pregnancy to breed a cow.

Return: AI carried out after a first tentative within a given reproductive period. A rank is attached to each return.

Rank: order of the return after the First AI (2, 3, 4, ...).

Fecundating AI: AI which is not followed by a return during a given period of time (2-3-4 months), or followed by a positive recorded pregnancy diagnosis, or by a calving after a period matching with the gestation length of the breed(s).

Double AI: two AI carried within a short lap of time, e.g. 48 hours, on the same female with or not the same bull. This information is recorded to avoid rejection when verification of dates.

Operator: person performing the artificial insemination, hired by AI stations, freelance, veterinarian technician, farmer.

Special characteristics: technical indication related to the semen (liquid / frozen, dilution), or to the straw (split-unit), or to special purpose of the AI (embryo production).

1.2.4.4 Recording of AI data

Data mentioned below are those that have to be transmitted to a data processing centre in charge of genetic procedures. In general the format of those data is not defined by this recommendation.

Items 4.4 to 4.11 have to be recorded compulsory.

1.2.4.4.1 Summary of items constituting the data set when AI are recorded:

When AI are recorded, some items have to be registered compulsory, by hand (paper form) or by electronic devices (laptop computers, PDA.). Those data will constitute the basic database.

Requested data are:

- AI centre or organisation/body in charge of processing AI for genetic purposes.
- Operator.
- Date.
- Herd.
• Female inseminated.
• AI bull.
• Some data will help the data processing and then used for optimisation of it.

Options:
For an improved system of recording desirable data may be added
• Rank.
• Double AI.
• Special characteristics.
• Batch number of straw.

1.2.4.4.2 Order of items
Recommendation does not address the order of items. The description of order has to be mentioned when data are exchanged.

1.2.4.4.3 Support
AI data are recorded either on forms either on electronic data files.

1.2.4.4.4 AI Centre or organisation/body issuing AI data
AI records have to be traced back to the AI centre or organisation issuing AI data.

1.2.4.4.5 Operator
The responsible organisation has to use a system to identify the operators in order to track back each insemination. Operators may be: technicians employed by the station, vets or inseminators under contract, free-lance operators, and farmers.

1.2.4.4.6 Date
The date of the day when the female was inseminated has to be recorded for each AI.

1.2.4.4.7 Herd
Herd have to be identified within the national system of registration dedicated to genetic data processing

1.2.4.4.8 Female inseminated
Females have to be identified within the national system of registration dedicated to genetic data processing. The identification number of females including country code has to be recorded for each AI.

Options:
Section 1 - General rules

Breed code may be optional recorded. The date of birth and the number of calving may not be recorded if the registration system is recording this information. Name and internal working number are not recorded compulsory.

### 1.2.4.4.9 AI bull

The female has to be bred by semen of an AI bull, known through the reference of its semen. The identification of the bull is that defined by the "ICAR guidelines for straw identification for bovine semen" as the international identification code or a world-wide unique bull code. **One of those codes has to be recorded for each AI.**

If a bull code is used, it must be linked with the international identification code after the recording, for genetic purposes.

### 1.2.4.4.10 Rank

The rank of intervention of each AI carried out within the same reproductive cycle has to be determined either by recording, either by the date known in the computer.

The number of the rank is 1 for the first AI or greater or equal to the rank of the previous AI plus 1 for each return.

In case of double AI the number of the rank has to be equal to the rank of the previous AI.

Remark: computer can determine the rank. The farmer or technician should not enter this information in the computer or write it down.

### 1.2.4.4.11 Double AI

The existence of a double AI has to be mentioned either by recording of a code either automatically.

### 1.2.4.4.12 Special characteristics

Special characteristics regarding the used straw, the semen or the service itself may be recorded in order to help the interpretation of AI data. The data dictionary accompanying data file must describe those characteristics.

It could be mentioned: freezing technology, dilution characteristics, split straw, sexed semen, AI for embryo production etc

### 1.2.4.5 Tests for validation of AI data

After recording AI data have to undergo series of test prior to be used in the genetic system. Those tests may be carried out at various levels according to the organisation and the equipment

#### 1.2.4.5.1 Completeness and integrity of data

Each item recorded must be checked against the data model to prove the intrinsic validity of data. All necessary data have to be available prior processing.
1.2.4.5.2 Test of coherence

When arriving in the database the items of AI records have to be checked against existing files to prove their coherence with existing information:

- The number of the organisation is known in the base.
- The number of the operator recorded is declared by a recognised organisation.
- The herd is registered.
- The female is registered.
- The AI bull is registered.

Moreover regarding the female:

- The identification corresponds to an animal registered as a female.
- The female is old enough to be bred (parameters defining the authorised limits are set up by country/breed/operator).
- If two AI are carried out on the same female on the same day an alarm message has to be edited.
- The female is alive.

Moreover regarding the AI bull, it is recommended that the semen used correspond to a declared stock in the database.

1.2.4.5.3 Likelihood tests

In order to secure the information likelihood tests have to be carried out:

- The female was registered in the herd the day where the insemination was carried out.
- The bull was recognised as an AI bull when the semen was used.
- There was a minimum period between the first AI and the last return of the previous cycle of the registered end of pregnancy (parameters defining the authorised limits are set-up by country/breed/operator).
- The herd identified is an active one (cattle are recorded within this particular herd).

1.2.4.6 Transmission of AI data to data bases for parentage assessment.

This recommendation aims to improve parentage assessment when AI data are brought together with other relevant data such as birth date.

Some extra conditions are required on the transmission of AI data:

- AI data have to be transmitted on a regular frequency to the data base where there are brought together with birth data.
AI data have to be available in this data base prior to the arrival of birth data.

All AI data have to be available in the data base whatever they are successful or not.

By bringing together all AI data and birth data, it is possible to assess the fecundating AI according to the dates recorded for birth and AI and the gestation length of the females of the breed. If only this information is required to be transmitted, the responsible body in charge of data processing has to describe the used method.

1.2.4.7 Quality controls

The efficiency of any information system depends on the quality of data proving that the expected result fits with the goal. For AI, regarding the genetic applications it deals with the accuracy of the records and with the proof that the progeny from mating was born from foreseen parents.

It is recommended that the organisation in charge with AI data processing carries out following controls and implement relevant indicators:

- Counting of failures on each test suggested above, in terms of completeness, integrity, coherence and likelihood of AI data.
- Implementing random sampling test using Blood typing, Micro satellite, or SNP parentage analysis to prove (or reject) the parentage of some groups of animals or specific animals.

1.2.4. Minimum requirements for purposes other than genetic

AI data are used for purposes other than strictly genetic, for management of the reproduction at herd or individual level.

In such a case bull information is not crucial, but the precise inventory of the herd with the in & out date of females is very important.

In addition to the recorded items on AI describe above, such as AI and births records, other data should be registered:

- Dates of the end of any pregnancy including stillborn.
- Observations of heat detection.
- Females treated for oestrus synchronisation. (note that in some cases it is important to record the protocol with dates, products, on the group that has been treated).
- Pregnancy diagnose (method, results).

For each item the identification of female has to be recorded with an unique number at least within the herd.
**SECTION 1.3 - ICAR GENERAL RULES ON PERFORMANCE RECORDING OF MILK**

The ICAR Agreement under Section 6 allows organisations a degree of freedom in deciding recording practices.

ICAR recording methods are:

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
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<tbody>
<tr>
<td>Method A</td>
<td>All the recordings are undertaken by an official representative of the Recording Organisation. This includes recordings undertaken by approved on farm systems that are supervised by an official representative of the recording organisation and that cannot be manipulated by the farmer or his nominee.</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>Method B</td>
<td>All the recordings are undertaken by the farmer or his nominee.</td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>Method C</td>
<td>The recordings are undertaken by the farmer or his nominee, and by an official representative of the Recording Organisation.</td>
</tr>
</tbody>
</table>

1. For official records an ICAR approved supervisory system must be maintained and check data regularly documented to provide authentication for the records.

2. ICAR Members must ensure that any of their associate recording organisations fully comply with ICAR approved recording methods and practices.
SECTION 1.4 - ICAR GENERAL RULES ON INDIVIDUAL ANIMAL CERTIFICATES

1.4.1 Basic rules

1. An official certificate issued by an ICAR Member should contain all the information essential to establishing the identity and value of an animal.

2. An official certificate must clearly indicate the recording methods used to produce the official record.

3. An official certificate must contain the latest information available on the date of issue.

4. Where any estimated information is included in an official certificate, this must be clearly indicated.

The following details must be reported:

a) The (ICAR member) organisation issuing the certificate.

b) The date of issue of the Certificate.

c) The identity number and name of the animal.

d) The animal’s “original number” and name, if different.

e) The date of birth of the animal.

f) The identity and names of the animal, sire and dam and of its grand sires and grand dams.

g) The breed of the animal, or in the case of cross breed animals, the main breed percentages in the animal’s breeding.

h) The sex of the animal.

i) That the animal is a known carrier of a genetic defect, defined by the International Breed Federation concerned.

The following details may be reported:

1. The name and address of the breeder of the animal.

2. The date of the animal moved to the present location, if other than the date of birth.

3. The date of commencement and the end date for each period production record.

4. The events which started and ended each production period.

5. The individual recording day production records.

6. Any health event recorded for the animal.

7. The dates and service sire of any recorded services.

8. The identity and sex of any progeny of the animal.

9. If the animal has been flushed to produced ova, the flushing dates and the number of viable ova collected.

10. If the animal has been used as a ‘recipient following ET, the date of transfer, the genetic sire and dam of the embryo and the sex of the embryo.
11. The fertility records of the animal, including its current fertility status.
12. Additional traits records and evaluations, such as milkability and locomotion scores.
13. That the animal is dead.
14. The number of true recording (no missing values) contained in the record for each production period.
15. The name of the register in which the record is held
16. The animal’s genetic evaluations.
17. The animal’s records of production.
18. The animal’s type classification evaluations.
19. Any events which have significantly affected the animal’s records.
20. The location of the animal on the date of the last recording.
21. The methodology used in the production of the record, where this is other than the Reference Method.
SECTION 1.5 - ICAR RULES ON SUPERVISION OF MILK RECORDING

1.5.1 Basic rules

1. ICAR Members involved in farm animal recording shall establish a system of supervision and quality control.

2. ICAR Members demonstrate that they have sufficient supervision by registering their supervisory practices with the ICAR Secretariat and by reporting on the checks carried out in the year.

1.5.2 Rules on supervisory practices

The supervision must ascertain the following:

1. That all recordings are carried out using ICAR approved methods and equipment.

2. That the recording devices are properly installed, accurately calibrated and properly used.

3. That the animals being recorded are properly and clearly identified.

4. That there are routine checks in place to detect and identify information that is inconsistent and cannot be accurate.

5. That action is taken to deal with inconsistent and inaccurate information, either by replacing it with the correct information (missing values procedures) or by deleting information known to be inaccurate from the official record.

6. That where 'supervision is carried out by a person, the supervisor must not be the person who did the recording or calculation being supervised.

1.5.3 Recommended supervisory practices

The following additional supervisory practices are recommended:

1. That quality control checks should be part of the normal recording working practices and systems, rather than occasional extra spot checks.

2. That the results of routine quality control checks should be reported to the recording organisations, users, to the regulators, and in the annual report of that organisation.

3. That an occasional check repeat recordings should be carried out on leading herds, flocks and individual animals, to maintain the reputation for accuracy, of the recording organisation and of ICAR member organisations.
SECTION 1.6 - ICAR GENERAL RULES ON REGISTRATION OF RECORDING METHODS

1.6.1 Duties of member organisations operating or approving recording services

Each member organisation is obliged to inform ICAR on recording methods used. ICAR should be informed, when the methods change. The description of the methods of recording should include the following items:

1.6.2 Identification and parentage

1. The method of recording the date of birth/breed and the sex of the animal.
2. The method of recording parentage.
3. The method used and description of method of supervision employed.
4. The frequency of recording.
5. The methods used for checking the accuracy of record collection.
6. The methods used for checking the accuracy of record processing.

1.6.3 Production (milk)

1. The method of recording milk yield.
2. The frequency of recording.
3. Sample testing procedures.
4. The number of milking at which yields and samples are collected if there is a difference between yield and sample recording numbers.
5. The methods used for checking the accuracy of records collection.
6. The methods used for checking the accuracy of records processing.
7. The methods used to calculate ‘official lactation totals.
8. The accuracy of the recording method used, calculated in a manner determined by ICAR, expressed in relation to the ‘standard method.

1.6.4 Production (meat and other traits)

1. The method of recording.
2. The methods used for checking the accuracy of record collection.
3. The methods used for checking the accuracy of records processing.
4. The methods used to calculate ‘official records.
5. The accuracy of the recording method used, calculated in a manner determined by the Committee.
SECTION 2.1 - ICAR RULES, STANDARDS AND GUIDELINES FOR RECORDING MILK AND MILK CONSTITUENTS

2.1.1. General rules

1. Milk yields should be recorded and milk samples collected using equipment approved or provisionally approved by ICAR.

2. The list of approved and provisionally approved equipment is included in the ICAR Rules, Standards and Guidelines for Approval and Checking of Devices and Equipment and is monitored and updated by the Secretariat and made available to members from time to time.

3. The equipment, materials and methods used for analysing the contents of recorded milk are referred to in the Section 11 and the appendices to this Section.

4. The accuracy of the equipment used for milk recording and analysis must be checked by an agency approved by the member organisations, on a regular and systematic basis using methods approved by ICAR. The list of methods is given in the ICAR Rules, Standards and Guidelines for Approval and Checking of Devices and Equipment.

5. The analyses of the chemical composition of a milk sample shall be carried out on the same milk sample. These samples should represent the 24 hour milking period or should be corrected to a 24 hour period by a method approved by ICAR.

6. Duration of recording: the lactation period

   6.1 Only approved lactation periods can be used. The ICAR Guidelines on lactation period contains a list of approved lactation periods.

   6.2 The reference lactation period shall be as described in the ICAR Guidelines on Lactation Period.

   6.3 Apart from the reference lactation period, performance records may also be presented for other recording periods e.g. annual yields.
7. Calculation methods

7.1 The quantities of milk and milk constituents shall be calculated according to one of the methods outlined in the ICAR Guidelines on Lactation Calculation.

7.2 Member organisations shall inform the Board on the calculation methods being used by the records processing operations in their country and shall be responsible for ensuring that the records are corrected and calculated as specified in the ICAR Guidelines for Lactation Calculation.

2.1.2. ICAR Standards for recording intervals

<table>
<thead>
<tr>
<th>Recording Interval (Weeks)</th>
<th>Minimum Number of Recordings</th>
<th>Interval between recordings per year (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>Reference method</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>55</td>
</tr>
<tr>
<td>Daily</td>
<td>310</td>
<td>1</td>
</tr>
</tbody>
</table>

Seasonal production and dry periods

Where a herd is dry for a period of the year, the minimum number of visits should be adjusted proportionately to the production period.

Guidelines - minimum number of herd recordings should be at least 85% of the normal number of recordings.

2.1.3. ICAR standard symbols used on records

2.1.3.1 Two milkings per recording day is the reference method

Recording other than by the reference method must be indicated using the appropriate symbols.
International Agreement on Recording Practices

<table>
<thead>
<tr>
<th>Number of milkings per day</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once per day milking</td>
<td>1 x</td>
</tr>
<tr>
<td>Three milkings</td>
<td>3 x</td>
</tr>
<tr>
<td>Four milkings</td>
<td>4 x</td>
</tr>
<tr>
<td>Continuous Milkings (e.g. robotic milking)</td>
<td>R x</td>
</tr>
<tr>
<td>Regular milkings not at the same times on each day</td>
<td>1.4 x</td>
</tr>
<tr>
<td>(e.g. 10 milkings per week)</td>
<td></td>
</tr>
</tbody>
</table>

Shown as the average number of milkings per day.
Animals that are both milked and suckled. (Number of times milked to prefix the S)

2.1.3.2 Recording schemes where not all milkings are recorded

1. Where the herd is recorded at one milking at one recording visit and a different milking at the next recording visit, the symbol T should be used. (Alternative milking).
2. Where the herd is recorded at the same milking at each recording visit, the symbol C should be used. (Corrected milking).

2.1.4. ICAR standard methods of lactation calculation

2.1.4.1. The Test Interval Method (TIM) (Sargent, 1968)

The Interpolation Method is the reference method for calculating lactations. The following formulae are used to compute the lactation record for milk yield (MY), for fat yield (FY), and for fat percent (FP).

\[
MY = I_0M_1 + I_1\frac{(M_1 + M_2)}{2} + I_2\frac{(M_2 + M_3)}{2} + \ldots + I_{n-1}\frac{(M_{n-1} + M_n)}{2} + I_nM_n
\]

\[
FY = I_0F_1 + I_1\frac{(F_1 + F_2)}{2} + I_2\frac{(F_2 + F_3)}{2} + \ldots + I_{n-1}\frac{(F_{n-1} + F_n)}{2} + I_nF_n
\]

\[
FP = \frac{FY}{MY} \times 100
\]

Where:

- M1, M2, Mn are the weights in kilograms, given to one decimal place, of the milk yielded in the 24 hours of the recording day.
- F1, F2, Fn are the fat yields estimated by multiplying the milk yield and the fat percent (given to at least two decimal places) collected on the recording day.
- I1, I2, In-1 are the intervals, in days, between recording dates.
- I0 is the interval, in days, between the lactation period start date and the first recording date.
In is the interval, in days, between the last recording date and the end of the lactation period.

The formulae applied for fat yield and percentage must be applied for any other milk components such as protein and lactose.

Details of how to apply the formulae are shown in the annex to the Appendix.

2.1.4.2 Calculation methods of daily yields from AM/PM milkings

2.1.4.2.1 Method of Liu et al. (2000)

A multiple regression method (MRM) is used for estimating 24-hour daily milk yield (DMY), daily fat yield (DFY) and daily protein yield (DPY) based on partial yields from either morning (AM) or evening (PM) milking. Fat percentage (DFP) or protein percentage (DPP) on a 24-hour daily basis are then derived using the estimated 24-hour daily yields. The MRM can be severed as a reference method for estimating daily yields and component percentages. The following formula is used for estimating DMY, DFY, or DPY based on partial milk yield (PMY), partial fat yield (PFY) or partial protein yield (PPY) from either AM or PM milking. The formula is applied separately to partial daily yields from AM or PM milking:

\[ y_{ijk} = a + b_{ijk} \times x_{ijk} \]

where:

- \( y_{ijk} \) is the estimated 24-hour daily yield (DMY, DFY or DPY);
- \( x_{ijk} \) is AM or PM partial daily yield on a test day (PMY, PFY, or PPY).
- Subscript \( i \) represents class of parity effect with two levels: first and later parities,
- Subscript \( j \) represents class of length of preceding milking interval with four levels: <13 hours, 13-13.5 hours, 13.5-14 hours and ≥14 hours for AM milking; <10 hours, 10.5-11 hours, 11-11.5 hours, and ≥11.5 hours for PM milking.
- Subscript \( k \) represents class of lactation stage (\( k = 1, 2, \ldots, 12 \)) that is calculated as the number of days in milk divided by 30 plus 1. If \( k > 12 \), then \( k = 12 \).
- \( a \) is the estimated intercept for the combination of parity class \( i \), milking interval class \( j \) and lactation stage class \( k \) for either AM or PM milking for a given trait.
- \( b_{ijk} \) is the estimated slope for the above mentioned combination of effects.

For a given yield trait a total number of 96 formulae are to be estimated for calculating 24 hour daily yield based on partial yield from either AM or PM milking. Component percentage, DFP or DPP, on a 24-hour daily basis is calculated by dividing estimated daily fat or protein yield by estimated daily milk yield:

\[
\text{DFP} = \frac{\text{DFY}}{\text{DMY}} \times 100, \text{ and} \\
\text{DPP} = \frac{\text{DPY}}{\text{DMY}} \times 100.
\]
### 2.1.4.2.2 Calculation example with method of Liu et al. (2000)

Example data from an evening milking

<table>
<thead>
<tr>
<th>Cow ID</th>
<th>Calving date</th>
<th>Lactation number</th>
<th>Milk yield (kg)</th>
<th>Fat content (%)</th>
<th>Protein content (%)</th>
<th>Fat yield (kg)</th>
<th>Protein yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1999.11.28</td>
<td>1</td>
<td>21.2</td>
<td>4.54</td>
<td>3.20</td>
<td>0.962</td>
<td>0.678</td>
</tr>
<tr>
<td>B</td>
<td>2000.01.13</td>
<td>1</td>
<td>21.2</td>
<td>4.54</td>
<td>3.20</td>
<td>0.962</td>
<td>0.678</td>
</tr>
<tr>
<td>C</td>
<td>1999.10.15</td>
<td>2</td>
<td>25.7</td>
<td>4.11</td>
<td>3.15</td>
<td>1.056</td>
<td>0.810</td>
</tr>
<tr>
<td>D</td>
<td>2000.02.15</td>
<td>2</td>
<td>25.7</td>
<td>4.11</td>
<td>3.52</td>
<td>1.056</td>
<td>0.905</td>
</tr>
</tbody>
</table>

Example data from a morning milking

<table>
<thead>
<tr>
<th>Cow ID</th>
<th>Calving date</th>
<th>Lactation number</th>
<th>Milk yield (kg)</th>
<th>Fat content (%)</th>
<th>Protein content (%)</th>
<th>Fat yield (kg)</th>
<th>Protein yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1999.11.28</td>
<td>1</td>
<td>21.2</td>
<td>4.54</td>
<td>3.20</td>
<td>0.962</td>
<td>0.678</td>
</tr>
<tr>
<td>B</td>
<td>2000.01.13</td>
<td>1</td>
<td>21.2</td>
<td>4.54</td>
<td>3.20</td>
<td>0.962</td>
<td>0.678</td>
</tr>
<tr>
<td>C</td>
<td>1999.10.15</td>
<td>2</td>
<td>25.7</td>
<td>4.11</td>
<td>3.15</td>
<td>1.056</td>
<td>0.810</td>
</tr>
<tr>
<td>D</td>
<td>2000.02.15</td>
<td>2</td>
<td>25.7</td>
<td>4.11</td>
<td>3.52</td>
<td>1.056</td>
<td>0.905</td>
</tr>
</tbody>
</table>

Calculation of 24-hour daily yields and components for the evening milking

<table>
<thead>
<tr>
<th>Cow ID</th>
<th>Calving date</th>
<th>Lactation number</th>
<th>Milk yield (kg)</th>
<th>Fat yield (kg)</th>
<th>Protein yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.322 + 1.934 x</td>
<td>0.172 + 1.755 x</td>
<td>0.074 + 1.935 x</td>
<td>1.860 / 43.32</td>
<td>1.386 / 43.32 x</td>
</tr>
<tr>
<td>B</td>
<td>2.204 + 1.980 x</td>
<td>0.168 + 1.776 x</td>
<td>0.062 + 2.005 x</td>
<td>1.876 / 44.18</td>
<td>1.422 / 44.18 x</td>
</tr>
<tr>
<td>C</td>
<td>2.356 + 1.905 x</td>
<td>0.158 + 1.729 x</td>
<td>0.088 + 1.889 x</td>
<td>1.984 / 51.31</td>
<td>1.618 / 51.31 x</td>
</tr>
<tr>
<td>D</td>
<td>2.837 + 1.920 x</td>
<td>0.251 + 1.629 x</td>
<td>0.098 + 1.908 x</td>
<td>1.971 / 52.18</td>
<td>1.824 / 52.18 x</td>
</tr>
</tbody>
</table>

Note that intercepts and slopes of the applied regression formulae are underscored.
Calculation of 24-hour daily yields and components for the morning milking

<table>
<thead>
<tr>
<th>Cow</th>
<th>DMY (kg)</th>
<th>DFY (kg)</th>
<th>DPY (kg)</th>
<th>DFP (%)</th>
<th>DPP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.364 + 1.850 x 0.082 + 1.742 x 0.031 + 1.816 x 1.757 / 39.58 x 1.262 / 39.58 x 0.082 + 1.742 x 193</td>
<td>167</td>
<td>21.2 = 39.58</td>
<td>0.962 = 1.757</td>
<td>0.678 = 1.262</td>
</tr>
<tr>
<td>B</td>
<td>0.748 + 1.800 x 0.089 + 1.722 x 0.040 + 1.776 x 1.746 / 38.91 x 1.244 / 38.91 x</td>
<td>193</td>
<td>21.2 = 38.91</td>
<td>0.962 = 1.746</td>
<td>0.678 = 1.244</td>
</tr>
<tr>
<td>C</td>
<td>1.099 + 1.783 x 0.107 + 1.714 x 0.047 + 1.763 x 1.917 / 46.92 x 1.475 / 46.92 x</td>
<td>25.7</td>
<td>25.7 = 46.92</td>
<td>1.056 = 1.917</td>
<td>0.810 = 1.475</td>
</tr>
<tr>
<td>D</td>
<td>0.867 + 1.820 x 0.203 + 1.595 x 0.039 + 1.804 x 1.887 / 47.64 x 1.672 / 47.64 x</td>
<td>25.7</td>
<td>25.7 = 47.64</td>
<td>1.056 = 1.887</td>
<td>0.905 = 1.672</td>
</tr>
</tbody>
</table>

Note that intercepts and slopes of the applied regression formulae are underscored.

### 2.1.4.2.2 Method of Delorenzo and Wiggans (1986)

Daily milk (DMY) and fat yield (DFY) estimates are based on measured yield and milking frequency. An adjustment factor accounts for differences in the average milking interval (expressed in decimal hours) between the preceding milking and the measured milking, and the time of day of the measured milking (started in a.m. or p.m.). For 2X milking, an additional adjustment is applied to milk yield for the interaction between milking interval and stage of lactation, with mid lactation (158 DIM) set to zero. Milking interval does not affect protein and SNF percentages and so the percentages for the sampled milking are used for test-day estimates. Protein yield is calculated from the measured percentage and the adjusted milk yield.

The prediction of DMY and DFY from single milking on morning or evening in herds milked twice a day requires factors, that are the reciprocal of the proportion of total yield expected from single milkings in relation to the milking interval.

### Adjustment of milking interval

The milking interval is the interval between milking time for the observed milking and the milking time preceding the observed milking. The milking interval is divided into 15-minutes classes. Factors for milk and fat yields may be calculated to each class by:

\[
\text{factor} = \frac{1}{(\text{intercept} + \text{slope} \times \text{milking interval})}
\]
Adjustment of lactation stage
Because the lactation stage of the cow has an influence on the effect of different milking intervals on milk production a second adjustment is made for every interval class through a covariate of days in milk as addition:

covariate · (days in milk – 158)

Estimating sample day yields
Formulas for prediction sample day yields and percentages in herds with two milkings are:

\[ DMY = \text{factor} \times \text{measured milk yield} + \text{covariate} \times (\text{days in milk} – 158) \]
\[ \text{daily fat percentage} = \text{factor for fat percentage} \times \text{measured fat percentage} \]
\[ DFY = DMY \times \text{daily fat percentage} \]
\[ DPY = DMY \times \text{daily protein percentage} \]

Practical Application
Two sets of factors are available for estimating DMY from a single milking, each for morning or evening milking sampling. The factors are calculated from the formula as described before.
Table 1. Factor of milk yield and covariate for herds milked twice a day.

<table>
<thead>
<tr>
<th>Length of milking interval in hours (minutes in decimal)</th>
<th>Morning milking</th>
<th>Evening milking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Factor</td>
<td>Covariate</td>
</tr>
<tr>
<td>&lt; 9.00</td>
<td>2.465</td>
<td>0.00710</td>
</tr>
<tr>
<td>9.00-9.24</td>
<td>2.465</td>
<td>0.00710</td>
</tr>
<tr>
<td>9.25-9.49</td>
<td>2.465</td>
<td>0.00710</td>
</tr>
<tr>
<td>9.50-9.74</td>
<td>2.411</td>
<td>0.00716</td>
</tr>
<tr>
<td>9.75-9.99</td>
<td>2.359</td>
<td>0.00726</td>
</tr>
<tr>
<td>10.00-10.24</td>
<td>2.310</td>
<td>0.00458</td>
</tr>
<tr>
<td>10.25-10.49</td>
<td>2.262</td>
<td>0.00399</td>
</tr>
<tr>
<td>10.50-10.74</td>
<td>2.217</td>
<td>0.00294</td>
</tr>
<tr>
<td>10.75-10.99</td>
<td>2.173</td>
<td>0.00223</td>
</tr>
<tr>
<td>11.00-11.24</td>
<td>2.131</td>
<td>0.00000</td>
</tr>
<tr>
<td>11.25-11.49</td>
<td>2.091</td>
<td>0.00000</td>
</tr>
<tr>
<td>11.50-11.74</td>
<td>2.052</td>
<td>0.00000</td>
</tr>
<tr>
<td>11.75-11.99</td>
<td>2.014</td>
<td>0.00000</td>
</tr>
<tr>
<td>12.00</td>
<td>2.000</td>
<td>0.00000</td>
</tr>
<tr>
<td>12.01-12.24</td>
<td>1.978</td>
<td>0.00000</td>
</tr>
<tr>
<td>12.25-12.49</td>
<td>1.943</td>
<td>0.00000</td>
</tr>
<tr>
<td>12.50-12.74</td>
<td>1.910</td>
<td>0.00000</td>
</tr>
<tr>
<td>12.75-12.99</td>
<td>1.877</td>
<td>0.00000</td>
</tr>
<tr>
<td>13.00-13.24</td>
<td>1.846</td>
<td>0.00000</td>
</tr>
<tr>
<td>13.25-13.49</td>
<td>1.815</td>
<td>0.00000</td>
</tr>
<tr>
<td>13.50-13.74</td>
<td>1.786</td>
<td>-0.00167</td>
</tr>
<tr>
<td>13.75-13.99</td>
<td>1.757</td>
<td>-0.00258</td>
</tr>
<tr>
<td>14.00-14.24</td>
<td>1.730</td>
<td>-0.00347</td>
</tr>
<tr>
<td>14.25-14.49</td>
<td>1.703</td>
<td>-0.00363</td>
</tr>
<tr>
<td>14.50-14.74</td>
<td>1.677</td>
<td>-0.00332</td>
</tr>
<tr>
<td>14.75-14.99</td>
<td>1.652</td>
<td>-0.00316</td>
</tr>
<tr>
<td>15.00</td>
<td>1.628</td>
<td>-0.00235</td>
</tr>
</tbody>
</table>
For estimating daily fat percentage there is only one table independent of morning or evening sampling.

Table 2. Factor of fat percentage for herds milked twice a day.

<table>
<thead>
<tr>
<th>Length of milking interval in hours</th>
<th>Fat (percentage factor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 9.00</td>
<td>0.919</td>
</tr>
<tr>
<td>9.00-9.24</td>
<td>0.927</td>
</tr>
<tr>
<td>9.25-9.49</td>
<td>0.934</td>
</tr>
<tr>
<td>9.50-9.74</td>
<td>0.941</td>
</tr>
<tr>
<td>9.75-9.99</td>
<td>0.948</td>
</tr>
<tr>
<td>10.00-10.24</td>
<td>0.955</td>
</tr>
<tr>
<td>10.25-10.49</td>
<td>0.961</td>
</tr>
<tr>
<td>10.50-10.74</td>
<td>0.968</td>
</tr>
<tr>
<td>10.75-10.99</td>
<td>0.974</td>
</tr>
<tr>
<td>11.00-11.24</td>
<td>0.980</td>
</tr>
<tr>
<td>11.25-11.49</td>
<td>0.986</td>
</tr>
<tr>
<td>11.50-11.74</td>
<td>0.992</td>
</tr>
<tr>
<td>11.75-11.99</td>
<td>0.997</td>
</tr>
<tr>
<td>12.00</td>
<td>1.000</td>
</tr>
<tr>
<td>12.01-12.24</td>
<td>1.003</td>
</tr>
<tr>
<td>12.25-12.49</td>
<td>1.008</td>
</tr>
<tr>
<td>12.50-12.74</td>
<td>1.013</td>
</tr>
<tr>
<td>12.75-12.99</td>
<td>1.018</td>
</tr>
<tr>
<td>13.00-13.24</td>
<td>1.023</td>
</tr>
<tr>
<td>13.25-13.49</td>
<td>1.028</td>
</tr>
<tr>
<td>13.50-13.74</td>
<td>1.033</td>
</tr>
<tr>
<td>13.75-13.99</td>
<td>1.037</td>
</tr>
<tr>
<td>14.00-14.24</td>
<td>1.042</td>
</tr>
<tr>
<td>14.25-14.49</td>
<td>1.046</td>
</tr>
<tr>
<td>14.50-14.74</td>
<td>1.050</td>
</tr>
<tr>
<td>14.75-14.99</td>
<td>1.054</td>
</tr>
<tr>
<td>≥ 15.00</td>
<td>1.058</td>
</tr>
</tbody>
</table>
Milking-interval factors are calculated with the formula:

\[ \text{Milking-interval factor} = 1 / \text{Intercept} + (\text{Slope} \times \text{Milking interval}) \]

where the intercept and slope are as follows:

<table>
<thead>
<tr>
<th>Trait</th>
<th>Intercept started in a.m.</th>
<th>Intercept started in p.m.</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield</td>
<td>0.0654</td>
<td>0.0634</td>
<td>0.0363</td>
</tr>
<tr>
<td>Fat yield</td>
<td>0.1965</td>
<td>0.1939</td>
<td>0.0254</td>
</tr>
</tbody>
</table>

The milking interval has no significant influence on protein percentage. Therefore the protein percentage of the sampled milking is used as the daily protein percentage.

### 2.1.4.2.2.1 Calculation example with method of Delorenzo and Wiggans (1986)

#### Calculation to alternative recording for milk yield and components

**Example data for a cow from morning milking**

- Begin of recording: 6:15 (morning milking)
- Start of preceding milking: 17:25
- Length of milking interval: 12 hours 50 minutes (expressed as decimal 12.83)
- Milk results at morning: 12.0 milk-kg, 4.12 fat-percentage, 3.45 protein-percentage, 120 days in milk

**Calculation of daily yields form morning milking**

- The factor for milk yield from table 1 is 1.877
- The factor for fat percentage from table 2 is 1.018.

The sample-day milk yield: \(1.877 \times 12.0 \text{ kg} + 0 \times (120 - 158) = 22.5 \text{ kg}\)
- The sample-day fat percentage: \(1.018 \times 4.12 = 4.19\)
- The sample-day fat yield: \(22.5 \text{ kg} \times 0.0419 = 0.94 \text{ kg}\)
- The sample-day protein yield: \(22.5 \text{ kg} \times 0.0345 = 0.78 \text{ kg}\)
Example data for a cow from evening milking

Begin of recording: 16:48 (evening milking)
Start of preceding milking: 6:35
Length of milking interval: 13 hours 47 minutes (expressed as decimal 13.78)
Milk results at evening:
- 14.0 milk-kg
- 4.00 fat-percentage
- 3.40 protein-percentage
120 days in milk

Calculation of daily yields from evening milking

The factor for milk yield from table 1 is 1.763
the covariate is -0.00339
The factor for fat percentage from table 2 is 1.037

The sample-day milk yield: $1.763 \times 14.0 \text{ kg} - 0.00339 \times (120 - 158) = 24.8 \text{ kg}$
The sample-day fat percentage: $1.037 \times 4.00 = 4.15$
The sample-day fat yield: $24.8 \text{ kg} \times 0.0415 = 1.03 \text{ kg}$
The sample-day protein yield: $24.8 \text{ kg} \times 0.0340 = 0.84 \text{ kg}$

Calculation for herds with alternate recording of components but milk yield measured for both milkings.

For this plan only the sample-day fat yield has to be calculated with regard to milking interval. The milk yield is the sum of evening and morning milk results.

Example data for a cow from both milkings

Begin of recording evening: 17:25
Milk results at evening: 10.0 (only milking-yield)

Begin of recording morning: 6:15
Milk results at morning:
- 12.0 milk-kg
- 4.20 fat-percentage
- 3.50 protein-percentage
Calculation of daily yields from both milkings

Length of milking interval: 12 hours 50 minutes (expressed as decimal 12.83)
The factor for fat percentage from table 2 is 1.018.

The sample-day milk yield: 10.0 kg + 12.0 kg = 22.0 kg
The sample-day fat percentage: 1.018 \times 4.20 = 4.28
The sample-day fat yield: 22.0 kg \times 0.0428 = 0.94 kg
The sample-day protein yield: 22.0 kg \times 0.0350 = 0.77 kg

Calculation for 3X Milking

For 3X herds, a single milking or two consecutive milkings may be weighed. The sample may be collected at one or both of these milkings. Stage of lactation \times milking interval adjustments are not used for greater than 2\times milking. These AP factors for estimating daily yields in 3X herds should not be confused with factors that adjust 3X records to a 2X basis. Milking-interval factors are calculated using the same formula with the intercept and slope as follows:

<table>
<thead>
<tr>
<th>Trait</th>
<th>For measured milking started between 2 a.m. and 9:59 a.m.</th>
<th>For measured milking started between 10 a.m. and 5:59 p.m.</th>
<th>For measured milking started between 6:00 p.m. and 1:59 a.m.</th>
<th>Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk Yield</td>
<td>0.077</td>
<td>0.068</td>
<td>0.066</td>
<td>0.0329</td>
</tr>
<tr>
<td>Fat Yield</td>
<td>0.186</td>
<td>0.186</td>
<td>0.182</td>
<td>0.0186</td>
</tr>
</tbody>
</table>

When two milkings are included for sampling, the intercepts and intervals for both milkings are included in determining a factor for calculated estimated milk yield that is applied to the total yield from both milkings.

\[
\text{Milking-interval factor} = \frac{1}{(\text{Intercept 1} + \text{Intercept 2}) + (\text{Slope} \times (\text{Milking interval 1} + \text{Milking interval 2}))}
\]

Milk and fat percent factors are calculated separately based on the number of milkings weighed or sampled.

For 4X - 6X Milking

The intercept terms for calculating 3X factors (0.077, 0.068, and 0.066) are multiplied by the factor \(3 / \text{(milkings per day)}\) for use in calculating factors for milking frequencies greater than 3X.

Reference

2.1.4.3 Other lactation calculation methods

2.1.4.3.1 Interpolation using Standard Lactation Curves (ISLC) (Wilmink, 1987)

With the method 'Interpolation using Standard Lactation Curves' missing test day yields and 305-day projections are predicted. The method makes use of separate standard lactation curves representing the expected course of the lactation, for a certain herd production level, age at calving and season of calving and yield trait. By interpolation using standard lactation curves, the fact that after calving milk yield generally increases and subsequently decreases is taken into account. The daily yields are predicted for fixed days of the lactation: day 0, 10, 30, 50 etc.

The cumulative yield is calculated as follows:

\[
\sum_{i=1}^{n} \left[ (INT_i - 1) \cdot y_i + (INT_i + 1) \cdot y_{i+1} \right] / 2
\]

where:
- \( y_i \) = the \( i \)th daily yield;
- \( INT_i \) = the interval in days between the daily yields \( y_i \) and \( y_{i+1} \);
- \( n \) = total number of daily yields (measured daily yields and predicted daily yields).

The next example illustrates the calculation of a record in progress. The cow was tested at day 35 and day 65 of the lactation. To determine the lactation yield, daily milk yields are determined for day 0, 10, 30 and 50 of the lactation, by means of the standard lactation curves. The daily yields are in Table 1.

Table 1. Measured and derived daily yields, used to calculate the record in progress in the example

<table>
<thead>
<tr>
<th>Day of lactation</th>
<th>Milk (kg)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>25.9</td>
<td>Predicted</td>
</tr>
<tr>
<td>10</td>
<td>27.8</td>
<td>Predicted</td>
</tr>
<tr>
<td>30</td>
<td>31.7</td>
<td>Predicted</td>
</tr>
<tr>
<td>35</td>
<td>31.8</td>
<td>Measured</td>
</tr>
<tr>
<td>50</td>
<td>32.9</td>
<td>Interpolated using standard lactation curve</td>
</tr>
<tr>
<td>65</td>
<td>33.0</td>
<td>Measured</td>
</tr>
</tbody>
</table>
Next, the record in progress can be calculated by means of the formula for a cumulative yield as follows:

\[
\frac{[(10 - 1) \times 25.9 + (10+1) \times 27.8]}{2} + \frac{[(20 - 1) \times 27.8 + (20+1) \times 31.7]}{2} + \frac{[(5 - 1) \times 31.7 + (5+1) \times 31.8]}{2} + \frac{[(15 - 1) \times 31.8 + (15+1) \times 32.9]}{2} + \frac{[(15 - 1) \times 32.9 + (15+1) \times 33.0]}{2} = 2005.3 \text{ kg.}
\]

This corresponds to the surface below the line through the predicted and measured daily yields (see Figure 1).

![Figure 1. Example of calculation of record in progress.](image)

**2.1.4.3.2 Best prediction (VanRaden, 1997)**

Recorded milk weights are combined into a lactation record using standard selection index methods. Let vector \( \mathbf{y} \) contain \( M_1, M_2, \ldots, M_n \) and let \( \mathbf{E}(\mathbf{y}) \) contain corresponding the expected values for each recorded day. The \( \mathbf{E}(\mathbf{y}) \) are obtained from standard lactation curves for the population or for the herd and should account for the cow's age and other environmental factors such as season, milking frequency, etc. The yields in \( \mathbf{y} \) covary as a function of the recording interval between them (I). Diagonal elements in \( \text{Var}(\mathbf{y}) \) are the population or herd variance for that recording day and off-diagonals are obtained from autoregressive or similar functions such as \( \text{Corr}(M_1, M_2) = .995^I \) for first lactations or .992\(^I\) for later lactations. Covariances of one observation with the lactation yield, for example \( \text{Cov}(M_1, MY) \), are the sum of 305 individual covariances. \( \mathbf{E}(MY) \) is the sum of 305 daily expected values. Lactation milk yield is then predicted as:

\[
MY = \mathbf{E}(MY) + \text{Cov}(\mathbf{y}, MY)^\dagger \text{Var}(\mathbf{y})^{-1} [\mathbf{y} - \mathbf{E}(\mathbf{y})]
\]
With best prediction, predicted milk yields have less variance than true milk yields. With TIM, estimated yields have more variance than true yields. The reason is that predicted yields are regressed toward the mean unless all 305 daily yields are observed. With best prediction, the predicted MY for a lactation without any observed yields is E(MY) which is the population or herd mean for a cow of that age and season. With TIM, the estimated MY is undefined if no daily yields are recorded.

Milk, fat, and protein yields can be processed separately using single-trait best prediction or jointly using multi-trait best prediction. Replacement of \( M_1, M_2, \ldots, M_n \) with \( F_1, F_2, \ldots, F_n \) or \( P_1, P_2, \ldots, P_n \) gives the single-trait predictions for fat or for protein. Multi-trait predictions require larger vectors and matrices but similar algebra. Products of trait correlations and autoregressive correlations, for example, may provide the needed covariances.

2.1.4.3.3 Multiple-Trait Procedure (MTP) (Schaeffer and Jamrozik, 1996)

The Multiple-Trait Procedure predicts 305-d lactation yields for milk, fat, protein and SCS, incorporating information about standard lactation curves and covariances between milk, fat, and protein yields and SCS. Test day yields are weighted by their relative variances, and standard lactation curves of cows of similar breed, region, lactation number, age, and season of calving are used in the estimation of lactation curve parameters for each cow. The multiple-trait procedure can handle long intervals between test days, test days with milk only recorded, and can make 305-d predictions on the basis of just one test day record per cow. The procedure also lends itself to the calculation of peak yield, day of peak yield, yield persistency, and expected test-day yields, which could be useful management tools for a producer on a milk recording program.

The MTP method is based upon Wilmink’s model in conjunction with an approach incorporating standard curve parameters for cows with the same production characteristics. Wilmink’s function for one trait is

\[
y = A + Bt - C \exp(-0.05t) + e
\]

where \( y \) is yield on day \( t \) of lactation, \( A, B, \) and \( C \) are related to the shape of the lactation curve.
The parameters $A$, $B$, and $C$ need to be estimated for each yield trait. The yield traits have high phenotypic correlations, and MTP would incorporate these correlations. Use of MTP would allow for the prediction of yields even if data were not available on each test day for a cow. The vector of parameters to be estimated for one cow are designated:

$$
\mathbf{c} = \begin{pmatrix}
A_M \\
B_M \\
C_M \\
A_F \\
B_F \\
C_F \\
A_P \\
B_P \\
C_P \\
A_S \\
B_S \\
C_S 
\end{pmatrix}
$$

where $M$, $F$, and $P$ represent milk, fat, and protein, respectively, and $S$ represents somatic cell score. The vector $\mathbf{c}$ is to be estimated from the available test-day records. Let $\mathbf{c}_o$ represent the corresponding parameters estimated across all cows with the same production characteristics as the cow in question.

Let

$$
\mathbf{y}_k = \begin{pmatrix}
M_k \\
F_k \\
P_k \\
S_k 
\end{pmatrix}
$$

be the vector of yield traits and somatic cell scores on test $k$ at day $t$ of the lactation.
The incidence matrix, $X_k$, is constructed as follows:

$$
X_k = \begin{bmatrix}
1 & 0 & 0 & 0 \\
t & 0 & 0 & 0 \\
\exp(-0.05t) & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & t & 0 & 0 \\
0 & \exp(-0.05t) & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & t & 0 \\
0 & 0 & \exp(-0.05t) & 0 \\
0 & 0 & 0 & 1 \\
0 & 0 & 0 & t \\
0 & 0 & 0 & \exp(-0.05t)
\end{bmatrix}
$$

The MTP equations are:

$$(X'R^{-1}X + G^{-1})\hat{c} = X'R^{-1}y + G^{-1}c_o$$

where

$$X'R^{-1}X = \sum_{k=1}^{n} X_k' R_k^{-1} X_k$$

and

$$X'R^{-1}y = \sum_{k=1}^{n} X_k' R_k^{-1} y_k$$

and $n$ is the number of tests for that cow. $R_k$ is a matrix of order 4 that contains the variances and covariances among the yields on $k^{th}$ test at day $t$ of lactation. The elements of this matrix were derived from regression formulas based on fitting phenotypic variances and covariances of yields to models with $t$ and $t^2$ as covariates. Thus, element $ij$ of $R_k$ would be determined by

$$r_{ij}(t) = \beta_{0ij} + \beta_{1ij}(t) + \beta_{2ij}(t^2).$$

$G$ is a 12 x 12 matrix containing variances and covariances among the parameters in $c$ and represents the cow to cow variation in these parameters, which includes genetic and permanent environmental effects, but ignores genetic covariances between cows. The parameters for $G$ and $R_k$ vary depending on the breed, but must be known. Initially, these matrices were allowed to vary by region of Canada in addition to breed, but this meant that there could exist two cows with identical production records on the same days in milk, but because one cow was in one region and the other cow was in another...
region, then the accuracy of their predictions would be different. This was considered to be too confusing for dairy producers, so that regional differences in variance-covariance matrices were ignored and one set of parameters would be used for all regions for a particular breed. Estimation of $G$ is described later.

If a cow has a test, but only milk yield is reported, then

$$y_k' (M_k 0 0 0),$$

and

$$R_k = \begin{bmatrix}
  r_{MM}^{(2)} & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0 \\
  0 & 0 & 0 & 0
\end{bmatrix}$$

The inverse of $R_k$ is the regular inverse of the nonzero submatrix within $R_k$, ignoring the zero rows and columns. Thus, missing yields can be accommodated in MTP.

Accuracy of predicted 305-d lactation totals depends on the number of test-day records during the lactation and DIM associated with each test. Thus, any prediction procedure will require reliability figures to be reported with all predictions, especially if fewer tests at very irregular intervals are going to be frequent in milk recording. At the moment an approximate procedure is applied that uses the inverse elements of $(X'R^{-1}X + G^{-1})^{-1}$.

**Example calculations**

Four test day records on a 25 mo old, Holstein cow calving in June from Ontario are given in the table below.

**Table 1. Example test day data for a cow.**

<table>
<thead>
<tr>
<th>Test No.</th>
<th>DIM = $t$</th>
<th>$\exp(-.05t)$</th>
<th>Milk (kg)</th>
<th>Fat (kg)</th>
<th>Protein (kg)</th>
<th>SCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>0.47237</td>
<td>28.8</td>
<td></td>
<td></td>
<td>3.130</td>
</tr>
<tr>
<td>2</td>
<td>54</td>
<td>0.06721</td>
<td>29.2</td>
<td>1.12</td>
<td>0.87</td>
<td>2.463</td>
</tr>
<tr>
<td>3</td>
<td>188</td>
<td>0.000083</td>
<td>23.7</td>
<td>0.97</td>
<td>0.78</td>
<td>2.157</td>
</tr>
<tr>
<td>4</td>
<td>250</td>
<td>0.0000037</td>
<td>20.8</td>
<td></td>
<td></td>
<td>2.619</td>
</tr>
</tbody>
</table>
Notice that two tests do not have fat and protein yields, and that intervals between tests are irregular and large. The vector of standard curve parameters based on all available comparable cow, is

\[
\mathbf{c}_0 = \begin{bmatrix}
27.53957 \\
-0.024306 \\
-2.996587 \\
0.874776 \\
-0.000044 \\
0.172253 \\
0.801297 \\
-0.00208 \\
-0.109917 \\
2.042824 \\
0.001917 \\
0.997263
\end{bmatrix}
\]

The \( R_k \) matrices for each test day need to be constructed. These matrices are derived from regression equations. The equations for Holsteins were:

\[
\begin{align*}
\mathbf{r}_{MM}(t) &= 71.0752 - 0.281201 t + 0.0004977 t^2 \\
\mathbf{r}_{MF}(t) &= 2.4365 - 0.013274 t + 0.0000302 t^2 \\
\mathbf{r}_{MP}(t) &= 2.0504 - 0.008286 t + 0.0000163 t^2 \\
\mathbf{r}_{MS}(t) &= -1.7993 + 0.013209 t - 0.000056 t^2 \\
\mathbf{r}_{PF}(t) &= 0.1312 - 0.000725 t + 0.000001586 t^2 \\
\mathbf{r}_{FP}(t) &= 0.0739 - 0.000386 t + 0.000000926 t^2 \\
\mathbf{r}_{FS}(t) &= -0.0386 + 0.000292 t - 0.000001796 t^2 \\
\mathbf{r}_{PS}(t) &= 0.066 - 0.000267 t + 0.000005636 t^2 \\
\mathbf{r}_{SS}(t) &= -0.0404 + 0.000369 t - 0.000001743 t^2 \\
\mathbf{r}_{SP}(t) &= 3.0404 - 0.000083 t - 0.000006105 t^2
\end{align*}
\]
The inverses of the residual variance-covariance matrices for yields for the four test days are as follows:

\[
R_1 = \begin{bmatrix}
0.0151259 & 0 & 0 & 0.0080354 \\
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
0.0080354 & 0 & 0 & 0.3334553
\end{bmatrix}
\]

\[
R_2 = \begin{bmatrix}
0.1685584 & 0.345947 & -4.851935 & 0.0254775 \\
-0.345947 & 26.830915 & -17.40281 & -0.041445 \\
-4.851935 & -17.40281 & 187.18579 & -0.584885 \\
0.0254775 & -0.041445 & -0.584885 & 0.3365425
\end{bmatrix}
\]

\[
R_3 = \begin{bmatrix}
0.2620161 & 0.1479068 & -7.943903 & 0.0316069 \\
0.1479068 & 54.446977 & -56.01333 & 0.3306741 \\
-7.943903 & -56.01333 & 317.9609 & -0.92601 \\
0.0316069 & 0.3306741 & -0.92601 & 0.3654369
\end{bmatrix}
\]

\[
R_4 = \begin{bmatrix}
0.0329465 & 0 & 0 & 0.0251039 \\
0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 \\
0.0251039 & 0 & 0 & 0.3981981
\end{bmatrix}
\]

The matrix \( G \) of order 12 is the same for all cows of the same breed, and is shown in partitioned form:

**Upper Left** 6 x 6

\[
\begin{bmatrix}
0.1071767 & 0 & 0 & -0.136926 & 0 & 0 \\
7715.8655 & 0 & 0 & -17488.1 & 0 & 0 \\
0.0081987 & 0 & 0 & -0.016434 & 0 & 0 \\
23.298605 & 0 & 0 & 0.002507 & 0 & 0 \\
1758757 & 0 & 0 & 0.3654369 & 0 & 0 \\
1.235102 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\]

**Upper Right** 6 x 6

\[
\begin{bmatrix}
-3.277253 & 0 & 0 & 0.0159958 & 0 & 0 \\
0 & -216515.9 & 0 & 0 & 2036.696 & 0 \\
0 & 0 & -0.2011 & 0 & 0 & 0.002507 \\
-18.22036 & 0 & 0 & 0.1014891 & 0 & 0 \\
0 & -1261220 & 0 & 0 & 8337.366 & 0 \\
0 & 0 & -0.585594 & 0 & 0 & -0.00712
\end{bmatrix}
\]
Note that many covariances between different parameters of the lactation curves have been set to zero. When all covariances were included, the prediction errors for individual cows were very large, possibly because the covariances were highly correlated to each other within and between traits. Including only covariances between the same parameter among traits gave much smaller prediction errors.

The elements of the MTP equations of order 12 for this cow are shown in partitioned format also:

\[ X'R^{-1}X = \]

### Upper Left \(6 \times 6\)

<table>
<thead>
<tr>
<th></th>
<th>0.4786468</th>
<th>66.824686</th>
<th>0.0184957</th>
<th>-0.19804</th>
<th>9.125325</th>
<th>-0.023239</th>
</tr>
</thead>
<tbody>
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<td>11814.771</td>
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<td>9.125325</td>
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<td>-0.001563</td>
</tr>
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<td>14684.901</td>
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</tr>
<tr>
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<td>81.277893</td>
<td>11684.901</td>
<td>1.8078249</td>
<td>2002612.9</td>
<td>98.228104</td>
<td>0.1212006</td>
</tr>
</tbody>
</table>

### Upper Right \(6 \times 6\)

<table>
<thead>
<tr>
<th></th>
<th>-12.79584</th>
<th>-1755.458</th>
<th>-0.326758</th>
<th>0.0902237</th>
<th>13.714392</th>
<th>0.0055107</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-1755.458</td>
<td>-29491.75</td>
<td>-17.73328</td>
<td>13.714392</td>
<td>2762.2039</td>
<td>0.1493179</td>
</tr>
<tr>
<td></td>
<td>-0.326758</td>
<td>-17.73328</td>
<td>-0.021917</td>
<td>0.0055107</td>
<td>0.1493179</td>
<td>0.001908</td>
</tr>
<tr>
<td></td>
<td>-73.41614</td>
<td>-11470.26</td>
<td>-1.174292</td>
<td>0.2892287</td>
<td>59.928675</td>
<td>-0.002758</td>
</tr>
<tr>
<td></td>
<td>-11470.26</td>
<td>-2030482</td>
<td>-64.03474</td>
<td>59.928675</td>
<td>11566.49</td>
<td>-1.4526</td>
</tr>
<tr>
<td></td>
<td>-1.174292</td>
<td>-64.03474</td>
<td>-0.078612</td>
<td>-0.002758</td>
<td>-0.14526</td>
<td>-0.000187</td>
</tr>
</tbody>
</table>

### Lower Right \(6 \times 6\)

<table>
<thead>
<tr>
<th></th>
<th>505.14668</th>
<th>69884.681</th>
<th>12.607147</th>
<th>-1.510895</th>
<th>-205.6737</th>
<th>-0.39387</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>11783844</td>
<td>684.32233</td>
<td>-205.6737</td>
<td>-34434.43</td>
<td>-2.137195</td>
<td>-0.002642</td>
</tr>
<tr>
<td></td>
<td>0.845549</td>
<td>-0.39387</td>
<td>-2.137195</td>
<td>1.4336329</td>
<td>191.42681</td>
<td>0.1801651</td>
</tr>
<tr>
<td></td>
<td>1.4336329</td>
<td>191.42681</td>
<td>0.1801651</td>
<td>38859.772</td>
<td>3.5902121</td>
<td>0.0759252</td>
</tr>
</tbody>
</table>

And the **Lower Right** \(6 \times 6\)
Section 2 - Rules, standards and guidelines for milk production recording

\[
X'R^{-1}y = \\
\begin{bmatrix}
1.813004 \\
257.30912 \\
0.24295 \\
18.048269 \\
2762.4114 \\
0.3174273 \\
3.6520902 \\
653.97454 \\
0.0166432 \\
4.9935515 \\
678.86668 \\
0.6708264
\end{bmatrix}
\]

\[
G^{-1}c_x = \\
\begin{bmatrix}
0.2378446 \\
-137.8976 \\
-0.002795 \\
2.2183526 \\
624.94513 \\
0.3192604 \\
1.1512642 \\
3441.8785 \\
-0.380704 \\
0.7334103 \\
-7.895393 \\
0.0169737
\end{bmatrix}
\]
The solution vector for this cow is

\[
\mathbf{e} = \begin{bmatrix}
28.875659 \\
-0.028768 \\
-0.454583 \\
0.9842104 \\
-0.00124 \\
0.3339813 \\
0.8375506 \\
-0.00034 \\
-0.038198 \\
2.084599 \\
0.0017539 \\
1.9446955
\end{bmatrix}
\]

To predict 305-day yields, \( Y_{305} \)

\[
Y_{305} = \sum_{t=1}^{305} (A + Bt + C\exp(-0.05t))
\]

\[
= 305(A) + 46665(B) + 19.504162(C),
\]

is used separately for each trait (milk, fat, protein, and SCS). The results for this cow were 7456 kg milk, 301 kg fat, and 239 kg protein. The result for SCS is divided by 305 to give an average daily SCS of 2.477.
### 2.1.5. ICAR guidelines for lactation calculation

#### 2.1.5.1. Calculation examples by using the Test Interval Method

**Data:**

**Calving March 25**

<table>
<thead>
<tr>
<th></th>
<th>Date of recording</th>
<th>Number of days</th>
<th>Quantity of milk weighed in kg</th>
<th>Fat percentage</th>
<th>Fat in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>8</td>
<td>14</td>
<td>28.2</td>
<td>3.65</td>
<td>1 029</td>
</tr>
<tr>
<td>May</td>
<td>6</td>
<td>28</td>
<td>24.8</td>
<td>3.45</td>
<td>856</td>
</tr>
<tr>
<td>June</td>
<td>5</td>
<td>30</td>
<td>26.6</td>
<td>3.40</td>
<td>904</td>
</tr>
<tr>
<td>July</td>
<td>7</td>
<td>32</td>
<td>23.2</td>
<td>3.55</td>
<td>824</td>
</tr>
<tr>
<td>August</td>
<td>2</td>
<td>26</td>
<td>20.2</td>
<td>3.85</td>
<td>778</td>
</tr>
<tr>
<td>August</td>
<td>30</td>
<td>28</td>
<td>17.8</td>
<td>4.05</td>
<td>721</td>
</tr>
<tr>
<td>September</td>
<td>25</td>
<td>26</td>
<td>13.2</td>
<td>4.45</td>
<td>587</td>
</tr>
<tr>
<td>October</td>
<td>27</td>
<td>32</td>
<td>9.6</td>
<td>4.65</td>
<td>446</td>
</tr>
<tr>
<td>November</td>
<td>22</td>
<td>26</td>
<td>5.8</td>
<td>4.95</td>
<td>287</td>
</tr>
<tr>
<td>December</td>
<td>20</td>
<td>28</td>
<td>4.4</td>
<td>5.25</td>
<td>231</td>
</tr>
</tbody>
</table>

Beginning of lactation: March 26  
End of lactation: January 3  
Duration of lactation period: 284 days  
Number of testings (weighings): 10
Computation by using the Test Interval Method

(continued)

<table>
<thead>
<tr>
<th>Interval both days included</th>
<th>Days</th>
<th>Kg milk</th>
<th>Grams of fat</th>
<th>Kg fat</th>
<th>Kg fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 26 - Apr 8</td>
<td>14</td>
<td>28.2</td>
<td>1 029</td>
<td>395</td>
<td>14.410</td>
</tr>
<tr>
<td>Apr 9 - May 6</td>
<td>28</td>
<td>(28.2+24.8)</td>
<td>(1 029+856)</td>
<td>742</td>
<td>26.389</td>
</tr>
<tr>
<td>May 7 - June 5</td>
<td>30</td>
<td>(24.8+26.6)</td>
<td>(856+904)</td>
<td>771</td>
<td>26.400</td>
</tr>
<tr>
<td>June 6 - July 7</td>
<td>32</td>
<td>(26.6+23.2)</td>
<td>(904+824)</td>
<td>797</td>
<td>27.648</td>
</tr>
<tr>
<td>July 8 - Aug. 2</td>
<td>26</td>
<td>(23.2+20.2)</td>
<td>(824+778)</td>
<td>564</td>
<td>20.817</td>
</tr>
<tr>
<td>Aug. 3 - Aug 30</td>
<td>28</td>
<td>(20.2+17.8)</td>
<td>(778+721)</td>
<td>532</td>
<td>20.980</td>
</tr>
<tr>
<td>Aug 31 - Sept. 25</td>
<td>26</td>
<td>(17.8+13.2)</td>
<td>(721+587)</td>
<td>403</td>
<td>17.008</td>
</tr>
<tr>
<td>Oct. 28 - Nov. 22</td>
<td>26</td>
<td>(9.6+5.8)</td>
<td>(446+287)</td>
<td>200</td>
<td>9.536</td>
</tr>
<tr>
<td>Nov. 23 - Dec. 20</td>
<td>28</td>
<td>(5.8+4.4)</td>
<td>(287+231)</td>
<td>143</td>
<td>7.253</td>
</tr>
<tr>
<td>Dec. 21 - Jan. 3</td>
<td>14</td>
<td>4.4</td>
<td>231</td>
<td>62</td>
<td>3.234</td>
</tr>
</tbody>
</table>

Total quantity of milk: 4 973. kg

Total quantity of fat: 190 kg

Average fat percentage \(\frac{190.216 \times 100}{4 973} = 3.82\%\)
2.1.5.2. Additional approved calculation methods (centering date method)

<table>
<thead>
<tr>
<th>Date of recording</th>
<th>Quantity of milk kg</th>
<th>No of days per interval</th>
<th>Fat %</th>
<th>Total milk kg</th>
<th>Fat kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>April</td>
<td>8</td>
<td>28.2</td>
<td>28</td>
<td>3.65</td>
<td>790</td>
</tr>
<tr>
<td>May</td>
<td>6</td>
<td>24.8</td>
<td>28</td>
<td>3.45</td>
<td>694</td>
</tr>
<tr>
<td>June</td>
<td>5</td>
<td>26.6</td>
<td>28</td>
<td>3.40</td>
<td>745</td>
</tr>
<tr>
<td>July</td>
<td>7</td>
<td>23.2</td>
<td>28</td>
<td>3.55</td>
<td>650</td>
</tr>
<tr>
<td>August</td>
<td>2</td>
<td>20.2</td>
<td>28</td>
<td>3.85</td>
<td>566</td>
</tr>
<tr>
<td>August</td>
<td>30</td>
<td>17.8</td>
<td>28</td>
<td>4.05</td>
<td>498</td>
</tr>
<tr>
<td>September</td>
<td>25</td>
<td>13.2</td>
<td>28</td>
<td>4.45</td>
<td>370</td>
</tr>
<tr>
<td>October</td>
<td>27</td>
<td>9.6</td>
<td>28</td>
<td>4.65</td>
<td>269</td>
</tr>
<tr>
<td>November</td>
<td>22</td>
<td>5.8</td>
<td>28</td>
<td>4.95</td>
<td>162</td>
</tr>
<tr>
<td>December</td>
<td>20</td>
<td>4.4</td>
<td>28</td>
<td>5.25</td>
<td>123</td>
</tr>
</tbody>
</table>

Total quantity of milk: (kg) = 4 866
Total quantity of fat (kg) = 187

Average fat percentage: \[ \frac{186.575 \times 100}{4 \text{,} 866} = 3.83\% \]

2.1.6. ICAR guidelines on the Lactation Period (LP)

2.1.6.1. A lactation Period is considered to commence:

a) The day the animal gives birth.

or

b) In the absence of a birth date, the best estimate of day that the animal commenced milk production and

c) When a birth is defined as a parturition taking place after the mid point of the gestation period if a service has been recorded, or if no service event has been recorded taking place after at least 75% of the normal gestation period has elapsed since the previous birth event was recorded.

Any parturition falling outside the above definition shall be recorded as an 'end pregnancy/ abortion and shall not start a new lactation period.

For cows of dairy breeds the normal gestation length shall be 280 days.

For goats and sheep, the normal gestation length shall be 150 days.

If the first recorded date falls within 4 days of the lactation start date, the milk yield and contents at the first recorded visit should not form part of the official lactation record.
2.1.6.2. A lactation period is considered to end:

1. The day that the lactation period as defined by the member or by ICAR has been completed or
   The day that the animal ceases to give milk (goes dry) or
   The animal is suckled in any recording day other than the first in the lactation period or
   The day the animal gives less than the "minimum standard quantity" of milk for the species (unless
   recorded sick/absent).
   The minimum standard quantity is:
   a) Cows < 3 kg/day or < 1.0 kg/milking.
   b) Goats/Sheep < 0.2 kg/day or 0.05 kg/milking.

2. When it is normal practice to record dry dates, in the absence of a date, the due to dry off date
   may be used, or the animal may be assumed to be dry the day after it was last recorded to be in
   milk or
   When it is normal practice not to record the dry date, the day of the midpoint between the last
   recording with the cow in milk and the first recording day with the animal dry may be assumed to
   be the Dry Date.
   The lactation period ends on which ever date of 1 or 2 above occurs first.
   Animals may be recorded as absent or sick on recording days, without such an event ending the
   lactation period.

2.1.6.3. Milking period

In the case of animals which are suckled for a significant period after the lactation period start date
(e.g. some sheep) the lactation record should be expressed as a 'milking period' record.
The milking period (symbol MP) begins the day after the animal was last suckled and ends as defined
for the lactation period.

2.1.6.4. Production period

In the case where yield records are calculated on the basis of a 'period of production', usually a year, the
record should be expressed as a 'production period record' (symbol PP).
The production period beginning the day after the last production period ended and ending as defined by the
length (in days) of the production period.

2.1.7. ICAR guidelines on missing results and/or abnormal intervals

1. A daily test value is the best estimate of the yield and the components of the milk weighed, sampled and recorded in 24 hours on the day of recording.
When herds are normally milked at intervals such that the test day is other than 24 hours, the yields shall be adjusted to a 24 hour interval using the following procedure (or other procedures approved by the ICAR Board):

Divide 24 by the interval, then multiply by the yield. For example:

a) For a 25 hour interval \((24/25) \times 35 \text{ kg} = 33.6 \text{ kg}\)

b) For a 20 hour interval \((24/20) \times 35 \text{ kg} = 42 \text{ kg}\)

2. A ‘recording is a set of daily test values for a given animal on a given day of recording, one or some or all of them can be missed (missing values).

3. ‘Missing Values can be due to:
   - Vacation (once per year).
   - Out of range (see note 5).
   - Sickness, injury, animal under treatment or on heat (see note 6).
   - Disaster (reason must be reported).
   - No sample test results.

4. The number of the official and complete (milk, fat and protein) recordings in the lactation should be reported.

5. Range of the daily test values.

<table>
<thead>
<tr>
<th>Milk (kg)</th>
<th>Fat %</th>
<th>Protein %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Main Dairy Cattle Breeds</td>
<td>3.0</td>
<td>99.9</td>
</tr>
<tr>
<td>High Fat Cattle Breeds a</td>
<td>3.0</td>
<td>99.9</td>
</tr>
<tr>
<td>Goats</td>
<td>0.3</td>
<td>30.0</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.3</td>
<td>30.0</td>
</tr>
</tbody>
</table>

*Breed average higher than 5.0 for fat %.

Outside of these ranges, the daily test value will be considered as a ‘missing value.

6. The true daily test values collected from animals labeled by the farmer as sick, injured, under treatment, or ‘on heat must be used in the computation of the lactation record unless the milk yield is less than 50% of the previous milk yield or less than 60% of the predicted yield. In such a case, the whole set of daily test values may be considered as missing.

7. Estimates of the missing values of a daily test can be computed by using interpolation procedures or by more sophisticated procedures approved by ICAR.

8. For any ICAR method the interval between two consecutive recordings must routinely fulfil the value for the acceptable range. This rule does not apply to the recordings at the beginning and at the end of the lactation.

9. If the first recording occurs within 14 days from calving, then no adjustment is required to the first test value when computing the lactation record. If the first recording occurs 15 to 80 days from calving, then an adjustment procedure may be applied.
10. If the 305th day of a lactation falls before the last recording, the interpolation method should be used also for the last period to compute the yields.

2.1.8 Milk recording from Automatic Milking Systems (AMS)

2.1.8.1 Estimation of 24-hour milk yield

2.1.8.1.1 Using data on more than one day (Lazenby et al., 2002)

2.1.8.1.1.1 Principles

An average of most recent milk weights is used for estimating 24-hour daily milk yield collected from Automatic Milking Systems. The average of most recent milk weights can be calculated using a number of preceding milkings or a number of preceding days. If number of milkings is used, the optimal estimate of the milking rate is obtained using an average of current milking together with the 12 most recent milkings back in time. The optimal estimate is the maximum value of the difference curve at which the correlation with the ‘true’ 24-hour milk yield is greatest and the variance across milkings is minimized. If number of days is used, the optimal estimate of the milking rate is obtained using an average of all milkings occurred in the last 96 hours (4 most recent days). In Table 2.1.8.1 percent of maximum difference for various number of milkings and days is reported. The optimal estimate is independent from stage of lactation and parity.

<table>
<thead>
<tr>
<th>Days</th>
<th>Percent Max.</th>
<th>Current milking + most recent milkings</th>
<th>Percent Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49.38</td>
<td>10</td>
<td>97.85</td>
</tr>
<tr>
<td>2</td>
<td>77.26</td>
<td>11</td>
<td>99.08</td>
</tr>
<tr>
<td>3</td>
<td>92.34</td>
<td>12</td>
<td>99.70</td>
</tr>
<tr>
<td>4</td>
<td>98.91</td>
<td>13</td>
<td>99.81</td>
</tr>
<tr>
<td>5</td>
<td>98.50</td>
<td>14</td>
<td>99.40</td>
</tr>
</tbody>
</table>
### 2.1.8.1.1.2 Example for calculating 24-hour milk yield

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk Yield (kg)</th>
<th>Time (hrs)</th>
<th>Current Milking</th>
<th>12 Milking Back</th>
<th>4 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-12-26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_1 = 10.7$</td>
<td>$t_1 = 6.50$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_2 = 10.1$</td>
<td>$t_2 = 6.03$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_3 = 13.2$</td>
<td>$t_3 = 7.80$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000-12-25</td>
<td>$y_4 = 9.6$</td>
<td>$t_4 = 6.00$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_5 = 12.5$</td>
<td>$t_5 = 7.02$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_6 = 11.9$</td>
<td>$t_6 = 6.50$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_7 = 10.4$</td>
<td>$t_7 = 6.20$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000-12-24</td>
<td>$y_8 = 11.7$</td>
<td>$t_8 = 6.77$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_9 = 11.0$</td>
<td>$t_9 = 6.38$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_{10} = 10.1$</td>
<td>$t_{10} = 6.45$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_{11} = 8.5$</td>
<td>$t_{11} = 5.13$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000-12-23</td>
<td>$y_{12} = 13.7$</td>
<td>$t_{12} = 4.32$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_{13} = 6.0$</td>
<td>$t_{13} = 6.90$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_{14} = 10.5$</td>
<td>$t_{14} = 6.90$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$y_{15} = 9.5$</td>
<td>$t_{15} = 6.30$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Therefore, 24-hour yield estimation using most recent milkings \((1+12)\):

\[
24 \text{ Hour Milk Yield} = \left( \frac{\sum_{i=1}^{13} y_i}{\sum_{i=1}^{13} t_i} \right) \times 24 = \left( \frac{10.7+10.1+13.2+\cdots+8.5+13.7+6.0}{6.5+6.03+7.8+\cdots+5.13+4.32+6.9} \right) \times 24 = 40.8
\]

And, 24-hour yield estimation using all milkings occurred in the last 96 hours (most recent 4 days), all milking in the last 4 days are included:
24 Hour Milk Yield = \left( \frac{\sum_{i=1}^{15} y_i}{\sum_{i=1}^{15} f_i} \right) \times 24 = \left[ \frac{(10.7 + 10.1 + 13.2 + \cdots + 6.0 + 10.5 + 9.5)}{(6.5 + 6.03 + 7.8 + \cdots + 6.9 + 6.9 + 6.3)} \right] \times 24 = 40.2

### 2.1.8.1.3 Advantages and disadvantages of this method

Concerning Milk Yield, this method leads to a better accuracy of the estimation of the true performance than a performance estimated on a 24h basis only. However, problems of disconnection between Milk weights and contents may arise if contents are recorded on one day only. Moreover, some cows may begin or finish their lactation during the period of recording. In this case the computation of milk yield must be adapted. The number of data that need to be validated is higher (for instance, contents have short interval between two milkings).

### 2.1.8.1.2 Using data on 1 day (Bouloc et al., 2002)

When the number of milkings is reduced to milkings obtained during one day only, the accuracy of the estimation of the true performance is the same as classical milk recording methods with the same interval between two test days. For instance, Milk Yield estimated from all the milkings recorded during 24 hours, and with an interval between two test days of four weeks has the same accuracy than A4.

### 2.1.8.2 Estimation of fat and protein yield (Galesloot and Peeters, 2000)

Calculation of fat and protein percent must be based on milk weights at time of sampling. The 24-hour protein percentage can be predicted by the protein percentage of the sample without adjustment. However, the 24-h fat percentage is more difficult to predict, as levels of fat percent are inversely proportional to the amount of milk yield. It is important then to have a close connection between time of samples and actual milk yields. The best prediction of 24-hour fat percentage should include fat percentage, protein percentage, milk yield and milking interval of the sampled milking, milk yield and milking interval of the preceding milking, and the interaction between milking interval and the ratio of fat to protein percentage of the sampled milking. After the estimation of 24-hour fat and protein percentages, 24-hour fat and protein yield are computed using the preceding 24-hour average milk yield. Under defined restrictions (correct matching, interval at least 4 hours, no interrupted milking) one sampled milking suffices to get a satisfactory estimate for the test day fat yield.

A disadvantage of this procedure is that a 24-hour milk yield computed using an average of the last day is subject to a higher degree of variability (see Table 2.1.8.1). A possible solution could be to use the optimal estimate of 24-hour yield (12 milkings or 4 days) accounting for the negative relationship between fat and protein percent and milk yield.
Fat\%_\text{est} = \text{Fat\%}_\text{obs} + b(Milk\text{\_}\text{est}-\text{Milk\_}\text{obs})

Where \text{Fat\%}_\text{obs} is the observed fat percent at time of sample/s, \text{Milk\_}\text{est} is the optimal estimate of 24-hour milk yield, \text{Milk\_}\text{obs} is the observed milk yield at the time of sample/s, and \(b\) is a linear or curvilinear regression of milk yield on fat percent. Further research is needed to estimate a \(b\) specifically for each population/breed.

2.1.8.3 Sampling period (Hand et al., 2004; Bouloc et al., 2004)

Given the high variability of milking frequency within and across cows during a 24-hour period, the best estimate of fat and protein percents could be then calculated when samples are taken through the complete period. However, a 24-hour sampling is not always a feasible solution for milk recording agencies due to higher cost of this procedure. A less than 24-hour sampling period could be sufficient for a reasonable estimation of fat and protein percentages. Comparison of different protocols suggests collecting all samples (adjusted or unadjusted for covariates) on a 16-hour test day is the optimal protocol when estimating 24-hour yields of fat and protein. Table 2.1.8.3.1 illustrates differences in concordance correlations at various lengths of sampling periods.

<table>
<thead>
<tr>
<th>Sampling hours</th>
<th>Adjusted for covariates</th>
<th>Unadjusted for covariates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Concordance correlation</td>
<td>Lower</td>
</tr>
<tr>
<td>10</td>
<td>0.887</td>
<td>-0.668</td>
</tr>
<tr>
<td>12</td>
<td>0.836</td>
<td>-0.833</td>
</tr>
<tr>
<td>14</td>
<td>0.922</td>
<td>-0.584</td>
</tr>
<tr>
<td>16</td>
<td>0.936</td>
<td>-0.607</td>
</tr>
<tr>
<td>18</td>
<td>0.953</td>
<td>-0.462</td>
</tr>
</tbody>
</table>

Estimation of milk contents: It is recommended to select only milkings which took place at least 4 hours after the previous milking.

2.1.8.4 Milking events collected by the data recording system

(ADR, 2000: Recommendation 1.8 for Milk Procedures with Systems and for Calculation of Performance; Bouloc et al., 2002)

All the milking events and milk yields (i.e., raw data) should be recorded by the data recording system. The computation of the 24h performance is done by the Milk Recording Organization, not via the AMS software in order to guaranty the harmonization of the method of calculation of performance between AMS.
2.1.9 Milk recording from Electronic Milk Meters (EMM)

2.1.9.1 Estimation of 24-hour milk yield

2.1.9.1.1 Using data on more than one day (Hand et al., 2006)

2.1.9.1.1.1 Principles

An average of most recent milk weights is used for estimating 24-hour daily milk yield collected from Electronic Milk Meters. The average of most recent milk weights can be calculated using a number of preceding days. Table 2.1.9.1 reports the concordance correlations for a range of multiple-day averages. As soon as at least the 3 preceding days are used in the calculation, the concordance correlation reaches a high value of at least 0.981. There are no significant differences between 3, 4, 5, 6 and 7-day averages. The correlations are independent from stage of lactation and parity. Thus, 24 hr yields can be the average of from 3 to 7 daily milkings previous to the test day when fat and protein samples were taken.

Table 2.1.9.1 Concordance correlations for different multiple-day averages.

<table>
<thead>
<tr>
<th>Multiple-day average</th>
<th>Concordance correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.957</td>
</tr>
<tr>
<td>2</td>
<td>0.975</td>
</tr>
<tr>
<td>3</td>
<td>0.981</td>
</tr>
<tr>
<td>4</td>
<td>0.981</td>
</tr>
<tr>
<td>5</td>
<td>0.982</td>
</tr>
<tr>
<td>6</td>
<td>0.981</td>
</tr>
<tr>
<td>7</td>
<td>0.981</td>
</tr>
<tr>
<td>10</td>
<td>0.979</td>
</tr>
<tr>
<td>14</td>
<td>0.977</td>
</tr>
</tbody>
</table>
2.1.9.1.1.2 Example for calculating 24-hour milk yield

Example for Calculating 24-hour milk yield using 5 day average

<table>
<thead>
<tr>
<th>Date</th>
<th>Milk yield (kg)</th>
<th>24-hour milk yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-11-10</td>
<td>(y_1 = 21.5)</td>
<td>(m_{24} = 42.5)</td>
</tr>
<tr>
<td></td>
<td>(y_2 = 21.0)</td>
<td></td>
</tr>
<tr>
<td>2007-11-09</td>
<td>(y_1 = 22.5)</td>
<td>(m_{24} = 45.5)</td>
</tr>
<tr>
<td></td>
<td>(y_2 = 23.0)</td>
<td></td>
</tr>
<tr>
<td>2007-11-08</td>
<td>(y_1 = 24.0)</td>
<td>(m_{24} = 41.0)</td>
</tr>
<tr>
<td></td>
<td>(y_2 = 17.0)</td>
<td></td>
</tr>
<tr>
<td>2007-11-07</td>
<td>(y_1 = 25.0)</td>
<td>(m_{24} = 47.0)</td>
</tr>
<tr>
<td></td>
<td>(y_2 = 22.0)</td>
<td></td>
</tr>
<tr>
<td>2000-11-06</td>
<td>(y_1 = 26.5)</td>
<td>(m_{24} = 43.0)</td>
</tr>
<tr>
<td></td>
<td>(y_2 = 16.5)</td>
<td></td>
</tr>
</tbody>
</table>

Therefore, 24-hour yield estimation averaging over 5 days:

\[
24 \text{ Hour Milk Yield} = \left( \frac{\sum_{i=1}^{5} m_{24_i}}{5} \right) = \left[ \frac{(42.5 + 45.5 + 41.0 + 47.0 + 43.0)}{5} \right] = 43.8
\]

2.1.9.1.3 Advantages and disadvantages of this method

Concerning Milk Yield, this method leads to a better accuracy of the estimation of the true performance than a performance estimated on a 24h basis only. However, problems of disconnection between Milk weights and contents have been shown. The estimation bias increases proportionally to the number of days use to compute the 24 hr average. Thus, this method is recommended only if milk weight is the only variable of interest. If milk contents are of interest then the milk weight should be calculated using the milkings from the same day of sampling.

2.1.9.2 Estimation of 24-hour fat and protein yield

Fat and protein yields should be determined from the 24 h yield on the day of sampling, and not the averaged value.
SECTION 2.2 - STANDARDS AND GUIDELINES FOR PERFORMANCE RECORDING IN DAIRY SHEEP

Statement of principles

The aim of this section is to provide definitions, guidelines and standards on performance recording in dairy sheep.

The guidelines have been set up for the first time in 1992 with the purpose of being informative more than normative. They have been regularly updated since then. The reader must have in mind the following considerations to clearly understand the principle of the guidelines.

Unlike the simple situation of exclusively milking soon after calving which predominates in dairy cattle, the dairy sheep systems are much more varied and complicated. In most cases, normal husbandry systems include a suckling (or suckling plus milking) period of at least one month. These variations in systems play a major role in determining the difference in milk recording methods and lactation calculation used for sheep.

Moreover, the impact of milk recording is weak in dairy sheep, even more for qualitative recording, due to its high cost. Therefore, simplified methods such as AT and AC designs are strongly promoted and official milk recording with a purpose of collective valorization should be concentrated in farmers involved in breeding schemes. For commercial flocks within this pyramidal management of the population, a very simplified non official recording called D method, designed only for technical and economic development within a flock, has been proposed.

To meet specific situations in which basic rules of milk recording might not be respected, alternative official milk recording are described, such as E recording or alteration of AC recording.

Finally, as functional and health traits are of growing interest, the last updates in 2014 include udder morphology recording.

2.2.1. The ICAR standard definitions of milk traits

The following terms are used to describe all dairy sheep breeding systems covered:

- **Suckling length** corresponds to the suckling period of lambs or the simultaneous suckling and milking period. *If the lambs only suckle during the colostral phase, the suckling length is considered to be zero.* If there is an initial suckling phase, milk yield during this suckling period is equal either to the milk suckled, if suckling only, or to the milk suckled plus that milked, should there be partial milking during the suckling period.

- **Milking-only length** corresponds to the period during which the ewe is milked, starting when the lamb(s) has (have) been weaned, and until drying off.

- **Lactation length** is equal to the sum of the suckling length plus milking-only length; it is also the difference in days between the date of lambing and the date of drying off.

- **Total milk yield (TMY)** is the milk yield produced from lambing to drying off for a ewe with no suckling period.

- **Total milked milk (TMM)** is the milk yield produced during the milking only period, in the case of lactation with milking only after a suckling period.
• **Total suckled and milked milk (TSMM)** is the sum of the milk yield of the suckling period (milk suckled, or milk suckled plus that milked) plus the TMM.

• **Milk recorded yield**: only the milk yield during exclusive milking can be a part of milk recording on farms. If the suckling period is not of zero length, the milk yield in dairy sheep only takes into account exclusive milking and the length of the milking-only period (which starts once the lambs are fully weaned and is over when the ewe dries off): it corresponds to the TMM.

The following situations therefore arise:

2.2.1.1 Milking from lambing

The ewes are milked after lambing (once the colostral phase is over), as is usually the case with dairy cattle.

<table>
<thead>
<tr>
<th>Lambing</th>
<th>Drying off</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Milking only</td>
</tr>
</tbody>
</table>

The lactation length and the length of the milking-only period are thus equal (not counting the colostral phase). Milk yield during exclusive milking equals the total milk yield during lactation (TMY).

2.2.1.2 Milking after a suckling period

The ewes are milked after a suckling period for the lambs or after a combined suckling plus milking period.

<table>
<thead>
<tr>
<th>Lambing</th>
<th>Weaning</th>
<th>Drying off</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Suckling</td>
<td>Milking only</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>(suckling plus milking)</td>
</tr>
</tbody>
</table>

Milk yield during the milking-only period (TMM) is therefore smaller than total milk yield during lactation (TSMM); only the downward phase of the lactation curve is recorded in almost all cases, and the lactation peak falls within the initial suckling (or suckling plus partial milking) period. The length of the milking-only period equals the lactation length minus the suckling length.

Through the incorrect use of language, we often speak broadly of lactation calculations, whereas here it is used specifically for the milk yield calculation using the milking-only period (TMM).
2.2.1.3 Total milk yield and production of reference

Either the total milk yield per lactation (TMY or TSMM) or the milk yield during the milking-only period (TMM) is calculated, according to whether mechanical/by hand milking starts from lambing, or whether it starts after a suckling period. Because breeding systems may differ significantly between area and breed, it is impossible to define a standard lactation length or a standard milking length (of the milking-only period). We therefore recommend that the approved organisation defines, for each breed and category of ewes (by age or lactation number), a reference production per lactation, or a reference production for the milking-only period, according to the breeding system. The chosen standard length (in days) must be declared in the publication of the results.

2.2.2. ICAR rules and standards

This chapter describes all the standards applicable in all cases for official methods A, B, C or E milk recording for sheep.

2.2.2.1 Responsibility and type of recording

The recording operations described below are carried out by a State employee or an employee of an officially registered organisation (the milk recording itself being undertaken by an official tester of the organisation in method A; by the farmer or his employee in method B; by the official tester and/or the farmer in methods C and E):

- Identification of animals by conventional or RFID devices on the basis of the official national system.
- Recording of information on mating, artificial insemination, lambing, milk recording (ewe and flock), and inventories in the flocks of owner-breeders.
- Checking records and making periodic visits to the sheep farms: organisation of controlled mating (optional), keeping of lambing records; marking of lambs at birth; checking on sire and dam assignment based on the average length of gestation and its standard deviation (i.e. an average gestation period of x days, plus or minus y days). The values of x and y must be provided for each breed or group of breeds concerned in each country.

Whatever the recording method - A, B, C or E - used for milk recording, certain information is provided by the breeder himself, such as mating and lambing information (in the case of controlled mating). Breeders are subject to a supervisory system that must be operated by a recognised recording organisation. For instance, in this case, it may be a check on pedigree by blood group or DNA testing. Any information produced directly by the breeders (rather than an official recorder) must be subject to the supervisory procedure described by the recognised recording organisation.

2.2.2.2 Ewes to be controlled

2.2.2.2.1 Case of the methods A, B, C

The breeder may split his flock into one or several flocks for management purposes. If the breeder is managing several flocks, he may record only one of his flocks, on the condition that he agrees to always breed the recorded flock separately from his other non-recorded flock(s), which can be
considered to be commercial flocks. Similarly, if only one of the flocks of the breeder is recorded, mixing the ewes of a non-recorded flock with the ewes of the recorded flock during the milking period is not permissible.

An inventory of those ewes on the recorded flock(s) that belong to the breeder in question is kept throughout the milk recording operation, from the beginning to the end of milking. Whenever there is (quantitative) milk recording for the recorded flock, all the ewes being exclusively milked (of the breeds or genotypes involved in the breeding program) must be recorded; the principle of complete recording is essential to avoid sampling biases. Ewes suckled, or suckled and partially milked, during the sucking phase (see Section 2.2.1) must not be included, as it is impossible to measure the individual milk yield of suckled ewes, or suckled and partially milked ewes, simply and accurately (an essential condition for the large-scale application of milk recording on sheep farms). Consequently, only milk recording carried out when the ewe is definitively separated from its lamb(s) i.e. only when being milked exclusively, can be taken into account.

In addition, if dairy ewes belonging to another farmer are being kept for part of the year at the farm where milk is being officially recorded, they must not be included in the official recording for that farm. This is why it is essential that all ewes belonging to a breeder who applies method A or B or C milk recording for his flock(s) must be included in an up-to-date and accurate inventory.

2.2.2.2 Case of the method E

Method E is a flexible official method applied when the breeding purpose is to maintain the breed with all the typical standard performance signs (flocks without milk production and/or flocks with only a fraction of the ewes belonging to the flock-book). In the first case, the rule of not recording suckling ewes may not be respected (the lambs must be removed at least 12 hours before the test-day). In the second case, the rule of recording all the animals of the flock may not be respected (only designated ewes or designated lactations are recorded). A comprehensive description of method E is available in the minutes of the meeting of the Working Group on Milk Recording of Sheep, held in Interlaken on 28 May 2002 (on the web at: www.icar.org/Documents/Astruc/Minutes_28_5_2002.doc)

2.2.3 First test-day

2.2.3.1 For the flock

The first test-day of the flock takes place four to 15 days after the beginning of mechanical/hand-milking only in the flock. This recommendation is suitable for the practical organisation of tests on the basis of a monthly recording interval.
2.2.2.3.2 For a ewe

The first milk recording of a ewe must take place within the 35 days following complete separation from its lambs (method E excepted), with a tolerance of 17 days to take into account the starting of milking only by batch and fluctuations in the periodicity of milk recorders' visits. Consequently, the difference between lambing and the first (quantitative) milk recording of a ewe is at most equal to the average sucking length of the breed in question plus 52 days (35 + 17). If this difference is greater than the threshold described above, there should be no lactation calculation for the ewe in question. For example, for breeds whose average suckling period lasts 0 days (colostral phase only), 25 days or 45 days, the first quantitative milk recording of each ewe must take place less than 52, 77 or 97 days, respectively, after lambing.

2.2.2.4 Frequency and number of milk recording visits

2.2.2.4.1 For the flock

In the case of record of the two daily milkings, the average recording interval (days) between two successive milk recording for a flock is monthly (30 days, with a range from 28 to 34 days) for the A4, B4, C4 or E4 methods, and it can reach, respectively, 36 and 42 days for the A5, B5 or C5, and A6, B6 or C6 methods. If only one daily milking is recorded (AT, BT, CT, AC, BC, CC, EC or ET methods), the average recording interval is monthly (30 days), as for the A4 method (considered as the standard method). There is no minimum interval, so supplementary testing can be carried out when necessary, due to the way the lambing is spread out (e.g. a fortnight to three weeks between two successive tests, so as to cover the start of milking of ewe lambs and taking into account the interval between the adult ewe tests).

There is no fixed number of monthly recordings per flock and per milk period: it must, therefore, be decided upon by each official organisation, as must clauses on the maximum interval (in days) between the first and last (quantitative) milk tests on the flock within a milking operation.

2.2.2.4.2 For a ewe

The maximum interval between two successive non-zero tests on the same ewe is 70 days (2 x 35 days). There is, therefore, a tolerance of one missed test on the basis of a monthly test. If the interval between two tests (i) and (i+1) is greater than the maximum, the lactation calculation for the ewe being tested is stopped at the test (i).

The minimum number of valid monthly tests (milk not zero) per ewe needed for the lactation calculation is not set; it must, therefore, be described for each breed and category of ewe considered (first lactation, second and more).
2.2.2.5 Type and expression of milk recording

The only obligatory milk recording is that of the quantity of milk (i.e. volume/weight recording). Tests on the chemical composition of the milk or qualitative tests are optional (see section 2.2.3). Quantitative recording concerns the quantity of milk supplied by the ewe when milked in the usual conditions on the farm, whether milked by hand or by machine. Should milking be mechanical, it is recommended that the volume of individual milk collected during hand or machine stripping is not taken into account, in order to favor indirect selection as regards adaptability to machine milking. If, nevertheless, the (hand or machine) stripping yield is recorded, it is necessary to mention it in the presentation of the results.

Milk is measured at the two daily milkings (methods A4, B4, C4 or E4; methods A5, B5 or C5; methods A6, B6 or C6). However, this measurement may only be applied at one of the two daily milkings; in this case, either the strict alternating monthly test is applied (methods AT, BT, CT or ET) or the corrected monthly test for evening/morning differences, taking into account the total volume of milk produced by the whole flock over the two milkings concerned (methods AC, BC, CC or EC).

Milk may be measured by weight (grams) or volume (millilitres). It is acceptable to take volumetric measurements, as they are usually quicker and can be as accurate as weighing (if milk meter measurements are independent of froth). The conversion factor of weight (grams) into volume (millilitres) is 1.036 (normal sheep milk density). The minimum daily quantity tested is set at 200 g or 200 ml. The limit of error (standard deviation of error) is 40 g or 40 ml.

ICAR approval for dairy sheep equipment has been available since 1995. The devices approved for sheep are listed in appendix 5 of section 11. In the meantime, milk may be weighed or measured by means of a device approved by the organisation using it before 1 January 1995, and, if possible, checked by an appropriate government agency.

2.2.2.6 Lactation calculation clauses

2.2.2.6.1 For the flock

A farmer must adopt a single test method for a given milk period: method A (A4 or A5 or A6 or AC or AT); method B (B4 or B5 or B6 or BC or BT); method C (C4 or C5 or C6 or CC or CT); or method E (E4 or EC or ET).

2.2.2.6.2 For a ewe

When milked from lambing, total milk yield per lactation (TMY) is calculated using the Fleischmann method (or another method, if proved to be of equivalent accuracy). When milked only after a suckling period, milk yield during exclusive milking (TMM) is also calculated using the Fleischmann method (or another method, if proved to be of equivalent accuracy), basic measurements only concerning the yield from milking after the lambs have been fully weaned (in method E, as an exception, total suckled and milked milk (TSMM) may be calculated).

Calculations may be based on the real weaning and drying off dates. They may also be based on dates calculated on the basis of standard lengths for the suckling period, and the interval between the last non-zero milk recording and drying off. The whole calculation procedure is defined by each country and/or breed, in which case it is necessary for the calculation clauses to be accurately described when the results are presented (see Section 2.2.4).
Milking from lambing

The total milk yield per lactation (TMY) is calculated (as for cattle), together with the corresponding lactation length (difference between the drying off date and the lambing date). The lambing date is the real date. The drying off date is either real or calculated. There may or may not be a minimum number of tests per ewe before applying the Fleischmann method of calculation. The calculation procedure is described by the organisation responsible for its implementation.

Milking after a suckling period

The milk yield during the milking-only period (TMM) and the corresponding length of the milking period (difference between the drying off date and the weaning date) are both calculated. The lambing date is the real date. The weaning date is either real or calculated (standard suckling length). The drying off date is also either real or calculated. There may or may not be a minimum number of tests per ewe before applying the Fleischmann method of calculation. The calculation procedure is described by the organisation responsible for its implementation.
2.2.2.7 Quality assurance regarding AC method

This section has been constructed to solve specific problems relating to the AC method. However, the described procedure may also be applied to the BC, CC, and EC methods and also relates to the AT, BT, CT and ET methods.

The AC method requires the total amount of milk the flock produced over 24 hours to calculate the AC coefficient applicable to each ewe recorded at the recorded milking, in order to obtain a daily production total. The following situations, in which the AC method procedures cannot be applied without producing biases, have been identified:

- Flocks where a part is registered and therefore recorded, whereas the bulk milk is that of the whole flock. This is particularly frequent in countries/breeds where the milk recording practice is laborious and can be supported by the farmer only for a part of the whole flock. In some situations, permitting farmers to record only a portion of their flock should result in more recorded flocks (due to the fact that farmers of some large flocks would adhere to milk recording if they are allowed to record only a part of the flock). This strategy contributes to an increase in the cost-effectiveness of milk recording, by distributing the costs related to visiting one flock among a larger number of recorded ewes, and also to an increase in genetic progress.

- Flocks where a portion of the ewes is milked once a day, whereas the other portion is milked twice a day. Once-a-day milking is becoming more and more frequent in some production systems, in order to reduce labour; for example, to save time for domestic cheese-making, as well as to reduce energy costs. Once-a-day milking may occur at the end of the lactation period (early summer) only for ewes that lambed in autumn, whereas ewes that lambed later are still milked twice a day.

Although, according to the guidelines, such practices should not occur, a procedure of quality assurance is proposed both to control and elaborate on an alternative AC coefficient. The main features of the procedure are described below; the entire procedure being available in a document produced at the ICAR meeting held in Cork on 29 May 2012 and available on the ICAR website (www.icar.org/pages/working_groups/wg_Performance_recording_dairy_sheep.htm). Basically, this procedure introduces one monthly record at the two milkings per flock-year, in order to check the quality of the AC design in the flock. This approach should result in a flock coefficient (average of individual coefficients), either to be directly applied to all test dates, or to check the quality of the actual AC coefficients. Nevertheless, before setting up the procedure of quality assurance, which may be costly, and to avoid it if possible, it is strongly recommended that the breeder separates the ewes not registered beforehand, or, in the case of systems with ewes milked once a day, either to separate the ewes milked once, or to identify them. Such practices should enable the application of the AC coefficient only for appropriate ewes.

Applying the procedure of quality assurance is optional. It is up to the organisation to decide to apply it, as far as the situation requires it. The procedure solves the problem of milk yield, but not the problem of samples.

2.2.3. ICAR guidelines on optional records

This chapter describes:

- Optional records that can be kept within the framework of official methods A, B, C or E
- Method D, which is a non-official method of milk recording.
2.2.3.1 Qualitative tests or tests on the milk’s chemical composition in official methods A, B, C or E

Given that it is expensive and often technically difficult to administer in large flocks, testing milk’s chemical composition, which entails taking representative samples in order to analyse fat and protein content, is optional.

Such a qualitative test may be implemented either for experimental purposes or within the framework of integrated selection schemes, which are already very efficient as regards milk quantity on the scale of the recorded population. In the second case, the qualitative test must be part of the flock’s monthly quantitative recording (A4, B4, C4 or E4, AC, BC, CC, EC, AT, BT, CT, ET) or approximately monthly quantitative recording (A5, B5 or C5, A6, B6 or C6), whether carried out each month or only in certain months. Furthermore, an attempt should be made to sample all or most ewes in one or more categories or classes of age found to be present during the corresponding quantitative tests, in order to avoid sampling bias.

The qualitative test procedure is described by each officially recognised organisation: objectives of the qualitative test (experimental or for selection purposes); frequency of testing; sampling procedure; categories of ewes sampled and percentage, with respect to those ewes whose milk quantity is recorded; supervisory procedures followed (for the samples taken and milk analysis laboratories); type of chemical analysis and calculations made.

Analysis for protein content (or nitrogen content) and fat content must be carried out on the same reference sample of the recorded milkings. The equipment used for determining fat and protein content should be submitted to periodic checking, in accordance with suitable standards approved by ICAR.

2.2.3.2 Recording of udder morphology

Within the functional traits in which interest is growing, with the global purpose of reducing the costs of production, those relating to udder health and udder morphology are becoming increasingly documented. Whereas somatic cell count is a standard indicator for udder health, the scoring of udder morphology takes different forms, according to the breeds and the countries involved.

This chapter aims to:
1. propose different traits that may be scored, according to the specificity of each breed, and
2. list references for genetic parameters, especially around the relationship between milk traits and udder traits. No recommendation is made because there is, at this stage, no requirement for rationalisation.

This chapter uses results presented at the workshop 'Udder Recording Comparison between Teams', which was held in Leon, Spain (27-29 May 2002), in the framework of the EU contract QLK5-2000-00656 project called 'Genesheepsafety'.

As in cattle (Section 5.1 of the Guidelines), linear traits are scored individually, the scores covering a biological range. They describe the degree of trait, not the desirability. The recommended scale is 1-9. Udder appraisal tables contain several traits. The traits scored in at least one breed/country are the following:
1. Teat position
2. Udder depth
Section 2 - Rules, standards and guidelines for milk production recording

3. Udder attachment
4. Udder cleft
5. Teat size

1. Teat position

<table>
<thead>
<tr>
<th>Breed</th>
<th>Vertical</th>
<th>Horizontal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish Churra</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>French Lacaune</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Italian Sarda</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

What is scored?

- Spanish Churra: Teat placement
- French Lacaune: Right teat angle
- Italian Sarda: Udder cistern height
2. Udder depth

<table>
<thead>
<tr>
<th>Breed</th>
<th>Shallow</th>
<th>Deep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish Churra</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>French Lacaune</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Italian Sarda</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Israeli Afec Assaf</td>
<td>1</td>
<td>9</td>
</tr>
</tbody>
</table>

What is scored?
- Spanish Churra: Udder depth respect to abdomen basis
- French Lacaune: Distance between udder floor and hock
- Italian Sarda: Distance between udder cleft and hock
- Israeli Afec Assaf: Udder depth respect to abdomen basis
### 3. Udder attachment

<table>
<thead>
<tr>
<th></th>
<th>Spanish Churra</th>
<th>Italian Sarda</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wide = 9</strong></td>
<td></td>
<td>Width larger than height = 9</td>
</tr>
<tr>
<td><strong>Weak = 1</strong></td>
<td></td>
<td>Width equals height = 7</td>
</tr>
<tr>
<td>What is scored?</td>
<td>Perimeter of insertion to the abdominal wall</td>
<td>Width smaller than height = 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Ratio: udder height/attachment width</strong></td>
</tr>
</tbody>
</table>

- **Spanish Churra**
  - Wide = 9
  - Weak = 1

- **Italian Sarda**
  - Width larger than height = 9
  - Width equals height = 7
  - Width smaller than height = 1
4. Udder cleft

<table>
<thead>
<tr>
<th>Breed</th>
<th>Description</th>
<th>Score 1</th>
<th>Score 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>French Lacaune</td>
<td>Missing = 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well marked = 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italian Sarda</td>
<td>Missing = 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average = 5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Well marked = 9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is scored? Furrow

<table>
<thead>
<tr>
<th>Breed</th>
<th>Description</th>
<th>Score 1</th>
<th>Score 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spanish Churra</td>
<td>Short = 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long = 9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What is scored? Udder separation

The traits described above and the corresponding tables (list of traits included in udder appraisal) might be updated by either other breeds/countries implementing udder morphology recording, or by the above breeds/countries, if their traits or table evolve. Please advise the chairman of the working group on dairy sheep of any updates to the list of traits/tables.
References to the genetic parameters of the traits estimated in the various countries and used in the above tables were obtained from the following papers:


2.2.3.3 Other types of testing in official method A, B, C or E

Following on from qualitative milking recording, other possibilities include somatic cell count, mastitis and, similar to other milk characteristics, the possibility of measuring machine milking ability via milk flows that can be recorded using automated sheep milk recording systems. Prior to milk recording, reproductive traits can also be recorded; these include information on the reproduction method used (artificial insemination following induced oestrus, induced oestrus and hand mating, or natural mating etc.), the number and sex of lambs born, the open day-time from lambing to conception etc. Procedures for such optional measurements are described by the officially recognised organisations responsible for their implementation.

2.2.3.4 Method D

Method D is defined as a simplified, non-official recording, based on two to four recordings per flock and per year with the aim of getting two to three test-days per ewe in the middle of the lactation. The record may be realised either on one of the daily milkings on all the ewes being exclusively milked at the test-day, or on all the daily milkings on all the ewes being exclusively milked at the test-day. Of course, it is recommended to record only one of the daily milkings, since it is a very simplified method. In this case, the test-day may be adjusted in order to get a daily milk (for instance by multiplying it by two or by any other coefficient, taking into account the morning/evening difference).

The purpose is to implement a within-flock ranking of the ewes either an individual ranking or a ranking in sub-parts of the flock to manage replacement and culling. The ranking may be based on such criteria as the average test-day or lactation calculation, which may or may not be corrected for variation factors such as lactation number, age, or month of lambing. Nevertheless, in such a simplified design, lactation calculation is not recommended, even though possible, given the low number of test-days per ewe. Thus method D may be useful in two types of situations:

- It may be applied to commercial flocks out of the well-established nucleus of a pyramid breeding scheme.

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• In developing countries, in order to provide advice to farmers on feeding, health, breeding and, if possible, on genetics. In this situation, it could be the first step to the implementation of an official recording for genetic purposes.

Whatever the situation, method D does not meet the requirements for the ICAR Certificate of Quality.

2.2.4 ICAR Rules on presentation of results

This paragraph concerns the methods A, B, C and E.

To facilitate the presentation, the following vocabulary is used for milk yield calculations:
• Total milked yield/total milked milk
• Milking length.

**Milk yield equals:**

Total milk yield per lactation (TMY) in the case of milking from lambing or;
Milk yield during the milking-only period (TMM), in the case of milking after a suckling period.

**Milking length equals:**

Lactation length in the case of milking from lambing, or length of the milking-only period, in the case of milking after a suckling period.

2.2.4.1 Obligatory results

It is obligatory to provide the following results for a given breed and a given year or milk period:

2.2.4.1.1 Information on the milk recording and calculation methods

- Organisations responsible for the milk recording.
- Method of quantitative recording used: methods A4, B4, C4 or E4, A5, B5 or C5, A6, B6 or C6, AT, BT, CT, ET, AC, BC, CC or EC.
- Unit of measurement used for milk quantity: litres or kilos.
- Type of milk recording equipment (milk meter...) used: to be described.
- Organisation responsible for the lactation calculation.
- Drying off date: real or calculated; specify the procedure if calculated or describe whatever rule is applied to determine the end of the milking period.
- Lamb weaning date (should there have been a suckling period): real or calculated; indicate the average length of suckling used, should this date be calculated.
- Minimum number of milk recording tests per ewe to calculate milk yield.
- Calculation of milk yield: based on the real length of milking or a standard length to be described.
Section 2 - Rules, standards and guidelines for milk production recording

- Published milking length: provide the calculation formula [difference between dates used].
- Existence of adjustments for milk yield or not: type and description (example of adjustments for age, lambing period etc.).
- Existence of supervisory systems or not: type and description.

2.2.4.1.2 Information on the flocks subject to official method A, B, C or E milk recording

- Number of farms subject to official milk recording (year).
- Number of ewes on these farms (inventory at lambing).
- Number of lactating ewes on these farms (calculated milk yield).
- What breeding system is used as regards lactation calculation?

System 1: milking from lambing
System 2: milking after a suckling period
  - If system 2: average length of the suckling period (in days) and detailed description of the initial suckling or suckling plus milking phase.
  - Description of reproduction objectives: achievement of one or more lambings per milking period; age at first lambing.
  - Type of milking: machine (% of farms and ewes subject to official recording) or by hand (% of farms and ewes subject to official recording).
  - Results of milk recording: total milked yield and length of milking (cf. box above); average daily milk yield (total milked yield divided by the milking length). If possible, the milk yield results should be presented for all lactations and according to lactation number. Furthermore, raw milk results should be provided, with no adjustment for factors of variations.

2.2.4.1.3 Information on the ewes

The following information must be provided for each lactation whose obligatory results are published:
- The ewe's ID
- Age at lambing
- Lactation number or category of age (to be described)
- In the case of suckling, the real or standard suckling length
- Milk yield (without adjustment): TMY or TMM
- Milking length
- Average daily milk yield

The following results may also be published:
- Difference (in days) between the lambing date and the date of the first test-day
- Maximum milk recording test (with the lactation stage)
- Total number of monthly milk tests realised for this ewe
- A production of reference (and the chosen standard length)
2.2.5 ICAR guidelines on publication of results of optional recording

2.2.5.1 Information on the implementation of qualitative milk recording

The following relates to methods A, B, C or E (§ 2.2.3.1 and 2.2.3.2) and method D (§ 2.2.3.3):

- Objectives of the qualitative testing: experimentation or selection.
- Description of the sampling procedure used.
- Test methodology used: milkings tested, test frequency, categories of ewes sampled.
- Results: percentage of ewes sampled in relation to the ewes tested for milk quantity (for the same category of females).
- Analyses: types of milk analyses, methods and units of measurement used for results.
- Calculations made: description of the type of calculations and results published.
- Presentation of mean results: breed, flock and ewe.
- Existence of supervisory systems or not: type and description.

2.2.5.2 Reproduction results

- General description of breeding system distinguishing two main systems: one lambing per year or aiming to have several lambings per year
- Description of reproduction methods used (and their frequency for farms subject to milk recording): induced oestrus and artificial insemination, induced oestrus and hand mating, natural mating. Open day-time from lambing to conception.
- Results of average age at first lambing, depending on the reproduction method
- Description of lambing periods (frequency) per age group and reproduction method
- Average fertility results per age group and reproduction method
- Average prolificity results per age group and reproduction method.

2.2.5.3 Other optional results

These results can be provided for the breed, flock, ewe or region. The following information is an example of such optional results:

- Results of weighing lambs at birth or on weaning
- Results of weighing ewes at parturition or lambing
- Causes for reform in the framework of milk recording
- Frequency of mastitis etc. ...
2.2.5.4 Method D

Precise description of method D used as a simplified design:

- design (number of recordings per flock and year);
- calculations and type of ranking set up.

Whatever the design, calculation and type of ranking, method D does not meet the requirements for the ICAR Certificate of Quality.
SECTION 2.3 - ICAR RULES, STANDARDS AND GUIDELINES
FOR MILK RECORDING IN GOATS

The purpose of the present standards and guidelines is to provide results which can be applied for integrated selection schemes and for international exchange of animals and information.

2.3.1 The ICAR standard definitions of milk traits

The following terms will be used to describe the possible livestock breeding systems:

- The **suckling length** corresponds to the suckling period of kids or the simultaneous suckling and milking period. If the kids only suckle during the colostral phase, the suckling length is considered to be zero. If there is an initial suckling phase, milk yield during this suckling period is equal either to the milk suckled if suckling only, or to the milk suckled plus that milked should there be partial milking during the suckling period.

- The **milking-only length** corresponds to the period during which the goat is milked starting when the kid(s) has (have) been weaned and until drying off.

- The **lactation length** is equal to the sum of the suckling length plus milking-only length: it is also the difference in days between the date of kidding and the date of drying off.

- The **total milk yield per lactation** (TMY) is the milk yield produced in the case of lactation with milking from kidding (without suckling period).

- The **total milked milk** (TMM) is the milk yield produced during the milking only period, in the case of lactation with milking only after a suckling period.

- The **total suckled and milked milk** (TSMM) is the sum of the milk yield of the suckling period (milk suckled, or milk suckled plus that milked) plus the TMM.

Only the milk yield during exclusive milking can be a part of milk recording on farms. If the suckling period is not of zero length, the milk yield in dairy goat only takes into account exclusive milking and the length of the milking-only period (which starts once the kids are fully weaned and is over when the goat dries off): it corresponds to the TMM.

The following situations therefore arise:

2.3.3 Milking from kidding

The goats are milked after kidding (once the colostral phase is over) as is usually the case with dairy cattle.
The lactation length and the length of the milking-only period are thus equal (not counting the colostral phase). Milk yield during exclusive milking equals the total milk yield during lactation (TMY).

2.3.4 Milking after a suckling period

The goats are milked after a suckling period for the kids or after a combined suckling plus milking period.

<table>
<thead>
<tr>
<th>Kidding</th>
<th>Weaning</th>
<th>Drying off</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suckling</td>
<td></td>
<td>Milking only</td>
</tr>
</tbody>
</table>

Milk yield during the milking-only period (TMM) is therefore smaller than total milk yield during lactation (TSMM): only the downward phase of the lactation curve is recorded in almost all cases, and the lactation peak falls within the initial suckling (or suckling plus partial milking) period. The length of the milking-only period equals the lactation length minus the suckling length. Through the incorrect use of language, we often speak broadly of lactation calculations, whereas here it is strictly used for the milk yield calculation using the milking only period (TMM).

2.3.4 Total milk yield and production of reference

The breeding systems may differ very much from region (breed) to region (breed), therefore it is not possible to define a standard lactation length or a standard milking length (of the milking-only period): we therefore recommend that the approved organization define, for each breed and category of goats (age or lactation number), a reference production per lactation or a reference production for the milking-only period, according to the breeding system. The chosen standard length (in days) must be declared in the publication of the results.

2.3.5 ICAR rules and standards

This chapter describes standards applicable in all cases for official methods A, B, C or E milk recording.

2.3.6 Responsibility and type of recording

The various recording operations described below are carried out by an employee of an officially registered organization (the milk recording itself being undertaken by an official tester of the organization in the method A, and by the farmer or his employee in the method B, by the official tester and/or the farmer in the methods C and D and E):
• Identification of animals by conventional or RFID devices on the basis of a national system providing a unique number for the animals. The identification of the kids has to be done within a maximum of 30 days from birth. It is only necessary to identify those kids which are kept for breeding purposes.

• Recording of information on mating and artificial insemination (in the case of recorded mating), and kidding, milk recording (goat and flock), keeping of goat and buck inventories on the flocks of owner-breeders.

• Checking of the records and periodic visits of the goat farms: organization of controlled mating (optional), keeping of kidding records, marking of kids, checking on maternal/paternal filiations based on the average length of gestation and its standard deviation (i.e. an average gestation period of x days plus or minus y days). The values of x and y must be provided for each breed or group of breeds concerned in each country.

Whatever the method A, B, C, D or E used for milk recording, certain information is provided by the breeder himself, such as mating and kidding information (in the case of controlled mating): they are subject to a supervisory system which has to be effected a recognized recording organization: for instance, in this case it may be a check on pedigree by DNA analysis. Any information produced directly by the breeders (rather than an official recorder) must be subject to the supervisory procedure described by the recognized recording organization.

2.3.7 Goats to be controlled

2.3.7.1 Case of the methods A, B, C, D

The breeder may split his flock into one or several flocks. If the breeder is managing several flocks, he may record only one of his flocks, on condition that he agrees to breed the recorded flock, always separately from his other non-recorded flock(s) which can be considered as commercial flocks. Likewise, if only one of the flocks of the breeder is recorded, it is forbidden to mix goats of a non-recorded flock with the goats of the recorded flock, during the milk period.

An inventory of those goats on the recorded flock(s) which belong to the breeder in question is kept throughout the milk recording operation from the beginning to the end of milking. Whenever there is (quantitative) milk recording for the recorded flock, all the goats being exclusively milked (of the breeds or genotypes involved in the breeding program) must be recorded: the principle of an exclusive record is essential to avoid sampling biases. Goats suckling or suckling with partial milking during the suckling phase (see Section 2.3.1) must not be included: it is impossible to measure the individual milk yield of suckled goats or suckled and partially milked goats simply and accurately (essential conditions for the large-scale application of milk recording on farms). Consequently, only milk recording carried out when the goat is definitively separated from its kid(s), i.e. only when being milked exclusively (see Section 2.3.1) must be taken into account. **All goats milked on the day of milk recording, must be controlled.** Likewise, if dairy goats belonging to another farmer are being kept for part of the year at the farm where milk is being officially recorded, they must not to be included in the official recording for that farm. This is why it is essential that all goats belonging to a breeder who applies Method A or B or C or D milk recording for his flock(s) must be included in an up-to-date and accurate inventory.
2.3.7.2 Case of the method E

Method E is a flexible official method applied when the breeding purpose is to maintain the breed with all the typical standard performance signs (flocks whose only a part of the goats belongs to the flock-book). The rule of recording all the animals of the flock may not be respected (only designated goats or designated lactations are recorded).

2.3.8 First test-day

2.3.8.1 For the flock

The first test-day of the flock takes place 4 to 15 days after the beginning of mechanical/by hand milking only in the flock. This recommendation is suitable for the practical organization of tests on the basis of a monthly recording interval.

2.3.8.2 For a doe

2.3.8.2.1 Milking from kidding

The first milk recording of a doe has to take place not before 6th day from kidding and not later than 80 days after kidding to take into account the starting of milking only by batch and fluctuations in the periodicity of milk recorders' visits. If this difference is greater than the threshold described above, there should be no lactation calculation for the goat in question.

2.3.8.1.2 Milking after suckling

The first milk recording of a doe must take place within the 35 days following complete separation from its kids, with a tolerance of 17 days to take into account the starting of milking only by batch and fluctuations in the periodicity of milk recorders' visits. Consequently, the difference between kidding and the first (quantitative) milk recording of a goat is at most equal to the average suckling length of the breed in question plus 52 days (35 + 17). If this difference is greater than the threshold described above, there should be no lactation for the goat in question.

2.3.9 Frequency and number of milk recording visits

2.3.9.1 For the flock

In the case of record of the two daily milking, the average recording interval (days) between two successive milk recording for a flock is monthly (30 days, with a range from 28 to 34 days) for A4, B4, C4 or D4 method, and it can reach 36 days for A5, B5, C5 or D5, and 42 days for A6, B6, C6 or D6 method. If only one daily milking is recorded (AT, BT, CT, DT, AC, BC, CC or DC method), the average recording interval is monthly (30 days), as for the A4 method (considered as the standard method). There is no minimum interval, so supplementary testing can be carried out when necessary due to the way the kidding is spread out (e.g.: a fortnight to three weeks between two successive tests).
2.3.9.2 For a doe

The maximum interval between two successive non-zero tests on the same doe is 2 x average number of days in recording interval (depending on method). There is thus a tolerance of one missed test. If the interval between two tests (i) and (i+1) is greater, the lactation calculation for the goat being tested (i) is stopped.

The minimum number of valid monthly tests (milk not zero) per goat needed for the lactation calculation is not set; it must therefore be described for each breed and category of goat considered (first lactation, second and more).

2.3.10 Quantitative milk recording

The only obligatory milk recording is that of the quantity of milk (i.e. quantitative recording). Tests on the chemical composition of the milk or qualitative tests are optional (see Section 2.2.3). Quantitative recording concerns the quantity of milk supplied by the goat when milked in the usual conditions on the farm, whether milked by hand or by machine. Should milking be mechanical, it is recommended not to take into account the volume of individual milk collected during hand or machine stripping in order to favour indirect selection as regards ability to machine milking. If nevertheless the (hand or machine) stripping yield is recorded, it is necessary to mention it in the presentation of the results. Milk is measured at the two daily milking (method A4, B4, C4, D4 or E4 method A5, B5, C5 or D5, method A6, B6, C6 or D6). However, this measurement may only be applied at one of the two daily milking: in this case, either the strict alternating monthly test is applied (method AT, BT, CT or DT) or the corrected monthly test for evening/morning differences, taking into account the total volume of milk produced by the whole flock over the two milking concerned (method AC, BC, CC or DC). Milk may be measured by weight (grams) or volume (milliliters). It is acceptable to take
volumetric measurements as they are usually quicker and can be as accurate as weighing (if milk meter measurements are independent of froth). The conversion factor of weight (grams) into volume (milliliters) is 1.032 (normal goat milk density). The minimum daily quantity tested is set at 200 g or 200 ml. The limit of error (standard deviation of error) is 40 g or 40 ml. Milk should be weighted or measured by means of an instrument approved by the organization using it, and, if possible, checked by an appropriate government agency. List of approved milk recording devices for sheep and goat approved by ICR is available on ICAR web site at: www.icar.org/pages/Sub_Committees/sc_recording_devices_approved_milkmeters_sheep-goats.htm.

2.3.11 Lactation calculation clauses

2.3.11.1 For the flock

A farmer must adopt a single test method for a given milk period: method A (A4 or A5 or A6), method B (B4 or B5 or B6), method AT (AT4, AT5 or AT6) or method C (C4, C5 or C6), method D (D4, D5 or D6) and method E (E4).

2.3.11.2 For a doe

When milked from kidding, total milk yield per lactation (TMY) is calculated using the Fleischmann method (or another method if proved to be of equivalent accuracy). When milked only after a suckling period, milk yield during exclusive milking (TMM) is also calculated using the Fleischmann method (or another method if proved to be of equivalent accuracy), basic measurements only concerning the yield from milking after the kids have been fully weaned. Calculations may be based on the real weaning and drying off dates. They may also be based on dates calculated on the basis of standard lengths for the suckling period and the interval between the last non-zero milk recordings and drying off. The whole calculation procedure is defined by each country and/or breed, in which case it is necessary for the calculation clauses to be accurately described when the results are presented.

2.3.11.3 Milking from kidding

![Diagram]

The total milk yield per lactation (TMY) is calculated (as for cattle), together with the corresponding lactation length [difference between the drying off date and the kidding date]. The kidding date is the real date. The drying off date is either real or calculated. There is a minimum of 3 tests per goat before applying the Fleischmann method of calculation. The calculation procedure is described by the organization responsible for its implementation.
2.3.11.4 Milking after a suckling period

The milk yield during the milking-only period (TMM) and the corresponding length of the milking period (difference between the drying off date and the weaning date) are both calculated. The kidding date is the real date. The weaning date is either real or calculated (standard suckling length). The drying off date is also either real or calculated. There is a minimum of 3 tests per doe before applying the Fleischmann method of calculation. The calculation procedure is described by the organization responsible for its implementation.

2.3.11.4.1 End of lactation

To estimate the milk production for the period from the last recording to the drying off, it is necessary to multiply the yield by a number of days equal to half the interval period chosen.

The lactation length chosen must be declared by the organization.

2.3.11.5. Calculation methods

The total quantity of milk and the percentage of butterfat and/or protein is to be calculated by one of the following two methods (or by another method if proved to be of equivalent accuracy). Methods incorporating the centering principle are to be preferred, i.e. centering the results for any test day on a period for which the test day is the mid-point or alternatively, by applying the average of results at the beginning and the end of a period (see Method n° 2).

2.3.11.5.1 Method no. 1

For each interval between two successive testings a separate calculation is made of the quantity of milk produced by multiplying the results of the weighing of the test day by the number of days in the interval leading up to it. The addition of these interval yields gives the total milk produced for the entire lactation period. The quantity of fat and protein contained in the milk is obtained in the same way.

The average percentage of fat and protein contained in the milk is obtained by multiplying the total quantity of fat and protein (in kg) by 100 and dividing these totals by the total quantity of milk (in kg).
2.3.11.5.2 Method no. 2

- For each interval between two successive testing a separate calculation is made by adding the results of the weighing of the two test days, and dividing by two.
- The quotient is then multiplied by the number of days between the two test days.
- The lactation yield of milk is obtained by totaling the milk yield calculated for all the intervals.
- The quantity of fat and protein contained in the milk is obtained in the same way.
- The average percentage of fat and protein contained in the milk is obtained as indicated for Method N° 1.

If recording is suspended for a period not exceeding 100 days, the missing figure or figures can be estimated by taking average of the preceding and subsequent testing, or by another suitable method.

2.3.12 ICAR Guidelines on optional records

This chapter describes:
- on the one hand, the optional records which can be kept within the framework of official method A, B, C or E recording;
- on the other hand, the method D which is a non-official method of milk recording.

2.3.12.1 Qualitative tests or tests on the milk’s chemical composition in official method A, B, C, D or E

Given that it is expensive and often technically difficult to administer in large flocks, testing milk’s chemical composition (which entails taking representative samples in order to analyze fat and protein content) is optional.

Such a qualitative test may be implemented either for experimental purposes or within the framework of integrated selection schemes which are already very efficient as regards milk quantity on the scale of the recorded population in question. In the second case, the qualitative test must be part of the flock’s monthly quantitative recording (A4, B4, C4 or E4, AC, BC, CC, AT, BT, CT,) or approximately monthly quantitative recording (A5, B5 or C5, A6, B6 or C6), whether carried out each month or only certain months. Furthermore, an attempt should be made to sample all or most goats in one or more categories or classes of age found to be present during the corresponding quantitative tests in order to avoid sampling bias.

The qualitative test procedure is described by each officially recognized organization: objectives of the qualitative test (experimental or for selection purposes), frequency of testing, sampling procedure, categories of goats sampled and percentage with respect to those goats whose milk quantity is recorded, supervisory procedures followed (for the samples taken and milk analysis laboratories), type of chemical analysis and calculations made. Analysis for protein content (or nitrogen content) and fat content must be carried out on the same sample representative of the recorded milking. The equipment used for determining fat and protein content should be submitted to periodic checking in accordance with suitable standards, approved by ICAR.

1. Methods approved by the Committee for estimating the fat and protein (or nitrogen matter) contained should be employed.
The equipment and materials used for analyses should be prepared or checked by the technical services of the same organization.

2. Analysis for protein content (or nitrogen content) and fat content must be carried out on the same milk sample.
   The samples should be taken after the milk produced by a single goat has been properly mixed. A 24 hour composite milk sample is required for analysis.
   If a preservative is used it should not influence the results of the sample analysis.

3. The equipment used for determining fat and protein content should undergo periodic checking in accordance with suitable standards.

   Every member organization is required to inform the Committee of these standards.

2.3.12.2 Other types of testing in official method A, B, C, D or E

Other possibilities following on from the qualitative milking recording include somatic cell count, mastitis and similarly, for other milk characteristics, the possibility of measuring machine milking ability via milk flow (milking speed) which can be recorded using automated goat milk recording systems. Even before milk recording, reproductive traits could also be recorded; this includes information on the reproduction method (artificial insemination following induced oestrus, induced oestrus and hand mating, natural mating etc.), the number and sex of kids born, the days open (time from kidding to conception), etc. Procedures for such optional measurements are described by the officially recognized organizations responsible for their implementation.

2.3.12.3 Method D

Method D is defined as a simplified non-official recording based on 2 to 4 recordings per flock and per year in the aim to get 2 to 3 test-days per goat in the middle of the lactation. The record may be realized either on one of the daily milking on all the goats being exclusively milked at the test-day, or on all the daily milking on all the goats being exclusively milked at the test-day. Of course, it is recommended to record only one of the daily milking since it is a very simplified method. In this case, the test-day may be adjusted in order to get daily milk (for instance by multiplying it by 2 or by any other coefficient taking into account the morning/evening difference). The purpose is to implement a within flock ranking of the goats (either an individual ranking or a ranking in sub-parts of the flock - in three thirds or four quarters for example) to manage replacement and culling. The ranking may be based on such criteria as average test-day or lactation calculation corrected or not for variation factors such as lactation number, age, month of kidding... Nevertheless, in such simplified design lactation calculation is not recommended even though possible, given the low number of test-days per goat. This method D may be useful in two types of situation:

- It may be applied to commercial flocks out of a well-established nucleus of a pyramidal breeding scheme.
- This type of simplified milk recording should also be suitable in developing countries in order to provide advice to farmers on feeding, health, breeding (and if possible on genetics). In this situation, it could be the first step before the implementation of an official recording for genetic purposes.

Whatever the situation, method D does not provide ICAR Certificate of quality.
2.3.13 ICAR standards on presentation of results

This paragraph concerns the methods A, B, C, D or E

To facilitate the presentation, the following vocabulary is used for total milk yield calculations:

- Total milked yield
- Milking length.

**Total milk yield equals**: Total milk yield per lactation (TMY) in the case of milking from kidding or milk yield during the milking only period (TMM) in the case of milking after a suckling period

**Milking length equals**: Lactation length in the case of milking from kidding or length of the milking-only period in the case of milking after a suckling period

The production may be expressed in kg or in l. The milk quantity produced in the strippings must not be included. Determination of fat or protein content (or nitrogen matter) is optional.

2.3.13.1 Obligatory results

It is obligatory to provide the following results for a given breed and a given year or milk period:

2.3.13.1.1 Information on the milk recording and calculation methods

- Organizations responsible for the milk recording
- Method of quantitative recording used: method A4, B4, C4 or D4, E4, A5, B5, C5 or D5, A6, B6, C6 or D6, AT, BT, CT, DT, AC, BC, CC or DC
- Unit of measurement used for milk quantity: liters or kilos
- Type of milk recording equipment (milk meter...) used: to be described
- Organization responsible for the lactation calculation
- Drying off date: real or calculated; specify the procedure if calculated or describe whatever rule is applied to determine the end of the milking period
- Kid weaning date (should there have been a suckling period): real or calculated; indicate the average length of suckling used should this date be calculated
- Minimum number of milk recording tests per goat to calculate milk yield
- Calculation of total milk yield: based on the real length of milking or a standard length to be described
- Published milking length: provide the calculation formula [difference between dates used]
- Existence of adjustments for milk yield or not: type and description (example of adjustments for age, kidding period etc.)
- Existence of supervisory systems or not: type and description.

2.3.13.1.2 Information on the flocks subject to official method A, B, C, D or E milk recording

- Number of farms subject to official milk recording (year).
- Number of goats on these farms (inventory at kidding).
• Number of lactating goats on these farms (calculated milk yield).
• What system is used as regards lactation:
  - system 1: milking from kidding;
  - system 2: milking after a suckling period.
• If system 2: average length of the suckling period (in days) and description of the initial suckling or suckling plus milking phase.
• Description of reproduction objectives: achievement of one or more kidding per milking period; age at first kidding.
• Type of milking: machine (% of farms and goats subject to official recording) or by hand (% of farms and goats subject to official recording).
• Results of milk recording: total milked yield and length of milking (cf box above); average daily milk yield (total milked yield divided by the milking length). If possible, the milk yield results should be presented for all lactations and according to lactation number. Furthermore, raw milk results should be provided with no adjustment for factors of variations.

2.3.13.1.3 Information on the goats

The following information must be provided for each lactation whose obligatory results are published:
• The goat's ID.
• Age at kidding.
• Lactation number or category of age (to be described).
• In the case of suckling, the real or standard suckling length.
• Total milk yield (without adjustment): TMY or TMM.
• Milking length.
• Average daily milk yield.

It is possible to publish also the followed other results:
• Difference (in days) between the kidding date and the date of the first test day.
• Maximum milk recording test (with the lactation stage).
• Total number of monthly milk tests realized for this doe.
• A production of reference (and the chosen standard length).

2.3.14 ICAR guidelines on publication of results of optional recording

2.3.14.1 Information on the implementation of qualitative milk recording

This paragraph concerns the methods A or B or C (§ 2.2.3.1 and 2.2.3.2) and the method D or E (§ 2.2.3.3)

Information on the implementation of qualitative milk recording
• Objectives of the qualitative testing: experimentation or selection.
• Description of the sampling procedure used.
• Test methodology used: milking tested, test frequency, categories of goats sampled.
• Results: percentage of goats sampled in relation to the goats tested for milk quantity (for the same category of females).
• Analyses: type of milk analyses, methods and units of measurement used for results.
• Calculations made: description of the type of calculations and results published.
• Presentation of mean results - breed, flock and goat.
• Existence of supervisory systems or no: type and description.

2.3.14.2 Reproduction results
• General description of breeding system distinguishing 2 main systems: one kidding per year or aiming to have several kidding per year.
• Description of reproduction methods used (and their frequency for farms subject to milk recording): induced estrus and artificial insemination, induced estrus and hand mating, natural mating. (Open day - time from kidding to conception).
• Results of average age at first kidding depending on the reproduction method.
• Description of kidding periods (frequency) per age group and reproduction method.
• Average fertility results per age group and reproduction method.
• Average prolificacy results per age group and reproduction method.

2.3.14.3 Other optional results
These results can be provided for the breed, flock or goat or region. The following information is an example of such optional results:
• Results of weighing kids at birth or on weaning.
• Results of weighing goats at parturition or kidding.
• Causes for reform in the framework of milk recording.
• Frequency of mastitis etc....

2.3.14.4 Method D
Precise description of method D used as a simplified design:
• Design (number of recordings per flock and year)
• Calculations and type of ranking set up.

Whatever the design, calculation and type of ranking, method D has no ICAR Certificate of quality.
SECTION 2.4. - ICAR GUIDELINES FOR BUFFALO MILK RECORDING FOR LOW TO MEDIUM AND MEDIUM TO HIGH INPUT PRODUCTION SYSTEMS

2.4.1 Purpose

Milk recording in buffalo concerns:

- milk yield produced in lactation;
- fat content (optional);
- protein content (optional).

2.4.2 Organization in charge

Buffalo milk recording activity in a country, a region or district should be developed and supervised under a single organization, through its national, regional and/or local structures. The organization could be a public or private institution such as a research institute, farmers co-operative, an NGO or even a private company. To be sustainable it needs the official recognition of the concerned government ministry and the promotion and support of the stakeholders benefitting from milk recording.

To become internationally recognised the country and the milk recording organization needs to seek the membership of ICAR.

This organization is responsible for:

- preparing sheets and books for data collection;
- processing the data;
- printing of the lactation certificate;
- publishing an annual report;
- supervising all activities in the farm and in the offices.

2.4.3 Farmers duties

The farmer wanting to participate in milk recording must:

- accept the regulations of the recording organization
- register his buffaloes under the animal identification system provided by the recording organization
- put under milk recording all buffaloes of the herd

Note: A herd could also refer to a group of herds in a village in cases where the individual herds are composed of very small number of animals

2.4.4 Control technicians

Milk recording activity is performed by trained technicians who have the following tasks:
• provide the farmer with the identifications for all newborn calves
• visit the herds according to the calendar established by the recording activity
• register inseminations, matings, calving, deaths, dates of drying-off, diseases
• weigh the milk produced by each individual buffalo at the two daily milkings. Milk must be weighed on a scale with sensitivity of at least 250 grams or volumetrically measured with calibrated measures with sensitivity of 250 cc. ICAR authorised measuring devices can be also used.
• register the milk productions on the forms established by the recording organization

2.4.5 Milk recording

1. milk recording has to be carried out during the whole lactation;
2. milk recording has to be carried out on all the buffaloes of the herd;
3. milk yield must be registered;
4. fat and protein percentage can be determined;
5. the first milk recording cannot be performed before the evening of the 5th day after calving;
6. the first milk recording must be performed within the 75th day after calving;
7. minumum interval between two tests should be 25 days;
8. maximum interval between two tests should be 46 days;
9. When the average interval between two tests calculated on the whole lactation falls between 28 and 33 days, the recording will be considered of A4 method; when it falls between 38 and 46 days it will be considered A6 method. The method has to be stated in the documents in which the lactation records are reported;
10. due to proved and justified reasons, only one longer interval in one lactation can be accepted, provided that the number of days between two consecutive records does not exceed 75;
11. the milk record must be performed on all 24 hours milkings of the recorded herd; time at which record is performed must be registered;
12. milk yield can be expressed either in kg or in litres;
13. milk must be weighed on a scale with sensitivity of at least 250 g or volumetrically with calibrated measures.
14. Milk meters and recording jars can be approved by the ICAR member organization of each country after appropriate trial. Results of the trial will be sent to ICAR. Approved milk meters and recording jars as well as the country in which they were approved are indicated in the appendix of the present regulations;
15. In case fat/protein contents are determined, samples must be collected from all buffaloes and for the whole recording duration. Samples may be taken by any of the following methods:
   a) a sample for each milking;
   b) a proportional composite sample for all milkings within the 24 hour test period;
   c) alternate (i.e. am/pm) samples on consecutive sampling days;
d) samples must all be added with the allowed preserving drug according to the analysis system used;

e) milk analysis must be performed no later that four days from the day of recording;

f) methods for the analysis of milk components are the official ones approved by ICAR for cattle.

16. When, at the recording visit, the animal is found to have dried-off, the date of the drying-off of that animal is fixed at 14 days after the date of the last milk recording when she was still in milk;

17. In case the animal is found to have dried-off after the longer recording interval (46-75 days), the milk recorder is requested to ask the farmer the effective date for the drying-off. If the effective date falls within 30 days from the last recording, the date of the drying-off of that animal is fixed at 14 days after the last recording; otherwise, it is fixed at 44 days after the date of the last milk recording when the animal was still in milk.

2.4.5.1 Calculation of total lactation production

The calculation of total lactation production will be done as follows:

a. partial production from calving to first milk recording: multiply milk production at first recording by the number of days from calving to first recording

Example: date of calving March 10; date first recording April 6; milk production on April 6: 3.2 kg. Therefore, partial production from calving to first milk recording = 3.2 kg x 27 days = 86.4 kg.

b. partial production during all milk recordings: multiply the average milk yield of two subsequent recordings by the interval between the two recording.

c. partial production from last milk recording do drying-off day: multiply milk production at last recording by the number of days from last milk recording to drying-off:

1) The date of milk recording when the animal is found to have dried off is February 1: multiply milk production of last recording by 14 = 2 kg x 14 = 28 kg.

2) The date of milk recording when the animal is found to have dried off is February 23 and the farmer states that the buffalo dried-off on February 20: multiply the milk yield of last recording by 30 and add (last recording yield + (last recording yield/2)/2) x 14. Therefore: (2 x 30) + ((2+1)/2) x 14 ) = 81 kg

Total lactation production is given by the sum of partial lactations (a) + (b) + (c).
Example:

<table>
<thead>
<tr>
<th>Date of Recording</th>
<th>Milk yield kg</th>
<th>Interval (days)</th>
<th>Average kg milk of two subsequent recordings</th>
<th>Yield of two subsequent recordings kg</th>
<th>Cumulative yield kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 10</td>
<td>Calving</td>
<td>27</td>
<td>3.2</td>
<td>86.4</td>
<td></td>
</tr>
<tr>
<td>April 6</td>
<td>3.2</td>
<td>40</td>
<td>3.2</td>
<td>128</td>
<td>214.4</td>
</tr>
<tr>
<td>May 16</td>
<td>3.2</td>
<td>37</td>
<td>3.55</td>
<td>131.35</td>
<td>345.75</td>
</tr>
<tr>
<td>June 22</td>
<td>3.9</td>
<td>38</td>
<td>4.45</td>
<td>169.1</td>
<td>514.85</td>
</tr>
<tr>
<td>July 30</td>
<td>5.0</td>
<td>42</td>
<td>5.75</td>
<td>241.5</td>
<td>756.35</td>
</tr>
<tr>
<td>Sept 10</td>
<td>6.5</td>
<td>37</td>
<td>6.25</td>
<td>231.25</td>
<td>987.6</td>
</tr>
<tr>
<td>Oct 17</td>
<td>6.0</td>
<td>37</td>
<td>4.5</td>
<td>166.5</td>
<td>1,154.1</td>
</tr>
<tr>
<td>Nov 23</td>
<td>3.0</td>
<td>41</td>
<td>2.5</td>
<td>102.5</td>
<td>1,256.6</td>
</tr>
<tr>
<td>Jan 3</td>
<td>2.0</td>
<td>299 days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb 1</td>
<td>dried</td>
<td>14</td>
<td>2</td>
<td>28.0</td>
<td></td>
</tr>
<tr>
<td>Feb 23</td>
<td>dried</td>
<td>44</td>
<td>2 + 1.5</td>
<td>81.0</td>
<td></td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td>313</td>
<td>343</td>
<td>1,284.6</td>
<td>1,337.6</td>
</tr>
</tbody>
</table>

### 2.4.5.2 Calculation of lactation production until 270 days

The calculation of lactation production until 270 days will be done as follows:

When the buffalo is still in milk at the recording date falling after 270 days, the average milk production of the two recordings bracketing 270 days is multiplied by 270 minus the number of days from the last recording before 270 days.

Example: In the above table the two recordings bracketing 270 days are Nov 23 (3 kg milk) and Jan 3 (2 kg milk).

Nov 23 falls 258 days from calving; milk yield up to Nov 23 is 1,154.1 kg; therefore:

\[(270-258) \times ((3+2)/2) = 12 \times 2.5 = 30\]  

Then 1,254.1 + 30 = 1,284.1 kg.
The buffalo in the example will have a total lactation of 313 (or 343) days, total milk yield of 1,284.6 kg (or 1,337.6 kg) and 270 days yield of 1,184.1 kg.

When the buffalo dries-off before 270 days, total lactation yield and 270 days yield have the same value. 270 days lactation production must be equal to or lower than total lactation production, never higher.

**Note 1:** Lactation milk yields, both total and 270 days, are production parameters; they are not meant to express the genetic merit of the buffalo. Therefore they should not be projected using extension factors. In case the lactation is very short for involuntary reasons, the reason will be mentioned in individual certificates by a code to be indicated beside the individual production. E.g. (1) = sale; (2) accident, etc.

**Note 2:** When the 270 days milk production will be used to calculate the average values by herd, village and total covered area, only the information from lactations having reached a minimum of 150 days will be used.

### 2.4.6 Data processing

The organization in charge is responsible of collecting and processing all the information registered by the technician.

The organization in charge will process and calculate the following:

1. Milk production of each buffalo during all the days she was in milking (total lactation production).
2. Milk production of each buffalo from calving to 270 days (270 days milk production).
3. Average values of total lactation production and 270 days milk production by herd, village, total covered area.
4. Average age at calving by herd, village, total covered area.
5. Average number of calvings by herd, village, total covered area.
6. Average days open by herd, village, total covered area.
7. Average days of lactation by herd, village, total covered area.

Parameters 1 and 2 will be used to produce individual buffalo certificates and will be processed whenever requested by the farmers.

Parameters from 3 to 7 will be processed at periods fixed by the organization in charge, according to the needs of the participating herds. In any case, annual average values of parameters 3 to 7 will be calculated for the total covered area to be sent yearly to ICAR.

Calculation (optional) of fat yield (kg) and protein yield (kg) will be done in the same way as for milk.

Calculation (optional) of average fat and protein percentage will be calculated as follows:

\[
\text{Average fat (or protein) percentage = } \frac{\text{kg fat (or protein) x 100}}{\text{kg milk}}
\]

When calculated, the last two parameters can be included in the processing as the parameters 1 to 7 above.
2.4.7 Output produced by the organization in charge

The organization in charge should produce three types of output:

1. Feedback reports to the farmers to help in management decisions. The reports should include:
   1. Individual productivity sheet for each animal, including: genealogy; date of birth; date of the calvings; total lactation production (number of days and total produced milk) for each lactation; 270 days lactation production (number of days and total produced milk) for each lactation; indication of interrupted lactation. 2. Average values of total lactation production, number of days in milking, 270 days lactation production (*), calving intervals, age at first calving, lactation number; by herd,

2. Information on buffalo milk productivity at village, region, and/or national levels to extensionists, dairy industry, government authorities and policy makers including: (average values of total lactation production, number of days in milking, 270 days lactation production (*), calving intervals, age at first calving, lactation number by village, area).

3. Information on buffalo milk productivity in the covered area to ICAR for international comparisons. (same parameters as in 2.).

(*) Only the lactations over 150 days will be considered when the average 270 days production is calculated.

2.4.8 Authorised milk measuring systems

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Country of approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milko Scope II</td>
<td>Milk meter</td>
<td>Italy</td>
</tr>
<tr>
<td>Alfa-Laval 7274031-80</td>
<td>Recording jar</td>
<td>Italy</td>
</tr>
<tr>
<td>Tecnozoo</td>
<td>Recording jar</td>
<td>Italy</td>
</tr>
</tbody>
</table>
SECTION 3.1 - ICAR RULES, STANDARDS AND GUIDELINES FOR BEEF PERFORMANCE RECORDING

3.1.1 General rules

3.1.1.1. Scope

The present general rules are minimum requirements for a harmonised beef performance recording for the management and genetic evaluation purposes. They are applicable for beef performance recording in various production systems and breed orientations.

3.1.1.2 Recording Schemes

Recording schemes include:
- suckler herds from birth to weaning;
- test stations;
- finishing herds after weaning to slaughter;
- sales and marketing (merchandising);
- abattoirs.

3.1.1.3 Symbols

A three letters symbol stands for the method of recording “A”, “B” or “C” (see Section 1.3 ICAR Rules, standards and guidelines on methods of recording).

3.1.1.4 Definitions

For the purpose of these rules the following definitions apply:
- **Performance**: heritable measure or observation concerning an animal in relation with the economic result of a production system.
• **Beef performance**: performance in relation with the quantity and the quality of saleable lean meat.

• **Weights**: measure in kilograms obtained from weighing scale checked for accuracy.

• **Reference performance**: expression for a performance to be used, in addition to other locally approved expressions, in order to compare phenotypic values or for data exchange between different performance recording schemes.

• **Herd**: group of animals kept for the same purpose at the same location.

**3.1.1.5 General rules for all recording schemes**

Beef performance recording requires an identification and registration system for new born calves which includes

- animal identification;
- birth date;
- breed;
- calving parity;
- sex;
- parent identification;
- type of calf (single, multiple or embryo transfer);
- farm identification where calf is born.

**3.1.1.6 References to the International Agreement of Recording Practices**

The following rules of the International Agreement of Recording Practices fully apply to the recommendations for beef performance recording:

- recording: basic principles;
- organisation of recording;
- recorded herds.

**3.1.2 Guidelines for suckler herds from birth to weaning**

**3.1.2.1 Introduction**

This recommendation does not deal with a complete performance recording system for suckler herds, which usually cover a wide range of traits, from the low hereditary traits like reproduction (e.g. calving ease), mid hereditary traits like growth (e.g. weaning weight) and highly hereditary traits like body conformation (e.g. muscularity).

**3.1.2.2 Field of application**

This recommendation applies to in field beef performance recording undertaken in herds of cows which suckle their calves until an age of at least four months.
Data is collected in order to provide farmers with useful information for herd management and to provide raw data for genetic evaluation. This recommendation may also apply to progeny test stations. It allows for genetic evaluation of both growth ability and milking ability.

3.1.2.3 Description

The performance recording which meets the following requirements fully complies with the recommendation for beef performance recording in suckler herds from birth to weaning.

a) Symbol

The symbol of this recommendation is “SH”.

b) Method of Recording

The methods “A”, “B” and “C” can be used.

c) Recorded Animals

Records have to be obtained for all animals from the same group of cow/calf units kept at the same location for the same purpose.

d) Mandatory Records

For each of the animals the following data should be recorded:

- Animal identification,
- Weighing date
- One weight taken at an age between 90 and 250 days
- Farm identification,
- Abnormal records in relation with preferential supplies of concentrates,
- Identification of the management group within herd when they exist,
- Identification of fostered calves.

e) Reference Performance

The reference performance is the weight adjusted for an age of 200 days.

The calculation method is:

let \( AW \) be the age at weighing in days,
let \( WG \) be the weight in kilograms,
let \( BW \) be the actual birth weight or a breed standard,
the reference performance is equal to:

\[
((WG - BW) / AW) \times 200 + BW.
\]

3.1.3 Guidelines for test stations

3.1.3.1 Introduction

The main objective is to estimate the breeding value of potential sires by removing all possible sources of non genetic variation.
Until recently, the most this recording scheme could offer, was a comparison within a test group. Animal Model using the relationships between the recorded bulls now allows for comparisons when there are enough genetic connections between animals from different stations. The more the conditions of individual performance tests are similar to those under which the progeny will be reared, the more the tests are efficient in terms of expected improvement. Individual performance test procedures should be designed to meet the requirements of specific production systems. The length of test, the age of the animal at the end of the test, as well as the regime in terms of energy level is a compromise, taking into account the breeding ability, the age of progeny at slaughtering, the testing capacity and the conditions under which those bull’s progeny will be reared. Consequently a lot of different procedures may meet the requirements of present rules.

3.1.3.2 Field of application

This recommendation applies to individual performance test stations where the objective is to assess genetic differences mainly from individual performances of bulls from several herds assembled in a single location and raised under uniform and standardised conditions. Tested bulls may be from dairy, dual purpose or specialised beef breeds. They may be designed for use by AI or by natural service. It applies neither to progeny test station, nor to experimental stations.

3.1.3.3 Description of test

Performance recording which meets the following requirements fully complies with the rules, standards and guidelines for beef performance recording in test stations.

3.1.3.3.1 Symbol

The symbol of this testing scheme is “PT”.

3.1.3.3.2 Method of recording

Only “A” methods should be used, i.e. recording must be carried out by an official recording organisation.

3.1.3.3.3 Recorded animals

Records have to be obtained for all the bulls entering the stations. The bulls should origin from several herds. The herds must participate in an ICAR official performance recording scheme which may be milk recording or any other official performance recording, namely in suckler herds.
3.1.3.3.4 Test procedure description
The test procedure should be precisely documented and published.

3.1.3.3.5 Management of the test
The bulls should enter the stations as soon as possible. The test consist in two separate periods: the pre test period and the test period. The length of the pre test period which is necessary to limit the importance of compensatory growth is at least of four weeks. The length of the test period is at least of four months (120 days). The maximum difference in age should not exceed three months (90 days) at the beginning of the test period.

3.1.3.3.6 Mandatory records
For each of the recorded animals the following data should be recorded:
- animal identification,
- date of weighing at the start of the test period,
- live weight at the start of the test period,
- date of weighing at the end of the test period,
- live weight at the end of the test period.
Live weights must be the average of at least two weights taken on successive days.

3.1.3.3.7 Recommended records
Each recording organisation may decide to carry out them. In that case the records must be obtained for each of the recorded animals. Linear scoring both for muscular and skeletal development as well as for functional capacity may be recorded.

3.1.3.3.8 Reference performance
The reference performance is the average daily gain. The calculation method is:
let AS be the age at start in days,
let AF be the age at finish in days,
let SW be the live weight at start,
let FW be the live weight at finish,
the average daily gain is equal to:
\[(FW - SW) \times 1000 / (AF - AS)\].
3.1.4. Guidelines for finishing herds after weaning to slaughter

3.1.4.1 Field of application

This recommendation applies to any situation where animals are reared after weaning to subsequent breeding or slaughter.
Data is collected in order to provide farmers with information useful for herd management and to provide raw data for genetic evaluation.
The animals may be calves, young bulls, steers and heifers up to 36 months of age. They may result from crossing between specialised milk breeds and specialised beef breeds, or from dairy breeds or from beef breeds.
This recommendation may apply to progeny test stations.

3.1.4.2. Description

The performance recording which meets the following requirements fully complies with the ICAR recommendation for finishing herds after weaning to slaughter.

3.1.4.2.1 Symbol

The symbol of this recommendation is “FH”.

3.1.4.2.2 Method of recording

The methods “A”, “B” and “C” can be used.

3.1.4.2.3 Recorded animals

Records have to be obtained for all the animals kept for the same purpose at the same location.

3.1.4.2.4 Mandatory records

For each of the recorded animals the following data should be recorded:

- Animal identification,
- Date of weighing at the start of the finishing period,
- Live weight at the start of the finishing period,
- Date of weighing at the end of the finishing period,
- Live weight at the end of the finishing period,
- Identification of the finishing farm,
- Identification of the management group within herd, if existing.

The interval between first and last weighing must be at least two months (60 days).
3.1.4.2.5 Recommended records

Each recording organisation may decide to carry out them. In that case they have to be obtained for each of the recorded animals. Linear scoring both for muscular and skeletal development as well as for functional capacity may be performed.

3.1.4.2.6 Reference performance

The reference performance is the average daily weight gain. The calculation method is:

let AS be the age at start in days,
let AF be the age at finish in days,
let SW be the live weight at start,
let FW be the live weight at finish,
the average daily weight gain is equal to:

\[
\frac{(FW - SW) \times 1000}{AF - AS}
\]

3.1.5 Guidelines for sales and marketing (merchandising)

3.1.5.1 Introduction

Animals are sold routinely for breeding, for finishing or for slaughter. Data and information is required to ensure benefit to both buyer and seller. For the purpose of this Guideline animals which are reared purely for slaughter will be deemed "commercial" and those which are reared to provide the parents of future generations will be called "seedstock". Effective merchandising for seedstock producers depends upon the integrity of the data and information available (the records) to the buyer of the animal, breed and the breeder. Credibility of the records is enhanced if the herd has a sound and progressive data recording system coupled with a good management programme. It is increasingly important to provide genetic evaluations for the full range of commercially relevant traits. Seedstock buyers rely upon this information to assist them in making appropriate decisions.

3.1.5.2 Field of Application: Records for Animals Offered for Sale

Data are collected in order to provide farmers with information useful for herd management, breeding decisions, sale of stock and to provide raw data for genetic evaluations. The animals may be embryos, calves, bulls, heifers, steers or cows. They may result from cross breeding between specialist dairy breeds and specialist beef breeds, or from dairy breeds or beef breeds. The same lifetime identification must be used by both farmers and purchasers. The field of application is the provision of information in advance of a purchaser buying an animal.
3.1.5.3 Mandatory Information (seedstock and commercial)

For each recorded animal which is offered for sale the following information must be made available to potential purchasers without alteration from the official recording database:

- Official animal identification
- Breed composition to the nearest 32nd
- Identification of farm where the animal is located and other owner, who is offering the animal for sale
- Sex of the animal
- Date of birth of the animal
- Official identification of sire and or dam where known
- The conclusions in relation to the disease status of the herd and animal arising from any disease testing conducted on the animal or other animals in the same herd.
- The vaccination status of animal with respect to all diseases for which vaccination has been carried out in the herd where the animal is located.

3.1.5.4 Mandatory Records for Seedstock (in addition to the above)

- The most recent official genetic evaluations of the animal, including those for overall indices and individual traits in accordance with the guidelines of the organisation(s) responsible for genetic evaluations.
- The reliability (or accuracy) of the genetic evaluations for the animal
- The status of the animal in the Herd Book.
- All indicators of the quality of the recording conducted in the herd where the animal is located.
- Other such traits as may be reasonably required by breed organisation or purchaser.

3.1.6 Guidelines for abattoirs

3.1.6.1. Introduction

Commercial slaughter results are recorded routinely by abattoirs to meet the requirements of different regulations.

This information is obtained routinely for commercial use.

Though this data was not field performance it may be considered as beef performance recording.

3.1.6.2. Field of application

This recommendation fits any type of cattle slaughtered before an age of thirty six months.

Data is collected in order to provide farmers with information useful for herd management and to provide raw data for genetic evaluation.
The animals may be calves, young bulls, steers and heifers up to an age of 36 months. They may be from crossing between specialised milk breeds and specialised beef breeds, or from dairy breeds or from beef breeds.
This recommendation may apply to progeny test stations.
It requires abattoirs and farmers to use the same animal identification.

3.1.6.3. Description
The performance recording which meets the following requirements fully complies with the recommendation for beef performance recording in abattoirs.

3.1.6.3.1 Symbol
The symbol of this recommendation is “AB”.

3.1.6.3.2 Method of recording
There is only an „A“ method. Carcasses have to be weighed and graded according to the national official system.

3.1.6.3.3 Recorded animals
Records must be obtained for all animals slaughtered from the same group of animals kept for the same purpose at the same location.

3.1.6.3.4 Mandatory records
For each of the recorded animals the following data should be recorded:
- Animal identification,
- Abattoir identification,
- Slaughter date,
- Commercial official slaughter weight of carcass,
- Finishing farm coding.

3.1.6.3.5 Mandatory records for animals slaughtered in the European Union
For each of the recorded animals the following data should be recorded:
- official EUROP carcass score for carcass conformation
- official fat score.

3.1.6.3.6 Reference performance
The reference performance is net weight gain per day of age.
The calculation method is:

let \( AS \) be the age at slaughtering in days,
let CW the commercial carcass weight, 
the net weight gain per day of age is equal to, 
\[(CW \times 1000) / AS.\]
SECTION 3.2 - ICAR GUIDELINES FOR BEEF RECORDING

3.2.1 Introduction

Beef recording is a basic tool for herd management as well as for genetic evaluation and breeding. Its aim is to collect information about economically relevant traits that show genetic variation and that are used for the calculation of genetic proofs.

3.2.1.1 Objectives

As shown in the ICAR survey of 2001, many countries have been involved in beef recording for decades and independently developed national approaches of their own. As a consequence, a huge diversity of national recording schemes can now be observed at present. In view of this background the present guideline aim to provide:

- A common understanding of beef recording schemes that enables producers and breeders to communicate efficiently across countries;
- Global standards in beef recording;
- Advice and help for the establishment of new national beef recording schemes;
- A solid data interface for genetic evaluation of beef characteristics;
- For the improvement in the reliability of genetic proofs, by implementing appropriate data structures;
- For the improvement in the accuracy of genetic proofs, by the identification and recording of the important non-genetic effects;
- For the establishment of an international data dictionary for beef cattle which allows for efficient national and international data exchange;
- Assistance to recording and breeding organizations involved in genetic evaluation programmes;
- A reliable code of practice.

3.2.1.2 Scope

The present guideline aims to provide guidelines for the relevant matters which must be undertaken in the routine execution of beef recording schemes.

Beef production is predominantly based on specialised beef breeds that use natural mating, the rearing of calves by their mothers and the finishing of the young animals in specialized finishing units. On the other hand, dual purpose and dairy breeds that mainly use artificial insemination and separate the young calf from the mother immediately after birth, also contribute significantly to beef production in many countries. Therefore, the present guideline aims to provide for the recording of all cattle used for meat production.

Genetic evaluation is not considered in detail in these guidelines, as this field of activity is subject to highly sophisticated approaches which are continually enhanced by teams of specialists. Standardisation would be inappropriate, as it would impede future developments.
The ICAR survey clearly indicated two main beef recording traditions. The European type approaches on the one hand and North American type approaches, as represented by the Beef Improvement Federation (BIF), on the other hand. The differences between them can in the main be traced back to substantial differences in consumer’s demand impacting the pricing system and consequently the selection objectives and also the significant differences in the production environment and in particular herd sizes.

The present guideline aims to combine recording standards of all regions in as much as this is possible. However, overall uniformity can not be fully accomplished. For example no agreement about weight standardisation in weaner calves has been achieved today. Most European countries use a standard age of 210 days whereas 205 days are applied in North America. Differences such as this should not be viewed as failures in developing international standards. It matters little when weaner calf weights are recorded or to what age they are adjusted, as long as all of the pertinent information is furnished, such as weight, date of recording and contemporary group information.

Documenting differences enables the person interpreting data to see that “weaning weight” from different sources may not mean the same thing, but with the appropriate information it may be possible for the values to be adjusted and used to compute a meaningful comparison or evaluation.

The guideline recommends basic procedures. However, there will be situations where national organizations will develop more refined procedures that are more suitable for their members. Furthermore there might be national or legal restrictions in the use of proposed or recommended units of measurements (e.g. non use of metric units) thus preventing a body from using uniform international standards.

### 3.2.2 General

#### 3.2.2.1 Applied beef recording schemes

Beef recording requires recording schemes that can accommodate beef production as implemented in practice. The recording procedures must account for all important effects including the existence of genotype by environment interactions. Beef recording may be undertaken in:

- Breeding farms.
- Finishing farms.
- Individual test stations.
- Progeny test stations.
- Abattoirs.

In accordance with existing ICAR terminology recording methods “A”, “B” and “C” may be used to describe the following methods of recording.

- The A method means recording done by a technician.
- The B method means recording done by the farmer.
- The C method means recording done by a mixed system of recording by farmers and technicians.

#### 3.2.2.2 Factors to be considered

The following factors should be considered as basic requirements in beef recording:
• A contemporary group may comprise of animals of the same breed, sex and age range kept under the same or at least similar management conditions. Its definition should be carefully established.

• Tests on animals should be organised in such a way that maximum information can be obtained. This particularly relates to the composition of contemporary groups. This applies especially in relation to the degree of relationship within the contemporary group. The contemporary group animals should be as unrelated as is practically possible.

• The animals must be identified permanently by a unique number that is always retained with all individual records or documents relating to the animal.

• Invariant or permanent animal data and further basic information on the animal should be stored in a centralised database. All performance data on an animal should be verified and correct on loading to the database.

• National cattle databases used to identify, register and monitor birth, movements and the death of animals should be used in the beef recording schemes as far as this is possible.

• All personnel charged with data collection duties must understand the need for accurate and dated records, which should also include the identification of the recorder. Data may be collected by farm personnel or trained technicians depending on the trait. Complex traits such as conformation assessment using a linear scale or ultrasound measures of fat and muscle must be collected by trained personnel that undergo routine evaluation and retraining procedures when necessary.

• Data verification systems must be in place which undertake thorough record checks and identify and reject inconsistent or unacceptable data.

• The contemporary group should include the progeny of at least two sires.

3.2.2.3 Principles of beef data recording

It is essential that some basic principles should be taken into account in beef recording practices to improve recording efficiency, data storage, data exchange and usability of the animal’s performance data.

Throughout the whole recording process, there are four essential key pieces of information which should be included in any animal’s data record:

• Identification number of the animal.

• Date of recording.

• Identification number of the location (farm, station).

• Identification number of the recorder (recording person).

It is desirable therefore for practical reasons to allocate standardized unique identification codes or numbers not only to the animal but also to locations (holding ID) and to recording personnel. The animal’s holding identification together with recorder identification provides information which allows for the correction for environmental effects and therefore is needed for statistical analysis and genetic evaluation. Furthermore the information in respect of the recorder (recording technician) allows for identification of recording methods (A = recording by official technicians; B = recording by the keeper; C = mixed systems), in accordance with the general ICAR standards.

In general, details relating to an animal can be categorised into four different types as follows.
3.2.2.3.1 **Invariable data**

There are 3 groups of invariable data:

### 3.2.2.3.1.1 Invariant animal data

This includes all data that are specific to an animal, are available at the birth of the animal and do not change during its lifetime. This set of data comprises at least:
- The ID no.
- Birth date.
- Birth location.
- Birth type (single, twins, triplets etc.).
- If the animal is an identical twin or a clone, the ID no(s) of the other genetically identical animal(s).
- Sex.
- The breed or breed composition.
- The ID no. of the animal’s genetic parents.
- Information in respect of embryo transfer if applicable.
- ID number of recipient dam in case of embryo transfer.
- Information in respect of fostering if applicable.
- ID no. of foster mother case of fostering

### 3.2.2.3.1.2 Invariant location data

All holdings should have a permanent unique ID to identify correctly fixed effects in genetic evaluation and to study the evolution of these fixed effects (specially herd effects) over time. Furthermore this fixed location ID allows for tracing the origin and later locations of the animal as it moves through the whole production chain.

### 3.2.2.3.1.3 Invariant recording personnel data

Many records are influenced by an operator or recorder effect. This applies not only for subjective assessments such as linear scoring but also to some degree to measured traits like weights, as the accuracy of the recording and other individual influences differ significantly between recording persons. Therefore, in the case of data recorded by technicians, the operator’s ID number should be included in each record.

### 3.2.2.3.2 Life history data

This class of animal data includes information on the status of the animal (alive or dead, suckling or weaned etc.) and the farm or management conditions the animal is kept in. These data are time-critical in that, for a given animal and a given date, it should be possible to retrieve all relevant information pertaining to management condition, reproduction status etc.
There are two main areas of information that have to be collected and permanently updated in this class of data.

### 3.2.2.3.3 Physical location of the animal

Many animals change location during their lifetime. Records may start in the birth herd, continue in a finishing herd or test station and then be completed in an abattoir. The date of arrival and date of departure from each establishment must be recorded so that data collected during each period can be verified if necessary from the recording herd.

The identity of an animal must not change between locations. The original identification must be checked before it leaves one location for the next and then checked again on arrival.

The standard format for recording a change of location or status may include the following:

- Animal ID.
- Date of change of status/location.
- Recording person.
- Current location: farm ID (management-group within farm if applicable).
- New location: farm ID (management-group within farm if applicable).
- Range of codes to describe such events as weighed, weaned, died, sold for breeding, sold for slaughter etc.

Animal movements from one herd to another or between management groups within herd, should be recorded as soon as possible.

### 3.2.2.3.4 Reproductive status of the animal

The reproductive status describes the standing of the animal in respect of its breeding cycle/status. It includes such events as mating, insemination, embryo transfer and birth/calving for females, and castration for males. If females are kept with one or several bulls during the mating period, then all possible mates in the mating time window should be recorded. Where natural service is used, then the dates of introduction and withdrawal of sires should be recorded.

The relevant data can also be collected in a standardized format:

- Animal ID.
- Date.
- Recording person.
- Actual location: farm ID (management-group within farm if applicable).
- Code to describe the reproductive event.
- ID of other animal(s) involved (e.g. mating partner, calf, foster calf etc.; if applicable).

Having these two types of data of an animal’s life history, it should be possible to access all relevant information for the calculation of and statistical analysis of performance data.
3.2.2.3.5 Recorded data

Recorded data are those details directly recorded on an animal or animal group. It includes both objective measures and subjective assessments.

A number of general principles apply in respect of this data.

- Provided there is no conflict to legal national units of measurement the data should be recorded in metric units (meters or centimetres, kilogram).
- All recorded data should be stored as raw data without any adjustment or transformation.
- Recorded data should include information about all known non-genetic effects and circumstances affecting the level of recorded performance.

It should be noted that a ‘recorded trait’ should strictly be the actual measurement, count or subjective score. If a trait has to be standardized for a given age or for environmental factors, the resulting adjusted weight is a calculated or derived trait. Adjusted weight may be a function of the recorded weight and age derived from the weighing date and the birth date. Thus, ‘weight’ is a recorded trait, whereas ‘weight at 200 days’ is a calculated or derived trait. In principle, 4 different types of data records can arise.

3.2.2.3.5.1 Objective measurements

Measurements like weights, heights etc. which are assessed with the use of some technical equipment. These measurements, if recorded properly have a high degree of accuracy and are relatively easy to standardize if the definition is clear. However, it should be mentioned that some recording device (e.g. ultrasound measurements) needs careful training and supervision of the operator as otherwise the accuracy of measurement is not guaranteed.

3.2.2.3.5.2 Date/Time

It is strongly recommended that for recording purposes, the recording date should be used rather than the animal’s age. The reason is, that additional information is required to derive the age of an animal, and this may lead to erroneous recordings, arising from different formats (age in years, months, or days) or just deficient or inaccurate information which can subsequently be corrected.

The recording date allows for the calculation of age when combined with the birth date. The birth date should be recorded in the database for every animal.

The date of recording also provides information on the month or season in which the recording has been undertaken. This information may be useful for the further interpretation or statistical/genetic analyses of the recorded data.

Where date of data collection is recorded then the date should be stored as an 8-digit number using the format

- YYYYMMDD.

For most performance traits the date of data collection is sufficient information, the time not normally being necessary unless needed for management reasons. However, where recording time is collected then the 24-hour clock should be used. The time should be stored as an 6-digit number using the format

- hhmmss.
3.2.2.3.5.3 Nominal classification

This occurs where observations are recorded in discrete, unordered classes, like breed or reason for disposal. Well defined and comprehensive categories are required to gain as much information as possible. The classes should be mutually exclusive, i.e. no overlapping of classes should occur. There may be a need for an additional open class for all cases, that cannot be attributed to one of the defined classes. This class should be as small as possible and should include a brief description in order to facilitate the creation of additional classes if necessary.

3.2.2.3.5.4 Subjective scores

This type of recording classifies animals, using a finite ordinal scale, into one of a number of possible classes. Often the classes are an ordered sequence of numeric scores, where the lowest and the highest numbers represent extreme phenotypes expressed in the population under consideration. It is desirable that descriptions of the different classes be provided in text and where appropriate as pictures/drawings.

As outlined later, the main problem with subjective scores is to ensure that values are comparable, even if they are assessed by different persons or by the same person at different points of time and at different locations. This requires clear definitions, ongoing and systematic training as well as the permanent supervision of the recording process. It is essential that periodic verification of the aptitude of the recording technicians be undertaken.

Regardless of the type of recorded trait, it is possible to use a standard format:

- Animal ID (or group of animals if applicable).
- Date of recording.
- Recording person.
- Actual location: farm ID (management-group within farm if applicable).
- Trait name/trait code.
- Trait value.
- Additional information pertaining to the animal.
- Additional information pertaining to the recording procedure.

It is essential, that for all recorded traits in a given recording scheme, the trait be sufficiently well defined. Additionally unique two or three letter trait codes may be specified (e.g. one code for “shoulder width”, another code for “roundness of thighs” etc.) where it is not practical to use the full name. It is strongly recommended to use trait definitions and/or trait codes in accordance with international standards where available from an international breed umbrella organisation.

3.2.2.3.6 Calculated traits

This type of trait is different from the other categories, as calculated traits are derived from the ‘raw’ data information. These traits are calculated according to clearly defined rules. Where the calculated trait requires complex computing procedures or is frequently used, the results may be stored rather than re-calculated each time.

In general, calculated traits may be divided into three different classes of traits.
3.2.2.3.6.1 Counts

This category includes summarized information from recordings such as the number of inseminations or matings per mating period, the number of calves born and the number of ticks observed per unit area.

3.2.2.3.6.2 Adjusted or derived traits

Raw data will often have to be adjusted to a defined age, weight, or length of testing period, to comply with the defined standard. If, for example, the weight at 365 days is defined as a standard beef trait, but an animal which is born on March 1, 2000 is weighed on March 15, 2001, the recorded weight is taken at 380 days. Therefore, it has to be adjusted to the standard age by using a linear or other adjustment procedure.

For these classes of traits it makes sense to use a similar data format as for the unadjusted recorded trait. Distinct trait codes should be used in order to avoid confusion. Information that already has been accounted for in any adjusting procedure is omitted.

3.2.2.3.6.3 Functions of several recorded traits

A number of interesting performance traits are derived from a combination of recorded traits. Daily gain in the test period for example is the difference between weight at end and weight at start of the test period, divided by the difference of age at end and age at start of test period, expressed as grams per day. This type of data can be derived both from raw recorded data and from adjusted traits.

With these kind of traits, one often has several overlapping additional pieces of information. For example combined traits are recorded by different recorders, at different dates, and at different locations. Combined traits therefore should be defined to be largely independent of this type of additional information. A daily gain in a test period should pertain to a standardized test length.

The trait definitions given in the following section will specify which additional information is needed in detail.

The resulting general data format for calculated traits may be as follows:

- Animal ID (or group of animals if applicable).
- Date of recording (start/end of test period etc.).
- Age of animal.
- Relevant location.
- Trait code of calculated trait – where applicable.
- Value of calculated trait.
- Additional information pertaining to the animal (e.g. contemporary group).

Note that in this case the age (as a calculated trait) is included, while for recording purposes, it is strongly recommended to record actual dates of events.
3.2.2.3.7 Genetic proofs and other population-related indices

This type of data applies, if an animal’s performance is related to the performance of other animals in the same population. Genetic evaluation includes trait information (raw or adjusted), pedigree information, classification of fixed environmental effects and covariables etc. Typically such analyses are done for all animals of a population simultaneously.

Results of genetic proofs are by definition independent of any environmental factors, but values may change over time. Therefore they should be stored with the animal’s identification number, the date of estimation together with a definition of the reference base used in the particular genetic evaluation.

3.2.2.3.8 Data requirements for the calculation of genetic proofs

In most cases the required data formats for trait information, fixed and random effects and pedigree information are clearly defined in the genetic evaluation system. The data file should be provided in a standard format. Where raw data is subjected to ongoing maintenance which allows for changes of historical data (e.g. change of parentage, fixed effects etc.), submitted data for genetic evaluation should include all animals of the relevant population rather than just a subset of new or recently recorded animals.

Data for the calculation of genetic proofs should comprehensively account for management conditions and other non-genetic effects affecting the animal’s performance. Much attention should be paid in the definition of contemporary groups held under similar management conditions. However, the definition of contemporary groups frequently will be a compromise between a precise specification of the group with possibly loss of contemporaries on the one hand and a wider specification with loss of information accounting for fixed effects.

Usually the pedigree file is a separate file containing the animal identification number and that of its parents together with breed sex and birth date. The pedigree file should contain all animals contributing to the genetic structure of the breeding population. Where pedigree data originates from separate regional or historical sub-populations or separate databases, it may happen that different ID numbers and/or different names of identical animals occur. Therefore special consideration should be given to identifying and attaching unique ID numbers to the relevant animals.

There are some special situations which need to be taken into account:

- In case of identical twinning and cloning, it is necessary to record the fact that two or more individuals are genetically identical, since on the basis of pedigree information alone (identical parent IDs), these animals would be falsely identified as full sibs.
- In genetic evaluation systems it is common practice to include ‘genetic groups’ for founder animals. Animals with unknown parents are grouped according to age (year born), country of origin and/or breed composition (if more than one breed is included). Therefore, it is essential to record this data especially for older animals in the pedigree file.

3.2.2.3.9 Data storage and management

Given that genetic proofs will be used for the assessment of the production or breeding potential of an animal, it is essential that data are stored in a centralized form, which typically would be a national database, but also may be a database at the level of regions, large farms, commercial
breeding companies or breed associations etc. The necessity for a database results from the fact, that performance data of different animals or the same animal at different ages might be combined to retrieve the relevant information.

Ideally, data from one ‘breeding population’ are stored in one database or in databases following a common structure with well established links and defined interfaces for data exchange. The data structure should be defined in such a way, that flexible and efficient use of the relevant data for a variety of purposes is enabled. ‘Structure’ means both the hierarchy of different types of data and the general format, in which data should be recorded and stored.

### 3.2.3 Specific recommendations for data collection

#### 3.2.3.1 Identification

##### 3.2.3.1.1 Animals

Animal identification is outlined in detail in section 1.1. of ICAR’s International Agreement on Recording Practices. The following chapter therefore only provides a brief overview on the most important aspects for identification issues. More details can be found in the relevant International Agreement.

Having decided on which performance traits are to be measured, it is then vital that a system is adopted that successfully records data relating to an individual animal and allows it to be transferred to the body responsible for genetic evaluation. The key to this success is an individual animal identification number.

The recorded animal identity must be unique to that animal. The approach taken in the EC is to have a two-character code for the country and then a numeric code for the individual that may incorporate geographic and herd information in addition to the animal number. Within Breeds Associations, a numbering system may be used allied to ear tags or tattoos. This may be in addition to the official governmental numbering system or it may be a stand alone system. Where both systems are in use then one numbering system must be agreed as the definitive identifier and used in all data collection, communications and evaluations concerning an animal.

Where an official governmental identification system is in place, it is recommended that this identification system be the primary identifier for each animal.

The internationally accepted standard for an animal identity number is a maximum of 12 digits (including a check digit where used) together with the alphabetic ISO country code if the country of origin needs to be identified. Each newly born calf must be tagged with its unique identifier as close to birth as possible. Ideally this should be within 24 hours of birth but could be up to 30 days provided some temporary measure is taken to ensure its identity is not confused with cohorts. The animal’s identity number may be attached to it by, a tag, tattoo, sketch, photo, brand or electronic device. The preferred methods of attachments are those least likely to be confused or lost. Dual identification with a combination of methods or duplication of one method (for example two tags – one in each ear) are recommended for insurance.

Compared to the visible animal ID, a 3-digit ISO country code may replace the alpha country code for data storage and data transfer. In accordance with ISO 3166, the resulting number is composed of 15-digits where the first 3 digits represent the country of birth and the remaining 12 digits represent a unique number within the country of origin. Leading zeros are recommended to fill up to 12 digits.
Animals that lose their identity must be re-identified, wherever possible using their original number. If doubt over the identity exists then all possible efforts should be taken to determine the true identity. The use of DNA genotyping from known (or suspected) relatives should be considered.

For the purposes of performance recording it is essential that the records of calves that are born dead or, die shortly after birth are entered in the system. This can be done without identification of the dead calf if the relevant calving is seen as an event of the appropriate dam.

Cattle that move from one country to another or become parents to offspring in another country (through AI or ET) should continue to be identified using their original identity number (and name if appropriate).

In the case of imported animals, where the number has been changed, the official records should also show the original name and number. The original name and number must be reported on Export Certificates, AI catalogues and show and sale catalogues.

The responsible organisation must maintain a data base that links the animal’s identity to its performance records and its parents identities. In the case of embryo transfer the genetic parents and the surrogate dam identities should all be recorded.

### 3.2.3.1.2 Parentage recording

Parentage recording is outlined in detail in section 1.2. of ICAR’s International Agreement on Recording Practices. Again, the following section only aims to provide a brief overview on this subject.

The identity of the animals served and the service sire must be recorded on the farm on the day of service for AI. For groups of cows bred by natural service the expected parents should be noted and confirmed or deleted at pregnancy diagnosis. The record must contain the identity numbers of the sire and dam including names where available, the breed or breed cross and the date of mating where AI is used or the natural mating was witnessed. If the mating was not witnessed a record of the period the dam and sire were kept together should be made.

To verify the parentage record the cow served and the service bull must be properly identified and exist in or be entered on to the database. The gestation length, where it can be calculated should be within +/- 6% of the average gestation length for the breed of the service sire. The service bull must be verified by an AI record or evidence that the sire was on the farm on the day of service or, in the case of ET, a declaration by the supervising Veterinary Surgeon should be available in respect of the required information.

It is recommended that all mating details be notified to the database as soon as possible after the mating event. This will provide the basic information needed to evaluate a range of fertility traits and may help to identify fertility problems early. It is recommended that the mating details should be reported at least within sixty days after the mating. This will help to minimise errors in pedigree and provide useful fertility and gestation information.

Visual inspection or DNA analysis of the progeny may be carried out to confirm parentage.

### 3.2.3.1.3 Farms/Herds

The data collected for specific animals must relate to the birth herd, finishing herd, test station or abattoir in which it was collected. One animal may have data from a number of sources contributing to its performance record so the source must be acknowledged. Farms and herds must be uniquely
identified by the organisation responsible for the data collection. This identification may use an existing Government or nationally recognised farm identification system or may be generated specifically for the purpose of data collection.

Within farms or herds differential management of cohorts must be clearly identified. Differentiation may occur through deliberately different feeding regimes or through use of pastures with different herbage type and hence nutritional value.

The herd or farm identification codes may be formulated to include geographical location in a country. This may provide the basis for improving the design of the contemporary groups to be used.

3.2.3.2 Life history

3.2.3.2.1 Introduction

Life history refers to the full cycle of an animal’s reproductive and productive herd life. There are many more breeding females and young animals destined for beef production than breeding males. Efficient beef production depends upon three component elements, female reproduction, viability and growth of the young and culled female production. In the production system, the breeding male may be regarded as an overhead.

The reproductive life of an animal is determined by age at puberty (or sexual maturity) and stayability. Age at puberty is the time at which the animal acquires the ability to reproduce offspring and stayability refers to the ability of a breeding animal to remain in the breeding herd. The definition of puberty by precise events in both the male and the female (see Annex) allows for the calculation of age at puberty. In cattle this is between 9 and 15 months of age. But age at puberty is of little practical relevance due to the difficulty to accurately determine the date of these events.

The productive life refers to the period of growth of the young and to the period of fattening of slaughter animals and culled cows.

Reproductive and productive lifetimes are influenced by a wide range of genetic, environmental, nutritional and management factors.
### 3.2.3.2.2 Synopsis of life history recording events

<table>
<thead>
<tr>
<th>State</th>
<th>Recording requirements 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calf</strong></td>
<td></td>
</tr>
<tr>
<td>Conception</td>
<td>Outcome of a breeding, success or failure</td>
</tr>
<tr>
<td></td>
<td>Date of the relevant breeding</td>
</tr>
<tr>
<td>Birth</td>
<td>Date, identification, sex, weight 2)</td>
</tr>
<tr>
<td>Pre-weaning period</td>
<td>Date of weight, measurements 3)</td>
</tr>
<tr>
<td>Weaning</td>
<td>Date, weight, measurements</td>
</tr>
<tr>
<td>Post Weaning period</td>
<td>Date of weight, measurements</td>
</tr>
<tr>
<td>Death/Disposal</td>
<td>Date, reason</td>
</tr>
<tr>
<td><strong>Breeding female</strong></td>
<td></td>
</tr>
<tr>
<td>Puberty</td>
<td>Date</td>
</tr>
<tr>
<td>First and Subsequent Breeding(s)</td>
<td>Type (AI, natural service, multiple sires)</td>
</tr>
<tr>
<td></td>
<td>Rank of AI</td>
</tr>
<tr>
<td></td>
<td>Sire identification</td>
</tr>
<tr>
<td></td>
<td>Date (AI, mating, mating period)</td>
</tr>
<tr>
<td></td>
<td>Measurements, Weight</td>
</tr>
<tr>
<td>Calving</td>
<td>Date, parity</td>
</tr>
<tr>
<td></td>
<td>Calving ease, Measurements 2)</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
</tr>
<tr>
<td>Death/Disposal</td>
<td>Date, Reason</td>
</tr>
<tr>
<td><strong>Breeding male</strong></td>
<td></td>
</tr>
<tr>
<td>Puberty</td>
<td>Date</td>
</tr>
<tr>
<td>Mating/Semen collection</td>
<td>Date, Measurements, Weight, Semen characteristics</td>
</tr>
<tr>
<td>Death/Disposal</td>
<td>Date, Reason</td>
</tr>
<tr>
<td><strong>Slaughter animal</strong></td>
<td></td>
</tr>
<tr>
<td>Finishing</td>
<td>Date (Start/Finish)</td>
</tr>
<tr>
<td></td>
<td>Measurements, Weights</td>
</tr>
<tr>
<td>Slaughter</td>
<td>Date, Carcass, Measurements, Weight; Meat quality measurements</td>
</tr>
</tbody>
</table>

1) The location where each of these events occurs should always be recorded according to the rules given in the section relating to physical location of the animal. Herd identification and slaughter identification are at stake.

2) Weight means live weight or carcass weight.

3) Measurement refers to any body measurement on the live animal or carcass measurement.
3.2.3.3 Reproduction and fertility of male and females

3.2.3.3.1 Introduction

Fertility is the most important economic trait in beef cattle. The recording and use of reproductive traits are of major importance in beef cattle breeding because they are directly connected with the birth of animals and the cycle in which animals are born. Environmental effects have a significant impact on reproductive performances, for example season of breeding and diseases. Fertility also can be influenced by management, for example, grouping of calvings and the ability of the breeder to detect oestrus and the system of production. Management treatments which increase the growth rate in growing animals or the production levels in high production cows can also greatly influence fertility.

Some reproductive traits are simple attributes of an individual animal (i.e. age at puberty, gametes production) and others are complex traits because they are related to reproductive peculiarities of the female, the male and the embryo or foetus (i.e. conception, production of a developing embryo). Basically, most male and female reproduction traits are physiological traits recorded on the animal (sperm production in bulls and oestrus or pregnancy in females) and calculated traits from life history records as for instance dates and outcome of breeding.

Calculated traits from recorded life history information provide ages at various stages of the reproductive cycle and facilitate the calculation of time intervals between various reproductive stages. This information also facilitates the calculation of conception rates.

3.2.3.3.2 Male reproduction

Male reproductive performances can be assessed by traits measured on the male itself (semen production and libido) or by the outcome of breeding recorded in mates (conception rate). Moreover, AI bulls also can be genetically evaluated for any sex-limited fertility traits recorded on their female’s relatives (e.g. age at calving, calving interval).

With AI bulls all that is required is a source of fertile sperm and with natural service bulls, libido and mating ability are most important.

Furthermore, some experiments show that male reproductive traits are genetically related to female reproduction and to body growth. For example, testis size is related to age at puberty and ovulation rate of female’s to body weight in the male.

3.2.3.3.2.1 Semen production

After collection, semen can be examined generally and microscopically and quantity and quality assessed by measuring or by scoring several criteria. These examinations include the volume of ejaculate, the spermatozoa concentration, the proportion of live spermatozoa, the sperm percent forward motility, the proportion of spermatozoa with morphological abnormalities and the semen freezeability. Procedures for semen evaluation have been developed by the Society of Theriogenology (www.therio.org). Semen examination can facilitate the calculation of age at puberty. After semen processing, the number of straws produced in a specified period can assess the bull’s fecundity.
Moreover, it has been established that total sperm cells production, testicular size and scrotal circumference (SC) are highly correlated in young bulls. Therefore, SC can be used as an indicator of the sperm producing capacity of a bull until about 5 years of age. SC varies with the breed, size and age of the bull. Yearling bulls of different breeds have SC of about 30-36 cm.

**Recording Scrotal Circumference**

- **Recorded Scrotal Circumference**
  
  The Scrotal Circumference (cm) should be taken at the largest diameter of the scrotum with a flexible tape placed around the scrotum after both testicles has been positioned beside each other in the scrotum.

- **Calculated yearling Scrotal Circumference**
  
  Adjustment should be done by breed for age or weight.

  Adjusted 365 days SC = actual SC + (365 – days of age) x breed adjustment factor.

### 3.2.3.3.2.2 Sexual behaviour

The male reproductive behaviour is of particular importance in natural service, but the hereditary component of these traits should not be disregarded in AI.

**Recorded behaviour traits**

- **Libido or sex drive**: defined as the “willingness and eagerness” of a bull to attempt to mount and service of a female. A libido score system has been developed to assess both sex drive and mating ability (Chenoweth, 1981)

- **Mating ability**: the physical ability of bull to complete service

- **Serving capacity**: a measure of the number of services achieved by a bull under stipulated conditions and thus includes aspects of both libido and mating ability (Blockey, 1976, 1981).

### 3.2.3.3.2.3 Calculated conception rates/breeding Index

The conception rate and breeding index are calculated from the outcome of a single breeding, i.e. whether a female conceives (code=1) or not (code=0) or whether a zygote develops into an embryo or not. The outcome of a single breeding can be assessed at different times of the gestation cycle according to the methods of pregnancy diagnosis applied.

When recorded on female mates, conception rate may be a practical measure of the fertilizing ability of the sperm cells and as such can be regarded as a fertility trait of the service bull.

To avoid dependencies or complications associated with successive inseminations (variation in cow fertility owing to the rank of oestrus, use of fertile bulls or natural mating for the second and latter mating, varying payment systems related to repeated AI services) only the first inseminations should be used as valid records.

**Recorded traits**

- **Breeding index**: number of matings / conception, gestation or calving.

  It is of practical use only when the same (only one) bull is used to breed each cow and to obtain a conception, gestation or calving.
• Conception rate after first breeding: proportion of cows, a bull had been mated to or inseminated with one bull’s semen, which conceived or was pregnant at a defined stage of gestation or subsequently calved (calving rate).

3.2.3.3.2.4 Calculated non-return rates (NRR)

Non-return rate (NRR) is a particular expression of conception rate mainly used in AI industry. NRR is based on the observation that a bred/mated cow has not returned for another service within a defined number of days. In order to facilitate the understanding of the NRR and to facilitate the harmonization of calculations between countries, ICAR recommended a precise description for the expression of NRR.

The real value of the non-return rates is to the artificial insemination industry since they can be calculated on a large number of inseminations.

In AI, non-return rates are usually calculated as an index of the fertility of the bulls and the efficiency of the inseminators. These indices are based on the assumption that a cow is pregnant to first insemination if she has not been submitted for a second insemination within a specified interval.

Non-return rate generally overestimate the calving rate due to loss of cows from the herd (sale, death), to embryonic or foetal loss, to failure to detect any subsequent heat and also returns to service that occur later than the specified interval. Furthermore, in some cases up to 10% of pregnant cows may show signs of behavioural oestrus.

The ICAR “International Agreement of Recording Practices” (ICAR, 2003) gives guidelines for the expression of non-return rates (NRR) for the purpose of AI organisations (Section 6.1).

Non-return rate after first insemination (NRR) is the proportion of cows inseminated for the first time during a given period of time (such as a month) that have not been recorded as having returned for another service within a specified number of days, and so are presumed pregnant. Only first inseminations should be considered. This means that first insemination to breed a heifer or first insemination to breed a cow after the end of each pregnancy should only be used.

The interval within which the cows are observed for return after insemination should be specified (e.g. 56 day NRR).

The females with short returns only, can be considered either as non-returned females and are as such considered pregnant (included in the calculation) or alternatively as non-inseminated females (and excluded from the calculation).

As a recommendation, short returns, within 3 days after AI, should be considered like non-inseminated females and both limits of the considered interval should be indicated (e.g. 3-56 day NRR) and these limits should be inclusive. Any other chosen option should be mentioned.

NRR Trait Details
• The NRR related to the date of each AI

Each of n cow inseminated for the first time within a specified period is observed for return during the same interval (3-24, 18-24) after the date of each AI.

o Recommended ICAR NNR expression

’specified period’ (n=): ‘start of interval’-‘end of interval’ = day NRR
• The 60 to 90 day NRR
The cows inseminated for the first time within a specified month are observed for return during a 90 days interval from the first day of the month of insemination. In this case, the cows inseminated the first day of the month of insemination will have 90 days in which to be recorded for a subsequent service, while those inseminated the last day of the month of insemination will have only 60 days?

• Additional information to record
  o The specific period in which cows have been inseminated.
  o The number of females inseminated for the first time, (n=).
  o The treatment of cows with short returns, either like non-returned and pregnant (included in the calculation) or like non-inseminated (excluded from the calculation).
  o The return interval this side of which a return is considered short return, the start of interval in the expressions given above.
  o The interval during which the returns for another service have been recorded after the first insemination.
  o Factors which NRR have been corrected for such as parity and season.

3.2.3.3.2.5 Additional Information about the male
In order to identify the reproduction and the environmental effects, which have an impact on reproductive performances of both male and female, some additional information related to the male, should be recorded. Some additional information about the mate to which the mating is made may also be pertinent to the reproductive performances of the bull (see additional information about the female).

• The mode of fertilisation (artificial insemination with frozen or fresh semen, natural mating).

• In case of artificial insemination
  o Semen processing (e.g. dilution) in case of AI.
  o Date of semen collection, collection or ejaculate identification on straws.
  o AI by an inseminator or by Do It Yourself (DIY).
  o Identification of the inseminator.
  o AI day of the week.
  o Time interval from heat detection until AI completed.

3.2.3.3 Female reproduction
The female reproductive performance refers not only to her capacity to produce developing embryos but also to her capacity to give birth to a live calf and to ensure a proper postnatal maternal environment for normal calf growth. Female reproductive traits include fertility traits calculated from life history dates and from the outcome of lifetime events such as breeding, pregnancy, parturition and weaning.
Furthermore, sires breeding values can be predicted from most female reproductive traits recorded on relatives. It should be recognised that some reproductive traits depend on the farmer’s arbitrary decisions such as breeding dates or culling decisions.

**3.2.3.3.3.1 Oestrus / Breeding / Conception / Calving dates**

The recording of reproductive life history dates in respect of each cow allows for the calculation of the ages at various reproductive events and time intervals between reproductive stages. Important events include:

- Date of heifer first oestrus (puberty).
- Dates of first oestrus postpartum.
- Breeding dates:
  - Date of first breeding in heifer or dates of first breeding postpartum in cow. This date is needed to calculate NRR.
  - Date(s) of subsequent or repeated AI.
  - Dates of observed natural mating.
  - Pasture natural mating exposure dates (start and end of breeding season).
- Fertilizing breeding date, conception date.
  
  If several consecutive breeding or matings occurred, the last breeding date before calving is considered as the conception date. Moreover, the last breeding identifies the putative or assumed sire of the calf. The last breeding date should be compatible with the gestation length.
- Calving date as a trait of the female.

**3.2.3.3.3.2 Calculated ages at various reproductive events**

Many ways of calculating ages and intervals as measures of reproductive performances are reported. In order therefore to provide a comprehensive picture of the trait, the details of the animals involved and of the elements included in the calculation are required.

- Age at puberty.
- Age at first breeding (in days or months).
- Age at first successful breeding (in days or months).
- Age at first calving (in days or months).
  
  The first calving of the animal should be checked against normal biological criteria and with reported calving number.
- Age at nth calving (in days or months).
3.2.3.3.3.3. Calculated interval between various reproductive events

- Calving to first oestrus postpartum interval (days), measures the precocity of postpartum oestrus cycle resumption
- Calving to first breeding interval (days)
- Calving to conception interval (days open), can be computed for previous breeding cycles (days)
- Interval between services, assessment of the current breeding efficiency (days)??
- Calving interval, the calving numbers involved should be specified, it can be computed for previous breeding cycles (days). Calving events have to be consistent with calving number.
- Average lifetime calving interval. This is the number of days between first and last calving divided by the number of calving (days). The number of the last calving should be specified.
- Average days to calving = days from bull in to calving when pasture natural mating exposure is practised during a breeding season
- Gestation length. The number of days between known conception date and subsequent calving date. In case of several consecutive breeding the last one is considered to be the conception date.

3.2.3.3.3.4 Pregnancy diagnosis, recording of the result of a breeding in female

The pregnancy diagnosis allows the determination of the outcome of a mating, its success or failure can be recorded as a binary trait (pregnant = yes not pregnant = no).

- Methods of pregnancy diagnosis:
  - Observation of failure to return to oestrus in a specified return interval (e.g. between 18 and 24 days after breeding).
  - Palpation of ovaries, persistence of the corpus luteum (day 18-24).
  - Progesterone essay (at day 24).
  - Palpation of amniotic vesicle (from day 30-65).
  - Ultrasonic method to detect the embryo (from about day 20), (see Kastelic et al., 1988)
  - Calf birth.
- The date of pregnancy diagnosis

3.2.3.3.3.5 Calculated conception rates or indices

Conception rate calculated from the outcome of a mating (whether a cow conceives or not), can be a measure of her capacity to ovulate and to produce a properly fertilizable ovum and her capacity to complete the implantation of the conceptus. As such, conception rate can be regarded as a fertility trait of the female. Moreover, conception is little if any influenced by the farmer because once he decided to breed a cow, success is always the desired outcome. As a female trait, conception rate can also be used to genetically evaluate sires.
Given hereafter are the basic definition of the main conception rates and indices used, but there are various ways of calculating such conception rates and indices. So it is important to define clearly the animals involved in numerator and denominator, the time or the interval at conception diagnostic from breeding date and the breeding number.

- Female breeding index: number of matings / conception or gestation or calving. This measure of female fertility is often influenced by farmer’s decisions, for example elite cows may be bred more times than other ones that are likely to be culled earlier.

- Number of calves produced per cow and per year at herd level

The outcome of a single breeding can be assessed at different times of the gestation according to the method of pregnancy diagnosis applied. So conception rate should be calculated at a defined day or interval from the date of breeding and could be calculated at the herd or progeny group level. The breeding ranks and parities also should be recorded.

- Conception rate: proportion of cows bred in a herd or in a progeny group, which conceived or was pregnant at a defined stage of gestation (day or interval) or which calved (calving rate).

- Non return rate at a given interval (see guidelines from ICAR for calculations NRR in male reproduction section).

**3.2.3.3.3.6 Number of calves per gestation, prolificacy**

The number of calves per gestation is important in so far as it may affect calving mode, birth weight, weaning weight and growth during pre-weaning period. Moreover, in the case of suckling of both twins by the mother pre-weaning growth and maternal ability assessment also are influenced.

- Code for number of calves: (1) single calf, (2) twins, (3) triplets or more.

- Additional information: suckling of both twins by the mother or fostering of one calf or artificial rearing of one or both.

When prolificacy is a trait of interest, the number of embryos, foetuses or calves could be an indicator of the ovulation rate for one oestrus cycle but dizygotic twins should only be considered. Blood groups or DNA polymorphism can assess the zygotic status. Dizygotic twins are considered full sibs.

**3.2.3.3.3.7 Additional Information about the female**

To define at best the management of reproduction and the environmental effects, which have an impact on reproductive performances of both male and female, some additional information related to the female, should be recorded. Some additional information about the male is also pertinent to the reproductive performances of the cow (see additional information about the male).

- Time of service with respect to the onset of oestrus.

- Mode of oestrus detection (visual, devices, teaser bulls).

- The hormonal treatments of the dam if any (induction of oestrus).

- The previous calving mode of the dam.

- The postpartum pathology of the dam (metritis, retained placenta).

- Fertility problems in the dam (anoestrus, anovulation, ovarian cysts).
• Cow disposal for infertility / sterility in case of unsuccessful breeding.
• Type of calf rearing (suckling calf or fostering of the calf or artificial rearing), which may affect the moment of the resumption of oestrus cycles postpartum. Suckling delays the onset of postpartum oestrus.
• Abortion.

3.2.3.3.8 Mothering aptitude (see temperament/behaviour)
The maternal behaviour may affect the viability of the calf and can require fostering.
• Production trait, the milk yield the cow produces to allow pre-weaning growth of the calf, usually assessed by the weaning weight.
• Behavioural trait of the mother towards her calves, i.e. the way the mother takes care of her calves after birth.

3.2.3.3.9 Embryo transfer and ovum pickup
In some breeds, Multiple Ovulation and Egg Transfer (MOET) is used as a breeding technique or/and in selection program. Ovum Pick Up technique (OPU) is an alternative source of cattle embryos that required in vitro maturation of oocytes and their in vitro fecundation and culture to the stage of blastocyst before egg transfer.

In order to fulfil the standard data for an animal and to properly use records, the following information should be recorded:
• Identification of the embryo and of its genetic parents.
• Date of transfer.
• Coding of the calves produced by egg transfer.
• Identification of the recipient cow.
• Coding of donor and recipient dams to identify cows which did not raise a natural calf.

To specifically analyse the efficiency of the multiple ovulation technique, the traits to be recorded are:
• Number of unfertilised oocytes/flushing.
• Number of degenerate embryos/flushing.
• Number of transferable embryos/flushing.

Moreover some environmental factors may influence the results and particular information should be recorded in the donor cow including the multiple ovulation treatment used and date, the dates of AI and of flushing and the identification of the technician.

As for the result of the egg transfer, the following information should be recorded:
• The date of eggs transfer.
• The mode of transfer as fresh or thawed embryos.
• The type of oestrus of the recipients as natural or by hormone treatment and
• The identification of the technician.
3.2.3.3.10 Calving ease or difficulty, calving mode

Difficult calvings lead to increased calf and cow mortality and could impair the health of the calf, the health of the dam, her subsequent fertility and her production performances.

Dystocia can be of maternal or foetal origin. Maternal factors are:
1. anatomical or pathological defects in the pelvic canal (variation in pelvic opening area, pelvis immaturity, and fibrosis of the reproductive tract);
2. insufficient preparation for parturition or expulsive contractions.

Foetal factors are:
1. oversize (relative, absolute or pathological);
2. faulty position;
3. dead calf;
4. twinning.

For breeding purposes, the most relevant causes of dystocia are oversized calf and narrow pelvic area in relation with dam’s age. The presence of a veterinarian at calving is not necessarily associated with these causes, but may have been requested for any of the other causes of dystocia. So the description of a calving mode class by the veterinary assistance is meaningless in so far as breeding is concerned.

- Recommended codes for calving mode or ease
  1. Easy calving without assistance
  2. Easy calving with some assistance
  3. Difficult calving (hard pulling, assistance by 2 or more persons, mechanical assistance)
  4. Caesarean section
  5. Embryotomy

- Other additional information to be recorded: calving date, parity and age of the dam, sex of calf, calf presentation at parturition, twinning, breed of dam and ID of dam.

3.2.3.3.11 Birth weight

The most common cause of dystocia is foetal oversize and the most interesting cause in connection with the breeding ability of the sire for calving ease is the birth weight.

3.2.3.3.12 Pelvic opening

Most calving difficulty or dystocia occurs in first-calf heifers. Research indicates that disproportion between calf size (birth weight) and size of the female pelvic inlet (pelvic area) is a major contributor to calving difficulty. As a result the yearling pelvic measurements can be used as a culling tool to reduce the potential incidence and severity of calving difficulty among first-calf heifers.

- Pelvic measurements:
  - Sacropubic (vertical) diameter (cm).
  - Transilial (horizontal) diameter (cm).
• Calculated pelvic area (cm²)
  Estimated pelvic area is the product of vertical and horizontal measurements

• Yearling calculated pelvic area
  Pelvic measurements should be taken between 320 and 410 days of age and adjusted to 365 days of age to accurately evaluate yearling bulls and heifers. BIF proposed formulas for male and female (see annex calculated traits definition), but the adjustment should be breed specific.

3.2.3.3.13 Mortality from birth

The time of death can be recorded as date or/and code. Generally the codes are connected to live history events (birth, weaning, post-weaning) or to time period from such events which should be specified. The usual times of death are given hereafter:

• Date of death
• Code for time of death:
  o Death during parturition.
  o Perinatal death generally defined as death within first 48H.
  o Death within a specified time from birth.
  o Death in any specified interval.
  o Death after weaning.

From those records, various mortality or viability rates can be calculated, so the animals involved in numerator and denominator and the time or the interval from lifetime event considered should be clearly defined. These rates also could be calculated at herd or sire levels and separated according to different causes of mortality that should be specified.

• Calculated calf mortality rate
  Dead calves, within a time period or towards a defined event, as a % of cows exposed, pregnancies, calvings or calves born alive

• Calculated viability rate
  Alive calves, within a time period or towards a defined event, as a % of cows exposed, pregnancies, calvings or calves born alive

• Weaning rate: proportion of calves weaned for a specified denominator

• Causes of mortality:
  o Congenital defects.
  o Dystocic calving.
  o Accident.
  o Disease (respiratory, digestive, infectious, metabolic…).
  o other.
3.2.3.3.14 Disposal from birth

The time of disposal can be recorded as date or/and code. Generally the codes are connected to live history events or time period from such events that should be specified.

- Date of disposal.
- Code for time of disposal.
  - Postnatal, preweaning, postweaning, other.
- Causes of disposal.
  There are numerous causes of disposal, which can vary from one production system to another. So an exhaustive list of causes is difficult to establish. Moreover breeders may decide upon an animal’s disposal based on more than one reason. On can generally classify these causes into voluntary and involuntary decision of the breeder.
    - Voluntary: sale for fattening, sale for breeding, sale for slaughtering.
    - Involuntary: culling for defects, diseases, infertility, sterility, production deficiency, mothering ability, temperament, other.

- Calculated age at disposal, at culling.

From those records, various disposal statistics or rates can be calculated. The animals involved in numerator and denominator, the time or the interval from lifetime events should be clearly defined. These rates also could be calculated at herd or sire levels and separated according to different causes of disposal that should be specified.

- Calculated rates of disposal, for a specified type of animals at a specified age or event or within specified period.

3.2.3.4 Longevity traits

3.2.3.4.1 General

Longevity is an essential part of any breeding goal, reflecting the ability of an animal to cope successfully with the environmental conditions that arise in the production system. The length of the life of an animal can be calculated from its life history data as any survival trait may be defined as the length of time between two events. Longevity may be measured, from birth or from onset of production to the date of measurement of the specific trait for the last time in an animal’s life.

Life history data which are essential for longevity traits (see elsewhere in these guidelines) are birth date, calving dates and date of disposal. In addition for the calculation of longevity traits the cause of disposal needs to be recorded.

3.2.3.4.2 Calculated longevity traits

The trait generally suggested to describe the longevity of an animal is the productive life span (or also sometimes referred to as productive herd life). Length of productive life is the period of time between the start of production and the end of productive life. As detailed in these guidelines, this trait may be calculated if the recommendations for recording life history data are followed. The
endpoints for the calculation of the length of productive life need to be defined. Typically the productive life of a cow starts at her first calving and ends with her death. In using this data in a genetic evaluation, however, two problems have to be taken into account.

Firstly, incomplete records have to be considered in calculating the length of productive life where a different endpoint than the death of an animal is available. Examples are longevity data of animals which are still alive or which were sold for commercial use. To exclude incomplete records from the evaluation or consider them as dead would lead to biased results. One way to deal with this problem is to use indirect longevity indicators such as whether a cow is still alive at a certain age (‘Stayability’). This method is however associated with a great loss of information. Therefore it is suggested, that incomplete data are treated as censored and special statistical tools are designed for coping with such data used in analysis. For the latter case, the correct code for cause of disposal is mandatory.

Secondly, for genetic evaluation the ‘functional longevity’ should be the trait of interest, i.e. longevity corrected for performance. In this context, culling for low productivity is disregarded since performance is used as a different selection criterion. Only culling for health problems or other non-production causes is taken into account. As for dairy cattle, the performance being corrected for may be milk yield assessed by weaning weight or a weight at a fixed age.

In many cases, early predictors of productive herd life is used for breeding value predictions in young animals. These predictors are usually associated with linear type traits, body measurements and production records.

3.2.3.5 Live animal weights

The collection of live animal weights is critical to the analysis of productivity in the beef herd. Typical weights collected by producers are birth, weaning and yearling weights. It is important that these weights are collected consistently to ensure an informative analysis. Animals are typically weighed using suspension scales or electronic load cells. It is important to ensure that the weighing equipment particularly mobile scales are suitably located on a level surface. Scales should be regularly calibrated to ensure the accuracy of the recorded data. As a minimum, a scale that measures to an accuracy of 1kg/2lb should be used for birth weights and 2kg/5lb for later weights.

When weighing cattle several aspects must be considered. Birth weights are typically recorded on suspension scales. It is imperative that the calf is completely off the ground and is not obstructed in any way. It is best if the scale is mounted on a stand so that an accurate measure can be recorded. For weighing cattle on platform or suspension scales it is necessary that the scales are checked regularly for obstructions and that they are cleaned and balanced frequently.

3.2.3.5.1 Birth weight

Birth weight is the major contributor to dystocia in cattle. Therefore, collecting and analysing birth weight information is useful for many beef breeding programs. Birth weights should be collected within 48 hours of birth. Data that should be collected at birth include: Dam ID; Calf ID; birth date; birth weight; date of weighing and calving ease score. The calf should be dry and should be allowed to nurse the cow.
3.2.3.5.2 Weaning weight

Weaning weights are important to beef producers for several reasons. Weaning weights are an indication of the productivity of the dam and the genetic potential of the calf for pre-weaning growth. Weaning weights serve as the initial weight for determining post-weaning growth. Additionally, many producers market their calves at weaning based on the calves’ weights; therefore, weaning weights can have a significant influence on farm income. Genetic evaluations account for the environmental contribution to weaning weight and separate maternal and growth genetic components. Weaning weights should be collected at the time the calf is weaned. All calves in the contemporary group should be weighed at the same time. The age of the calf at this time may vary depending on the country of origin. For correct adjustment purposes the average age of the calves should be as close as possible to the age adjustment standard for that country or accepted management system. For example, the weaning adjustment age in the United States is 205 days of age, therefore, it is recommended that weaning weights should be taken when the average age of the calves is close to 205 days. If weights are taken at ages considerably different from this age the adjusted weights will not be as accurate.

3.2.3.5.3 Post-weaning growth

Weaning weights typically serve as the initial weight and yearling weights serve as the end-point for evaluating post-weaning growth. In situations where official weaning weights are collected prior to actual removal of the calf from the dam, the initial weight should be collected at the time of removal. Genetic evaluation of post-weaning growth may be reported different. This will either be reported as post-weaning growth or as yearling weight (which is typically the genetic value for weaning weight plus the genetic value for post-weaning growth). In either case the maternal component that influences the trait is accounted for so that the evaluation is on growth potential. Final weights for post-weaning growth are traditionally taken as close to 365 days as possible. However, there are exceptions depending on country and management systems. For example, in the United States there are three accepted ages for yearling weights: 365 days; 452 days; and 550 days. Post-weaning weights should be collected when the average age of the calves is close to the appropriate age. All calves in the contemporary group should be weighed at the same time.

3.2.3.5.4 Finish weights

Collected live finish weights at time of harvest or slaughter is often used as the sale weight and is also critical to assessing dressing percentages. Determining the appropriate time to harvest animals and collect finished weights varies greatly depending on the country and expected utilization of the carcass. For genetic evaluation purposes these weights will be adjusted to a consistent end-point (i.e. age, fat thickness, etc.). Empty weights (no feed or water for minimum 12 hours) should be taken at time of harvest. A scale that measures in increments of 2 kg or 5 lb, or less, should be used for finished weights.

3.2.3.5.5 Test weights

Initial and final test weights to compute growth rate may be either full or shrunk (empty) weights. If full weights are utilized, initial and final weights should be an average of weights taken on two consecutive days to minimize fill effects. Otherwise, a single weight after a 12-hour shrink (no feed
or water) is adequate. Weights may be collected at various points during the test to ensure that appropriate gains are being achieved. A scale that measures in increments of 2 kg or 5 lb, or less, should be used for test weights.

3.2.3.5.6 Chest girth circumference as a predictor of growth

In certain beef cattle management systems, where live weight cannot be recorded directly, chest circumference of animals may be recorded as indicator trait for growth rate in beef performance recording.

Chest girth can be recorded using a measuring tape; alternatively, it is possible to record chest girth using dedicated devices that can predict chest girth from the processing of digital images of the animal. Such devices must be composed by a digital - optical part that is in charge to take digital images of the animal and by a software that must interpret digital images and, using dedicated software, produce animal’s chest girth estimate.

The device precision in chest girth estimation must be periodically verified by field calibrations where the average difference between tape and predicted chest girth should not exceed 2.5% of tape chest girth.

Live weight, a direct beef performance trait, can be estimated from chest circumference using a transformation formula that includes both:

1. The age of the animal, and
2. Its chest circumference.

The age of the animal is calculated as the difference in days between date of recording and animal’s birth date. Transformation formulas may be specific to breed and sex.

It is suggested that use be made of transformation formulas derived from sufficiently large datasets where both chest circumference and live weight were recorded on the same animal, and collected on animals at different ages. Where transformation formula derived from a multiple regression approach are used then the relative R2 should be at least 0.90.

Where chest circumference data is used to estimate live weight it is recommended:

- That the recorded trait of chest circumference is specified, and that the appropriate units (centimetres, inches, meters, etc.) are specified;
- That the actual chest circumference is recorded;
- That chest circumference is stored in the central database and used to estimate live weight using appropriate and approved conversion formulae;
- That estimated live weight derived from chest circumference together with original chest circumference be recorded together on the database;
- That a code be recorded on the database with the animal record to indicate the procedure used to estimate growth from the chest measurement.
3.2.3.5.7 Adjusted growths and weights

Weights are recorded as raw weights together with the weighing date. In order to make live weights comparable among animals of the same breed and sex, and to allow data and information exchanges among countries, it is common practice to express live weights adjusted to specific reference ages. For instance, live weight at 365 days of age of the animal ("yearling weight") makes it possible to rank animals of same breed, sex or herd for their growth aptitude.

Reference ages are defined according to specific breeding events; for instance, 200 days of age refers to weaning of the calves. Weights at reference age are important because they allow comparative analyses for animals in different environments and countries. Usually, recording activity in a herd requires weights on all the animals that are present in that day to be recorded. It may not be possible to make the required measurements on the exact date required. If for example the yearling weight is to be recorded, but only monthly, bimonthly or tri-monthly weightings are technically possible, the expected weight at day 365 can only be calculated using an adjustment procedure and will be stored as a ‘calculated trait’.

When a recorded trait such as live weight is standardized for a given age, the resulting adjusted weight becomes a calculated or derived trait, which is a function of the recorded weight and of the age of the animal. Thus, ‘weight’ is a directly recorded trait, while ‘weight at 200 days’ will be a calculated trait. For the international exchange of data, a standardization of time intervals is strongly recommended, and each national organization should define reference ages for its beef cattle breeds. When storing such weights, it is necessary to specify that these are calculated traits derived from raw data.

Live weight measurements, both from direct (scale) recording and from transformation of biometric measures (e.g., chest circumference) are of primary importance in monitoring an animal’s growth. As already mentioned, weights are recorded as raw weights together with the weighing date and can be adjusted to the reference age of choice. However, such data can be used to calculate other traits that can more easily provide information on the growth potential of the animal.

This type of data refers to live growth rate in a specific time interval and expresses the growth potential of an animal in a specific time period. While live weight specifies an animal’s weight in a single day, growth traits can refer to two weights recorded on two dates and describes an animal’s growth performance in the specific period. The resulting information can be useful for management and comparison among animal growth potentials at differing stages of growth.

Growth traits are of primary importance in beef breeding and the beef industry since growth is highly correlated to the economic value of retail product. These traits are usually expressed as daily gain in g per day. These growth traits are calculated traits and can be divided into two categories:

- **Growth rate from birth to a specific age such as 365 days.**
- **Growth rate between defined periods in the animal’s life.**

3.2.3.5.8 Recommendation for weight correction to standardized age

The usual method for calculating standard age weight is based on determining average daily gain between two weight recordings; then, assuming growth to be linear between the recordings, estimate live weight increase from the day of first recording and reference day and add it to weight on first recording. It is preferable that the age to which weight is being adjusted occurs between two
successive recordings. If this is not possible, an extrapolation is possible if age at last recording falls within a specific time interval from the standard age. The time interval has to be determined by each recording organization based on recording frequencies.

3.2.3.5.8.1 Calculation method

Different situations can occur:

1. Where with the exception of birth weight, there is only one weight record available after birth:
   
   let AR be reference age
   let WR be weight at reference age
   let D_b be birth date
   let D_t be recording date t
   let W_b be birth weight
   let W_t be recorded weight at date t
   let A_t be age of animal at recording date ( = D_t - D_b)
   
   If AR < A_t then
   \[ WR = \left(\frac{W_t - W_b}{A_t}\right) \times AR + W_b \]

   If AR > A_t then
   \[ WR = \left(\frac{W_t - W_b}{A_t}\right) \times (AR - A_t) + W_t \]

2. Where there is more than one weight recordings are carried out after the birth is recorded. The following formula refers to the case of two recordings (n = 2). The procedure can be applied to any number n of recordings, noting that the reference age in this case should be comprised of the age intervals from two successive recordings, or, if this is not possible, should be closest to the last available record. The age range tolerance or limitation values should be specified by the recording organization, based on recording frequencies etc.

   let RA be reference age
   let RW be weight at reference age
   let D_b be birth date
   let D_{t-1} be recording date 1
   let D_{t-2} be recording date 2
   let W_{t-1} be recorded weight at date 1
   let W_{t-2} be recorded weight at date 2
   let A_{t-1} be age of animal at recording date 1 ( = D_{t-1} - D_b)
   let A_{t-2} be age of animal at recording date 2 ( = D_{t-2} - D_b)
   
   If RA < A_{t-1} then
   \[ RW = \left(\frac{W_{t-2} - W_{t-1}}{A_{t-2} - A_{t-1}}\right) \times (A_{t-1} - RA) - W_{t-1} \]

   If A_{t-1} < RA < A_{t-2} then
   \[ RW = \left(\frac{W_{t-2} - W_{t-1}}{A_{t-2} - A_{t-1}}\right) \times (RA - A_{t-1}) + W_{t-1} \]

   If RA > A_{t-2} then
   \[ RW = \left(\frac{W_{t-2} - W_{t-1}}{A_{t-2} - A_{t-1}}\right) \times (RA - A_{t-2}) + W_{t-2} \]
In suckler herds participating in birth to weaning recording scheme, where the reference performance trait is weight adjusted for 200 days, the recommended calculation method is as follows:

let $At$ be the age at weighing in days
let $Wt$ be the weight in kilograms
let $WB$ be the recorded birth weight or a breed standard,
then reference performance is calculated as:

$$RW = \left(\frac{W_t - WB}{At}\right) \times 200 + WB$$

Where it is necessary to extrapolate to an age outside the lower and higher recording ages, a maximum allowable interval should be specified between the standard adjustment age and the available recording ages. This interval can be related to animal’s breed sex and growth potential in the period under consideration. Intervals greater than such threshold should not be used. For example, it may be decided that weight at 365 days can only be calculated if records are within a time period of ± 45 days. Useful weights to calculate 365 days weight should then only be recorded in the age range 320 and 410 days of age. Considering the variation in these parameters throughout recording schemes, the decision of threshold period for determining weight at standard age for each breed is left to member countries. Generally, computational method used are standard linear interpolations. However, if threshold periods are very large, a non-linear standardization may also be necessary within a recording scheme. For the international exchange it is recommended that raw weights and dates of recording be provided as a minimum.

3.2.3.5.9 Recommendation for growth traits calculation

A number of weight gains definitions can be defined:

- **Average daily weight gain**: This is total live weight increase between two weight recordings, divided by the number of days between the two weighing records. The trait is expressed in grams per day.

- **Live weight gain per day of age**: Given a specific weight record, taken at a specific age of the animal, and given an actual or default birth weight of an animal, a live weight gain from birth may be calculated. For the calculation of this trait, birth weight and birth date of the animal should be mandatory data. In the case of missing or invalid birth weights the average birth weight for the breed and sex can be used. The trait is expressed in grams per day.

- **Net weight gain per day of age**: This is the commercial carcass weight divided by days of age at slaughter. Birth date is mandatory in order to calculate age at slaughter. Net gain is expressed in grams per day. It is important to record the trim specification of the carcass as this can vary significantly.

The above-mentioned performance traits are calculated from a combination of recorded traits (weight recording and corresponding dates). This type of trait can be derived both from raw recorded data and from adjusted weights

**Calculation method**

Refer to current ICAR guidelines for the method.
3.2.3.5.10 **Suckler herds from birth to weaning**

Weight gain may be calculated as follows:

- Let \( W_W \) be the corrected live weight at weaning, expressed in kilograms
- Let \( B_W \) be the birth weight, expressed in kilograms
- Let \( A_W \) be the age at weaning, expressed in days

Then, weight gain from birth to weaning is calculated as:

\[
(W_W - B_W) \times 1000 / A_W
\]

3.2.3.5.11 **Test stations**

The reference performance trait in test stations is average daily weight gain:

- Let \( A_S \) be the age at test start, expressed in days
- Let \( A_F \) be the age at test end, expressed in days
- Let \( S_W \) be the live weight at test start, expressed in kilograms
- Let \( F_W \) be the live weight at end of test, expressed in kilograms

Then, average daily weight gain is calculated as:

\[
(F_W - S_W) \times 1000 / (A_F - A_S)
\]

and is expressed in kilograms.

3.2.3.5.12 **Finishing herds after weaning to slaughter**

The reference performance trait is average daily weight gain.

- Let \( n \) weight recordings be performed during the period
- Let \( A_{n-1} \) be the age at weight recording \( n-1 \), expressed in days
- Let \( A_n \) be the age at weight recording \( n \), expressed in days
- Let \( W_{n-1} \) be the live weight at weight recording \( n-1 \), expressed in kilograms
- Let \( W_n \) be the live weight at weight recording \( n \), expressed in kilograms

Then, average daily weight gain is calculated as:

\[
(W_{n-1} - W_n) \times 1000 / (A_{n-1} - A_n)
\]

and is expressed in grams per day.

3.2.3.6 **Live animal assessments**

3.2.3.6.1 **Assessment of muscularity**

Linear scoring is a technique which allows a systematic description of an animal’s morphology. Linear scoring reveals part of the animal’s economic value and, if the scored traits are heritable, part of its genetic value. Economic and environmental conditions vary over time and between countries so the economic importance of each scored trait may differ depending on the circumstances. The specific relative importance has to be determined by the responsible breeding organisations.

As well as the description of a single animal, data from linear scorings are used for genetic evaluation of dairy, dual purpose and specialised beef breeds.
Many breeders, breed societies and those in the AI industry use linear scoring in routinely performed animal recording. In beef breeds linear scoring of muscle shape is particularly important as an indicator of saleable beef yield per animal, and thus is an indispensable part of the beef recording system. To meet the need for an efficient world wide, genetic exchange, international comparison of breeds, and demand for more comparability of individual cattle between countries, procedures for linear scoring of muscularity should be harmonised. This need is best served by an internationally recognised set of recommendations.

The following recommendation may help organisations design a linear scoring system for beef performance recording which suits their market conditions, and which may lead to more homogeneous and comparable scores between different countries.

The present recommendation refers only to linear scoring of muscularity, which is usually part of a complete integrated scoring system within breed. It does not deal with the full spectrum of linear scoring. A complete linear scoring system for a given breed often includes further items such as skeletal traits, udder, legs etc.

The following recommendation may be used both for dual-purpose breeds as well as for specialised beef breeds. Linear scoring can be conducted on any category of animals, such as male and female calves, heifers, cows, bulls and steers.

### 3.2.3.6.2 Recommended approach to be taken in organising Linear Scoring

Linear scoring has the following characteristics:

- Linear scoring is a systematic description of an animal’s morphology.
- It is usual for a linear scoring scheme to takes several anatomical sites into account.
- The anatomical sites must be precisely defined.
- Within one single anatomical site, linear scoring provides a description of the biological extremes and a number of intermediates.
- The scores represent an ordinal scale, which should allow for sufficient discrimination in the degree of expression of the linear trait.
- The extremes and the intermediates are ordered according to the degree of expression of the trait. For example thin and thick, long and short etc.
- A high or a low score has no particular meaning and it is not necessarily desirable or undesirable.
- By convention one of the extremes receives the score ‘1’; the other levels receive a number in ascending order which describes the expression of the trait.
- A scale from 1-9 points is recommended for most traits.
- Where the range of biological extremes is large in the population of animals under consideration, (e.g. double muscling or an across breed recording scheme) the scale may need to be extended. A 1 to 15 point scale is recommended in such circumstances.
- The scoring system should be consistent across contemporary groups, i.e. breeds/breed groups.
- Linear scoring should if possible be conducted on animals which belong to the same category in terms of sex and age.
- For each category of animals the scoring scale for muscle shape should be the same.
• Scoring for muscularity relates to muscle shape only.

The traits which should, as a minimum, be taken into account in a muscularity linear scoring scheme are:
• shoulder width.
• loin width.
• rump length.
• rump width.
• thighs width.
• thighs depth.
• thighs inside.
• thighs rounding.

The following is a graphical representation of the linear muscular anatomical sites.

a. Shoulder width

b. Loin width/ development
c. Rump/pelvic length

d. Rump width

e. Thighs width

f. Thighs depth
g. Inside thighs

h. Rounding/Development of the thighs

### 3.2.3.6.3 Requirements for linear scoring

All factors accounting for any non-genetic variance should be recorded, e.g.
- Scorer’s identification.
- Scoring date/time.
- Management group.
- Nutritional status etc.

All information should be recorded in accordance with ICAR recommendations where they apply. Within contemporary group (e.g. animals of one scoring season within farm) all animals of the same category should be scored according to the standard of the appropriate category.

In order to prevent any pre-adjustments by the scorer, it is necessary that no information other than the animal’s identification should be provided when scoring. No other information, particularly in relation to the ancestors of the animal, or its age should be available.

Linear scoring requires well trained technicians. The practical and theoretical knowledge of the scorer should be tested after receiving appropriate training. The training should allow the scorer to:
- Make full use of the scale within the category of animals being recorded.
- Attain a minimum level of repeatability within scorer.
- Attain a minimum level of repeatability across scorer.

If possible, a routine regional rotation of the scorers is recommended as this facilitates and improves the statistical evaluation of data from linear scoring in different herds by giving a better estimation of the scorer’s effect.
The responsible breeding organisation should establish a routine supervision procedure for the scorers. The competency of all scorers should be monitored and training should be provided annually or more often if necessary.

### 3.2.3.6.4 Assessment of body condition

Condition scoring can be defined as an objective attempt to describe the body condition or degree of fatness of cattle by visual assessment. By adjusting the plane of nutrition, body condition can, to a large extent be controlled.

#### 3.2.3.6.4.1 Purpose

Condition scoring provides a means of attaining the desired target condition scores for optimum production and reproduction, whilst simultaneously making optimum use of available feed sources. Differences in condition can also be recorded within contemporary groups as a means of quantifying differences among animals or for consideration in models for genetic evaluations.

#### 3.2.3.6.4.2 Recommended methods

Different scoring systems have been developed through the years. For example, one such system has been developed by the East of Scotland College of Agriculture in 1973. In this instance the score range between 1 (extremely thin) and 5 (extremely fat) with half scores sometimes used between the main scores.

The method recommended is based on the nine-point system developed for zebu cattle by Nicholson and Butterworth (1985) or similar systems. A nine-point system gives distinguishable steps that can be described and used to account for the wide range of body conditions that are shown by cattle from temperate to tropical areas. It avoids the use of half-points, which can be common when applying a five point system. An arrangement in which three main categories are first defined, and which are then each sub-divided into three to give nine possible options gave repeatable results as well as being easy to teach and explain to others. Units of three worked well where subjective assessment was required. There is always one unit at each end and one in the middle, making decisions easier.

#### 3.2.3.6.4.3 How to condition score

Condition scoring is primarily concerned with two specific areas in assessing fat cover (Figure 1). The first is the loin area (between the hip bone and the last rib) which incorporates the spinous and transverse processes of the lumbar vertebrae. The area surrounding the tail head and pin bones is the second.
Figure 1. Areas on the body where fat cover is assessed for body condition scoring.

The fat cover over the loin area (transverse and spinous processes) is the most important scoring area since changes in fat deposition can be clearly felt and assessed particularly in thinner animals (Scores 1 to 5 on the 9 point scale). The deposition of fat in cattle with a score greater than 5 is such that the transverse processes become increasingly difficult to feel. Fat deposition over the pin bones and the surrounding tail head area becomes increasingly excessive in cows with scores of 7, 8 and 9. The difference between a score of 6 and 7 is the actual deposition of fat on either side of the tail-head which must be clearly visible.

Ideally, the weighing of animals and condition scoring should be carried out simultaneously so that the relevant assessing areas can be felt. Continuous practicing in condition scoring of cattle will increase the accuracy of assessment and the speed at which it is carried out by the operator.
Table 2. Description of the body condition scores for cattle on a scale from 1 to 9.

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very thin (Emaciated)</td>
</tr>
<tr>
<td>2</td>
<td>Thin</td>
</tr>
<tr>
<td>3</td>
<td>Less thin</td>
</tr>
<tr>
<td>4</td>
<td>Less than moderate</td>
</tr>
<tr>
<td>5</td>
<td>Moderate</td>
</tr>
<tr>
<td>6</td>
<td>More than moderate</td>
</tr>
</tbody>
</table>
(Table 2. Continued.)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Less fat</td>
</tr>
<tr>
<td></td>
<td>Back flat; cannot feel spinous processes; hooks (tuber coxae) just visible; fat on neck and shoulder area beginning to expand over ribs; flanks filling, neck thickening.</td>
</tr>
<tr>
<td>8</td>
<td>Fat</td>
</tr>
<tr>
<td></td>
<td>Animal appears well covered with body rounded with fat and bones not discernible; flanks filled, broad back.</td>
</tr>
<tr>
<td>9</td>
<td>Very fat (obese)</td>
</tr>
<tr>
<td></td>
<td>Bones buried in fat; back broad or flat, in some cases crease along the backbone; large accumulations of fat on neck, over shoulder area and ribs; flank filled with fat.</td>
</tr>
</tbody>
</table>

Notes: 1-3 frame obvious. 4-6 frames and covering balanced. 7-9 frame not as obvious as covering.

The following series of illustrations can serve as a guide in scoring cattle for condition (Figure 2).

![Figure 2. Illustration of body condition scores.](image)

Condition scoring does not eliminate the need for weighing animals. Ideally these two operations should be carried out simultaneously. Condition scores should not be affected by weight, age or breed.

More accurate alternatives exist to compare differences in animals for body condition, such as subcutaneous fat thickness measurements by using Real Time Ultrasound methods. Visual condition score, however is a cheap and quick alternative.
3.2.3.7 Ultrasound measurements

3.2.3.7.1 Introduction

Real time ultrasound imaging equipment to record carcase characteristics in live animals for livestock improvement programs has been in use for more than two decades. Its usefulness in beef cattle has been well demonstrated e.g. Brethour (1994), Wilson et al. (1998).

Ultrasound scanning has been used since the late 1980’s in many beef cattle breeding programs to overcome the inherent difficulty of recording carcase data from progeny tests under extensive production systems and in performance test situations where access to carcase information is not possible. A number of genetic evaluation programs have now included scan data in their routine analysis.

3.2.3.7.2 Practical Application of ultrasound imaging

The application of ultrasound is highly technical and requires:

- The use of sophisticated equipment.
- Strict adherence to proper equipment calibration.
- Proper animal preparation.
- Adherence to a standard scanning protocol.
- Adherence to a standard image interpretation protocol.
- Suitable animal handling facilities.

3.2.3.7.3 Animals to be scanned

3.2.3.7.3.1 Scanning for genetic evaluation

It is important for genetic evaluation that animals are allowed to express their inherent genetic potential. As fat measurements are directly related to the nutritional state of the animals it is essential to record only groups of animals which are on a reasonable level of nutrition. Otherwise too many animals will be recorded with minimum fat levels and no intramuscular fat thus generating information of little value since the true genetic potential will not have been expressed. Such data is useless for genetic evaluation where the intention is to identify genetic differences.

As ultrasound measurements are used to provide an insight into a number of carcase characteristics and to a limited extent into meat quality, the most valuable records will come from young animals undergoing selection for breeding and on which no direct carcase information can be collected. Yearling bulls and yearling heifers are the most obvious animals to scan. In many commercial production systems a progeny test through steers or bulls is also possible.

In summary scanning can provide useful information for the estimation of carcase EBVs or EPDs using records from

- Yearling bulls.
- Yearling heifers.
- Groups of progeny fed for slaughter.
The most common age window for young breeding stock is between 320 to 500 days. It may vary depending on production system.

The development of body composition EBVs or EPDs requires that scanned animals be associated with a well-defined contemporary group.

For animals scanned on the farm of birth a contemporary group is comprised of all animals of the same sex that are reared and managed together. A 60 days birth window is recommended. Where herd sizes are small and calving season extended the contemporary group may cover a longer birth season window. A typical contemporary group definition would include herd code, birth season, weaning group (date, location, and management), operator (if scanned by more than one operator) and scanning group (date, location, and management).

For animals scanned at a central station test, the contemporary group should include animals from the same sex born within 60-90 days age window and the same test end. The herd of origin and other birth and weaning group information may also be included.

The practise of harvesting/slaughtering animals from groups when they reach market target weights reduces the management group size as records from animals slaughtered on different days and in particular in different abattoirs should not be directly compared. Scanning for carcass traits of all animals prior to the first selection of any animals to be slaughtered will provide a basis for direct comparison of all animals in the group.

### 3.2.3.7.3.2 Scanning of slaughter animals

Real time ultrasound scanning for subcutaneous fat can also be used to determine market suitability of commercial slaughter animals. However, scanning of animals that have reached target market specifications should not be compared with the use of the same technology for performance recording purposes.

Special care must be taken to avoid any bias in the mean of the observations. Such a bias could have severe financial implication if animals are slaughtered and found to be outside market specifications. For the purpose of genetic evaluation a consistent bias will be part of the management group effect and will not affect the accuracy of genetic evaluation.

### 3.2.3.7.4 Technical requirements

#### 3.2.3.7.1.1 Recording device

A number of real time ultrasound recording devices are on the market. Most of them have been developed for human health or veterinary purposes (e.g. pregnancy testing). The small transducer used for medical purpose is of limited use for scanning of carcass characteristics and so special transducers are required when scanning for carcass traits.

For a list of scanning devices used in animal recording see Appendix 1 following. Ultrasound equipment is undergoing continuous improvement resulting in smaller and more sophisticated models being developed and marketed on an ongoing basis.
3.2.3.7.4.2 Facilities

Efficient ultrasound scanning of large groups of animals requires well designed yards, races and chutes to hold the animals in a stress free and secure manner and release them as soon as all necessary information has been recorded. The operator should insure that the cattle handling facilities for scanning are adequate in respect of health and safety considerations before he commences scanning. A squeeze chute with fold-down side panels is best for scanning beef cattle.

A shaded area is required to allow the operator a good view of the monitor, as direct sunlight will make it difficult to see the images on the screen. Therefore the chute should be located under a roof that can block direct sunlight and provide protection from rain or other inclement weather conditions. A clean and grounded power signal is required at the chute-side. It is best if the electrical circuit is a dedicated line to the chute, free from the interference of other electrical equipment such as motors etc.

Most ultrasound equipment does not operate efficiently and accurately when the ambient air temperature falls below 8 degrees Celsius or 45 degrees Fahrenheit. The breeder should make provisions to keep the facility heated in these situations. The operator should provide some portable supplemental heating systems to keep the ultrasound equipment warm if required.

3.2.3.7.4.3 Preparation of the animal

Animals should be cleaned and clipped particularly in winter or early spring when their hair is too long to get quality images. The requirement for clipping is even higher if scanning is used to determine intramuscular fat % (IMF%) as the lack of complete contact between the ultrasound transducer and the animal’s skin can have a direct effect on the predicted IMF%. In general the length of hair coat should be no more than 1,5 cm or 1/2 inches. Prior to scanning a liquid, commonly vegetable oil, should to be applied to the scan site to provide maximum contact between transducer and skin. The temperature of the oil applied to the skin should be above 20 degrees Celsius or 68 degrees Fahrenheit for best results. This might require a warm water bath for the bottle containing the oil during times of lower temperatures.

Wet animals can be scanned successfully as the water can easily be removed from the scan area. For the scanning of eye muscle area a curved guide or offset made from super-flap will help and will allow a curved image to be recorded without the need to apply excessive pressure to maintain good contact as this would result in distortions of the muscle or fat measurements resulting.

3.2.3.7.5 Recorded Traits

Real Time ultrasound imaging has so far been used for the measurement of subcutaneous fat cover as well as for Eye Muscle Area and Muscle Depth and the Intramuscular Fat Percent in the longissimus dorsi. The appropriate areas of interest are shown in Figure 3.
3.2.3.7.5.1 Rump fat thickness

Rump fat thickness or P8 scan is an indicator of fatness and can be used to improve the overall accuracy of external fat measurements. This measurement can be particularly beneficial when scanning leaner animals such as yearling bulls.

For measurements the ultrasound transducer is aligned directly between the hook- and pin bones without a standoff guide to collect this image. Rump fat thickness is measured at the apex of the biceps femoris muscle. The site is located at the perpendicular intersection of the line from the high bone (third sacral vertebra) with a line from the inside of the pin bone (Tuber ischii) (see Appendix 2, Figure 2 and 3). Rump fat thickness should be reported to the nearest millimetre or 1/25 of an inch. Operators may report to a higher degree of accuracy if desired.

3.2.3.7.5.2 Rib fat thickness

The selection of the site for rib fat and eye muscle depth or area may coincide with the traditional quartering site of beef carcasses in the country. In general the records on different sites are genetically highly correlated, however they might show different variation and are more or less easy to record as different muscles might interfere.

A common site assessed in a number of countries (e.g. Australia, Canada, New Zealand, US) is located ¾ of the distance from the medial to the dorsal end of the longissimus dorsi at a lateral point between the 12th and 13th rib. Rib fat thickness will be reported to the nearest millimetre or 1/25 of an inch. As with Rump fat thickness recordings may be reported to a higher degree of accuracy. Rib and rump fat thickness are well correlated (genetic correlation exceeding 0.70) with rib fat commonly having a lower mean. However, interactions between breed, management system and environment exist.
Section 3 - Rules, standards and guidelines for meat production recording

3.2.3.7.5.3 Eye Muscle Area (EMA)/ Eye Muscle Depth

Carcase ribeye usually is measured between the 12th -13th ribs of the ribbed carcase. The ultrasound ribeye measurement commonly is made from the same image used to measure 12th - 13th rib fat thickness.

Eye Muscle Area/Eye Muscle Depth is measured as the cross sectional area of the longissimus dorsi muscle. Care should be taken not to include other muscles that occur at this site. Similarly the image should be taken between the ribs not over a rib as the latter will cause distortion.

The presence of well-defined intercostal muscles under the Longissimus dorsi is an indication that the transducer is properly aligned directly between the 12th and 13th rib for this measurement (see Appendix 2, Figure 4).

3.2.3.7.5.4 Intramuscular fat percent (IMF%)

Intramuscular fat percent or marbling is an important meat quality characteristic in certain high priced markets, because consumer equate it with outstanding eating quality. The carcase benchmark for intramuscular fat is the chemical extraction of all fat from a meat sample taken as a slice off the longissimus dorsi. Most analytical software for IMF% use a longitudinal image in the region of the 11th, 12th and 13th ribs approximately 2/3rds of the distance from the medial to the dorsal end of the longissimus dorsi (see Appendix 2, Figure 5).

In experiments it has been demonstrated that the correlation between a longitudinal sample and a cross sectional sample is very high. Research has shown that variation between images on the same side is larger than variation within an image selecting different but overlapping areas for the analysis.

The IMF% trait is the most difficult of all ultrasound traits to measure accurately. Equipment calibration, animal preparation, electrical power signal noise, existence of atmospheric radio waves, and transducer-animal contact are just some of the factors that can influence the measurement accuracy. Therefore it is strongly recommended that the IMF% result be reported as the average of at least three images and even better, the average of five images to increase the accuracy.

Most machines do not provide a direct measure of IMF% and thus there is a requirement for specialised PC software. An image frame from the ultrasound scan is digitised and analysed on a computer. Such analysis software is normally designed specifically for a particular ultrasound machine (Hassen et al., 2001).

3.2.3.7.5.5 Scanning weight

The scanning weight of each animal should be measured within +/- 7 days of the scanning date.

3.2.3.7.6 Recorded data

Recorded data should comprise as a minimum:

- Identification of the operator.
- Type of scanner used.
- Scanning date.
- Farm/Herd identification.
• Animal number.
• Trait definition.
• Actual recorded measurement.
• Unit of measurement.

3.2.3.7.7 Qualification of the operator

3.2.3.7.7.1 Image Interpretation

The accurate interpretation of real-time ultrasound images for fat thickness, eye muscle area and IMF% requires a high degree of skill. A number of training programs are currently recognised within the beef cattle industry. Ultrasound scanning operators should participate in and satisfactorily complete such a course in ultrasound methodology before undertaking scanning activities.

3.2.3.7.7.2 Certification of commercially operating operators

To guarantee high quality data for genetic evaluation and research purposes Real Time Ultrasound Scanners should be regularly tested for their proficiency (e.g. annually). Successful completion of such proficiency tests can be made a prerequisite for the acceptance of data into national genetic evaluation systems by those organisations, which control access and input to beef cattle data bases (e.g. recording organisations or breed societies).

3.2.3.7.8 Training and Testing Protocol

3.2.3.7.8.1 Test design

Attempts should be made to select a group of about 30 animals with a range of values for the traits of interest, namely fat depth, eye muscle area, muscle depth and intramuscular fat. All animals should be clipped with some oil applied to the measurement site prior to the test.

As each operator will measure the animals twice, all animals should be tagged with numbers (best on their backs) and these numbers have to be changed between runs.

All operators should have a scanning station to themselves and will be allowed fixed time (e.g. 6 minutes per animal) to complete all measurements on the animals. All crushes should be sequentially aligned so that any time delay by one operator will delay the whole team. Note no two machines should take power from the same power plug to avoid interference between machines, which can particularly influence the prediction of intramuscular fat.

3.2.3.7.8.2 Testing protocol

Official sheets should be provided to record measurements. Sheets should be customised for operators with different machines. No other recording is to be permitted. These sheets are to be collected at the end of each run with at least fat depths recorded. They will be photocopied and returned to those who need them to submit eye muscle area, muscle depth or intramuscular fat.
Other measurement, e.g. eye muscle area should be submitted within 48 hours of completing the test. Operators recording images for eye muscle areas will be required to submit tapes when submitting the EMA records. Operators who wish to submit EMA measurements on the spot can do so.

Intramuscular fat measurements will be submitted within 48 hours of completing the test. Test animals should be killed between 24 and 48 hours after the completion of the test and after allowing for a settling down period to overcome any stress related downgrading of the carcases. Carcase data should be recorded by at least two experienced staff independently to allow for measurement error correction. It has to be remembered that recording of carcase data in the chiller is not error free and also requires skills. Care must be taken to identify carcases whose physical attributes have been changed through the slaughter process e.g. commonly used hide pullers can remove some of the subcutaneous fat on rump or rib. Tightly packed carcases can deform and reduce muscle area. Left or right handed quartering of carcases can affect the surface area and may bias the results for the eye muscle measurement.

3.2.3.7.8.3 Criteria for certification

The criteria for a pass in the proficiency test has to be established. The standards established by the Performance Beef Breeders Association (PBBA) in Australia, Table 1 and the Beef Improvement Federation in the USA, Table 2 are presented as examples. These criteria may be adjusted if the mean and standard deviation of the carcase traits are found to be different to the values in the test that were used to establish these criteria. There does not need to be a requirement to achieve a minimum bias. As bias affects all animals in a similar way it is an effect confounded with the management group of the animal. However note that a comparison of scanned records and real carcase records which reveal large biases will undermine the confidence of breeders in the technique. Mean and standard deviations between animals and between carcase graders have to be recorded to monitor quality recording of carcase data and a consistent variation between the test animals.

A number of different statistics should be calculated to show the proficiency of the scanner.

1. Standard deviation of the difference between first and second scans of the same animals together with the correlation. For this, animals don’t have to be slaughtered and this statistic can be used to evaluate scanners during a training phase. Only scanners reaching minimum standards here, that means those that are consistent in what they are measuring will be allowed to attempt the expensive accreditation involving carcase data.

2. Standard deviation of difference between scan results and mean carcase value and the correlation between scan and carcase results.

3. The bias between scan and carcase measurement.
Table 1. Recommended standards for Proficiency Testing of Real Time Ultrasound Assessment of Live Cattle used in Australia.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Maximum Standard error of repeatability</th>
<th>Maximum Standard error of measurement (prediction)</th>
<th>Correlation with carcase measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rib Fat Thickness (12/13th rib)</td>
<td>1.0 mm 0.04 inches</td>
<td>1.0 mm 0.04 inches</td>
<td>0.9 0.9</td>
</tr>
<tr>
<td>Rump Fat Thickness (12/13th rib)</td>
<td>1.5 mm 0.06 inches</td>
<td>1.5 mm 0.06 inches</td>
<td>0.9 0.9</td>
</tr>
<tr>
<td>Eye Muscle Area (EMA)</td>
<td>6.0 cm² 0.90 inches²</td>
<td>5.5 cm² 0.80 inches²</td>
<td>0.8 0.8</td>
</tr>
<tr>
<td>Intramuscular fat percent (IMF%)</td>
<td>1.0 % 1.0 %</td>
<td>0.9 % 0.9 %</td>
<td>0.75 0.75</td>
</tr>
</tbody>
</table>

Table 2. Guidelines on the minimum requirements for operators as set by the Beef Improvement Federation of the United States of America.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Standard Error of Prediction</th>
<th>Standard Error of Repeated Measures</th>
<th>Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat thickness</td>
<td>≤ 0.10</td>
<td>≤ 0.10</td>
<td>≤ 0.10</td>
</tr>
<tr>
<td>Ribeye area</td>
<td>≤ 1.20</td>
<td>≤ 1.20</td>
<td>≤ 1.20</td>
</tr>
<tr>
<td>% IMF</td>
<td>≤ 1.20</td>
<td>≤ 1.10</td>
<td>≤ 0.70</td>
</tr>
</tbody>
</table>

Alternative statistical methods, like goodness to fit, can also be considered when the proficiency of operators (scanners) are evaluated.

3.2.3.7.8.4 Supervision of the operator

The responsible breeding organisation should establish a routine supervision procedure for the operator. The competency of all operators should be monitored and training should be provided at regular intervals.
3.2.3.7.9 Appendix 1

Ultrasound scanner used in Beef cattle performance recording

<table>
<thead>
<tr>
<th>Model</th>
<th>Manufacturer</th>
<th>Used by</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSD 210 DX II</td>
<td>Aloka</td>
<td>Kansas State</td>
<td>Requires Software for IMF%</td>
</tr>
<tr>
<td>SSD 500V</td>
<td>Aloka</td>
<td>Iowa State</td>
<td>Requires software (Iowa State)</td>
</tr>
<tr>
<td>Pie 200 Vet</td>
<td>Pie</td>
<td>Australia, US</td>
<td>Includes software for IMF%</td>
</tr>
<tr>
<td>Scanner 200 SLC</td>
<td>Tequesta</td>
<td>US</td>
<td>Requires Software for IMF%</td>
</tr>
</tbody>
</table>

3.2.3.7.10 Appendix 2

![Location of P8 Site (Rump fat thickness).](image)

*Figure 4. Location of P8 Site (Rump fat thickness).*
Figure 5. Ultrasound rump fat image with typical landmarks identified. Notice how the point of biceps femoris is near the 2/3 position of the image, and the fat lines are very defined and not blurred. Additionally, the pelvic bone is absorbing the ultrasound waves on the lower right portion of the image. The transducer is placed above a straight line between the hooks and the pins. The animal’s head is to the right side of the image, and the tail is to the left of the image.

Figure 6. Cross-sectional ultrasound image and outline of important landmarks @ 12-13 rib, where a carcass would be broken into quarters.
1 – Spinalis Dorsi
2 – Acorn Fat or the “Hook” of the ribeye
3 – Longissimus Costarum
4 – “Break” in the intercostals
5 – Intercostal muscle boundaries or “Railroad Tracks”
Figure 7. Longitudinal ultrasound image taken over the 13th, 12th, and 11th ribs. The first uniform layer of is the hide of the animal. The second layer is the subcutaneous fat layer. Notice also the triangular shaped section of spinalis dorsi under the fat layer above the 11th rib, and the added brightness of the image under the spinalis dorsi.

3.2.3.8 Test period feeding and test arrangements

3.2.3.8.1 Feed Intake

Recording feed intake and the calculation of EBV’s for feed conversion efficiency or Net Feed Efficiency is a goal of many breeding programmes. Clearly defined procedures are a prerequisite in the recording of feed intakes and feed efficiencies. The ultimate objective, however, is to generate EBVs having removed non-genetic variation as much as is possible. Standardizing the test procedures within and between locations will reduce non-genetic variation, and with adequate genetic linkages between tests centres, data from different tests both in time and location can be used for estimating BVs.

3.2.3.8.1.1 Feed efficiency

Efficiency of gain in beef production can be defined as the ratio of nutrient input to beef output. It is normally expressed as the kg of feed consumed per kg of live weight gain. However the definition of feed conversion efficiency needs to be clearly defined for any particular animal recording scheme. Test animals may be fed in varying forms. The ration may be a fully formulated to include roughage and concentrate and fed in cube or loose form. Alternatively, the test animals may be fed with a standard ration supplemented with some form of roughage such as hay or straw. The nutritional contribution of the roughage element may not in some efficiency tests be included in the calculations.
Feed consumed may also be expressed in units of dry matter. This will be important where the dry matter content of the ration may vary. Beef output is normally recorded as the total live animal gain. Carcass gain for example may be an alternative measure of beef output.

**Recommendations:**
- Nutrition of test animals and definition of beef output should be clearly detailed in the test description.
- A standardised feeding regime should be adopted which minimizes dry matter variation in the ration fed within and over the tests.

### 3.2.3.8.1.2 Testing facilities

Feed conversion efficiency recording may be undertaken on farm or in a central test station. The test facilities should be approved in respect of satisfying the minimum standards for such tests and should be monitored from time to time to ensure compliance with these minimum standards. Any modifications of the testing procedures of facilities should be notified to the body responsible for genetic evaluation.

### 3.2.3.8.1.3 Eligibility of animals for testing

#### 3.2.3.8.1.3.1 Age and age range of test group

It is desirable that the tests be conducted earlier in the animals life to minimize pre-test non-genetic effects. The range in age within a contemporary group should be kept as low as possible. However for many reasons such as the population size of the breed and birth pattern through the year, it may not be feasible to set a very restrictive age range within a contemporary group. It is recommended that the age range within the contemporary group should not exceed 90 days.

The age over which a feed conversion efficiency determination is made varies considerably between test programmes being normally influenced by production systems. The test may commence soon after birth and continue until the later stages of their growth phase which would normally not extend to greater than two years of age. As the test can be expensive to run, a more restricted test period is normally conducted to facilitate the testing of larger numbers of animals and to minimise costs.

#### 3.2.3.8.1.3.2 Sex

Bulls, steers or heifers may be tested. Where resources are limited it is recommended that bulls only should be tested, especially at Central Test facilities.

### 3.2.3.8.1.4 Length of test period

Most feed conversion efficiency tests begin after weaning at about six months of age and should be sufficiently long to facilitate an accurate estimation of feed conversion efficiency or net feed efficiency. The test period should provide for a sufficient adjustment period to allow any pre-test environmental effects to be minimised and to ensure that all animals have adjusted to the conditions and the diet.
3.2.3.8.1.4.1 Recommendation for the test period

It is recommended that the minimum period over which feed conversion efficiency should be determined is at least 60 days together with an adjustment period of at least 21 days.

3.2.3.8.1.5 Pre-test treatment

Animals destined for entry to a performance test station should be identified in sufficient time to facilitate all of the necessary health tests to be completed. Animals entered for feed conversion efficiency evaluation should not be given any special treatment prior to entry but should be fed on a normal plane of nutrition. They should have been introduced to concentrate feeding and be weaned in sufficient time such that the stress on entering the performance test station is minimized and they can be confidently expected to adapt to the test conditions within the adjustment period.

3.2.3.8.1.6 Animal health

All animals within a test shall be subjected to identical health treatments. All animals entering a test should receive standard health treatments that allow each animal to achieve its potential growth performance in that environment. Records of any remedial health treatments administered to individual animals on test should be maintained.

3.2.3.8.1.7 Withdrawal of animals from test

Where an animal on test has encountered any condition or circumstance, which has had a significant influence on its performance and for which there is insufficient time for the animal to recover, then such animals should be withdrawn from test.

3.2.3.8.1.8 Allocating animals to groups

A "group" may consist of any number of animals in individual pens. These pens should be adjacent to each other and have the same physical environment.

The test facilities under which feed conversion efficiency determinations are made can vary considerably. Test facilities designs include:

- Individual pens.
- Group pens of similar size with individual feed boxes.
- Group penning with automated feed stations.

Where an animal is temporarily withdrawn from a pen for any reason, it should upon recovery be returned to the same pen if possible.

Recommendation

In the case of individual penning, all animals should be randomly allocated to the pens. Where animals are group penned, it will normally be necessary for management reasons to assign animals to pens based on animal size. These groups should be randomly assigned to the pens.
All animals in the same test must be fed and maintained under similar physical conditions, and must be fed a ration containing ingredients from the same batch.

### 3.2.3.8.1.9 Feeding regimes and rations

A well-organised feeding system using reliable equipment is essential. Variation in ration and feeding procedures is a significant source of variation between contemporary groups and test centres. Feeding systems vary from simple manually based systems where feed is manually weighed, recorded and dispensed to varying levels of automation including mechanically dispensed to fully computer controlled systems where feed is dispensed under full control to electronically identified animals kept in group pens.

Many test programmes calculate feed conversion efficiency on the basis of ad-libitum feeding. Some evaluation schemes determine feed conversion efficiency based on a restricted level of feeding which is set to achieve a pre-determined level of performance for the group. Such systems need careful monitoring to ensure that the average performance targets are being attained.

Where ad-libitum feeding is being practised, the level of feeding given to the animals should be increased to appetite as soon as possible after the beginning of the test.

In the event of a mechanical failure or any disruption to the feeding system, alternative procedures should be in place to enable all cattle to have access to their normal allocation of ration within 24 hours. If for any reason the feed dispensed on any day cannot be accurately weighed or recorded then that days data must be examined and appropriate adjustments made to the database records.

Where feed intake for a day is lost the estimated feed intake for that day should be based on the average intake of the previous 7 days. Automated dispensing systems should be monitored to ensure that feeding levels are being achieved and animals are not reluctant to use the equipment.

The dispensing and recording systems should be checked on a routine basis to ensure the accuracy of all recorded data.

**Recommendation**

The feeding system used must incorporate accurate measurement and recording of daily individual animal feed intake.

### 3.2.3.8.1.10 Feeding

A balanced ration appropriate to the biological needs of the animal should be fed in a form which minimises any ingredient selection by the test animal. The ration formulation may change in the course of the test as the nutritional needs of the animal change. All animals within the contemporary group should be fed the same ration. Feeding of roughage may not be a requirement depending on the ration formulation. It may be fed as an aid to rumen function. Access to roughage should be controlled in order to avoid interference with ration intake. Roughage in such quantities as are required to maintain good rumen function should be fed. The pen construction and bedding material should be such as not to interfere with the ration or roughage consumption of the test animals.

Commercially available feed additives or supplements may be included in a ration to minimise health risks, or to ensure that the ration meets the minimum standards for metabolisable energy and crude protein, provided they are included within the manufacturers recommendations and to accepted industry standards.
Recommendations
Consignments of ration should be sampled and analysed on a random basis by an approved feed analytical service to ensure that the ration satisfies the pre-defined specification.
Where more than one test centre is involved in a joint evaluation, the specification of the ration fed should, as far as is possible, be similar. Care should be taken to ensure the ration is suitable for the class of stock.
It is strongly recommended that feed analyses performed before the commencement of test are conducted in sufficient time to modify the intended ration if there is a risk that the ration could fall outside the stipulated levels and cause the data generated to be rejected.

3.2.3.8.1.11 Adjustment period
A sufficiently long adjustment period is necessary in order to allow animals in the test to adjust to the test conditions. In ad-libitum tests the intake of animals should be gradually increased during this period until the animals are eating to appetite. Assessments should be made during this period to determine intake level as a proportion of theoretical intake potential of the animal.
Recommendation
A minimum of 21 days should be provided to facilitate full adjustment to the station conditions.

3.2.3.8.1.12 Data recording
Comprehensive and accurate data recording systems should be established.
Details should be recorded in respect of the following.

3.2.3.8.1.12.1 The individual test details
As a minimum this should include:
• Station ID where a number of test centres are involved.
• Test year.
• Test number.
• Test type.
• Date start (beginning of adaptation period).
• Date start of test for feed conversion efficiency.
• Date end of test.

3.2.3.8.1.12.2 Animals within the test
• ID number of station.
• Test year.
• Test number.
• Animal ID.
• Station working number of animal if different from the permanent ID.
• Pen number.

**3.2.3.8.1.12.3 Intake details of animals on test**

The recording of intake details is determined to some degree by the feeding procedures used. With computer based fully automated systems it is possible to record daily feed intake together with average daily weight derived from weighings taken from each visit to the feed station. In non-computer controlled systems the feed record will hold the accumulated daily feed intake data since the previous intake information was recorded. The period over which feed intakes will be accumulated will normally be determined by the weigh period.

As a minimum each intake record should include
• Animal identification.
• Date of record.
• Quantity of feed eaten in this period.

**3.2.3.8.1.12.4 Weight details of animals on test**

This record will store the weight of the animal. Weighings should be taken on a routine basis while minimising gut-fill variation. Weighing the test animals on a regular basis facilitates the close monitoring of performance and early diagnosis of any difficulties within the test. Routine weighings together with a matching feed intake record facilitates the computation of within weigh period daily gains and feed efficiencies together with cumulative daily gains on test and feed conversion efficiency statistics. Depending on the design of the test it may be possible to combine the weight and feed intake details on a single record.

As a minimum the record should record:
• Animal ID.
• Date of weighing.
• Weight.

**3.2.3.9 Health traits**

**3.2.3.9.1 General**

Healthiness of the animals is an essential prerequisite for any production system. Animal health is an increasingly important subject for beef recording schemes. Diseases may affect level of production, shorten length of productive life of animals and be the cause of confiscation of parts or of the whole carcass. Confiscation may be based on the risk to consumers’ health and/or on the effect on the quality of carcass or meat. In all cases, profitability of the beef production system is affected because of veterinary treatment, loss of value of carcasses or of the value of the final meat product, increasing costs of slaughtering animals and the potential impact on consumers’ demand.
Compilation of health data provides a mechanism of control of health status that may affect the profit of the beef enterprise, animal welfare and public health. Recording of animal health data is a tool for monitoring and controlling animals’ diseases. It is also a useful tool for national and international trade in animals and their products as well as for the control of the epidemiology of diseases with special interest for zoonoses.

Disease resistance traits are among the most difficult to include in genetic improvement programs. They require good field measurements of the disease status of the animals under selection. In particular, infectious diseases depend very much upon environmental factors such as the degree of exposure to pathogen agent. In this context, molecular information may be a key tool for breeding purposes. Another approach in considering animal health as a whole is to include functional longevity in the set of breeding goals. Molecular information could provide an important tool for selection of genetic resistance to diseases.

3.2.3.9.2 Condition for data recording

Immunizations and screening tests are an important part of preventive veterinary services. Prevention has a strong impact diminishing morbidity and mortality in animal population. Most health service systems create population immunity from vaccination campaign or seasonal treatments. However, there is a number of diseases with a high prevalence in the beef cattle populations whose impact may be reduced through selection for diseases resistance. Recording of health traits allows for improvement in disease resistance. In countries where veterinary services are directly linked to performance recording schemes, there is an ideal environment to obtain information on health traits for breeding or/and epidemiological purposes. In other situations, it will be necessary to generate the need of systematic recording of animals health status among those professionals responsible for animals health and farmers. It is required at least a compromise solution of systematic recording of diseases which are obliged to be declared. The International Office of Epizooties (http://www.oie.int/eng/normes/mcode/a_summary.htm) provides information each year on the most significant epidemiological events with particular attention to contagious and economically significant diseases. OIE publishes two lists of disease, A and B. Diseases on list A are assumed to be either highly contagious and/or with significant economic effect (OIE list A). Diseases on list B (OIE list B) are less contagious than those on List A, but pose a significant threat to national economies or public health.

A systematic recording and storing of data at slaughter as a regular practice in abattoirs may be an important source of information for diseases at post mortem meat inspection. It is of particular interest for cases when non visible clinical signs have been detected. It is also of great interest when data is linked to on farm recording systems to identify risk factors.

Data recording need to be done on individual basis. It is also necessary to compile information that allows the establishment of the ‘environmental conditions’, timing, transmission factors etc.

3.2.3.9.3 Data recording

- Animal Identification: this will link the animal to its invariable animal data such as sex, birth date, pedigree and herd of birth or/and changes of location.
- Code for disease.
- Clinical signs or not: False or True. If true:
  - Date of visual appraisal of clinical signs.
• Person responsible.
• Type of diagnostic:
  • Clinical: symptoms.
  • Patognomonic lesions.
  • Laboratory Techniques: T or F. If true:
    - Technique: Direct (detection of the agent): Faecal counts (eggs or larvae counts), Inmunohistochemistry, PCR, Antigens, Culture and Isolation. Indirect: Delayed hypersensitivity: Antibodies, Others.
    - Lab.
    - Specificity or sensitivity of the technique.
• Sample.
• Date of sample.
• Vaccination: T or F. If true:
  • Vaccine
  • Date of vaccination.
• Treatment: T or F. If true:
  • Treatment.
  • Date of treatment.
• Relapse.
• Date of relapse.

### 3.2.3.9.4 Classification of diseases and injuries

For data recording and storing is necessary to establish a systematic classification of diseases. As a first approach, there is an international classification of diseases from the World Health Organization (WHO). Thus, firstly, disease could be grouped as in the following list which is based on that classification (http://www.who.int):

- Infectious and parasitic diseases.
- Systemic diseases.
- Endocrine, metabolic and nutritional diseases and immunity disorders.
- Diseases of the nervous system or neurological diseases.
- Diseases of the respiratory system.
- Diseases of the circulatory system.
- Diseases of the digestive system.
- Diseases of the genitourinary system.
- Diseases of skin and subcutaneous tissue.
• Diseases of the musculoskeletal system and connective tissue.
• Traumatism, injury and poisoning.
• Genetic disorders.
• Disease of blood and blood forming organs.
• Complication of pregnancy and delivery.

3.2.3.9.5 Annex I - Diseases included in list A and B of the OIE

The following diseases are included in List A:
• Foot and mouth disease.
• Bluetongue.
• Vesicular stomatitis.
• Rinderpest.
• Contagious bovine pleuropneumonia.
• Rift Valley fever.

The following diseases are included in List B, within the category of multiple species diseases:
• Ántrax.
• Aujeszky’s diseases.
• Echinococcosis/hydatidosis.
• Leptospirosis.
• Q fever.
• Rabies.
• Paratuberculosis.
• Trichinellosis.
• New world screwworm (*Cochliomyia hominivorax*).
• Old world screwworm (*Chrysomya bezziana*).

The following diseases are included in List B, within the category of cattle diseases:
• Bovine anaplasmosis.
• Bovine babesiosis.
• Bovine brucellosis.
• Bovine genital campylobacteriosis.
• Bovine tuberculosis.
• Bovine cysticercosis.
• Dermatophilosis.
• Enzootic bovine leukosis.
• Haemorrhagic septicaemia.
• Infectious bovine rhinotracheitis(IBR)/infectious pustular vulvovaginitis.
• Theileriosis.
• Trichomonosis.
• Trypanosomosis (tsetse-transmitted).
• Malignant catarrhal fever.
• Bovine spongiform encephalopathy (BSE).

3.2.3.9.6 Annex II - Single –Locus genetic diseases

Single –Locus genetic diseases http://www.angis.org/Databases/BIRX/omia:
• Anhidrotic ectodermal dysplasia.
• Cardiomyopathy.
• Cardiomyopathy, dilated.
• Ceroid lipofuscinosis.
• Chediak-higashi syndrome.
• Chondrodysplasia.
• Chronic interstitial nephritis with diffuse zonal fibrosis.
• Citrullinaemia.
• Coat colour, albinism.
• Complex vertebral malformation.
• Deficiency of uridine monophosphate synthase.
• Dwarfism, dexter.
• Dwarfism, growth-hormone-receptor deficiency.
• Dwarfism, snorter.
• Dyserythropoiesis.
• Ehlers-danlos syndrome.
• Ehlers-danlos syndrome, type vii.
• Epitheliogenesis imperfecta.
• Factor xi deficiency.
• Gangliosidosis, gm1.
• Glycogen storage disease ii.
• Glycogen storage disease v.
• Goitre, familial.
• Hyperbilirubinaemia, unclassified.
• Hypotrichosis.
• Lethal trait a46.
• Leukocyte adhesion deficiency.
• Mannosidosis, alpha.
• Mannosidosis, beta.
• Maple syrup urine disease.
• Mucopolysaccharidosis i.
• Muscular hypertrophy.
• Myoclonus.
• Porphyria, congenital erythropoietic.
• Progressive degenerative myeloencephalopathy.
• Protamine-2 deficiency.
• Protoporphyria.
• Renal dysplasia.
• Sex reversal: xy female.
• Spastic lethal.
• Spherocytosis.
• Spinal dysmyelination.
• Spinal muscular atrophy.
• Syndactyly.
• Testicular feminization.
• Testicular hypoplasia.
• Tibial hemimelia.
• Trimethylaminuria.
• Vertical fibre hide defect.

3.2.3.10 Tick count recording

3.2.3.10.1 Management aspects

The aim with the recording of tick counts is the evaluation of the genetic variation between animals for tick susceptibility. For this reason, it serves no purpose to do tick counts on animals that are not exposed to tick infestation.

3.2.3.10.1.1 Guidelines

• Tick counts should be done on groups of animals that are kept in their natural environment (e.g. natural pastures), where they are exposed to ticks. (There is normally little or no exposure to tick infestation in feedlots, resulting in little or no variation in tick loads between animals).
• Tick-control measures:
The ideal is not to apply dipping or other tick-control measures on the particular group of animals for the testing period. However, this is not always possible if the tick infestation is severe.

If dipping or other tick-control measures is needed during the testing period, the following guidelines should be followed:

- Record tick counts immediately before dipping or the application of other tick-control measures. The ideal is not to dip or to use other tick-control measures on the to-be-recorded animals for at least three weeks prior to the tick count recording date.

This period should be selected based on:

- The effective period of the particular dip or other tick-control measure(s) being used. (A minimum of two weeks for long-acting remedies and a minimum of one week for short acting remedies is recommended).

- The dominant or major tick species in the specific region/area. (The one-host blue ticks which have a three-week life cycle and a shorter than three-week dipping interval would allow only infestation of immature blue ticks. Because the immature ticks are very small, they may easily be missed during counting. An ideal dipping interval would therefore be three weeks. This is of course not always possible in situations of heavy multi-host tick challenge, but is essential if any data is to be obtained in areas where the one-host blue ticks are the only or major tick species present).

- The general degree of tick infestation of that particular group of animals at the specific location and point in time.

- Tick count recordings should preferably be done during the season or period of expected high tick infestation - usually the warm (summer) months. The reason is that heavier tick infestation will increase the expression of genetic variation in tick resistance of individual animals, which in turn will be beneficial for genetic evaluation of tick resistance.

- Tick counts should preferably be done at a minimum of three or more occasions during the test period, with ideally at least three weeks between any two consecutive dates. This will increase the accuracy of the genetic evaluations.

- Each date during the test period on which tick counts are taken, should be recorded as a separate count or record for each animal.

- All tick species and types irrespective of sex and stage of maturity at a specific counting site should be counted at each event date on which counts are done during the test period.

- Each site on the animal where tick counts are done, should be recorded as a separate count (record) per animal.
Section 3 - Rules, standards and guidelines for meat production recording

### 3.2.3.10.1.2 Contemporary groups

Apart from the general requirements for contemporary groups, the following is recommended. For young animals, a contemporary group should be subjected to the same tick control measures and the tick counts should be recorded at the same dates. The animals should be born within a period of maximum 100 days of each other.

For older animals (cows and breeding bulls), different birth years and seasons may be evaluated in the same group, provided they are managed alike and they are in the same production stage. (Dry cows and cows suckling calves should, for example, be handled as separate groups).

The same person (recorder) should record tick counts on all animals in a contemporary group on the same date(s).

### 3.2.3.11 Carcass assessments

The ultimate goal of all beef cattle production systems is to efficiently produce a high yield of palatable beef. Meat quality and the quantity of edible portion are basic factors used to assess carcass merit. However, the relative emphasis to be placed on quality and quantity are subject to change with changing market demands.

Not all beef producers need complete carcass data. Careful thought should be given to the specific information that will be useful. Increasing the amount of traits to be recorded on large numbers of carcasses adds to the time required, costs, and likelihood of errors and may reduce beef processors’ interest in cooperating. Only trained personnel should be contracted to do this in the large processing plants. Carcass weight, composition and quality are essential traits to be recorded at the slaughterhouse.

An essential prerequisite for gaining records in the slaughterhouse is that the ID of the live animal stays with the carcass or that a system is used, that allows the reporting carcass data with the ID of the corresponding live animal.

The following traits, as illustrated in table 4, are recommended as mandatory traits for breeding purposes:

<table>
<thead>
<tr>
<th>Site</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anus area</td>
<td>Observed from the rear of an animal, the area under the tail, around the anus</td>
</tr>
<tr>
<td>Scrotum/udder</td>
<td>Observed from the rear of an animal, the area below the anus down to and</td>
</tr>
<tr>
<td>Ear</td>
<td>The inside area of the left or the right ear</td>
</tr>
<tr>
<td>Other</td>
<td>Non-specified area (Only for use of historical non-specified data)</td>
</tr>
</tbody>
</table>
Table 4. Mandatory traits for breeding purposes.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Recorded as ....</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass weight</td>
<td>Weight</td>
</tr>
<tr>
<td>Estimated meat yield</td>
<td>Percent; score</td>
</tr>
<tr>
<td>Carcass classification/Scoring system</td>
<td>Score</td>
</tr>
</tbody>
</table>

3.2.3.11.1 Carcass weight

Carcass weights are unaffected by variation in shrinking and therefore – apart from the scaling effect - show less variation than live weights. Compared to live weights they relate more to meat yield and to the consumers endpoint. Calculation of net gain is based on slaughter weight.

Typically, carcass weights are collected by commercial abattoirs; additionally experimental abattoirs come into consideration. Carcass weights should be collected consistently to ensure an informative data analysis.

Usually, carcass weight is defined by appropriate national legislation which clearly specifies which parts of the carcass are to be removed prior to taking the weight.

In the case of no legal definition, carcass weight should be defined as the hot weight of both half carcasses after removal of skin, bled and eviscerated and after removal of external genitalia, the limbs at the carpus and tarsus, head, tail, kidneys and kidney fats and the udder.

Preferably the unit of measurement should be metric to the nearest of 500 grams.

3.2.3.11.2 Carcass grade

Carcass grades significantly affect the market value of the carcass. Therefore they form a trait with big economic impact and should be used for the analysis of progeny productivity. Grading mostly is done according to national standards that frequently are based on appropriate legislation.

However, according to different market demands, national grading schemes frequently target different objectives and therefore are composed of different traits. On a global level there are two predominant types of grading schemes:

- USDA grading scheme including the following components
  - Class (steer, bullock, bull, heifer, cow)
  - Maturity
    - Meat colour
    - Texture of lean meat
  - Quality grade: 8 levels (Prime; Choice; Select; Standard; Commercial; Utility; Cutter; Canner)
    - Marbling
    - Firmness
  - Yield grade
    - External fat
Kidney, pelvic and heart fat
- Ribeye area
- Carcass weight

- EU grading scheme including the following components
  - Class (calf, young bull (=bullock), bull, steer, heifer, cow)
  - Conformation grade: 6 levels (S-E-U-R-O-P)
  - Fat grade: 5 levels (1-2-3-4-5)

As a consequence meat reports are almost incomparable across big market regions like e.g. North America, Europe and other continents. Therefore the grading system should be clearly indicated on reports provided for use outside the country where the grading scheme is applied. In order to provide useful information that might be used outside the market region, it is recommended additionally to record each of natural components forming the grade.

3.2.3.11.3 **Dressing percentage**

Dressing percentage describes the percent ratio between carcass weight and the live weight taken immediately before slaughter. Although dressing percentage mainly is used for the estimation of carcass weights of live animals, it provides additional information on the animal’s type even if carcass weight is measured directly.

A scale that measures in increments of 1 kg or 2 lb, or less, should be used for taking the live weight immediately before slaughter.

As live weight is largely influenced by shrinking, dressing percentage should account for this effect, by standardisation of the live weight to 12-hours shrinking time. The correction factors should apply in the special production environment of the animals.

Dressing percentage should be described as percentage with 1 decimal place.

3.2.3.11.4 **Meat yield**

Meat yield means the percentage of lean meat in the beef carcass as obtained by dissection. However, with regard to high costs arising from carcass dissection - meat yield frequently is estimated on the base of surrogate traits, that can be easily measured in the course of the slaughter process.

In some areas meat yield refers to the whole lean meat contained in the carcass, whereas other regions account for specified retail cuts forming the most evident part of the carcass value.

Meat yield should be described as percentage with 1 decimal place.

Some areas apply yield grades rather than meat yield itself; e.g. the USDA yield grade is a numerical score from 1 to 5 expressed as a whole number. It represents the yield of the boneless, closely trimmed retail cuts from the round, loin, rib and chuck. These cuts represent about 75% of the carcass weight and about 90% of the carcass value.

Y.G. = 2.5 + (2.5 X adjusted fat thickness, in inches)
+ (0.2 X per cent kidney-, pelvic-, heart fat)
+ (0.0038 X hot carcass weight, in pounds)
- (0.32 X Ribeye area)
The relation between yield grade and meat yield is described in table 5.

Table 5. USDA yield grade and meat yield.

<table>
<thead>
<tr>
<th>Yield grade</th>
<th>Boneless, closely trimmed retail cuts</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt; 53.3</td>
</tr>
<tr>
<td>2</td>
<td>52.3 - 50.0</td>
</tr>
<tr>
<td>3</td>
<td>50.0 - 47.7</td>
</tr>
<tr>
<td>4</td>
<td>47.7 - 45.4</td>
</tr>
<tr>
<td>5</td>
<td>&lt; 45.4</td>
</tr>
</tbody>
</table>

3.2.3.11.5 Meat quality

3.2.3.11.5.1 Definition of meat quality

In broader terms, quality refers to palatability, appearance, nutritional value and food safety. In practice, quality refers to the overall appearance and palatability of the edible portion of the carcass. Quality can be determined by evaluation of animal maturity, tenderness, subcutaneous fat, intramuscular fat (marbling), meat colour, fat colour, firmness of meat (lean) and texture of meat. Factors such as juiciness, flavour, aroma and undesirable flavours (off-flavours), are also quality traits, but can only be assessed through sensory taste panels and are therefore rarely recorded and evaluated.

Meat quality can be assessed on the basis of a subjective score (including e.g. a marbling score), through taste panels, or by using technical devices to measure the meat colour, tenderness, intramuscular fat, physiological parameters like the pH at different points of time, etc.

Meat quality can probably be defined as comprising four aspects of importance:

- **Visual quality:**
  Factors evaluated in classifying carcasses and/or factors that affect consumers’ decisions when purchasing meat (e.g. subcutaneous fat cover, bone content and meat and fat colour).

- **Eating quality.**
  Tenderness, juiciness, odour and flavour intensity of the cooked product.

- **Nutritional quality.**
  Proportions of proteins, vitamins and minerals relative to energy density.

- **Safety.**
  Negligible risk from food-borne illness or poisoning and absence of drug, chemical, antibiotic or hormone residues. (Dikeman, 1990).

In this section, the focus will be on visual quality and eating quality (palatability).
Section 3 - Rules, standards and guidelines for meat production recording

3.2.3.11.5.2 Maturity

Maturity can be defined as an estimation of the physiological age of the carcass, which can be determined by evaluating the size, shape, and ossification of the bones and cartilage, the number of permanent incisors and the colour and texture of the lean. Alternatively the chronological age of the animal may be used although physiological and chronological age are not necessarily the same.

Where the chronological age of the animal is unknown, maturity score is a useful unit of measurement. Maturity is usually classified according to the percentage ossification of the cartilage of thoracic buttons. In case maturity scoring, the following scores apply (Table 6).

Table 6. Numerical scores and maturity/age groupings.

<table>
<thead>
<tr>
<th>Maturity</th>
<th>Score</th>
<th>Chronological age</th>
<th>Percentage ossification of the cartilage of thoracic buttons</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.0 – 1.9</td>
<td>9 – 30 months</td>
<td>&lt;10</td>
</tr>
<tr>
<td>B</td>
<td>2.0 – 2.9</td>
<td>30 – 42 months</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>-</td>
<td>-</td>
<td>35</td>
</tr>
<tr>
<td>D</td>
<td>-</td>
<td>-</td>
<td>70</td>
</tr>
<tr>
<td>E</td>
<td>-</td>
<td>-</td>
<td>90</td>
</tr>
</tbody>
</table>

In some maturity classifications, numerical scores are given within the chronological age groupings, for a more accurate approximation of maturity. A numerical score of 1.5 would suggest that the carcass was in the middle of “A” maturity, while a score of 1.9 would be appropriate for a carcass at the upper end of “A” maturity but not quite into “B” maturity.

Initial maturity score is determined by the skeletal characteristics with adjustments made according to characteristics of the lean tissue. However, lean characteristics cannot be used to adjust final maturity of the carcass more than one full maturity group.

3.2.3.11.5.3 Marbling

Marbling can be defined as the flecks of fat in the lean. Marbling is usually evaluated visually in the rib-eye muscle, which is exposed between the 12th and 13th ribs. Marbling contributes to meat tenderness and is also associated with the palatability traits of juiciness and flavour.

Marbling is usually assessed by classification (e.g. 9 degrees of marbling, ranging from Practically Devoid to Abundant) related to the estimated percentage of intramuscular fat. Marbling scores and intramuscular fat percentages are specific to carcass assessments performed in North America and are not necessarily applicable to other countries.

As a consequence, marbling should be recorded according to BIF standards, where each degree of marbling is divided into tenths within each degree of marbling as in the table 7.
Table 7. Descriptive and numerical marbling scores for quality grades of “A” maturity carcasses.

<table>
<thead>
<tr>
<th>Quality Grade</th>
<th>Marbling</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime</td>
<td>Abundant</td>
<td>10.0 – 10.9</td>
</tr>
<tr>
<td>Prime</td>
<td>Moderately abundant</td>
<td>9.0 – 9.9</td>
</tr>
<tr>
<td>Prime</td>
<td>Slightly abundant</td>
<td>8.0 – 8.9</td>
</tr>
<tr>
<td>Choice</td>
<td>Moderate</td>
<td>7.0 – 7.9</td>
</tr>
<tr>
<td>Choice</td>
<td>Modest</td>
<td>6.0 – 6.9</td>
</tr>
<tr>
<td>Choice</td>
<td>Small</td>
<td>5.0 – 5.9</td>
</tr>
<tr>
<td>Select</td>
<td>Slight</td>
<td>4.0 – 4.9</td>
</tr>
<tr>
<td>Standard</td>
<td>Traces</td>
<td>3.0 – 3.9</td>
</tr>
<tr>
<td>Standard</td>
<td>Practically devoid</td>
<td>2.0 – 2.9</td>
</tr>
</tbody>
</table>

*B-maturity carcasses with Small or lower degrees of marbling cannot be graded Choice or Select.

Quality grades may vary in the number of degrees of marbling within a grade. If marbling is the primary determinant of quality grade, the numerical scores for grade should be the same as the marbling scores, except in cases in which they are discounted for maturity, colour, firmness of lean, or texture of lean.

The average relationship between marbling scores and intramuscular fat percentages is shown in the table 8.

Table 8. Marbling and intramuscular fat.

<table>
<thead>
<tr>
<th>Marbling score</th>
<th>Intramuscular fat, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slightly abundant</td>
<td>10.13</td>
</tr>
<tr>
<td>Moderate</td>
<td>7.25</td>
</tr>
<tr>
<td>Modest</td>
<td>6.72</td>
</tr>
<tr>
<td>Small</td>
<td>5.04</td>
</tr>
<tr>
<td>Slight</td>
<td>3.83</td>
</tr>
<tr>
<td>Traces</td>
<td>2.76</td>
</tr>
</tbody>
</table>

It is recommended that a highly trained and certified person be used to assess quality grade factors when collecting carcass data.

3.2.3.11.5.4 Colour firmness and texture of lean

Colour of the rib eye muscle is used as an additional indicator of maturity or physiological age. The visual appeal of beef at the retail counter is highly dependent on desirable colour. Dark cutters are carcasses that produce lean tissue that is dark red to almost black and often result from cattle that have been stressed prior to slaughter. Dark cutters are safe to eat and their palatability is not seriously affected. However, the colour reduces consumer acceptability and lowers carcass value dramatically.
Firmness of lean refers to the relative firmness or softness of the rib-eye muscle, whereas texture of lean refers to the apparent fineness or coarseness of muscle fibres within the rib-eye muscle. Colour, firmness, and texture of lean are widely used in North America, and are not necessarily applicable to other countries. Accordingly, those traits should be recorded according to the following BIF standards reported in Table 9.

### Table 9. Scores for lean tissue.

<table>
<thead>
<tr>
<th>Score</th>
<th>Colour</th>
<th>Firmness</th>
<th>Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Light cherry red</td>
<td>Very firm</td>
<td>Very Fine</td>
</tr>
<tr>
<td>6</td>
<td>Cherry red</td>
<td>Firm</td>
<td>Fine</td>
</tr>
<tr>
<td>5</td>
<td>Slightly dark red</td>
<td>Moderately firm</td>
<td>Moderately fine</td>
</tr>
<tr>
<td>4</td>
<td>Moderately dark red</td>
<td>Slightly soft</td>
<td>Slightly fine</td>
</tr>
<tr>
<td>3</td>
<td>Dark red</td>
<td>Soft</td>
<td>Slightly coarse</td>
</tr>
<tr>
<td>2</td>
<td>Very dark red</td>
<td>Very soft</td>
<td>Coarse</td>
</tr>
<tr>
<td>1</td>
<td>Black</td>
<td>Extremely soft</td>
<td>Very coarse</td>
</tr>
</tbody>
</table>

### 3.2.3.11.5.5 Standardized Warner-Bratzler shear force procedures for sire evaluation

More direct measures of palatability than quality grade include Warner-Bratzler shear tests for tenderness assessment, and trained sensory panel evaluation for tenderness, flavour, and juiciness. However, cost and availability will restrict usage of these alternative methods. An initiative to standardize the protocol for Warner-Bratzler shear force determinations was identified at the National Beef Tenderness Plan Conference in April, 1994. The purpose of this protocol is to facilitate consistent collection of Warner-Bratzler shear force determinations across institutions for comparative evaluation. These data can be used in progeny testing and in the development of carcass breeding values to improve meat tenderness. Any institution abiding by these guidelines can be certified to collect Warner-Bratzler shear force determinations for the beef industry.

### 3.2.3.11.5.5.1 Conversion of live animals to carcasses

The process of conversion of the live animal to the carcass can have a significant effect on meat tenderness; therefore, the slaughter process and the environmental conditions during slaughter should be controlled as closely as possible. Conditions that should be monitored and that could affect Warner-Bratzler shear force values include electrical stimulation and post mortem chilling. Although these factors can affect the ultimate tenderness of beef, these variables are probably not controllable by the researcher. Whenever feasible, chilling temperatures and the type of electrical stimulation used (if any) should be noted.

### 3.2.3.11.5.5.2 Sample preparation

Consistent sample collection and preparation are critical to obtaining repeatable and consistent Warner-Bratzler shear force determinations. The following procedures are to be utilized when preparing steaks for shear force determinations:
1. Steaks, 25 mm thick, should be removed from the longissimus lumborum between the 12th rib and the 5th lumbar vertebrae of the carcass. Only one steak per animal is needed for evaluation. Steaks should be trimmed free of fat and bone.

2. After removal from the carcass, steaks should be vacuum-packaged, aged 14 days then frozen at day 14 post mortem to -20 °C or lower until they can be evaluated at a later date. Steaks should be stored at 0 to 3 °C during the 14-day aging process. All steaks should be vacuum-packaged during refrigerated storage after removal from the carcass (assuming that they are cut from sub-primals before the end of the 14-day period) and during frozen storage. Steaks should be frozen individually without stacking (rather than after boxing) to ensure uniform, rapid freezing.

3. Internal temperature of the sample at the initiation of cooking can affect tenderness; thus, this variable must be standardized. Frozen samples should be thawed at 2 to 5 °C until an internal temperature of 2 to 5 °C is reached. For steaks, 1.0 in. thick, the time frame is approximately 24 to 36 hours (thawing time depends largely on the ratio of frozen meat to refrigerator/cooler size). During thawing, avoid steak overlap and stacking to improve the consistency of the thawing process.

4. Internal temperature of steaks will be determined prior to cooking. Steaks should not be cooked until a temperature of 2 to 5 °C is obtained throughout each steak. Steaks should not be thawed at room temperature.

5. To enhance consistency among institutions, steaks must be broiled on a Farberware Open Hearth Electric broiler (Kidde, Inc., Bronx, NY) or oven-broiled. Samples should be cooked to an internal temperature of 40 °C, turned and cooked to a final internal temperature of 71 °C (removed from the heat at 71 °C). For consistency in cooking, do not cook more than four steaks at a time on each Farberware grill.

6. Temperature will be monitored with iron- or cooper-constantan thermocouple wires with diameters less than 0.02 cm., and special limits or error of less than 2 °C. A metal probe, such as a 15-gauge spinal needle with a stylet (plunger), should be used to insert the thermocouple into the geometric center of the steak. Push the probe (with the stylet inside) completely through the meat, remove the stylet and thread the thermocouple wire into the needle through the pointed end. Remove the needle and pull the end of the thermocouple back into the center of the meat. Temperature can be monitored using a potentiometer or hand-held temperature recorder.

7. Steaks should not be held in foil or other types of containers prior to chilling because these processes affect chilling and cooling rates.

3.2.3.11.5.5.3 Core preparation

1. Cooling temperature and time after cooking, before coring, should be standardized. Two methods of cooling are recommended. Either chill samples overnight at 2 to 5 °C before coring (wrap with plastic wrap to prevent dehydration) or cool samples to room temperature prior to coring. Cooling samples to room temperature should be conducted so that a uniform temperature is obtained throughout the sample before coring. At least a 4-hour cooling time is required for 25 mm -thick steaks. Both procedures will remove variation in shear force caused by core temperature at shearing. Laboratories should intermittently check to assure that the chilling or cooling method they are
using is providing an even temperature throughout the steak prior to cooling. Adjustment by lengthening the cooling or chilling time should be implemented if the previous time intervals are not long enough.

2. Cores should be 1.27 cm. in diameter and removed parallel to the longitudinal orientation of the muscle fibres so that the shearing action is perpendicular to the longitudinal orientation of the muscle fibres. Cores can be obtained using a hand-held coring device or an automated coring device. Coring devices must be in good condition and sharp; otherwise the core diameters will vary, causing an increase in variation of shear values.

3. A minimum of six and maximum of eight cores will be obtained from each steak. Cores that are not uniform in diameter, that have obvious connective tissue defects, or that otherwise would not be representative of the sample, should be discarded. If samples are chilled before coring, cores should be kept refrigerated (2 to 5 °C) until they are sheared. All values obtained should be used for mean calculation, unless visual observation indicates that a value should be discarded (e.g., a piece of connective tissue).

4. Shear each core once in the centre to avoid the hardening that occurs toward the outside of the sample.

5. Shearing must be done by using a Warner-Bratzler shear machine or an automated testing machine with a WBS attachment and crosshead speed set at 20 cm./min.

### 3.2.3.11.5.5.4 Certification of Warner-Bratzler shear force

Certification of institutions that perform Warner-Bratzler shear force measurement is important in determining that the above procedures are being adhered to and to ensure that consistent, reliable data on meat tenderness are being collected. Certification requires that individuals performing Warner-Bratzler shear force tests at each institution maintain a shear force repeatability of 0.65 or higher on duplicate steaks from the same animal.

In the absence of a standard material, cooked meat from the same animal must serve as the standard. All shear force values will be adjusted to a MARC-shear-force equivalent. Institutions interested in certification should obtain four steaks from each of 15 animals, arrange to send one pair of steaks to MARC personnel for shear force determination, and analyse the second pair of steaks themselves. The coefficient of variation of shear force for the certification steaks must range between 20% and 35%, because the amount of variation affects repeatability. MARC personnel will calculate a repeatability value and an adjustment factor, if needed, to equate each institution’s mean shear force to a MARC basis.

### 3.2.3.11.5.6 Data to be recorded

For the purpose of genetic evaluations on meat quality traits from data collected at abattoirs, it is necessary to collect all relevant data that could influence the particular recorded meat quality data. These additional data may relate to pre-slaughter management and feeding (e.g. growth promoting implants), slaughter (e.g. electric stimulation), chilling (e.g. period), aging process (e.g. period) and cooking process (e.g. cooking method).

- Feedlot recordings
International Agreement on Recording Practices

- Regular data as specified in the section relating to tests in “Finishing Herds”, and additionally:
  - Implantations (where administered)
    - Date
    - Type
    - Dose/amount
    - Single or re-implant
  - Beta-agonist (in case of application)
    - Start date
    - End date
  - Pre-slaughter conditions:
    - Distance transported
    - Weather conditions
    - Time from loading to off-loading
    - Time from arrival at abattoir to slaughter

- Slaughter and warm carcass recordings
  - Regular data as specified in the section relating to “Commercial Slaughter Data”, and additionally:
  - Fat colour assessment
  - Meat colour assessment
  - Marbling assessment
  - Kidneys and channel fat weight
  - Eye muscle area
  - Electric stimulation:
    - (Yes/No)
    - Type of stimulator
    - Voltage
    - Duration/period
  - Ph 1.5h after slaughter

- Cold carcass recordings
  - Fat thickness (e.g. back fat and P8)
  - Chilling
    - Temperature
    - Period
  - pH 24h after slaughter
• Palatability recordings
  o Aging
    - Temperature
    - Duration/period
  o Frozen weight
  o Thawed weight
  o Thawed temperature
  o Time-on
  o Time-off
  o Cooking method
  o Final (meat core) temperature
  o Cooked weight
  o Shear force
    - Type of measurement
    - Sample core diameter
    - Shear force value

Frozen weight, thawed weight, thawed temperature, time-on, time-off, final temperature and cooked weight will be collected on each steak, in addition to the Warner-Bratzler shear values. Warner-Bratzler shear force should be reported as the mean of all core values.

  o Sensory scores
    - Maximum
    - Minimum
  o Sensory attributes
    - Juiciness score
    - Flavour score
    - Tenderness score
    - Aroma score
    - Off-flavour score
  o Chemical measurement of marbling
3.2.4 Organisation and execution of testing schemes

3.2.4.1 Field test

3.2.4.1.1 Field of application
This recommendation applies to on-farm beef performance recording undertaken in herds of cows, which suckle their calves until an age of at least four months.
Data is collected in order to provide farmers with information useful for herd management and to provide raw data for genetic evaluations.
It allows for genetic evaluation both for growth ability and milking ability.

3.2.4.1.2 Symbol
The symbol of the recommendation is ‘SH’.

3.2.4.1.3 Method of recording
ICAR recording methods “A”, “B” and “C” can be used.

3.2.4.1.4 Reference performance
The reference performance is the weaning weight adjusted to an age of 205 days. Additional references can be set such as adjusted 100 days weight.

3.2.4.1.5 Minimum requirements
3.2.4.1.5.1 Animals to be recorded
Records have to be obtained for all animals from the same group of dams/calves kept at the same location for the same purpose.

3.2.4.1.5.2 Mandatory data to be recorded
For each of the animals the following data should be recorded:
• Animal ID.
• Weighing date.
• One weight taken at an age between 90 and 250 days.
• Farm ID.
• Abnormal records in relation to any preferential treatment relative to the rest of the contemporaries.
• ID of the management group within herd when they exist.
• Fostering (if applied).
• Particular details in relation to illness or other performance related factors.
3.2.4.1.6 Optional data to be recorded

3.2.4.1.6.1 Weights

Additional weight records that may be recorded in suckler herds include:

- Regular calf (and dam) weights (e.g. every 30 days or every 90 days);
- Dam weight at mating.
- Dam weight at calving.
- Dam weight at weaning of calf.

Additional weight recordings should comply with the same standard, in that the ID of the animal, the date of weighing, the management group, etc. is recorded with the weight.

3.2.4.1.6.2 Assessments

Additional assessment records that may be recorded in suckler herds include:

- Body condition.
- Withers height.
- Muscular development.
- Temperament.

3.2.4.1.7 Age restrictions and test length

The recommended age for weaning weight is 205 ± 45 (161 to 250) days. The maximum variation in birth dates of all calves in a test should thus not exceed 90 days. This implies that the minimum and maximum age difference (with one weigh date for all calves) per test should also not exceed 90 days. Table 10 indicates the proposed age limits for Birth, Pre-wean and Wean Tests.

<table>
<thead>
<tr>
<th>Test</th>
<th>Age restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth</td>
<td>0-3 days</td>
</tr>
<tr>
<td>Pre-wean</td>
<td>51-150 days</td>
</tr>
<tr>
<td>Wean</td>
<td>161-250 days</td>
</tr>
</tbody>
</table>

3.2.4.1.8 Definition of contemporaries

Apart from the definition given in section 2, the following applies: The responsibility for proper contemporary grouping lies primarily with the individual farmer. In most cases calves born within the same season (preferably not longer than a 90-day period) on the same farm can be grouped together. However, consideration should always be given to the way the calves are managed and also to the nutritional regime they were subjected to. Differences can exist on the same farm within a season, which require the establishment of two or more contemporary groups.
Creep fed calves should be separated from non-creep fed calves. Likewise, orphaned or extremely sick calves should not be compared to their normal herd mates. Crossbred calves should not be compared to straight-bred calves, except where an appropriate correction or model is applied resulting in a fair comparison.

In very large ranches or cattle operations, environmental, pasture and even management differences may exist between cattle stations or paddocks on the same property. In such cases, it is recommended that such cattle stations or paddocks be regarded as different herds and calves from different cattle stations or paddocks be handled as separate contemporary groups.

It is recommended that the information used to determine contemporary groups be maintained in the data bank to facilitate any future changes in contemporary grouping. Contemporary groups of two animals per group are useful in cattle evaluations but may show a lack of useful variation.

Birth and weaning contemporary groupings should be independent. This facilitates the inclusion of birth weights from calves that died before weaning.

**3.2.4.2 Finishing herds**

**3.2.4.2.1 Field of application**

This recommendation applies to on-farm beef recording undertaken in finishing herds from start to slaughter.

Data may be collected in order to provide farmers with information useful for herd management and to provide raw data for genetic evaluation. It facilitates the genetic evaluation of performance traits including growth.

The test is often used for dual-purpose breeds where young calves are weaned at an early stage. As it is normally possible to assemble the contemporary groups it is important that the test design should be optimised as far as is possible. This property distinguishes the testing scheme from other field tests such as beef recording in abattoirs where no influence on the test design is possible. Therefore the inclusion of slaughter data does not affect the application of this testing system.

**3.2.4.2.2 Symbol**

The recommended ICAR symbol or abbreviation for this beef recording system is ‘FH’.

**3.2.4.2.3 Method of recording**

ICAR recording methods “A”, “B” and “C” may be used.

**3.2.4.2.4 Description of Test**

**3.2.4.2.4.1 Organisation of the test**

Weaned progeny of test and reference sires are grouped into finishing units and subjected to the same management conditions. The group should comprise at least 6 animals. In order to allow for an informative test design care must be taken to insure that the group is composed of progeny from several sires.
Accurate weighing should be undertaken on each animal on entering the finishing unit and on exit for slaughter. If an animal obviously is affected by illness or disease, this should be noted with the weighing details should always be retained with the weight and weighing date when the data is loaded to the database.

It is recommended that the length of the test be at least 1 year. At the end of the test further traits like body condition, muscular development, skeletal development may be recorded. Slaughter details of the animals such as shrunk live weight, carcass weight, national grading scores, carcass trim details and meat yield may also be recorded.

3.2.4.2.4.2 Minimum requirements

3.2.4.2.4.2.1 Animals to be recorded

Records should be recorded on all animals from the same group of finishing animals kept at the same location for the same purpose.

3.2.4.2.4.2.2 Mandatory data to be recorded

For each of the animals the following data should be recorded:

• Farm identification.
• Identification of the management group within herd when they exist.
• Animal ID number.
• Two weights taken at the start and end of the finishing period.
• Weighing dates.
• Abnormal records in relation to any preferential treatment relative to the rest of the contemporaries.
• Details of animals negatively affected by illness or other factors.

3.2.4.2.4.3 Optional data to be recorded

3.2.4.2.4.3.1 Slaughter records

Additional records that may be recorded in finishing herds include:

• Slaughter date.
• Shrunk weight.
• Hot carcass weight.
• Carcass grade according to the national grading system.
• Carcass cut details that provide information for meat yield.

3.2.4.2.4.3.2 Linear assessments

Additional assessment records that may be recorded in finishing herds include live animal data:

• Scoring date
• Body condition;
• Muscular development
• Skeletal development
• Other linear traits

3.2.4.2.4 Data verification
Prior to evaluation, records should be checked and combined with other data on the animal stored in the database (e.g. place of birth, birth date, breed, parents etc.). Inaccurate or implausible data should be removed from the data file. Apart from these deletions and rejection of records due to illness or disease, no other data should be excluded.

3.2.4.2.5 Definition of contemporaries
The contemporary group may comprise all animals from the same breed, sex, finishing period and management group. Due to the uniform environment within contemporary groups medium to high heritabilities can be expected.

3.2.4.3 Test Stations
3.2.4.3.1 Introduction
The main objective is to estimate the breeding value of potential sires by minimising all possible sources of non-genetic variation. Station testing can normally facilitate feed efficiency tests. The more the conditions in the test station replicate those under which the animals are reared commercially, the more the appropriate the test is as a measure of economic value. The test procedures should be designed to meet the requirements of specific production systems. Test specifications such as the length of test, the age of the animals at the end of the test, the diet in terms of energy level may be chosen taking into account commercial and production realities. Consequently a range of different procedures for such tests may satisfy the present recommendations.

3.2.4.3.2 Field of application
Test stations can be used for both individual performance test and for progeny test on males and/or females of test sires.

3.2.4.3.2.1 Individual performance test
The objectives is to assess genetic differences based on individual performances of assembled bulls from several herds in a single location and raised under uniform and standardized conditions. Tested bulls may subsequently go for use in AI or natural service. The animal model using the relationships between the recorded bulls allows for comparisons when there are enough genetic connections between animals from different management groups and/or different stations.
3.2.4.3.2.2 Progeny test

The objectives is to assess genetic differences from the performance records of a sires progeny from several herds assembled in a single location and raised under uniform and standardized conditions. Progeny testing is most useful where carcass traits or maternal traits such as (reproduction, calving aptitude, milking performance) are important. Tested sires are mainly designed for AI use. Generally the tested sires have been previously selected on the basis of an individual performance test. The size of the progeny groups will be determined by the accuracy required for the estimation of breeding value.

3.2.4.3.3 Test procedure description

The test procedure should be precisely documented and published.

3.2.4.3.4 Method of recording

Only the "A" method should be used, an official recording organization must carry out recording.

3.2.4.3.5 Recorded animals

Tested bulls may be from dairy, dual purpose or specialized beef breeds and the test animals should be selected from several herds. The herds of origin should ideally be participants in an ICAR compliant performance recording scheme to ensure that the records related to the pre-test influences are available in the database.

3.2.4.3.6 Organisation

3.2.4.3.6.1 Age at entry at station

Entry in the station should occur at the earliest opportunity after birth in order to minimize the environmental influences of the herd of origin. Age at entry varies according to the type of production (dairy or suckler herds), to the breed and to sanitary/veterinary requirements. Animals from dairy or dual-purpose breeds should be assembled before weaning, ideally within days after birth, and be artificially reared in a nursery up to the weaning stage. When selecting animals from suckler herds, animals should be selected as early as possible after weaning.

3.2.4.3.6.2 Adaptation period

Once weaned in the nursery or in the herd of origin, the test animals are assembled in the feedlot or finishing farm. During the post-weaning period the animals should undergo a pre-test adaptation period which is necessary to overcome as far as is possible any pre-test environmental influences, and to limit the effects of compensatory growth during the test period. This is particularly important for the suckler calves, which are generally older when they enter the test station. The housing and feeding environment during the adaptation period should allow an easy transition to the test conditions. The length of the pre test adaptation period should ideally be at least of four weeks.
3.2.4.3.6.3 Test period/termination point

The duration of the test period is determined by the age at the start, the plane of nutrition and the desired slaughter age. The test period should be sufficiently long for pre-test influences to be overcome. The test can be terminated at constant age or weight, at constant degree of finish or after a test period of fixed duration.

The recommended length of the test period should be at least of four months (120 days) in the case of performance testing.

3.2.4.3.6.4 Feeding and nutrition

Breed, nutritional factors and breed-nutrition interaction influence the rate of gain, the gain composition and feed efficiency.

Concentrate and roughage should be fed in a physical form, which prevents the selection of individual ingredients, in order to allow valid comparisons of gain and valid estimations of feed efficiency.

If complete high-energy diets are fed ad libitum (concentrates ad lib. / roughage restricted) daily gain will then be limited only by the growth potential of the bull. Conversely, if low energy diets are offered ad libitum (concentrates restricted / roughage ad lib.), daily gain will in addition also limited by the feed intake capacity of the bull.

Feeding restriction may be applied according to live weight to allow for a given average daily gain of the test group.

Feeding level and method should be documented.

- Feeding level: energy and protein concentrations
  - roughage / concentrate – restricted / ad libitum.
- Feeding method: restriction on age or weight or ad libitum

3.2.4.3.6.5 Slaughter

Progeny test animals are normally slaughtered to record slaughter traits.

Ideally the animals should be slaughtered at the optimal carcass weight for market requirements.

Animals are either slaughtered at constant live weight, at constant age or at constant degree of finish.

The animals should be slaughtered in the same place and the handling of the animals before slaughter, the slaughtering procedures and the post-slaughter aging should be standardized. Should it not be possible to slaughter all the animals at once, it will be necessary to ensure that satisfactory linkage is maintained in the slaughter groups.

3.2.4.3.6.6 Reference performance

During the test period, the reference performance is the average daily gain.

In case of slaughter (progeny test), the reference performance is the net carcass weight gain per day of age.
3.2.4.3.7 Mandatory data to be recorded

For each of the recorded animals, the following data should be recorded:

3.2.4.3.7.1 Test period
- Animal identification
- Station identification
- Identification of the management group, if existing
- Date of weighing at the start of the test period
- Live weight at the start of the test period
- Date of weighing at the end of the test period
- Live weight at the end of the test period

Live weight should be the average of at least two weights taken on successive days. If shrunk weights are measured, a single weight after a shrink period of 12 hours is adequate. Actual weights can also be adjusted using an appropriate regression to account for temporary environmental effects on individual animals. All raw data should be recorded and stored.

3.2.4.3.7.2 Slaughter
- Slaughter animal identification must be linked to the animal identification where different.
- Abattoir identification.
- Slaughter date.
- Live weight at slaughter (full or shrunk).
- Commercial official slaughter weight of carcass (hot or cold).

3.2.4.3.8 Optional data to be recorded
- Date and weight at entry in nursery if relevant.
- Date and weight at feedlot entry.
- Linear scoring both for muscular and skeletal development as well as for functional capacity.
- Individual feed intake over the test period (kg).
- Official carcass conformation and carcass fat score, for animals slaughtered where available.

3.2.4.3.9 Calculated traits
- Average daily gain during test period (kg).
Efficiency of feed conversion should be expressed as weight of feed (as fed) relative to gain (this ratio can be adjusted to a common body weight to allow for weight and growth rate differences as they affect feed requirements for maintenance). The way the feed intake is controlled should be described.

Dressing-out percentage (%).

3.2.4.3.10 Definition of contemporaries

A contemporary group is a set of animals of the same breed and sex, that are similar in age, that have been tested in the same season, on the same diet, in the same housing system and have received similar prophylactic treatments.

The animals within a contemporary group should be born within the shortest possible period, but not greater than 90 days.

Where acceptance of animals into a test station is continuous (animals to be evaluated enter the station throughout the year) season should also be taken into account.

Such a grouping into management groups should allow for sufficient genetic connections between contemporary groups, the size of which should be at least 15.

3.2.4.4 Commercial Slaughter Data

3.2.4.4.1 Field of application

This recommendation applies where beef recording is undertaken routinely at commercial abattoirs. Since only the finishing unit is likely to be identified and since changes in the ownership chain of the animal are usually unavailable, it is recommended that use is made only of animals who have been at least one year on the finishing farm. This test is particularly appropriate for dual purpose breeds using AI based breeding programs and where the calves enter the finishing unit at an age of 2-3 months and are kept there until slaughtered.

The link between slaughter records and basic animal data is provided by the animal’s ID number. It is important therefore that a link can be made between the national identification number and the carcass number if different. The ICAR symbol of this beef recording system is ‘SH’.

3.2.4.4.2 Description

3.2.4.4.2.1 Organisation of the test

Ideally at birth the basic non-variant data on the animal such as farm ID, animal ID, birth date, birth location, sex, calving ease score will have been stored in the central database. When the animal is slaughtered, the hot carcass weight and the carcass grade are determined and stored in the database of the abattoir. The slaughter data should be sent to the animal recording organisation at regular intervals. The link between slaughter records and the standing or non-variant data of the animal is provided by the animal’s ID number.
**3.2.4.4.2.2 Reference performance**

The reference performance is net gain being defined as hot carcass weight divided by the age at slaughter.

**3.2.4.4.2.3 Minimum requirements**

**3.2.4.4.2.3.1 Mandatory data to be recorded**

For each of the animals at least the following data should be recorded:

- ID of the finishing farm.
- Animal ID number.
- Hot carcass weight.
- Slaughter date.
- Carcass grade according to the national grading system.

**3.2.4.4.2.4 Optional data to be recorded**

Additional records that may be recorded include:

- Shrunken weight.
- Carcass cut details and trim specifications which allow the determination of meat yield.
- Video imaging results which can allow for the determination of meat yield, lean meat percentage, conformation score and fat score.

**3.2.4.4.2.5 Data editing, data verification**

Prior to any data evaluation, records should be check and combined with the other data on the animal. Inconsistent or non-plausible data should be removed from the data file. Apart from these deletions no other data should be excluded.

**3.2.4.4.3 Definition of contemporaries**

The contemporary group comprises all animals from the same breed type, sex, slaughter date and finishing farm. Due to the unknown specific environments of contemporary groups low to moderate heritabilities can be expected, thus requiring large progeny groups for accurate breeding values estimation.
3.2.5 Data transfer

3.2.5.1 General

Automated data exchange between computers is a fast growing business. This trend is strongly favoured by an increasing use of the Internet. Most areas of animal production are also involved in this process, such as routine data exchange between process computers, farm computers and mainframe computers at all levels of production, and in any direction within and across farms, breeding and recording organizations, commercial firms and administration authorities.

If animal production is subjected to quality assurance and/or takes place in complex production systems, i.e. in production chains with different owners and locations, there is the compelling necessity that the animal is accompanied by its individual data background during the whole production process beyond the animal’s own life span.

3.2.5.2 Use of the ADIS-ADED standard

Data exchange is still frequently carried out by individual agreements between sender and receiver about data contents and data structure. An alternative approach is the definition of fixed data formats by umbrella organisations applying for each member organisation and their personal members. However, such system quickly become inefficient with complex or fast growing information systems distributed to various participants.

The solution to this problem, is a fully automated data interchange based on flexible international standards. Automated data exchange using an international electronic data interchange protocol (EDI) avoids endless problem with bilateral data interfaces. Any individual agreements for data description are superseded and no adjustments to computer programs or manually operations are required any more. In the agricultural sector the use of the international ISO standard ADIS-ADED has become a routine application in many processor, personal and mainframe computers.

Compared to the prohibitive EDIFACT system, which is frequently used in the trade, the ADIS-ADED can be implemented stepwise thus saving resources. An ADIS-ADED interface is a simple ASCII file subject to the rules of ADIS-ADED. Because of this property it is able to ensure the data flow even through very heterogeneous system platforms. However, there is the restriction that ADIS-ADED only contains ordinary lists. Hierarchical or tree structures will not be reproduced.

ADIS-ADED provides a very transparent and clear interpretation of data fields. The clear definition of data items and entity tables with a unique distinction of different entry modes like key fields, mandatory and optional fields requires that the user accepts and anticipates the transparency of data definitions. The similarity of data structures and handling syntax with relational data banks makes the ADIS-ADED most suitable for data exchange across data banks without causing as much overhead as the standard internet data interchange protocol XML or EDIFACT. By using an appropriate SQL converter program, transmitted data can easily feed into the internal data bank.

3.2.5.3 Structure of the ADIS-ADED

Modern EDI systems are composed of modular structures to allow for an easy extension and for a stepwise integration of software components or modules from different manufacturers of diverse network systems. The most important components of ADIS-ADED is the Data Dictionary ADED (= Agriculture Data Element Dictionary) and the data transfer protocol ADIS (= Agriculture Data...
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Interchange Syntax). The following parts of this chapter aim to give a brief summary of the most important elements of ADIS-ADED. More details can be found at ISO http://www.iso.ch. The ADIS-ADED has been developed by ISO since 1995.

3.2.5.3.1 The Data Dictionary ADED

3.2.5.3.1.1 General

In the case of data exchange across computers the structure of transmitted data must be known and the data elements must be defined to enable the receiving program to pass the data according to its meaning into the internal data model. For this purpose the data dictionary contains data objects (entities), that are composed of a set of data elements (items and code sets).

Data elements as defined by the Data Dictionary ADED originally referred mainly to the data exchange across process control computers and management computers. However, there is no implication that data elements may not be used for other levels of data exchange such as across the management computer and external computers as well as between/across software applications within the same management computer. The use of the same version of the ADED Data Dictionary by the sender as well as by the receiver is an essential prerequisite for any data exchange.

The general structure of ADED is defined by ISO11788-1. There are 3 different standard levels of the data elements:

Level 1:
- International data elements as defined by ISO 11788-2 are centrally stored and apply world wide.
- International data element numbers are indicated by the leading digit “9”.

Level 2:
- National data elements are centrally stored and apply at national level.
- National data element numbers are indicated by a leading digit between “1” and “8”.

Level 3:
- Private data elements are specific to the software developer.
- Private data element numbers are indicated by the leading digit “0”.

In most cases data exchange will contain a mixture of international and national data elements. The international data dictionary for cattle is described in detail by ISO 11788-2. In this respect it is notable that the international Data Dictionary only contains a very limited number of items used for dairy farming and at present most Data Dictionary elements are developed on a national level.

Therefore a broad extension of the international data dictionary to include more elements for dairy and beef farming seems to be essential.

3.2.5.3.1.2 Data elements (items, code sets)

Data elements (DDI = items) provide a unique and clear definition of each item appearing in the Data Dictionary. They are uniquely defined by:
- Unique identification number.
- Name with a length of up to 65 characters.
• Data type that may my be either numerical or alphanumerical.
• Use of ISO units.
• Use of the extended 8-bytes ASCII characters (ISO 8-bit code).
• Being a component of at least 1 data object.

3.2.5.3.1.3 Data objects (Entities)

Data exchange requires the definition of entities. The entity describes the contents and the structure of records that are transmitted according to ADIS rules. An entity might be composed of international, national and producer specific data elements. It is defined as a logical unit and structured by attribute lists describing an event or a simple object. Entities show some analogy to tables in data banks. According to convention key fields should be placed first in each record line. Optional fields may be omitted if appropriate.

3.2.5.4 Recommendation

The ADIS-ADED standard is able to provide an unambiguous, flexible, fully automated and cheap data exchange standard across different system platforms and computer communication in a peer-to-peer system. Because of these properties it is recommended to use ADIS-ADED for any kind of data transfer in beef production and beef recording.

3.2.5.4.1 Scope

The international Data Dictionary ADED for cattle aims to unify and to standardise beef data interchange across computer systems on an international and also in certain circumstances at a national and private level. Furthermore it aims to map a comprehensive data model associated with cattle production relieving national and private bodies from the need to establish their own country-specific standards as far as possible.

The definitions and descriptions of ADIS-ADED apply for data exchange of ASCII-files within and across process computers, personal computers and mainframe computers in any direction across those systems. The data applies for data exchange within and across farm level, management- und evaluation computer programs on farm level and computer programs of service providers (e.g. recording organisations, breeding organisations and veterinarian and public services).

3.2.5.4.2 Responsibilities

3.2.5.4.2.1 The ISO ADIS-ADED Working Group

The international standards for data exchange by ADIS-ADED are developed by the ISO working group ISO/TC 23/SC 19/WG 2. However with regard to the maintenance, update and new developments of the cattle data dictionary, close cooperation with competent international professional bodies like ICAR is strongly recommended.
**3.2.5.4.2.2 Role of ICAR**

Within ICAR the Animal Recording Working Group is responsible for the development of the international Data Dictionary for ruminants. Therefore proposals to ISO/TC 23/SC 19/WG 2 for updates and extensions to the international dictionary for cattle are forwarded exclusively by this Group. The Animal Recording Working Group acts in close collaboration with the responsible ISO group and collects suggestions and proposals from other ICAR working groups and national developer groups involved in the development of an international ADED.

The other ICAR working groups contribute to the ICAR Animal Recording Group according to their specific expertise. Their contribution includes first drafts and proposals for new Data Dictionary elements being forwarded to the Animal Recording Group.

Beef recording implies an intensive data exchange between many participant involved in the recording and breeding process. Therefore the ICAR Beef Recording Group is developing a comprehensive data model referring to each of the recording schemes as mentioned in the previous chapters. This data model forms the base for the beef data elements which can be seen as a sub set of the Data Dictionary for cattle. Differences between national laws and regulations, breeds and production schemes will be taken into account.

Proposals for beef recording and beef breeding elements in the international cattle data dictionary may be made by individuals and organisations. However, prior to any handling within the ICAR Animal Recording Group they will be reviewed with regard to their relevance, completeness and systematic correctness by the ICAR Beef Group. If the Beef Group agrees, the proposals will be forwarded to the Animal Recording Group.

### 3.2.6 Glossary of terms

- **ABRI**
  - Agricultural Business Research Institute at University of New England (UNE) Armidale. Is responsible for data processing and commercial operation of BREEDPLAN.

- **AGBU**
  - Animal Genetics and Breeding Unit at joint institute of NSW Agriculture and UNE. Is responsible for research, development and management of BREEDPLAN

- **Age at first calving**
  - Age of the dam in days at first calving

- **Age at puberty**
  - Time at which the animal acquires the ability to reproduce offspring (first spontaneous ovulation or ability to produce an ejaculate of 50 million spermatozoa/ml)

- **Age of heifer first oestrus**
  - Age of the heifer in days

- **Birth Weight**
  - Weight of calf within 48 hours after birth

- **Body Condition Score**
  - Numerical score to describe the nutritional body state of the animal

- **Bone %**
  - Percent ratio of bone weight and carcass weight

- **Breeding**
  - Natural mating or artificial insemination service (AI)

- **BREEDPLAN**
  - The Australian genetic evaluation system for Beef Cattle.

- **Calf Mortality**
  - Mortality of the new born calf during or within 48 h after birth

- **Carcass length**
  - Carcass length between fixed points

- **Cause of death**
  - Choice from a coded list of causes of death

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<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code of Practice</td>
<td>The minimum requirements that have to be met in each case to achieve accreditation</td>
</tr>
<tr>
<td>Conception</td>
<td>Formation of a diploid zygote</td>
</tr>
<tr>
<td>Conception rate of bull</td>
<td>Number of services or matings per (a) conception, (b) gestation or (c) calving when the same (only one) bull is used to breed cows and to obtain a gestation</td>
</tr>
<tr>
<td>Conception rate of herd</td>
<td>Proportion of cows mated to a bull or inseminated with a bulls semen which conceived or become pregnant at a defined stage of gestation</td>
</tr>
<tr>
<td>Conformation score</td>
<td>Subjective assessment of conformation in live animals or carcasses</td>
</tr>
<tr>
<td>CRC</td>
<td>Co-operative Research Centre for the Cattle and Beef Industry (Meat Quality) with head office based at UNE and the Tropical Beef Centre at Rockhampton Queensland</td>
</tr>
</tbody>
</table>
| Disposal reason                           | Coded list to describe the exit of an animal from the herd;  
1. Death on farm  
2. Sale for breeding  
3. Sale for finishing  
4. Slaughter                                                                                                                                         |
| EBV                                       | Estimated Breeding Value. A measure of an animals genetic merit for a given trait                                                                                                                                 |
| Embryo                                    | The conceptus arising from the zygote through mitotic divisions                                                                                                                                           |
| Estimated weight                          | Linear function of chest girth and age by breed                                                                                                                                                           |
| Fat score                                 | Subjective assessment of fat cover of carcass                                                                                                                                                             |
| Fecundity                                 | Reproductive potential of an animal as measured by the quantity and quality of gametes produced or by the quantity of developing eggs or of fertile breeding                                                   |
| Fertility                                 | Reproductive potential of an animal as measured by the quantity and quality of gametes produced or by the quantity of developing eggs or of fertile breeding                                                   |
| Fertilization                             | Formation of a diploid zygote                                                                                                                                                                             |
| First successful semen collection         | Date of first successful collection                                                                                                                                                                        |
| Foetus                                    | The young organism after completion of organogenesis, when implantation of the conceptus is completed                                                                                                   |
| Herd female Non-return rate               | Proportion of cows inseminated for the first time during a given period of time, (such as a month), that have not been recorded as having returned for another service within a specified number of days, and so are presumed pregnant |
| Hot carcass weight                        | Weight of carcass after bleeding and removal of head, legs, skin, visceral organs                                                                                                                         |
| Implantation                              | Process of attachment of the conceptus in the uterus, begins at day 19-20 and is completed between days 35 and 42                                                                                           |
| Infertility                               | Any complete or partial (semi sterility) failure of an individual to produce functional gametes or viable zygotes                                                                                         |
Kidney fat %  Percent ratio of kidney fat weight and carcass weight
Linear score  A numeric score recorded on one or more anatomical sites on the animal using a numeric scale designed to describe the biological variation
Live empty/shrunk weight  Live weight following 12 hours of food and water withdrawal
Live full weight  Average of two consecutive live weights where animal has access to food and water recorded 24 hours apart
Mating date  Date of actual mating
NFE  Net Feed Efficiency. Refers to the difference in animals feed intake independent of requirements for growth rate and body weight
NFI  Net Feed Intake. The trait calculated by phenotypic adjustment of feed intake for body weight and growth as a measure of NFE
Oocytes produced  No. of oocytes per flush
Pastural natural mating dates  Start and end dates of exposure to sire(s)
PBBA Performance Beef Breeders Association. A technical committee representing each of the Breed Societies that conduct annual GROUP BREEDPLAN analyses
Pelvic Diameter  Vertical and or horizontal pelvic diameter
Prolificacy of female  Number of calves per gestation
Reproductive lifetime  A function of age at puberty and stayability
Scrotal Circumference  The largest circumference of the scrotum recorded with both testicles positioned beside each other
Serving capacity  Number of services achieved by a bull under stipulated/defined conditions
Sterility  Any complete or partial (semi sterility) failure of an individual to produce functional gametes or viable zygotes
Weaning Weight  Weight of calf at weaning

3.2.7 Literature


Section 4 - Use of DNA and other techniques
SECTION 4.1 - MOLECULAR GENETICS

4.1.1 Introduction

Advances in molecular biology provide a new set of information to be incorporated into animal industry. On one hand, the use of molecular information may contribute to the enhancement of consumers trust in the ability monitor and control the animal production chain. On the other hand, molecular information will greatly contribute to achievement of genetic improvement of animal traits through the use of MAS, gene introgression, heterosis prediction, and correct pedigree control. In most cases, advantages of using molecular information comes from improving accuracy, shortening of generation interval and increasing of selection intensities. Nevertheless, there is still a need for research and development in the search for associations between genetic markers and traits of interest. In addition to that, and before using genetic information in practical selection schemes, an understanding of gene action, gene interactions and differential gene expression to avoid negative collateral effects is needed. Cooperation between animal industry (sucklers, fatteners, slaughterers and retailers) and research is required for a successful and beneficial search for genetic information, in commercial beef cattle populations.

4.1.2 Current and potential uses of DNA Technologies

4.1.2.1 Parentage verification and parental assignment

Up until now, parentage verification has been one of the commercial uses of genetic markers (microsatellites type). Parentage testing is based on the exclusion of relationship when an animal has a genotype inconsistent to a putative relationship. New trends in animal production systems are tending to encourage animal production in more extensive conditions in response to environmental and production related constraints. As the cost of the analysis decreases and the number of genetic markers available increases, breed societies will be able to build up pedigree records using genetic markers to track the pedigree of calves born in a herd at a given time. This will require a prior knowledge on candidate sires and dams at a given time and a set of identified markers. The probability
of assignment to a correct pair of animals will depend on the number of alleles per loci, allelic frequencies in the population, the number of parents and number of possible matting. The International Society of Animal Genetics (http://www.isag.org.uk) has identified a panel of markers for this purpose.

4.1.2.2 Traceability of beef product and authentication of beef products with certified breed origin

Since the BSE crisis the traceability of beef products is of great concern to consumers. Traceability is based on the availability of a verification and control system which monitors all relevant details throughout the whole beef production chain. The genetic sequence of an individual is unique and does not change. DNA remains constant from 'conception to consumption'. Therefore, use of DNA information at a number of regions in the genome allows one to match DNA of an individual at birth to the final product. Microsatellites and SNP markers may be used for this purpose.

Genetic markers for the authentication of beef products for labels of quality related to geographic location (GPI) and labels of quality related to specific breeds or their crosses are/or will be very useful. However, it implies the establishment of molecular standards for each breed. A lot of information is coming from studies of genetic diversity among breeds. Genes subject to intense selection in each population such as coat colour, horned/pollled, shaped of horns etc are of interest.

4.1.2.3 Molecular genetic information for marker-assisted selection schemes

Quantitative traits are generally assumed to be controlled by a large number of genes. However individual genes sometimes account for a significant amount of variation of the trait. Such is the case of the double muscling gene. Since the genotype of an animal does not change during its lifetime, use of DNA information through the identification of markers linked to QTLs with effects on production traits or the identification of a gene itself will be of great interest in the near future. Nevertheless, while traits become more complex, there is a growing need of having a sufficiently large marker set to incorporate molecular information for selection decisions. Including molecular information as a selection criterion is of special interest for traits that are difficult and costly to measure or/and are measured late in life. Up to 2004, approximately 4000 loci have been identified in cattle populations. Many of them are genetic markers linked to QTLs. At the present time, there is a number of QTLs associated to beef traits (http://locus.jouy.inra.fr/).

Recording schemes have been collecting information for the most common production traits measured in live animals. There is an ever-increasing volume of information becoming available. Traits where genetic markers are under intense investigation are carcass and meat quality. As mentioned earlier, meat quality may be assessed from different point of views. In many cases, quality assessments of beef products are very expensive, difficult to obtain and performed late in the animal’s life. Recording of quality information is commonly made on a reduced number of animals of only one sex. On the other hand, many measures taken to determine quality lower the commercial value of the final product. Genetic markers will play an important role for this type of trait. There are already a number of loci related to tenderness, marbling, lean yield etc available. Furthermore there is a growing awareness of the link between diet and health. Consumers habits are changing. Nutritional value is a concern for consumers and they demand foods with health and beneficial properties. The nutritional value of beef products may be another approach to focus on for the selection of quality.
traits. This is the case of traits such as cholesterol content, fatty acids profiles, vitamins contents etc. Analyses to determine nutritional value or other specific traits that involve sophisticated techniques are very expensive. Thus, the molecular information available for these type of traits will be very useful and less expensive. Genetic markers will allow us to increase selection intensities since more candidates to selection will have recorded information.

4.1.2.4 Diseases resistance and genetic defects

Another group of traits with a high potential for the use of molecular data are those linked to resistance, –susceptibility to diseases. There are a number of multifactorial or complex diseases which are the result of a polygenic background and environmental components. Diseases resistance traits are among the most difficult to include in genetic improvement programs because they require good field measurement of the disease status of the animals and a systematic control of management or environmental conditions that allow for the identification of environmental influence on the health status of the animal. Infectious diseases depend very much upon environmental factors such as the degree of exposure to pathogen agent. Thus, if exposure is low, animals will show little variation. Part of the phenotypic differences for resistance may be differences in the degree of challenge. Therefore, if genes or genetic markers linked to resistance are correctly identified, resistant animals will be able to be selected on the base of their molecular information. In many diseases, identification of genes associated to resistance will require of experimental conditions to be found.

Genetic analysis to identify heterozygous carriers of genetic diseases caused by single recessive genes are currently in use. This is the case of BLAD (bovine leukocyte adhesion deficiency) and others (http://www.angis.org/Databases/BIRX/omia). In OMIA (Online Mendelian Inheritance in Animals) there are over three hundred familial inheritance disorders registered in cattle. Fifty six of them are single locus disorders for which twenty seven have the causative mutation identified.

4.1.3 Technical aspects

4.1.3.1 DNA collection

Systematic collection of DNA is recommended in beef cattle population. DNA may be obtained from any nuclear cell in the body. Protocols for DNA extraction are now available for blood (white cells), semen, saliva (epithelial cells), hair follicles, muscle, skin, organs (such as liver, spleen etc.). Small amounts of tissue material are required for routine DNA analysis. However, if future used of DNA is to involve its use for many different objectives (selection for a number of traits, traceability, etc) storage costs, DNA extraction costs, DNA yield will have to be carefully examined and optimised. Common collection methods include dried blood samples kept on blotting paper and stored at room temperature, ear tag systems that deposit tissue samples in an enclosed container or hair follicles.

4.1.3.2 Genetic markers commonly used

4.1.3.2.1 Microsatellites

These are segments of DNA containing tandem repeats of simple motifs usually dimers or trimers. These segments are located throughout the genome and normally in non-coding regions. These regions are subject to addition or subtraction of the number of tandem repeats which make them unique at each site of the genome.
4.1.3.2.2 SNP

These are a single nucleotide polymorphism located throughout the genome. The most informative SNPs are either located in coding regions, therefore different polymorphism imply a change in the structure or function of the encoded protein, or at non-coding regions that may be involved on regulatory function of the gene.

4.1.3.2.3 Data collection

The centralised database may be organised in respect to the main uses to be made of the genetic information:

- Parental verification and assignment.
- Traceability of beef products.
- Breed identification or breed diversity.
- Qualitative and Quantitative trait.

Tables may contain:

- Animal ID: to link to all other animals information including relatives.
- Number of genetic markers: n
- Identification of each marker i (for i = 1, n)
- First allele for marker i.
- Second allele for marker i.
- Association with other traits.
- A table of identified markers for each breed:
  - Standard Name of marker
  - Aliases
  - Complete Gene, Part of a gene, marker
  - Accession number
  - Allelic size
  - Genotypes

For standardization purposes in respect of the nomenclature of genes or loci, a web site is available: http://www.gene.ucl.ac.uk/nomenclature/ and markers http://www.ncbi.nlm.nih.gov/.
SECTION 4.2 - ICAR RULES AND GUIDELINES FOR LABORATORY ACCREDITATION OF PARENTAGE TESTING IN CATTLE

Considering the need for high quality standards in bovine parentage testing and identity verification due to the impact incorrect parentage assignment or identity may have in the estimation of genetic indexes and in national and international genetic evaluations, and based on two years of work by the genetic analysis task force, ICAR has decided to define the minimum requirements for laboratories performing DNA parentage testing and identity verification. Guidelines for accreditation are provided for microsatellite- and SNP-based analyses in cattle. Minimum requirements for additional species and DNA tests will be defined in the future.

Laboratories requesting microsatellite- and/or SNP-based accreditation will have to apply by downloading and filling out the appropriate forms (Annex II for microsatellites; Annex V for SNPs) on the ICAR website. The forms must be filled out accurately and completely, providing necessary documentation as required. The application will be evaluated by a Committee of Experts appointed by ICAR that will either approve it, request additional information, or reject it. In case of rejection, the applicant may submit a new form at least one year after her/his failed application. Accreditation will be given for a two-year period, at the end of which a new application is to be completed and submitted after participation in additional ISAG comparison tests.

Section 4.2.1 and 4.2.2 contain the rules and guidelines for laboratory accreditation of DNA paternity testing in cattle using microsatellites and the rules and guidelines for SNP-based parentage testing in cattle.

Annex I and Annex II contain the application form for laboratory accreditation of DNA paternity testing in cattle using microsatellites and the list of recommended ISAG microsatellite markers, respectively.

Annex III, and Annex IV contain the application form for laboratory accreditation for SNP-based testing in cattle and the list of recommended SNP markers, respectively.

Laboratories requesting accreditation will have to apply for it downloading and filling a questionnaire (Annex I) that will be made available on the ICAR website. The form is to be filled accurately, providing necessary documentation, when required. Accreditation will be released for a two-year period, at the end of which a new application is to be completed and submitted. The application will be evaluated by a Committee of Experts appointed by ICAR that will approve it, require additional information or reject it. In case of rejection the applicant may submit a new form at least one year after her/his failed application.
4.2.1 ICAR rules and guidelines for accreditation of DNA paternity testing in cattle

The present Rules contain **Minimum requirements** for accreditation of DNA paternity testing in cattle.

Annex I contains the questionnaire to be filled by applicants and e-mailed to the ICAR secretariat (dna@icar.org). Annex II contains the list of microsatellite markers recommended by ISAG and the method for calculating 1 parent and 2 parent exclusion probabilities.

1. **Laboratory identification**
   
   The applicant must be clearly identified by providing the following:
   - Name of the laboratory and Institution if relevant,
   - Institution if relevant
   - Address and Country
   - Contact person at the lab, as well as all information necessary for getting in touch with her/him quickly.

2. **Education and training of lab supervisor and operators**

   The minimum requirements for education and training of the laboratory supervisor and senior operator are:
   - Bachelor degree, or higher, in a scientific discipline for laboratory head or supervisor, and
   - At least five years of experience in molecular diagnostics for the laboratory senior operator.

   Experience is considered a key factor in data production and in the interpretation of results.

3. **Equipment**

   - Equipment used to run and score microsatellite must be described.
   - The year of purchase and last revision must be provided - this allows ICAR to evaluate the appropriateness of the technology being used and ensure each lab is following a proper maintenance program that should enable it to generate high quality data.
   - Yearly revision is considered a minimum requirement.
   - A personal opinion on the performance of the laboratory set up available is asked to foresee the need for improvements in quality standards.

4. **Certification**

   - International ISO17025 or ISO9001 is a minimum requirement for ICAR accreditation.

5. **Participation and performance in ring test**

   - The participation and performance in ISAG and national ring (comparison) tests must be disclosed, and certificates provided, when available. Applicants must also sign a release allowing ISAG to directly disclose their ring test results to the ICAR DNA Committee.
   - The participation in at least two ISAG ring tests is a minimum requirement.
   - Beginning with the 2009-10 ISAG ring test, lab typing performance for the official set of 12 ISAG microsatellites (see Annex II) must be disclosed (previous ISAG ring test reporting can be limited to 9 microsatellites).
   - The Committee of Experts will decide performance thresholds for each ring test with due consideration for the structure of the ring test and the average performance of laboratories in the ring test that year.
6. **Microsatellite markers**

   - The names of all microsatellites typed on all animals (marker set I) and of the additional ones assayed in the case of unresolved parentage (marker set II) must be declared, as well as the number of animals typed in at least the last two years.
   - The minimum requirement for international exchange is the complete set of 12 official ISAG microsatellite markers.
   - To ensure sufficient experience within the lab, analysis of 500 animals per year is set as minimum requirement for certification.
   - Exclusion probability (PE; 2 parents and 1 parent) of each marker and of the complete marker sets must be calculated and provided in the application. The type of population and number of animals (minimum 150) used for computations are to be described. ICAR recommends using Holstein as a reference group when possible. The ICAR Committee of Experts will evaluate that an appropriate PE is reached for accreditation, on the basis of the population analyzed.

7. **Marker nomenclature**

   - Nomenclature of markers must be described.
   - ISAG nomenclature is required for the official ISAG 12 marker set.

4.2.2 **ICAR rules and guidelines for SNP-based parentage testing in cattle**

   The present Rules contain **Minimum requirements** for accreditation of SNP-based DNA parentage testing in cattle.

   Annex III contain the application form for laboratory accreditation for SNP-based testing in cattle that has to be emailed to the ICAR secretariat (dna@icar.org). Annex IV contains the list of recommended SNP markers.

1. **Laboratory identification**

   The applicant must be clearly identified by providing the following:
   - Name of the laboratory.
   - Institution if relevant.
   - Address and Country.
   - Contact person at the lab, as well as all information necessary for getting in touch with her/him quickly.

2. **Education and training of lab supervisor and operators**

   The minimum requirements for education and training of the laboratory supervisor and senior operator are:
   - Bachelor degree, or higher, in a scientific discipline for laboratory head or supervisor.
   - At least five years experience in molecular diagnostics for the laboratory senior operator.

   Experience is considered a key factor in data production and in the interpretation of results.
3. Equipment
   • Equipment used to run and score SNPs must be described, as well as the methods used.
   • The year of purchase and last revision must be provided – this allows ICAR to evaluate the appropriateness of the technology being used and ensure each lab is following a proper maintenance program that should enable it to generate high quality data.
   • Yearly revision is considered a minimum requirement.

4. Certification
   • No certification is presently required. In the future, ISO17025 and/or ISO9001 will be a minimum requirement.

5. Participation and performance in ring test
   • The participation and performance in ISAG ring (comparison) tests must be disclosed and certificates provided, when available. Applicants must also sign a release allowing ISAG to directly disclose their ring test results to the ICAR DNA Committee.
   • Participation in at least one ISAG ring tests is considered a minimum requirement at this time.
   • A Committee of Experts will decide performance thresholds for each ring test with due consideration for the structure of the ring test and the average performance of laboratories in the ring test that year.

6. SNP markers
   • The name of all SNPs typed on all animals (marker set I) and of the additional markers assayed in the case of unresolved parentage (marker set II) must be declared, as well as the number of animals typed in at least the last two years.
   • It is a minimum requirement to use at least 95 SNPs from the set recommended by ISAG (see Annex VI) on all animals typed.
   • To ensure sufficient experience within the lab, genotyping 500 animals per year is set as a minimum requirement for accreditation.
   • Exclusion probability (PE; 2 parents and 1 parent) of the complete marker sets used must be calculated and declared. The type of population and the number of animals (minimum 150) used for computations are to be described. ICAR recommends using Holstein as a reference group when possible. The ICAR Committee of Experts will evaluate that an appropriate PE is reached for accreditation, on the basis of the population analyzed.

7. Marker nomenclature
   • Nomenclature of markers must be described.
   • ISAG nomenclature is required for the ISAG SNP marker set.
INTRODUCTION

Objective

These guidelines are intended to standardise the methods of assessment of conformation in accordance with rules and standards as established by each world/international federation of respective dairy cattle breeds.

Performance of the bull

The assessment of the bull occurs in the first step of selection at the age of about one year, preferably during events which permit the comparison with a larger number of animals. All traits must be scored or measured linearly from one biological extreme to the other. The range of scores must be from 1-9.

Features which indicate the disposition for a genetically dismissable defect of a bull will be considered.

Assessment of female progeny

a) Selection of bulls and size of sample

Conformation should be assessed for all test bulls. The sample must consist of at least 20 randomly selected daughters. At least 20 complete progeny groups should be included as a measure of comparison.

b) Traits

In all breeds such criteria should be considered as criteria which give an insight into performance traits or which have a limiting influence on the use of the animal.
c) Time of assessment

The evaluation of the daughters of test bulls should occur during the first lactation, if at all possible during the first four months of lactation, but not before the 15th day after calving. Dry cows cannot be considered in the evaluation.

d) Method

The progeny is being described according to a linear system with a score 1-9. In addition, further traits of conformation may be assessed. Details of the procedure including the presentation of results will be laid down by the organisation of the breeds concerned.

Personnel

Personnel charged with inspection must behave neutrally and must take their training and in-service training centrally. In order that the influence of the inspector may be corrected, the timing and regional use of them must be such that a number of inspectors participate in the assessment of the progeny of one bull.

The number of inspectors working in a population must be such that at least 200 cows are being assessed per inspector per year.

Collection of data for analysis

For the assessment of progeny this includes the birth, calving, and inspection dates of the assessed animal, identification (lifetime tag) of the assessed animal and its parentage at least and, if available, dam and dam of sire.

Publication

If breeding value assessment for conformation is not being carried out, the minimum information to be given for the publication of the results of the progeny assessment are:

• number of daughters, farms and bulls in the group of comparison.
• for traits of description, standardised deviation.
• for traits, averages and standardised deviations.

Additional conformation recording methods - as defined by the responsible organisation for the breed.
SECTION 5.1 CONFORMATION RECORDING OF DAIRY CATTLE

5.1.1 Introduction
The ICAR multi dairy breed conformation recording recommendation integrates with the World Holstein-Friesian Federation guidelines on the international harmonization of linear type assessment, trait definition, evaluation standards and publication of type proofs for bulls.

This document contains a list of approved standard traits, which is a list of traits which should be scored by all organisations in the same way to improve further harmonisation on international level, also on Interbull level. The data collected within these recommended standards qualifies for MACE evaluation by Interbull.

Further the document contains a list of 5 traits which are commonly used by organisations in the dairy and dual-purpose breeds world-wide. This list of common standard traits is added to improve harmonisation of these traits too.

Besides giving trait definitions on standard traits, recommendations are given on improvement and transparency of data collection and monitoring classifiers.

5.1.2 Traits definitions
Linear type traits are the basis of all modern type classification systems, and are the foundation of all systems for describing the dairy cow. Linear classification is based on measurements of individual type traits instead of opinions. It describes the degree of trait not the desirability.

Advantages of linear scoring are:
- Traits are scored individually.
- Scores cover a biological range.
- Variation within traits is identifiable.
- Degree rather than desirability is recorded.

5.1.3 International standard traits
The International standard traits satisfy the following definitions:
- Linear in a biological sense.
- Single trait.
- Heritable.
- Economic value; Direct or indirect with reference to the breeding goal.
- Possible to measure instead of score.
- Variation within the population.
- Each linear trait should describe a unique part of the cow which is not covered by a combination of the other linear traits.

Approved standard traits
1. Stature
2. Chest width
3. Body depth
4. Angularity
5. Rump angle
6. Rump width
7. Rear legs set
8. Rear legs rear view
9. Foot angle
10. Fore udder attachment
11. Rear udder height
12. Central ligament
13. Udder depth
14. Front teat position
15. Teat length
16. Rear teat position
17. Locomotion
18. Body condition score

Common standard traits
19. Hock development
20. Bone structure
21. Rear udder width
22. Teat thickness
23. Muscularity

5.1.4 Standard trait definition

The precise description of each trait is well defined and it is essential that the full range of linear scores to identify the intermediate and extremes of each trait be used. The assessment parameters for the calculations should be based on the expected biological extremes of a cow in the first lactation. The scale must cover the biological extremes of the current population.

Recommended Scale 1 - 9

Note
The linear scale used, must cover the expected biological extremes of the population in the country of assessment.
1. **Stature**
   - Ref. point: Measured from the top of the spine in between hips to ground. Precise measurement in centimetres or inches, or linear scale.
     - 1 Short
     - 5 Intermediate
     - 9 Tall

2. **Chest width**
   - Ref. Point: Measured from the inside surface between the top of the front legs:
     - 1 Narrow
     - 5 Intermediate
     - 9 Wide
3. Body depth

- Ref. Point: Distance between top of spine and bottom of barrel at last rib - the deepest point: independent of stature:
  - 3 Shallow
  - 5 Intermediate
  - 9 Deep

4. Angularity

- Ref. point: The angle and spring of the ribs; not a true linear trait:
  - 1 Lacks angularity: close ribs coarse bone
  - 5 Intermediate: with open rib
  - 9 Very angular: open ribbed flat bone

Reference scale: weighing of the two components; angle and spring of the ribs

Defining "spring of ribs" is another way of referring to the degree of openness between the ribs. When the ribs are tight there is no opening. When the ribs spring apart or expands open, the space between ribs become greater.
5. **Rump angle**

- Ref. Point: Measured as the angle of the rump structure from hooks (hips) to pins:
  - 1 High pins
  - 5 Intermediate
  - 9 Extreme slope

Depending on the population rump angle can be scored level with a score in the range of 3-5.

![Diagram of rump angle](image1)

6. **Rump width**

- Ref. point: The distance between the most posterior point of pin bones.
  - 1 Narrow
  - 5 Intermediate
  - 9 Wide

![Diagram of rump width](image2)
7. Rear legs rear view

- Ref. point: Direction of feet when viewed from the rear.
  - 1 Extreme toe-out
  - 5 Intermediate; slight toe-out
  - 9 Parallel feet

8. Rear legs set

- Ref. point: Angle measured at the front of the hock.
  - 1 Straight
  - 5 Intermediate
  - 9 Sickle

If the rear legs set is different, the most extreme one should be scored.
9. Foot angle
- Ref. point: Angle at the front of the rear hoof measured from the floor to the hairline at the right hoof.
  - 1 Very low angle
  - 5 Intermediate angle
  - 9 Very steep

If the foot angle is different, the most extreme one should be scored.
If the foot angle is difficult to score because of hoof trimming, bedding, manure etc. It is also possible to look at the angle of hairline.

10. Fore udder attachment
- Ref. point: The strength of attachment of the fore udder to the abdominal wall.
  Not a true linear trait.
  - 1 Weak and loose
  - 5 Intermediate
  - 9 Extremely strong and tight
11. Front teat position
- Ref. point: The position of the centre of the front teat placement at the point of the udder as viewed from the rear.
  - 1 Outside of quarter
  - 5 Intermediate
  - 9 Inside of quarter

12. Teat length
- Ref. point: The length of the front teat.
  - 1 Short
  - 5 Intermediate
  - 9 Long

Instead of scoring front teat, the rear teat can be scored. The choice of front teat or rear teat should be consistent in the whole system.
13. **Udder depth**
- Ref. point: The distance from the lowest part of the udder floor to the hock.
  - 1 Deep
  - 5 Intermediate
  - 9 Shallow
Potential point of reference is the level with the hock.

14. **Rear udder height**
- Ref. point: The distance between the bottom of the vulva and the milk secreting tissue: in relation to the height of the animal.
  - 1 Low
  - 5 Intermediate
  - 9 High
15. Central ligament
- Ref. point: The depth of cleft at the base of the rear udder:
  - 1 Convex to flat floor (flat), broken ligament
  - 5 Intermediate
  - 9 Deep cleft/strong ligament

16. Rear teat position
- Ref. Point: The position of the rear teat from the centre of quarter:
  - 1 Outside of quarter
  - 5 Intermediate
  - 9 Inside of quarter
17. Locomotion

Ref. Point: The use of legs and feet, length and direction of the step
- 1 Severe Abduction - Short Stride
- 5 Slight Abduction - Medium Stride
- 9 No Abduction - long stride
Score only if the cow can walk (cow has no lameness).

18. Body condition score

- Ref. Point: The covering of fat over the tail head & rump. Not a true linear trait.
  - 1 Poor
  - 5 Intermediate
  - 9 Grossly fat

With a score from 1-6 there mainly has to be looked at the loin, while the tail implant is important with the higher score (7-9).
19. Hock development

- Ref. Point: Cleanness and dryness of the hock.
  - 1 Hock with a lot of fluid
  - 5 Intermediate
  - 9 Complete clean and dry

![Hock Development Diagram]

20. Bone structure

Ref. Point: The thickness and width of the bone structure, assessed by both examining the rear leg from the rear and from the side.

- 1 Broad and thick
- 5 Intermediate
- 9 Flat

![Bone Structure Diagram]
21. Rear udder width
Ref. Point: Width of the udder at the point where the milk secretion tissue is attached to the body.
- 1 Narrow
- 5 Intermediate
- 9 Wide

22. Teat thickness
Ref. Point: Thickness of the teat in the middle of the front teat.
- 1 Thin
- 5 Intermediate
- 9 Thick
23. Muscularity

Ref. Point: The amount of muscles as seen in the loins and thighs. Not a linear trait.

- 1 Poor
- 5 Intermediate
- 9 Grossly muscular

5.1.5 Genetic evaluation

5.1.5.1 Type inspection system - Genetic evaluation

1. Breeding values for bulls and cows to be based on the classification of cows in the first lactation scored in a herd evaluation system.

2. In a herd evaluation system all first lactating cows, which have not be previously evaluated, must be scored during the visit of the classifier.

3. Additional classifications to obtain a bull proof may only be possible if completed by the same organisation and daughters are sampled randomly with sufficient number of herd mates (contemporaries) scored during the same visit. A minimum of 5 first lactating cows, which qualify for genetic evaluation, are inspected at the same visit.

5.1.5.2 Evaluation model

1. Modern BLUP evaluation techniques should be used to obtain accurate unbiased evaluations.

2. Data should be corrected for influencing factors such as age, stage of lactation and season by the model. Classifiers should not make adjustments during scoring.

3. Corrections for variation between classifiers are required to avoid heterogeneity of variance.

4. Herd mates are defined as the contemporaries of the evaluated heifers in the same lactation, scored during the same visit by the same classifier.

5.1.5.3 Publication of information

1. Publish bull-proofs around an average of 0 and a genetic standard deviation of 1.0.
2. Proofs of widespread bulls should be published as bar graphs covering the range between +3 and -3 standard deviations.

3. OR: Mean of 100 & the standard deviation in the base population where this standard deviation is adjusted to the situation the proofs of cows have a reliability of 100%.

4. The base of sire and cow evaluation should follow the definition of the production proofs, given by Interbull. This includes a stepwise fixed base that should be renewed every five years. The base is defined by cows born 5 years previously.

5.1.6 Composite traits and general characteristics

5.1.6.1 Composite traits

1. Composite traits are groups of linear traits relating to one specific area.
2. The individual linear traits are weighted according to economic breeding objectives.
3. The main composite traits are - Frame including rump, dairy strength, mammary, feet/legs.

5.1.6.2 General characteristics or breakdown for non Linear traits

a. Type classification programmes also include phenotype assessment. These are described as general characteristics or combined traits, which are not linear in a biological sense. A subjective score is given for the desirability of the cow according to the breeding goal.

b. Female animals are inspected, classified and assigned grades/scores ranging from 50-97 points.

c. The most common scale for mature cows (second or more lactations) are:
   - Excellent 90 - 97 points
   - Very Good 85 - 89 points
   - Good Plus 80 - 84 points
   - Good 79 - 75 points
   - Fair/Poor/Insufficient 50 - 74 points

d. The awarding of classification grades varies in each country depending upon the breeding goals, and therefore classification scores must be considered in the context of the country of inspection.

e. The final class and score are derived from a breakdown of the main functional areas of the female:
   - Frame including rump.
   - Dairy strength.
   - Mammary system.
   - Legs/feet.

f. The weighting of the component breakdown scores should meet the breeding goals in the Country of inspection. It is recommended that for first lactating cows the range of scores used is 70 - 90 points. The average score is always in the middle of the maximum and minimum a first lactating cow can be awarded.
SECTION 5.2 RECOMMENDATIONS ON IMPROVING QUALITY AND TRANSPARENCY OF DATA COLLECTION AND MONITORING CLASSIFIERS

5.2.1 Introduction

When collecting data on animal performances on a routine basis it is important to do this in a consistent and transparent way. In this way quality of data can be guaranteed and for everybody it is clear how it is done. This is also important for scoring animals for conformation traits, which is normally done by classifiers, specially trained doing this job.

This chapter describes the improvement of quality and transparency of data collection for conformation traits.

5.2.2 Practical aspects on type classification system

a. One organisation should be in charge of classifications within each evaluating system.

b. There should be a head-classifier in charge of training and supervising other classifiers within the evaluating system to achieve and maintain a uniform level of classification. Additionally the exchange of information between head-classifiers from different systems/countries is recommended.

c. Individual full time professionals should complete classification. Classifiers should be independent of commercial interest in AI-bulls/studs.

d. Classifiers must record the trait as observed without adjustment e.g. Age, stage of lactation, sire or management system.

e. The working information provided for the classifier should make no reference to the pedigree or performance of the cow.

f. Classifiers should always rotate classification areas (herds and regions) to ensure a good data connection between regions and to minimise the sequential scoring of cows by the same classifier. This way of working reduces this risk of classifier*regional genetics interaction or classifier*herd interaction.

g. An advisory group can be installed with expertise in the field of conformation classification, statistics, breeding, training people, in order to monitor and advise on the improvement to the classification system.

h. The housing system and type of floor should be registered when a herd is visited. This makes it possible to find possible interactions between housing system and the trait scored. Types of housing can be free stall, tie stall, mixture (stall plus outside). Types of floors can be concrete, cement with groves, slats, sand, rubber, straw, pasture.

5.2.3 Training and monitoring of classifiers

The monitoring and performance evaluation of classifiers is an important part of the standardisation of the ICAR international type program.
Objectives

1. Improve accuracy of data collection, within country all classifiers should
   - Apply the same trait definition
   - Apply the same mean
   - Apply the same spread of scores
2. Improve the genetic correlation for linear traits between countries (Interbull evaluation)
   - Apply the same trait definition in all countries

Tools for objective 1

- National group training sessions
- Statistical monitoring of individual classifiers performance with reference to mean, spread and normal distribution of scores
- Compute the correlation between the scores of one classifier and the group by using bivariate analysis. This shows the quality of harmonisation of trait definition between classifiers

Tools for objective 2

- International training of head classifiers
- International group training sessions
- Audit system
- If a country decides to change the definition of a trait, it is recommended not to use previous scores or use only as a correlated trait in the national genetic evaluation system

5.2.3.1 National group training sessions

One way of improving harmonisation of scoring by classifiers is having regular training sessions with a group of classifiers.

There are many ways to accomplish trait harmonisation through training sessions. Normally a training session consists of scoring a group of cows and the scores of individual classifier are compared with the scores of the other classifiers and/or head classifier.

Attention points are:
- Use a group of cows for training session which is representative for the cow population classifiers have to score during their herd visits.
- Deviations of individual scores are discussed and it is made clear which is the correct score for a certain trait on a cow.
- Scores of each classifier are analysed per trait using some analysis tools.
- Compute the mean and standard deviation of the deviations of the scores on cows per trait, per classifier. The deviation is the difference between the score and the average group score for a trait, for a cow. This gives insight in the scoring of individual classifier: always above of below the mean, more variation in scoring a trait than the group/head classifier. (with a test it can be shown if the differences found are significant).
- Compute the spread of the deviation of scores given by classifier per trait. This gives insight in how consistent a classifier is scoring a trait. (with a test it can be shown if the differences found are significant)

- Instead of scoring a group of cows once, the cows can be scored twice by the classifiers, for example in the morning and in the afternoon. Based on these scores (approximately 20) the repeatability per classifier per trait can be computed.

### 5.2.3.2 Statistical monitoring of individual classifiers

The scores of a classifier from a certain period in time can be analysed. A period can be 12 or 6 months, for example.

From these scores the mean and standard deviation can be computed. The mean should be close to \((\text{maxscore} - \text{minscore})/2\), and the standard deviation should be near \((\text{maxscore} - \text{minscore} + 1)/6\), where minscore is the lowest score on the scale and maxscore is the highest score on the scale. For example: scoring a trait on a scale of 1-9, a mean is expected of 5 and a standard deviation of 1.5.

Another option is to compute the correlation between the scores of one classifier and the scores of rest of the group by using bivariate genetic analysis. This shows the quality of harmonisation of trait definition between classifiers (Veerkamp, R. F., C. L. M. Gerritsen, E. P. C. Koenen, A. Hamoen and G. de Jong. 2002. Evaluation of classifiers that score linear type traits and body condition score using common sires. JDS 85:976-983).

For this analysis, two data sets are created, one with scores of one classifier and the other with scores of all other classifiers from a certain period, for example 12 months. Both data sets can be analysed in a bivariate analysis, estimating different (genetic) parameters. The analysis can be carried out for each trait and for each classifier. From the bivariate analyses the following parameters can be derived:

- Heritability: the heritability estimated within each classifier can be used as criteria for the repeatability of scores within classifiers, albeit the optimum value is not unity but depends on the true heritability of each trait.

- Genetic correlation: the genetic correlation between two data sets can be used as a measure of the repeatability between classifiers, where a genetic correlation of one between classifiers is expected.

- Genetic standard deviation.

- Phenotypic standard deviation (= square root of genetic variance and error variance).

For the evaluation of each trait for each classifier the diagram in Figure 1 can be used.
Evaluation obviously starts with the mean score for each classifier, i.e., the mean should be close to the trait standard (5 for linear traits and 80 for descriptive traits). Secondly, the genetic standard deviation should not be lower than the average.

If the genetic standard deviation is lower, this could be due to the scale used (measured by the phenotypic standard deviation), due to poor within classifier repeatability (a low heritability) or both. If the low genetic standard deviation goes together with a low phenotypic spread, the advice is the classifier should used the scale in a better way, use more the extreme scores. If the genetic spread goes together with a low heritability, then the classifier should score the trait more consistently, apply the same definition.

If the genetic correlation is too low the classifier is likely to score a trait different than other classifiers.

Figure 1. Scheme for evaluation trait by classifier combination using genetic parameters.
Section 5 - Guidelines on reference conformation recording methods

All the parameters from the system can be tested using the standard error on the parameters estimated. Every classifier can be tested against the average of the parameters of all classifiers for a certain trait. A classifier with a few scores may deviate a bit more from the average of the group, therefore taking the standard error into account in a statistical test is more fair.

5.2.3.3 Auditing a classification system

The Classification system applied can be further improved by using an audit system where experts familiar with the conformation classification in other countries or organisations, examine the situation in your organisation or country.

An important issue is that information is exchanged between people responsible for the classification system.

Different options to audit are:

- By using international workshops, in which information can be informally exchanged regarding how classifiers are trained and conduct their daily work
- By inviting classifiers and/or a head classifier from another country or organisation to participate in or lead group training sessions
- By having a group of experts visit an organisation responsible for classification, conduct a survey on methods and procedures, report their findings and makes suggestions for improvements.
SECTION 6 - FERTILITY RECORDING

SECTION 6.1 - GUIDELINES FOR THE EXPRESSION OF NON-RETURN RATES (NRR) FOR THE PURPOSE OF AI ORGANISATIONS

6.1.1 Scope

Non-Return Rates (NRR) as a management tool for AI industry to characterise bull fertility and technician performance or to compare different semen treatments.

The reproductive performances of any herd or flock is out of scope.

6.1.2 Aims

1. To facilitate the understanding of the “Non-return rates” usually provided by AI organisations, recommending a precise description of the method used for the calculation of NRR.

2. To suggest guidelines for calculations of NRR, in order to facilitate the harmonisation of the calculations between countries or AI organisations.

6.1.3 Definitions

First insemination = first insemination to breed an heifer or to breed a cow after the end of each pregnancy.

Non-Return Rate (NRR) = percentage of females that are inseminated for the first time during a given period of time (such as a month) and have not been recorded as having returned for another service within a specified number of days (e.g. 24, 56, 90).

6.1.4 Rules for calculation

6.1.4.1 Services to consider

Only first insecinations should be considered for the calculation of NRR (agreement for bull fertility in 5th ICAR meeting at TRENTE, 1964).
6.1.4.2 Females to consider

In a given herd, all females inseminated should be used for NRR calculation (without selection on reproductive parameters). Female breed(s) should be indicated.

6.1.4.3 Day of insemination

The day of insemination is Day 0.

6.1.4.4 Interval of returns

Calculation of a NRR (e.g. 56 day NRR) commonly excludes early returns according to the objective of the NRR (e.g. returns within 3 days after the insemination are excluded since it is considered usually as a problem due to females and not to the males). Thus, both limits of the considered interval should be indicated (e.g. 3-56 day NRR).

6.1.4.5 Limits of the interval of returns

As a rule, the limits given should be inclusive. For instance, for a 3-24 day NRR, if an insemination has occurred on Monday (D0), an early return recorded on Tuesday (D1) or Wednesday (D2) is excluded, and a return recorded from Thursday (D3) to D24 is considered.

6.1.4.6 Exclusion of short returns

The females with short returns, excluded as stated above, could be considered either like non-returned females (“pregnant”) or like non-inseminated females. The former will lead to a slight overestimation of NRR, the latter represents a better option but might be more complicated to implement. As a rule, short returns should be considered like non-inseminated females, i.e. should be eliminated from the file for the given year of calculation. Otherwise the chosen option should be indicated.

6.1.4.7 Number of first AI

The number of first AI should be indicated for any NRR, since it is related to the precision of the estimation. For example, a NRR of 50% based on 100, 400 or 1600 AI will have a standard deviation of 5, 2.5 or 1.25 units of percentage.

6.1.4.8 Correction of NRR

Numerous factors have been shown to be able to influence the NRR according to the breeding situation. Some of the factors commonly used are: parity of the female (cow/heifer), technician, day of the week, herd, area of AI, year or season or month, semen price, Do It Yourself or not, herds on milk recording or not, milk production for cows, female breed if several. As a minimum for correction, NRR should be adjusted for parity (cow/heifer).
In any case, it should be indicated if the NRR have been adjusted or not, and in case which factors have been used for correction.

### 6.1.5 The NRR related to the date of each Insemination

As stated above, one should indicate:

- the given period of time in which females have been inseminated
- the number of females
- the limits of the interval during which the returns have been observed after the date of each insemination (3-24, 18-24...)
- female breed(s)
- if females with short returns were considered either pregnant or non-inseminated
- if NRR have been adjusted or not (and if yes, the source of variation taken into account)

The suggested expression of the NRR is as follow:

\[
\text{‘Given period’ (n=): ‘beginning of interval’-‘end of interval’ day NRR} = \\\ne.g. \text{For January 2000 (n=1,531): 18-24 day NRR} = 68.4\%
\]

### 6.1.6 The 60 to 90 day NRR

60 to 90 day NRR has been a standard for AI organisations to work out breed receipts on a monthly rather than a daily basis. In that way the NRR of all the females bred in January is calculated at the end of March. The females bred on January first will have about 90 days in which to return. Those bred during the last days of January, however, would have had only about 60 days.

Pay careful attention that the common phrases “18-24 day NRR” and “60 to 90 day NRR” get things confused. “18-24 day” addresses to the two limits of the interval, whereas “60 to 90 day” only addresses to the end of the interval which has the particularity to vary according to the month’s day of the insemination.

The same information than for the previous NRR should be indicated.

The suggested expression of the NRR is as follow:

\[
\text{‘Given period’ (n=): ‘beginning of interval’-‘range of the end of interval’ day NRR} = \\\ne.g. \text{For the year 1999 (n=15,332): 3-60 to 90 day NRR} = 58.9\%
\]
SECTION 6.2 - RECOMMENDATION FOR RECORDING AND VALIDATION OF DATA FOR EMBRYO PRODUCTION AND TRANSFER IN RESPECT OF ASSESSMENT OF PARENTAGE OF BREEDING CATTLE

6.2.1 Object of the recommendation

The purpose of this recommendation is to improve quality of data in Embryo Production and Transfer on cattle in respect of assessment parentage of calves born out of this technology. It takes into account existing rules or guidelines already laid down to guaranty high level of exchanges at international level and is considered as an extension of those rules. It recommends the minimum items that should be recorded for using embryo data and the minimum of controls that data must undergo for being declared as valid.

It is a complementary addition to international rules governing embryo trade such as:

- Veterinarian requirements issued by EU or other national/international bodies.
- Zootechnical requirements issued by EU or other national/international bodies.
- Technological guidelines adopted by the IETS.

6.2.2 Field of application of the recommendation

The recommendation applies usage of embryo data to establish parentage of calves born out of embryos prior to registration in the herd-book. It also provides elements to insure embryos traceability.

It applies on females from which embryos are recovered, their sires and to the recipient female whatever the technology used to produce embryos subject to future transfer, such as classical production technique, IVF, splitting, embryonic cloning.

It applies for embryos produced within country or imported from the other countries.

It doesn’t apply to recording of data used for technology purposes such as:

- Assessment of embryo’s quality.
- Processing of embryos for freezing, or other technique (splitting, sex assessment) Then IETS guidelines including forms have to be used for international exchanges of embryos.

DNA references (or blood types as exceptions) have to be provided for the genetic parents of embryos. DNA references are the ISAG list of markers.

6.2.3 Definitions

- **AI**: insemination to produce embryos from a donor female, heifer or cow.
- **Donor female**: female chosen as genetic mother of future calves born out of embryos.
- **Double AI**: two AI carried within a short lap of time, e.g. 48 hours, on the same female with or not the same bull often to produce embryos. This information is recorded to avoid rejection when verification of dates.
- **Embryo transfer**: Implantation of embryos produced in vivo or in vitro into a recipient female.
6.2.4 Recording of relevant data

Data that have to be recorded in order to insure the parentage of calves born out of embryos and the traceability of embryos refer to:

- Recovering embryos, including IVF procedures (6.2.4.1).
- Embryo transfer (6.2.4.3).

Moreover it will be mentioned minimum items that should be mentioned on straws containing frozen embryos (6.2.4.2)

Annexe 6 describes provisions to follow movements of embryos.

6.2.4.1 Recording data at different steps of embryo producing

6.2.4.1.1 Summary of items to be recorded when embryos are recovered

When embryos are recovered, some items have to be registered compulsory, by hand (paper form) or by electronic devices (as example laptop computers, PDA.). Those data will be used to constitute the basic databases to trace back embryos history according to the various situations.

When embryos are imported, relevant data have the same status as recovering data.
Requested data are, either on farm recovering or importation:

In any situation:
- Recovering's references of the approved team and/or operator carrying out operations.
- Date of collection (or date of importation).
- Date of freezing (if different).
- ID Herd of the donor at time of embryo recovery.
- ID Donor female.
- Nature of recovering: embryos or Oocytes.

Only for embryos recovering:
- Possible ID sire(s if double AI have been carried out with 2 different bulls).
- Age of embryos.

Only for Oocytes recovering:
- nature of recovering: abattoir or OPU.

6.2.4.1.2 Summary of items to be recorded at fertilisation process or reproductive cloning (when relevant)

These items address any embryo (or on straw to identify embryos):
- Lab of fertilisation.
- Date of fertilisation.
- Possible ID sire(s).
- Operator of cloning.
- Date of cloning.

6.2.4.1.3 Technical characteristics: any information that may explain and optimise data processing

- Indication of genotyping by biopsy.
- Technical data such as codes requested by the IETS forms set.

6.2.4.1.4 Recapitulative of data to be transmitted to assess the parentage of the future calves, whatever the way of producing embryos or the location of production

- Embryo reference number (which may contain recovering reference number)
- Identification of the approved team and/or operator
- Date of freezing
- Embryo's sire(s): ID + breed code
• Embryo's dam: ID + breed code
• ID Herd of the donor
• Age of embryo (s)

If embryos are imported relevant data may be obtain from documents accompanying embryos:
• Herd Book pedigrees
• IETS appropriate forms

Recommendation does not address the order of items. The description of order has to be mentioned when data are exchanged.

Note
DNA has to be collected from parents, markers (or blood types) have to be provided along with the other data.

6.2.4.2 Identification of embryos on straws

On each straw containing embryos, an unique reference number has to be printed or hand-written in order to set cross-reference with following items on papers or accessible electronic files, that render possible to follow physical movements of embryos:
• Identification of the approved team/operator that has recovered embryo(s).
• Date of freezing.
• Embryo's sire(s): ID + breed code.
• Embryo's dam: ID + breed code.
• Number of embryos per straw.

In addition to the unique reference number, more information may be laid down on straws according to the needs of the clients or the breeding organisations. Then recommendation does not address the order of items.

The structure of the unique reference number isn't requested by this recommendation. It includes usually the team / operator code, the reference of recovering intra year and the rank within recovering operation.

In situation of embryos produced for export purposes it is strongly recommended that teams implement the IETS identification system.

6.2.4.3 Summary of items to be recorded when embryos are transferred

When embryos are transferred into recipients, some items have to be registered compulsory, by hand (paper form) or by electronic devices (such as laptop computers, PDA.). Those data will be used to constitute the basic database to assess parentage of the calves born out of embryos allowing distinction between genetic mother and biological mother.

Items addressing any embryo are:
• Operator.
• ID Herd of recipient.
• ID Recipient female.
• Date of transfer.
• Embryo's identification.

Recommendation does not address the order of items. The description of order has to be mentioned when data are exchanged.

6.2.4.4 Details on recorded items

6.2.4.4.1 Recovering reference number
Reference of the officially approved team that has recovered embryos and the intra team year number.

6.2.4.4.2 Embryo's reference number
Refers to recovering reference number to describe produced embryos: number of embryo produced intra team by an approved team.

6.2.4.4.3 Operators
Technicians or vets working under the responsibility of approved teams for recording or transfer embryos. Recording of individual operators is not compulsory.

6.2.4.4.4 Dates
The date of each operation has to be recorded. Dates of recovering embryos and freezing are usually the same.

6.2.4.4.5 Identification of herds and females
Herds and females have to be identified within the national system of registration dedicated to genetic data processing. The identification number of females including country code has to be recorded for each donor or recipient female.

6.2.4.4.6 AI bull
Donor females have to be inseminated by semen of AI bulls, known through the reference of their semen. The bull's identification is that defined by the "ICAR guidelines for straw identification for bovine semen" as the international identification code or a world-wide unique bull code.

6.2.4.4.7 Double AI
The existence of a double AI has to be mentioned, either by recording of a code, either automatically.
6.2.4.8 Breed codes

Those of the ICAR list for bulls and donors have to be used for international trade. In case of production of embryos, from breeds that are not on the list, teams are free to use any other code, provided that they not already on the list.

6.2.4.9 Herd

A herd may be either a farm or a station.

6.2.4.10 Age of embryos.

Embryos produced in vivo or in vitro, are transferred at stage of blastocytes, usually 7 days.

6.2.5 Transmission data related to embryos or their transfer to databases for parentage assessment

- Data have to be transmitted on a regular frequency to the database where there will be matched with birth data.
- Embryo identification data and AI data have to be available in the database.
- Transfer records have to be available in the database prior to birth data.
- Birth data have to be transmitted by the person in charge of the recipient at calving (sex of the calf is declared at birth and not by molecular analyse).

6.2.6 Parentage assessment

After calving of a female known as a recipient by indication of embryo transfer instead of AI (or natural service) as reproduction event, the system of parentage assessment has to establish the genetic parents of the calf. Two methods are possible according to the data processing organisation implemented within countries:

- Either parentage assessment requires that both parents and the calf are compulsory analysed for Micro satellite or SNP markers or blood types consistency on the basis of recorded data described in chapter 6.2.4.
- Either parentage assessment requires that relevant data undergo successfully tests described in annexe 2 and transmitted to the database according to chapter 6.2.5, prior that transfer data are matched with birth data.

If dates of implantation and of birth are consistent with the gestation length of calf’s breed, taking into account the age of the embryo, the genetic parents may be attributed the born calf.

It is recommended that parentage for the more valuable animals of the population should be confirmed using DNA analysis.

Note

Parentage of AI bulls, born out of AI or ET, has to be compulsory checked for checked for Blood typing, Micro satellite, or SNP parentage analysis in most countries.
6.2.7 Quality controls

The efficiency of any information system depends on the quality of data proving that the expected result fits with the goal. For embryos, it deals with the accuracy of the records and with the proof that the progeny from embryo transfer was born from foreseen parents.

It is recommended that the organisation in charge with data processing aimed to assess parentage from calves born out of embryonic techniques carries out controls and implement relevant indicators for failures on each test suggested above, in terms of completeness, integrity, coherence and likelihood of recorded date.

Note
Those quality controls are independent of those requested for the renewal of approval of ET teams.
SECTION 7.1 - GUIDELINES FOR RECORDING, EVALUATION AND GENETIC IMPROVEMENT OF HEALTH TRAITS

7.1.1. TECHNICAL ABSTRACT

Improved health of dairy cattle is of increasing economic importance. Poor health results in greater production costs through higher veterinary bills, additional labor costs, and reduced productivity. Animal welfare is also of increasing interest to both consumers and regulatory agencies because healthy animals are needed to provide high-quality food for human consumption. Furthermore, this is consistent with the European Union animal health strategy that emphasizes disease prevention over treatment. Animal health issues may be addressed either directly, by measuring and selecting against liability to disease, or indirectly by selecting against traits correlated with injury and illness. Direct observations of health and disease events, and their inclusion in recording, evaluation and selection schemes, will maximize the efficiency of genetic selection programs. The Scandinavian countries have been routinely collecting and utilizing those data for years, demonstrating the feasibility of such programs. Experience with direct health data in non-Scandinavian countries still is limited. Due to the complexity of health and diseases, programs may differ between countries. This document presents best-practices with respect to data collection practices, trait definition, and use of health data in genetic evaluation programs and can be extended to its use for other farm management purposes.

7.1.2. INTRODUCTION

The improvement of cattle health is of increasing economic importance for several reasons. Impaired health results in increased production costs (veterinary medical care and therapy, additional labor, and reduced performance), while prices for dairy products and meat are decreasing. Consumers also want to see improvements in food safety and better animal welfare. Improvement in the general health of the cattle population is necessary for the production of high-quality food and implies significant progress with regard to animal welfare. Improved welfare also is consistent with the EU animal health strategy, which states that that prevention is better than treatment (European Commission, 2007).
Health issues may be addressed either directly or indirectly. Indirect measures of health and disease have been included in routine performance tests by many countries. However, directly observed measures of health and disease need to be included in recording, evaluation and selection schemes in order to increase the efficiency of genetic improvement programs for animal health.

In the Scandinavian countries, direct health data have been routinely collected and utilized for years, with recording based on veterinary medical diagnoses (Nielsen, 2000; Philipsson and Linde, 2003; Østerås and Sølvør, 2005; Aamand, 2006; Heringstad et al., 2007). In the non-Scandinavian countries experience with direct health data is still limited, but interest in using recorded diagnoses or observations of disease has increased considerably in recent years (Zwald et al, 2006a,b; Neuenschwander et al., 2008; Neuenschwender, 2010; Appuhamy et al., 2009; Egger-Danner et al., 2010, Egger-Danner et al. 2012, Koeck et al. 2012a,b, Neuschwander et al. 2012).

Due to the complex biology of health and disease, guidelines should mainly address general aspects of working with direct health data. Specific issues for the major disease complexes are discussed, but breed- or population-specific focuses may require amendments to these guidelines.

### 7.1.3. TYPES AND SOURCES OF DATA

#### 7.1.3.1. Types of data

The collection of direct information on health and disease status of individual animals is preferable to collection of indirect information. However, population-wide collection of reliable health information may be easier to implement for indirect rather than direct measures of health. Analyses of health traits will probably benefit from combined use of direct and indirect health data, but clear distinctions must be drawn between these two types of data:

#### 7.1.3.1.1. Direct health information

- Diagnoses or observations of diseases
- Clinical signs or findings indicative of diseases

#### 7.1.3.1.2. Indirect health information

- Objectively measurable indicator traits (e.g., somatic cell count, milk urea nitrogen)
- Subjectively assessable indicator traits (e.g., body condition score, score for limb conformation)

Health data may originate from different data sources which differ considerably with respect to information content and specificity. Therefore, the data source must be clearly indicated whenever information on health and disease status is collected and analyzed. When data from different sources are combined, the origin of data must be taken into account when defining health traits.

In the following sections, possible sources of health data are discussed, together with information on which types of data may be provided, specific advantages and disadvantages associated with those sources, and issues which need to be addressed when using those sources.
7.1.3.2. Sources of data

7.1.3.2.1. Veterinarians

Content
- Primarily report direct health data.
- Provide disease diagnoses (documented reasons for application of pharmaceuticals), possibly supplemented by findings indicative of disease, and/or information on indicator traits.

Advantage
- Information on a broad spectrum of health traits.
- Specific veterinary medical diagnoses (high-quality data).
- Legal obligations of documentation in some countries (possible utilization of already established recording practices).

Disadvantages
- Only severe cases of disease may be reported (need for veterinary intervention and pharmaceutical therapy).
- Possible delay in reporting (gap between onset of disease and veterinary visit).
- Extra time and effort for recording (complete and consistent documentation cannot be taken for granted, recording routine and data flow need to be established).

7.1.3.2.2. Producers

Content
- Primarily direct health data.
- Disease observations ('diagnoses'), possibly supplemented by findings indicative of disease and/or information on indicator traits.

Advantages
- Information on a broad spectrum of health traits.
- Minor cases not requiring veterinary intervention may be included.
- First-hand information on onset of disease.
- Possible use of already-established data flow (routine performance testing, reporting of calving, documentation of inseminations).

Disadvantages
- Risk of false diagnoses and misinterpretation of findings indicative of disease (lack of veterinary medical knowledge).
• Possible need to confine recording to the most relevant diseases (modest risk of misinterpretation, limited extra time and effort for recording).
• Extra documentation might be needed.
• Need for expert support and training (veterinarian) to ensure data quality.
• Completeness of recording may vary in dependence on work peaks on the farm.

Remarks
• Data logistics depend on technical equipment on the farm (documentation using herd management software (e.g. including tools to record hoof trimming, diseases, vaccinations,..), handheld for online recording, information transfer through personnel from milk recording agencies.
• Possible producer-specific documentation focuses must be considered in all stages of analyses (checks for completeness of health / disease incident documentation; see Kelton et al., 1998).
• Preliminary research suggests that epidemiological measures calculated from producer-recorded data are similar to those reported in the veterinary literature (Cole et al., 2006).

7.1.3.2.3. Expert groups (claw trimmer, nutritionist, etc.)

Content
• Direct and indirect health data with a spectrum of traits according to area of expertise.

Advantage
• Specific and detailed information on a range of health traits important for the producer (high-quality data),
• Possible access to screening data (information on the whole herd at a given point in time),
• Personal interest in documentation (possible utilization of already-established recording practices)

Disadvantages
• Limited spectrum of traits,
• Dependence on the level of expert knowledge (certification/licensure of recording persons may be advisable),
• Extra time and effort for recording (complete and consistent documentation cannot be taken for granted, recording routine and data flow need to be established)
• Business interests may interfere with objective documentation

7.1.3.2.4. Others (laboratorles, on-farm technical equipment, etc.)

Content
• Indirect health data with spectrum of traits according to sampling protocols and testing requests, e.g., microbiological testing, metabolite analyses, hormone tests, virus/bacteria DNA, infrared-based measurements (Soyeurt et al. 2009a,b).
### Advantage
- Specific information on a range of health traits important for the producer (high quality data).
- Objective measurements.
- Automated or semi-automated recording systems (possible utilization of already established data logistics).

### Disadvantages
- Interpretation with regard to disease relevance not always clear.
- Validation and combined use of data may be problematic.

*Table 1 provides an overview of the possible sources of direct and indirect health information.*

<table>
<thead>
<tr>
<th>Source of data</th>
<th>Direct health information</th>
<th>Indirect health information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veterinarian</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
<tr>
<td>Producer</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
<tr>
<td>Expert groups</td>
<td>Yes</td>
<td>Possibly</td>
</tr>
<tr>
<td>Others</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### 7.1.4. Data security

Data security is a universally important issue when collecting and using field data. However, the central role of dairy cattle health in the context of animal welfare and consumer protection implies that farmers and veterinarians are obligated to maintain high-quality records, emphasizing the particular sensitivity of health data.

The legal framework for use of health data has to be considered according to national requirements and applicable data privacy standards. The owner of the farm on which the data are recorded is the owner of the data, and must enter into formal agreements before data are collected, transferred, or analyzed. The following issues must be addressed with respect to data exchange agreements:

- Type of information to be stored in the health database, e.g., inclusion of details on therapy with pharmaceuticals, doses and medication intervals).
- Institutions authorized to administer the health database, and to analyze the data.
- Access rights of (original) health data and results from analyses of the data.
- Ownership of the data and authority to permit transfer and use of those data.

Enrollment forms for recording and use of health data (to be signed by the farmers) have been compiled by the institutions responsible for data storage and analysis or governmental authorities (e.g., Austrian Ministry of Health, 2010).

For any health database it must be guaranteed that:
- The individual farmers can only access detailed information on their own farm, and for animals only pertaining to their presence on that farm.
- The right to edit health data are limited.
Access to any treatment information is confined to the farmer and the veterinarian responsible for the specific treatment, with the option of anonymizing the veterinary data. Data security is a necessary precondition for farmers to develop enough trust in the system to provide data. The recording of treatment data is much more sensitive than only diagnoses, and the need to collect and store such data should be very carefully considered.

### 7.1.5. Documentation

**Minimum requirements for documentation:**
- Unique animal ID (ISO number).
- Place of recording (unique ID of farm/herd).
- Source of data (veterinarian, producer, expert group, others).
- Date of health incident.
- Type of health incident (standardized code for recording).

**Useful additional documentation:**
- Individual identification of the recording person.
- Details on respective health incident (exact location, severity).
- Type of recording and method of data transfer (software used for on-farm recording, online-transmission).
- Information on type of diagnosis (first or subsequent).

The systematic use and appropriate interpretation of direct and indirect health data requires that information on health status be combined with other information on the affected animals (basic information such as date of birth, sex, breed, sire and dam, farm/herd; calving dates, and performance records). Therefore, unique identification of the individual animals used for the health data base must be consistent with the animal ID used in existing databases.

Widespread collection of health data may benefit from legal frameworks for documentation and use of diagnostic data. European legislation requests documentation of health incidents which involved application of pharmaceuticals to animals in the food chain. Veterinary medical diagnoses may, therefore, be available through the treatment records kept by veterinarians and farmers. However, it must be ensured that minimum requirements for data recording are followed; in particular, it must be noted that animal identification schemes are not uniform within or across countries. Furthermore, it must be a clear distinction made between prophylactic and therapeutic use of pharmaceuticals, with the former being excluded from disease statistics. Information on prophylaxis measures may be relevant for interpretation of health data (e.g., dry cow therapy), but should not be misinterpreted as indicators of disease. While recording of the use of pharmaceuticals is encouraged it is not uniformly required internationally, and health data should be collected regardless of the availability of treatment information.
7.1.6. STANDARDIZATION OF RECORDING

In order to avoid misinterpretation of health information and facilitate analysis, a unique code should be used for recording each type of health incident. This code must fulfill the following conditions:

- Clear definitions of the health incidents to be recorded, without opportunities for different interpretations.
- Includes a broad spectrum of diseases and health incidents, covering all organ systems, and address infectious and non-infectious diseases.
- Understandable by all parties likely to be involved in data recording.
- Permit the recording of different levels of detail, ranging from very specific diagnoses of veterinarian compared to very general diagnoses or observations by producers.

Starting from a very detailed code of diagnoses, recording systems may be developed that use only a subset of the more extensive code. However, the identical event identifiers submitted to the health database must always have the same meaning. Therefore, data must be coded using a uniform national, or preferably international, scheme before entering information into the central health database. In the case of electronic recording of health data, it is the responsibility of the software providers to ensure that the standard interface for direct and/or indirect health data is properly implemented in their products. When farmers are permitted to define their own codes the mapping of those custom codes to standard codes is a substantial challenge, and careful consideration should be paid to that problem (see, e.g., Zwald et al., 2004a).

A comprehensive code of diagnoses with about 1,000 individual input options (diagnoses) is provided as an appendix to these guidelines. It is based on the code of diagnoses developed in Germany by the veterinarian Staufenbiel (‘zentraler Diagnoseschlüssel’) (Annex). The structure of this code is hierarchical, and it may represent a ‘gold standard’ for the recording of direct health data. It includes very specific diagnoses which may be valuable for making management decisions on farms, as well as broad diagnoses with little specificity for analyses which require information on large numbers of animals (e.g. genetic evaluation). Furthermore, it allows the recording of selected prophylactic and biotechnological measures which may be relevant for interpretation of recorded health data.

In the Scandinavian countries and in Austria codes with 60 to 100 diagnoses are used, allowing documentation of the most important health problems of cattle. Diagnoses are grouped by disease complexes and are used for documentation by treating veterinarians (Osteras et al., 2007; Austrian Ministry of Health, 2010; Osteras, 2012).

For documentation of direct health data by expert groups, special subsets of the comprehensive code may be used. Examples for claw trimmers can be found in the literature (e.g. Capion et al. 2008; Thomsen et al. 2008; Maier, 2009a, b; Buch et al. 2011).

When working with producer-recorded data, a simplified code of diagnoses should be provided which includes only a subset of the extensive code (Neuenschwander et al., 2008; USDA, 2010). Diagnoses included must be clearly defined and observable without veterinary medical expertise. Such a reduced code may, for example, consider mastitis, lameness, cystic ovarian disease, displaced abomasum, ketosis, metritis/uterine disease, milk fever and retained placenta (Neuenschwander et al., 2008). The United States model (USDA, 2010) is event-based, and permits very general reports (e.g., “This cow had ketosis on this day.”), as well as very specific ones (e.g., “This cow had Staph. aureus mastitis in the right, rear quarter on this day.”).
7.1.7. DATA QUALITY

7.1.7.1. General quality checks

Mandatory information will be used for basic plausibility checks. Additional information can be used for more sophisticated and refined validation of health data when those data are available.

- The recording farm must be registered to record and transmit health data.
- If information on the person recording the data are provided, that individual must be authorized to submit data for this specific farm.
- The animal for which health information is submitted must be registered to the respective farm at the time of the reported health incident.
- The date of the health incident must refer to a living animal (must occur between the birth and culling dates), and may not be in the future.
- A particular health event can only be recorded once per animal per day.
- The contents of the transmitted health record must include a valid disease code. In the case of known selective recording of health events (e.g., only claw diseases, only mastitis, no calf diseases), the health record must fit the specified disease category for which health data are supposed to be submitted.
- For sources of data with limited authorization to submit health data, the health record must fit the specified disease category (e.g., locomotory diseases for claw trimmers, metabolic disorders for nutritionists).

7.1.7.2. Specific quality checks

In order to produce reliable and meaningful statistics on the health status in the cattle population, recording of health events should be as complete as possible on all farms participating in the health improvement program. Ideally, the intensity of observation and completeness of documentation should be the same for all animals regardless of sex, age, and individual performance. Only then will a complete picture of the overall health status in the population emerge. However, this ideal situation of uniform, complete, and continuous recording may rarely be achieved, so methods must be developed to distinguish between farms with desirably good health status of animals and farms with poor recording practices.

Countries with on-going programs of recording and evaluation of health data require a minimum number of diagnoses per cow and year (e.g., Denmark: 0.3 diagnoses; Austria: 0.1 first diagnoses); continuity of data registration needs to be considered. Farms that fail to achieve these values are automatically excluded from further analyses until their recording has improved. However, herd sizes need to be considered when defining minimum reporting frequencies to avoid possible biases in favor of larger or smaller farms. Any fixed procedure involves the risk of excluding farms with extraordinary good herd health, but to avoid biased statistics there seems to be no alternative to criteria for inclusion, and setting minimum lower limits for reporting. Different criteria will be needed for diseases that occur with low frequency versus those with high frequency, particularly when the cost of a rare illness is very high compared to a common one.
Because recording practices and completeness on farms may not be uniform across disease categories (e.g., no documentation of claw diseases by the producer), data should be periodically checked by disease category to determine what data should be included. Use of the most-thoroughly documented group of health traits to make decisions about inclusion or exclusion of a specific farm may lead to considerable misinterpretation of health data.

There are limited options to routinely check health data for consistency on a per animal basis. Some diagnoses may only be possible in animals of specific sex, age, or physiological state. Examples can be found in the literature (Kelton et al., 1998; Austrian Ministry of Health, 2010). Criteria for plausibility checks will be discussed in the trait-specific part of these guidelines.

7.1.8. CONTINUITY OF DATA FLOW - KEYS TO LONG-TERM SUCCESS

Regardless of the sources of health data included, long-term acceptance of the health recording system and success of the health improvement program will rely on the sustained motivation of all parties involved. To achieve this, frequent, honest, and open communications between the institutions responsible for storage and analysis of health data and people in the field is necessary. Producers, veterinarians and experts will only adopt and endorse new approaches and technologies when convinced that they will have positive impacts on their own businesses. Mutual benefits from information exchange and favorable cost-benefit ratios need to be communicated clearly.

When a key objective of data collection is the development of a genetic improvement program for health, producers must be presented with a reasonable timeline for events. When working with low-heritability traits that are differentially recorded much more data will be necessary for the calculation of accurate breeding values than for typical production traits. It is very important that everyone is aware of the need to accumulate a sufficient dataset to support those calculations, which may take several years. This will help ensure that participants remain motivated, rather than become discouraged when new products are not immediately provided. The development of intermediate products, such as reports of national incidence rates and changes over time, could provide tools useful to producers between the start of data collection and the introduction of genetic evaluations.

Health reports, produced for each of the participating farms and distributed to authorized persons, will help to provide early rewards to those participating in health data recording. To assist with management decisions on individual farms, health reports should contain within-herd statistics (health status of all animals on the farm and stratified by age and/or performance group), as well as across-herd statistics based on regional farms of similar size and structure. Possible access to the health reports by authorized veterinarians or experts will help to maximize the benefits of data recording by ensuring that competent help with data interpretation is provided.

7.1.9. TRAIT DEFINITION

Most health incidents in dairy herds fit into few major disease complexes (e.g., Heringstad et al., 2007; Koeck et al., 2010a,b, Wolff, 2012), each of which implies that specific issues be addressed when working with related health information. In particular, variation exists with regard to options for plausibility checks of incoming data including eligible animal group, time frame of diagnoses, and possibility of repeated diagnoses.
Distinctions must be drawn between diseases which may only occur once in an animal's lifetime (maximum of one record per animal) or once in a predefined time period (e.g., maximum of one record per lactation) on the one hand and disease which may occur repeatedly throughout the life-cycle. Assumptions regarding disease intervals, i.e., the minimum time period after which the same health incident may be considered as a recurrent case rather than an indicator of prolonged disease, need to be considered when comparing figures of disease prevalences and distributions. Furthermore, it must be decided if only first diagnoses or first and recurrent diagnoses are included in lifetime and/or lactation statistics. Differences will have considerable impact on comparability of results from health data analyses.

7.1.9.1. Udder health

**Mastitis** is the qualitatively and quantitatively most important udder health trait in dairy cattle (e.g. Amand et al., 2006; Heringstad et al., 2007, Wolff, 2012). The term mastitis refers to any inflammation of the mammary gland, i.e., to both subclinical and clinical mastitis. However, when collecting direct health data one should clearly distinguish between clinical and subclinical cases of mastitis. Subclinical mastitis is characterized by an increased number of somatic cells in the milk without accompanying signs of disease, and somatic cell count (SCC) has been included in routine performance testing by many countries, representing an indicator trait for udder health (indirect health data).

Cows affected by clinical mastitis show signs of disease of different severity, with local findings at the udder and/or perceivable changes of milk secretion possibly being accompanied by poor general condition. Recording of clinical mastitis (direct health data) will usually require specific monitoring, because reliable methods for automated recording have not yet been developed. Documentation should not be confined to cows in first lactation, but include cows of second and subsequent lactations. Optional information on cases that may be documented and used for specific analyses includes

- Type of clinical disease (acute, chronic).
- Type of secretion changes (catarrhal, hemorrhagic, purulent, necrotizing).
- Evidence of pathogens which may be responsible for the inflammation.
- Location of disease (affected quarter or quarters).
- Presence of general signs of disease.

Appropriate analyses of information on clinical mastitis require consideration of the time of onset or first diagnosis of disease (days in milk). Clinical mastitis developing early and late in lactation may be considered as separate traits.
### Parameters to check incoming health data

<table>
<thead>
<tr>
<th>Eligible animal group</th>
<th>Recommended inclusion criterion</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heifers and cows (obligatory: sex = female)</td>
<td></td>
<td>Exceptions possible (where appropriate, diagnoses in younger females may be considered separately)</td>
</tr>
<tr>
<td>Time frame of diagnoses</td>
<td>10 days before calving to 305 days in milk</td>
<td>Exceptions possible (where appropriate, diagnoses beyond -10 to 305 days in milk may be considered separately; shorter reference periods may be defined)</td>
</tr>
<tr>
<td>Repeated diagnoses</td>
<td>Possible per animal and lactation (possibility of multiple diagnoses per lactation)</td>
<td>Definition of minimum time period after which same diagnosis may be considered as recurrent case rather than prolonged disease</td>
</tr>
</tbody>
</table>

### 7.1.9.2. Reproductive disorders

Reproductive disorders represent a set of diseases which have the same effect (reduced fertility or reproductive performance), but differ in pathogenesis, course of disease, organs involved, possible therapeutic approaches, etc. To allow the use of collected health data for improvement of management on the herd and/or animal level, recording of reproductive disorders should be as specific as possible. Grouping of health incidents belonging to this disease complex may be based on the time of occurrence and/or organ involved. Within each of these disease groups, specific plausibility checks must be applied considering, for example, time frame of diagnoses and possibility of multiple diagnoses per lactation (recurrence). Fixed dates to be considered include the length of the bovine ovarian cycle (21 days) and the physiological recovery time of reproductive organs after calving (total length of puerperium: 42 days).

#### 7.1.9.2.1. Gestation disorders and peri-partum disorders

Examples:
- Embryonic death, abortion.
- Bradytocia (uterine inertia), perineal rupture.
- Retained placenta, puerperal disease, ...

#### 7.1.9.2.2. Irregular estrus cycle and sterility

Examples:
- Cystic ovaries, silent heat.
- Metritis (uterine infection), ...
<table>
<thead>
<tr>
<th>Parameters to check incoming health data</th>
<th>Recommended inclusion criterion</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible animal group</td>
<td>Heifers and cows</td>
<td>Minimum age should be consistent with performance data analyses</td>
</tr>
<tr>
<td>Time frame of diagnoses</td>
<td>Depending on type of disease</td>
<td>Fixed patho-physiological time frames should be considered (e.g. Duration of puerperium, cycle length)</td>
</tr>
<tr>
<td>Repeated diagnoses</td>
<td>Depending on type of disease: maximum of one diagnosis per animal (e.g. Genital malformation), maximum of one diagnosis per lactation (e.g. Retained placental) or possibility of multiple diagnoses per lactation (e.g. Cystic ovaries)</td>
<td>Definition of minimum time period after which same diagnosis may be considered as recurrent case rather than prolonged disease (e.g. 21 days for cystic ovaries because of direct relation to the ovary cycle)</td>
</tr>
</tbody>
</table>

### 7.1.9.3. Locomotory diseases

Recording of locomotory diseases may be performed on different level of specificity. Minimum requirement for recording may be documentation of locomotion score (lameness score) without details on the exact diagnoses. However, use of some general trait lameness will be of little value for deriving management measures.

Because of the heterogeneous pathogenesis of locomotory disease, recording of diagnoses should be as specific as possible.

Rough distinction may be drawn between **claw diseases** and **other locomotory diseases**, but results of health data analyses will be more meaningful when more detailed information is available. Therefore, recording of specific diagnoses is strongly recommended. Determination of the cause of disease and options for treatment and prevention will benefit from detailed documentation of affected structure(s), exact location, type and extent of visible changes. Such details may be primarily available through veterinarians (more severe cases of locomotory diseases) and claw trimmers (screening data and less severe cases of locomotory diseases). However, experienced farmers may also provide valuable information on health of limbs and claws.

Care must be taken when referring to terms from farmers' jargon, because definitions are often rather vague and diagnoses of diseases may be inconsistent. Documentation practices differ based on training and professional standards, e.g., claw trimmers and veterinarians, as well as nationally and internationally, and different schemes have been implemented in various on-farm data collection systems. To ensure uniform central storage and analysis of data, tools for mapping data to a consistent set of keys must to be developed, and unambiguous technical terms (veterinary medical diagnoses) should be used in documentation whenever possible.
7.1.9.3.1. Claw diseases

Examples:
- Laminitis complex (white line disease, sole haemorrhage, sole duplication, wall lesions, wall buckling, wall concavity).
- Sole ulcer (sole ulcer at typical site = rusterholz’s disease, sole ulcer at atypical site, sole ulcer at tip of claw).
- Digital dermatitis (mortellaro’s disease = hairy foot warts = heel warts = papillomatous digital dermatitis).
- Heel horn erosion (erosio ungulae = slurry heel).
- Interdigital dermatitis, interdigital phlegmon (interdigital necrobacillosis = foot rot), interdigital hyperplasia (interdigital fibroma = limax = tylom).
- Circumscribed aseptic pododermatitis, septic pododermatitis.
- Horn cleft, ...

The expertise of professional claw trimmers should be used when recording claw diseases. In herds with regular claw trimming (by the producer or a professional claw trimmer) accessibility of screening data, i.e., information on claw status of all animals regardless of regular or irregular locomotion (lameness) or absence or presence of other signs of disease (e.g., swelling, heat), will significantly increase the total amount of available direct health data, enhancing the reliability of analyses of those traits. Incidences of claw diseases may be biased if they are collected on based on examinations, or treatment, of lame animals.

Other information about claws which may be relevant to interpret overall claw health status of the individual animal, such as claw angles, claw shape or horn hardness, also may be documented. Some aspects of claw conformation may already be assessed in the course of conformation evaluation. Analyses of claw disease may benefit from inclusion of such indirect health data.

7.1.9.3.2. Other locomotory diseases

Examples:
- Lameness (lameness score).
- Joint diseases (arthritis, arthrosis, luxation).
- Disease of muscles and tendons (myositis, tendinitis, tendovaginitis).
- Neural diseases (neuritis, paralysis), ...

Low frequencies of distinct diagnoses will probably interfere with analyses of other locomotory diseases involving a high level of specificity. Nevertheless, the improvement of locomotory health on the animal and/or farm level will require detailed disease information indicating causative factors which need to be eliminated. The use of data from veterinarians may allow deeper insight into improvement options. Despite a substantial loss of precision, simple recording of lame animals by the producers may be the easiest system to implement on a routine basis. Rapidly increasing amounts of data may then argue for including lameness or lameness score in advanced analyses.
### Section 7 - Guidelines for recording of functional traits

#### Parameters to check incoming health data

<table>
<thead>
<tr>
<th>Eligible animal group</th>
<th>Recommended inclusion criterion</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No sex or age restriction</td>
<td>Sex- and/or age-dependent differences in intensity of systematic recording should be considered</td>
<td></td>
</tr>
<tr>
<td>Time frame of diagnoses</td>
<td>No time restriction</td>
<td>-</td>
</tr>
<tr>
<td>Repeated diagnoses</td>
<td>Possibility of multiple diagnoses per animal independent of lactation</td>
<td>Definition of minimum time period after which same diagnosis may be considered as recurrent case rather than prolonged disease (no clear physiological reference period)</td>
</tr>
</tbody>
</table>

#### 7.1.9.4. Metabolic and digestive disorders

The range of bovine metabolic and digestive disorders is generally rather broad, including diverse infectious and non-infectious disease. Although each of these diseases may have significant impacts on individual animal performance and welfare, few of them are of quantitative importance. Major diseases can broadly be characterized as disturbances of mineral or carbohydrate metabolism, which are caused in the lactating cow primarily by imbalances between dietary requirements and intakes.

#### 7.1.9.4.1. Metabolic disorders

Examples:
- Milk fever (i.e., hypocalcaemia, periparturient paresis), tetany (i.e., hypomagnesiaemia).
- Ketosis (i.e., acetonaemia), ...

#### 7.1.9.4.2. Digestive disorders

Examples:
- Ruminal acidosis, ruminal alkalosis, ruminal tympany.
- Abomasal tympany, abomasal ulcer, abomasal displacement (left displacement of the abomasum, right displacement of the abomasum).
- Enteritis (catarrhous enteritis, hemorrhagic enteritis, pseudomembranous enteritis, necrotisizing enteritis).
<table>
<thead>
<tr>
<th>Parameters to check incoming health data</th>
<th>Recommended inclusion criterion</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible animal group</td>
<td>Depending on type of disease: no sex or age restriction or restriction to adult females (calving-related disorders)</td>
<td>Sex- and/or age-dependent differences in intensity of systematic recording should be considered</td>
</tr>
<tr>
<td>Time frame of diagnoses</td>
<td>Depending on type of disease: no time restriction or restriction to (extended) peripartum period</td>
<td>Possible definition of risk periods (where appropriate, diagnoses beyond may be considered separately)</td>
</tr>
<tr>
<td>Repeated diagnoses</td>
<td>Depending on type of disease: maximum of one diagnosis per lactation (e.g. Milk fever), possibility of multiple diagnoses per lactation and independent of lactation (e.g. Enteritis)</td>
<td>Definition of minimum time period after which same diagnosis may be considered as recurrent case rather than prolonged disease (no clear physiological reference period)</td>
</tr>
</tbody>
</table>

### 7.1.9.5. Others diseases

Diseases affecting other organ systems may occur infrequently. However, recording of those diseases is strongly recommended to get complete information on the health status of individual animals. Interpretation of the effect of certain diseases on overall health and performance will only be possible, if the whole spectrum of health problems is included in the recording program.

Examples:

- Diseases of the urinary tract (hemoglobinuria, hematuria, renal failure, pyelonephritis, urolithiasis, ...).
- Respiratory disease (tracheitis, bronchitis, bronchopneumonia, ...).
- Skin diseases (parakeratosis, furunculosis, ...).
- Cardiovascular disease (cardiac insufficiency, endocarditis, myocarditis, thrombophlebitis, ...).
### Section 7 - Guidelines for recording of functional traits

#### 7.1.9.6. Calf diseases

Impaired calf health may have considerable impact on dairy cattle productivity. Optimization of raising conditions will not only have short-term positive effects with lower frequencies of diseased calves, but also may result in better condition of replacement heifers and cows. However, management practices with regard to the male and female calves usually differ between farms and need to be considered when analyzing health data. On most dairy farms the incentive to record health events systematically and completely will be much higher for female than for male calves. Therefore, it may be necessary to generally exclude the male calves from prevalence statistics and further analyses.

Examples:
- Omphalitis (omphalophlebitis, omphaloarteritiis, omphalourachitis).
- Umbilical hernia.
- Congenital heart defect (persistent ductus arteriosus botalli, patent foramen ovale, ...).
- Neonatal asphyxia.
- Enzootic pneumonia of calves.
- Disturbance of oesophageal groove reflex.
- Calf diarrhea, ... .

<table>
<thead>
<tr>
<th>Parameters to check incoming health data</th>
<th>Recommended inclusion criterion</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligible animal group</td>
<td>No sex or age restriction</td>
<td>Sex- and/or age-dependent differences in intensity of systematic recording should be considered</td>
</tr>
<tr>
<td>Time frame diagnoses</td>
<td>No time restriction</td>
<td>-</td>
</tr>
<tr>
<td>Repeated diagnoses</td>
<td>Possibility of multiple diagnoses per animal independent of lactation (e.g. Tracheitis)</td>
<td>Definition of minimum time period after which same diagnosis may be considered as recurrent case rather than prolonged disease (no clear physiological reference period)</td>
</tr>
</tbody>
</table>
Parameters to check incoming health data | Recommended inclusion criterion | Remarks
--- | --- | ---
Eligible animal group | Calves | Sex-dependent differences in intensity of systematic recording should be considered
Time frame of diagnoses | Depending on type of disease (e.g. Neonatal period, suckling period) | Possible definition of risk periods (where appropriate, diagnoses beyond may be considered separately)
Repeated diagnoses | Depending on type of disease: maximum of one diagnosis per animal (e.g. Neonatal asphyxia) or possibility of multiple diagnoses per animal (e.g. Diarrhea) | Definition of minimum time period after which same diagnosis may be considered as recurrent case (no clear physiological reference period)

7.1.10. USE OF DATA

Rapid feedback is essential for farmers and veterinarians to encourage the development of an efficient health monitoring system. Information can be provided soon after the data collection begins in the form individual farm statistics. If those results include metrics of data quality, then producers may have an incentive to quickly improve their data collection practices. Regional or national statistics should be provided as soon as possible as well. Early detection and prevention of health problems is an important step towards increasing economic efficiency and sustainable cattle breeding. Accordingly, health reports are a valuable tool to keep farmers and veterinarians motivated and ensure continuity of recording.

Direct and indirect observations need to be combined for adequate and detailed evaluations of health status. Reference should be made to key figures such as calving interval, pregnancy rate after first insemination, and non-return rate. A short time interval between calving and many diagnoses of fertility disorders is due to the high levels of physiological stress in the peripartum period, and also may indicate that a farmer is actively working to improve fertility in their herd. A low rate of reported mastitis diagnoses is not necessarily proof of good udder health, but may reflect poor monitoring and documentation.

In addition to recording disease events, on-farm system also can be used to record useful management information, such as body condition scores, locomotion scores, and milking speed (USDA, 2010). Individual animal statuses (clear/possibly infected/infected) for infectious diseases such as paratuberculosis (Johne's disease) and leukosis also may be tracked. Such data may be useful for monitoring animal welfare on individual farms.
7.1.10.1. Improvement of management (individual farm level)

7.1.10.1.1. Farmers

Optimized herd management is important for economically successful farming. Timely availability of direct health information is valuable and supplements routine performance recording for early detection of problems in a herd. Therefore, health data statistics should be added to existing farm reports provided by milk recording organizations. Examples from Austria are found in Egger-Danner et al. (2007) and Austrian Ministry of Health (2010).

7.1.10.1.2. Veterinarians

The EU-Animal Health Strategy (2007-2013), ‘Prevention is better than cure’, underscores the increased importance placed on preventive rather than curative measures. This implicates a change of the focus of the veterinary work from therapy towards herd health management.

With the consent of the farmer, the veterinarian can access all available information about herd health. The most important information should be provided to the farmer and veterinarian in the same way to facilitate discussion at eye-level. However, veterinarians may be interested in additional details requiring expert knowledge for appropriate interpretation. Health recording and evaluation programs should account for the need of users to view different levels of detail.

The overall health status of the herd will benefit from the frequent exchange of information between farmers and veterinarians and their close cooperation. Incorrect interpretation or poor documentation of health events by the farmer may be recognized by attending veterinarians, who can help correct those errors. Herd health reports will provide a valuable and powerful tool to jointly define goals and strategies for the future, and to measure the success of previous actions.

Immediate reactions

It is important that farmers and veterinarians have quick access to herd health data. Only then can acute health problems, which may be related to management, be detected and addressed promptly. An Internet-based tool may be very helpful for timely recording and access to data.

Long term adjustments

Less-detailed reports summarizing data over longer time periods (e.g., one year) may be compiled to provide an overview of the general health status of the herd. Such summary reports will facilitate monitoring of developments within farm over time, as well as comparisons among farms on district and/or province level. References for management decisions which account for the regional differences should be made available (Austrian Ministry of Health, 2010; Schwarzenbacher et al. 2010).

Definitions of benchmarks are valuable, and for improvement of the general health status it is important to place target oriented measures.

7.1.10.2. Monitoring of the health status (population level)

Ministries and other organizations involved in animal health issues are very interested in monitoring the health status of the cattle population. Consumers also are increasingly concerned about aspects of food safety and animal welfare. Regardless of which sources of health information are used, national
monitoring programs may be developed to meet the demands of authorities, consumers and producers. The latter may particularly benefit from increased consumer confidence in safe and responsible food production.

It is recommended that all information, including both direct and indirect observations, be taken into account when monitoring activity and preparing reports. For example, information on clinical mastitis should be combined with somatic cell count or laboratory results.

It is extremely important to clearly define the respective reference groups for all analyses. Otherwise, regional differences in data recording, influences of herd structure and variation in trait definition may lead to misinterpretation of results. To ensure the reliability of health statistics it may be necessary to define inclusion criteria, for example a minimum number of observations (health records) per herd over a set time period. Such lower limits must account for the overall set-up of the health monitoring program (e.g., size of participating farms, voluntary or obligatory participation in health recording).

Key measures that may be used for comparisons among populations are incidence and prevalence. In any publication it must be clear which of the two rates is reported, and also how the rates have been calculated.

**Incidence.**

Number of new cases of the disease or health incident in a given population occurring in a specified time period, which may be fixed and identical for all individuals of the population (e.g., one year or one month) or relate to the individual age or production period (e.g., lactation = day 1 to day 305 in milk).

For example, the lactation incidence rate (LIR) of clinical mastitis (CM) can be calculated as the number of new CM cases observed between day 1 and day 305 in milk.

\[
LIR_{CM} = \frac{\text{new cases of CM between day } 1 \text{ and day } 305 \text{ in milk}}{\text{total number of individuals present between day } 1 \text{ and day } 305 \text{ in milk in the population}}
\]

Another, and arguably a more accurate incidence rate could be calculated, by taking into account the total number of days at risk in the denominator population. This allows for the fact that some animals will leave the herd prematurely (or may join the herd late) and will therefore not contribute a ‘full unit’ of time of risk to the calculation.

\[
LIR_{CM} = \frac{\text{new cases of CM between day } 1 \text{ and day } 305 \text{ in milk}}{N(\text{days}) / 305}
\]

Where \(N(\text{days})\) is the total number of days that individual cows were present in the herd when between 1 and 305 days in milk; i.e., a cow present throughout lactation will add 305 days, a cow culled on day 30 of lactation will only contribute 30 days etc. (Divided by 305 as that is the period of analysis).
Prevalence.
Number of individuals affected by the disease or health incident in a given population at a particular point in time or in a specified time period.

\[ \text{Prevalence}_{CM} = \frac{\text{number of occurrences of CM between day 1 and day 305 in milk population during the same time period (e.g. N(days) / 305)}}{\} \]

7.1.10.3. Genetic evaluation (population level)

Traits for which breeding values are predicted differ between countries and dairy breeds. However, total merit indices have generally shifted towards functional traits over the last several years (Ducrocq, 2010). Currently, most countries use indirect health data like somatic cell counts or non-return rates for genetic evaluation to improve health and fertility in the dairy population. Direct health information may be used in the future, and already has been included in genetic evaluations for several years in the Scandinavian countries (Heringstad et al. 2007; Østeras et al. 2007; Johansson et al. 2006; Johansson et al. 2008; Interbull, 2010; Negussie et al. 2010).

Trait definitions for genetic analyses must account for frequencies of health incidents, with low incidence rates requiring more records for reliable estimation of genetic parameters and prediction of breeding values. Broader and less-specific definitions of health traits may mitigate this problem, with a possible loss of selection intensity. However, obligatory plausibility checks of data must be performed as specifically as possible, and any combination of traits at a later stage must account for the pathophysiology underlying the respective health traits. Examples of trait definitions found in the literature are given together with the reported frequencies in Table 2.

Many studies have shown that breeding measures based on direct health information can be successful (e.g., Amand, 2006, Zwald et al., 2006a,b; Heringstad et al., 2007). When using indirect health data alone or in combination with direct health data it must be remembered that the information provided by the two types of traits is not identical. For example, the genetic correlations among clinical mastitis and somatic cell count are in the range of 0.6 to 0.7 depending on the definition of the indirect measure of mastitis (e.g., Koeck et al, 2010b). Correlation estimates are lower for fertility traits, with moderately negative genetic correlation of -0.4 between early reproduction disorders and 56-day non-return-rate (Koeck et al., 2010a).

Heritability estimates of direct health traits range from 0.01 to 0.20 and are higher when only first rather than all lactation records are used (Zwald et al., 2004). Results from Fleckvieh and Norwegian Red indicate thatheritabilities of metabolic diseases may be higher than heritabilities of udder, locomotory, and reproductive diseases (Zwald et al., 2004; Heringstad et al., 2005). When comparing genetic parameter estimates, methodological differences such as the use of linear versus threshold models need to be considered.

Existing genetic variation among sires with respect to functional traits can be used to select for improved health and longevity. Experience from the Scandinavian countries shows that genetic evaluation for direct health traits can be successfully implemented. For several disease complexes it may be advantageous to combine direct and indirect health data (e.g.Johansson et al. 2006, Johanssen et al. 2008, Negussie et al. 2010, Pritchard et al. 2011 and Urioste et al. 2011; Koeck et al. 2012a,b).
Table 2. Lactation incidence rates (LIR), i.e. proportions of cows with at least one diagnosis of the respective disease within the specified time period.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Trait</th>
<th>Time period (parities considered)</th>
<th>LIR (%)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Danish Red</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Udder diseases</td>
<td>-10 to 100 days in milk (1st lactation)</td>
<td>22</td>
<td>Nielsen et al., 2000</td>
</tr>
<tr>
<td></td>
<td>Reproductive disturbances</td>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Digestive and metabolic diseases</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feet and legs disorders</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>Danish Holstein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Udder diseases</td>
<td>-10 to 100 days in milk (1st lactation)</td>
<td>21</td>
<td>Nielsen et al., 2000</td>
</tr>
<tr>
<td></td>
<td>Reproductive disturbances</td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Digestive and metabolic diseases</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feet and legs disorders</td>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>Danish Jersey</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Udder diseases</td>
<td>-10 to 100 days in milk (1st lactation)</td>
<td>24</td>
<td>Nielsen et al., 2000</td>
</tr>
<tr>
<td></td>
<td>Reproductive disturbances</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Digestive and metabolic diseases</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feet and legs disorders</td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Norwegian Red</strong></td>
<td>Clinical mastitis</td>
<td>-15 to 120 days in milk (1st, 2nd, 3rd lactation)</td>
<td>15.8</td>
<td>Heringstad et al., 2005</td>
</tr>
<tr>
<td></td>
<td>Milk fever</td>
<td>-15 to 30 days in milk (1st, 2nd, 3rd lactation)</td>
<td>0.1, 1.9, 7.9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ketosis</td>
<td>-15 to 120 days in milk (1st, 2nd, 3rd lactation)</td>
<td>7.5, 13.0, 17.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Retained placenta</td>
<td>0 to 5 days in milk (1st, 2nd, 3rd lactation)</td>
<td>2.6, 3.4, 4.3</td>
<td></td>
</tr>
<tr>
<td><strong>Swedish Holstein</strong></td>
<td>Clinical mastitis</td>
<td>-10 to 150 days in milk (1st, 2nd, 3rd lactation)</td>
<td>10.4, 12.1, 14.9</td>
<td>Carlén et al., 2004</td>
</tr>
<tr>
<td><strong>Finnish Ayrshire</strong></td>
<td>Clinical mastitis</td>
<td>-7 to 150 days in milk (1st, 2nd, 3rd lactation)</td>
<td>9.0, 10.6, 13.5</td>
<td>Negussie et al., 2006</td>
</tr>
<tr>
<td><strong>Fleckvieh (Simmental)</strong></td>
<td>Clinical mastitis</td>
<td>-10 to 150 days in milk (1st, 2nd, 3rd lactation)</td>
<td>9.6</td>
<td>Koeck et al., 2010a</td>
</tr>
<tr>
<td></td>
<td>Early reproductive disorders</td>
<td></td>
<td>7.2</td>
<td>Koeck et al., 2010a</td>
</tr>
<tr>
<td></td>
<td>Late reproductive disorders</td>
<td></td>
<td>14.3</td>
<td>Koeck et al., 2010b</td>
</tr>
</tbody>
</table>
(… continued Table 2)

<table>
<thead>
<tr>
<th>Breed</th>
<th>Trait</th>
<th>Time period (parities considered)</th>
<th>LIR (%)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>U.S. Holstein</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk fever</td>
<td>1 to 7 days in milk</td>
<td>2.9</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td>Retained placenta</td>
<td>1 to 7 days in milk</td>
<td>3.7</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td>Metritis</td>
<td>7 to 30 days in milk</td>
<td>9.8</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>0 to 305 days in milk</td>
<td>4.2</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td>Ketosis</td>
<td>0 to 305 days in milk</td>
<td>6.6</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td>Cystic ovaries</td>
<td>0 to 305 days in milk</td>
<td>12.0</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td>Clinical mastitis</td>
<td>0 to 305 days in milk</td>
<td>13.4</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td>Locomotory disorders</td>
<td>0 to 305 days in milk</td>
<td>20.9</td>
<td>Cole <em>et al.</em>, 2006</td>
<td></td>
</tr>
<tr>
<td><strong>Canadian Holsteins</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mastitis</td>
<td>0 to 305 days in milk</td>
<td>12.6</td>
<td>Koeck <em>et al.</em>, 2012b</td>
<td></td>
</tr>
<tr>
<td>Displaced abomasum</td>
<td>0 to 305 days in milk</td>
<td>3.7</td>
<td>Koeck <em>et al.</em>, 2012b</td>
<td></td>
</tr>
<tr>
<td>Ketosis</td>
<td>0 to 100 days in milk</td>
<td>4.5</td>
<td>Koeck <em>et al.</em>, 2012b</td>
<td></td>
</tr>
<tr>
<td>Retained placenta</td>
<td>0 to 14 days in milk</td>
<td>4.6</td>
<td>Koeck <em>et al.</em>, 2012b</td>
<td></td>
</tr>
<tr>
<td>Metritis</td>
<td>0 to 150 days in milk</td>
<td>10.8</td>
<td>Koeck <em>et al.</em>, 2012b</td>
<td></td>
</tr>
<tr>
<td>Cystic ovaries</td>
<td>0 to 305 days in milk</td>
<td>8.2</td>
<td>Koeck <em>et al.</em>, 2012b</td>
<td></td>
</tr>
<tr>
<td>Lameness</td>
<td>0 to 305 days in milk</td>
<td>9.2</td>
<td>Koeck <em>et al.</em>, 2012b</td>
<td></td>
</tr>
</tbody>
</table>
Further information on already-established genetic evaluations for functional traits including considered direct and indirect health information can be found on the Interbull website (www-interbull.slu.se/national_ges_info2/framesida-ges.htm).

Examples of national genetic evaluations (2010)

<table>
<thead>
<tr>
<th>Country (or countries)</th>
<th>DFS, Denmark, Finland, Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed(s)</td>
<td>Udder Health</td>
</tr>
<tr>
<td>Trait definition(s) and unit(s) of measurement²</td>
<td>1. TD Somatic Cell Score ln(SCC), mean=4.56 lact 1</td>
</tr>
<tr>
<td></td>
<td>2. - - - - - - - - - - - - - mean=4.86 lact 2</td>
</tr>
<tr>
<td></td>
<td>3. - - - - - - - - - - - - - mean=4.03 lact 3</td>
</tr>
<tr>
<td></td>
<td>4. Clinical mastitis as 0 or 1, -15 - 50 DM, mean=0.159 lact 1</td>
</tr>
<tr>
<td></td>
<td>5. - - - - - - - - - - - - - - - - - - - - mean=0.127 lact 1</td>
</tr>
<tr>
<td></td>
<td>6. - - - - - - - - - - - - - - - - - - - - mean=0.161 lact 2</td>
</tr>
<tr>
<td></td>
<td>7. - - - - - - - - - - - - - - - - - - - - mean=0.179 lact 3</td>
</tr>
<tr>
<td></td>
<td>8. Poor udder attachment, - - - - - - - - - - - - mean=0.57 lact 1</td>
</tr>
<tr>
<td></td>
<td>9. Udder depth, - - - - - - - - - - - - - - mean=0.51 lact 1</td>
</tr>
</tbody>
</table>

Method of measuring and collecting data
- Traits 1-3: Milk recording
- Traits 4-7: Veterinary reporting and from milk recording scheme
- Traits 8-9: Linear traits done by classifiers

7.1.11. ACKNOWLEDGMENTS

This document is the result the ICAR working group on functional traits. The members of this working group at the time of the compilation of this Section were:
7.1.12. LITERATURE


SECTION 7.2 - GUIDELINES FOR RECORDING, EVALUATION AND GENETIC IMPROVEMENT OF FEMALE FERTILITY IN DAIRY CATTLE

7.2.1 Technical abstract

These guidelines are intended to provide people involved in keeping and breeding of dairy cattle with recommendations for recording, management and evaluation of female fertility. Aspects of bull fertility are covered by another set of ICAR guidelines, compiled by the ICAR working group for Artificial Insemination (see: Guidelines for the expression of non-return rates (NRR) for the purpose of AI organisations). The guidelines described in this chapter support establishing good practices for recording, data validation, genetic evaluation and management aspects of female fertility.

To establish a recording scheme for female fertility the following data are desirable:

1. Calving dates.
2. All artificial insemination dates including natural mating dates where possible.
3. Information on fertility disorders.
4. Pregnancy test results.
5. Culling data.
7. Hormone assays.

Other novel predictors of fertility, such as activity based information (pedometer), are also growing in popularity.

This document includes a list of parameters for female fertility and information on recording and validating these data.

7.2.2 Introduction

In broad terms, “fertility” is defined as the ability to produce offspring. In the dairy industry, female fertility refers to the ability of a cow to conceive and maintain pregnancy within a specific time period; where the preferred time period is determined by the particular production system in use.

The relevance of certain fertility parameters may therefore differ between production systems, and evaluations of female fertility data have to account for these differences.

There are currently significant challenges to achieving pregnancy in high yielding dairy cows. Accordingly, female fertility has received substantial attention from scientists, veterinarians, farm advisors and farmers. Culling rates due to infertility are much higher than two or three decades ago, and conception rates and calving intervals have also deteriorated. There is no doubt that selection for high yields, while placing insufficient or no emphasis on fertility, has played a role in declining rates of female fertility worldwide, because genetic correlations between production and fertility are unfavourable (e.g. Pryce and Veerkamp 1999; Sun et al., 2010). Most breeding programs have attempted to reverse this situation by estimating breeding values for fertility and including them with appropriate weightings in a multi-trait selection index for the overall breeding objective of dairy cattle.
One of the most important ways that fertility can be improved, through both management strategies and getting better breeding values is by collecting high quality fertility phenotypes. Female fertility is a complex trait with a low heritability, because it is a combination of several traits which may be heterogeneous in their genetic background. For example, it is desirable to have a cow that returns to cyclicity soon after calving, shows strong signs of oestrus, has a high probability of becoming pregnant when inseminated, has no fertility disorders and the ability to keep the embryo/foetus for the entire gestation period. For heifers, the same characteristics except the first one apply. Multiple physiological functions are involved including hormone systems, defense mechanisms and metabolism, so a larger number of parameters may reflect fertility function or dysfunction. However, in initiating a data recording scheme for female fertility it is often not practical (although desirable) to encompass all aspects of good fertility.

The obstacles that exist in adequate recording of fertility measures include: data capture i.e. handwritten notebooks versus computerized data recording and how these data link to a central database used to store data from multiple herds. Although many countries already have adequate fertility recording systems in place, the quality of data captured may still vary by herd. Many farmers are already motivated to improve fertility (as there is global awareness of the decline in dairy cow fertility over recent years). However, what is not always clearly understood is the importance of different sources of fertility data in providing tools that can be used to improve fertility performance.

The principles and type of data that should be recorded are the same regardless of the production system. However, the way in which the data are used i.e. the measures of fertility may vary according to the type of production system. For this reason, we have made a distinction between seasonal and non-seasonal herds:

In seasonal systems cows calve (typically) in the spring, so that peak milk production matches peak grass growth. An alternative is autumn calving herds that use feed conserved from pasture grown in the summer months. True seasonal systems have all cows calving as a tight time frame, i.e. within 8 weeks of the planned start of calvings.

In year-round-systems heifers calve for the first time (predominantly) at a certain age e.g. close to two years of age regardless of the month of year and calvings occur all through the year, so that the calving pattern appears to be reasonably flat.

### 7.2.3. Types and sources of data

#### 7.2.3.1. Types of data

##### 7.2.3.1.1. Calving dates

Calving dates can be used to calculate the interval between consecutive calvings and to confirm previously predicted pregnancies / conceptions.

To consider: In order to handle bias from culling it is useful to also record culling of cows and the culling reasons.
7.2.3.1.2. Insemination data

Data on inseminations can be used either alone or in combination with other data e.g. calving dates to define interval traits. Where the measure is initiated by a calving date, it can only be calculated for cows.

Insemination (and calving) dates can be used to calculate the following traits, those that can be measured for cows and/or heifers are indicated in brackets:

- Interval from calving to first insemination (cows).
- Interval from planned start of mating to first insemination (cows and heifers).
- Non-return rate (to first insemination or within a defined time period) (cows and heifers).
- Conception rate (to any insemination).
- Calving rate within a time period (an individual’s phenotype is 0/1) (cows and heifers).
- Number of inseminations per lactation or insemination period (cows and heifers).
- Number of inseminations per calving or pregnancy.
- Interval from first to last insemination (cows and heifers).
- Interval between inseminations (cows and heifers).
- Interval from calving to last insemination (cows).

There is no best set of traits for evaluation of female fertility, but it is recommended to consider traits which reflect more than one aspect of fertility, e.g. interval from calving to first insemination or interval from calving to first oestrus (return to cyclicity) and non-return rate (probability of conception). For seasonal calving systems, submission rate and calving rate could be alternatives, see table 1. However, calving interval (the interval between two calvings) requires the least data, only calving dates, and is often used as a first step to genetic evaluations for fertility in the absence of insemination or other fertility data. It has to be used with care as highlighted above.

7.2.3.1.3. Fertility disorders

These data are either diagnoses related to treatments by veterinarians or observations from farmers. Details can be found in the ICAR Health Guidelines (ICAR guidelines for recording, evaluation and genetic improvement of health traits).

7.2.3.1.4. Milk production and composition data

Milk yield is correlated to fertility, and could be used as a predictor (for example in a multi-trait analysis of fertility). However, care should be taken, as the heritability of milk yield is high compared to fertility, the contribution of milk yield to the fertility breeding value could be considerable, making it difficult to identify bulls that are superior for both fertility and milk production. Results from selection based on Total Merit Indices show that it is possible to stabilize fertility if a certain weight is put on fertility.

Recent research confirmed genetic links between fertility and milk composition. In particular, changes of milk fatty acid profiles were identified (Bastin et al., 2011) as useful predictors.
7.2.3.1.5. Results of pregnancy tests and further hormone assays

Pregnancy status can be determined by veterinary diagnosis, such as uterine palpation or ultrasound or by using information from hormones or circulating peptides associated with pregnancy. The timing of this data is important and should generally be done in consultation with veterinary practitioners. Other hormones, such as progesterone can be used to determine the post-partum onset of cyclic activity and calculate e.g. interval from calving to first luteal activity (CLA) or other similar traits. The advantage of this trait, is that compared with the interval from calving to first insemination, it is not influenced by the farmer’s decision of when to start inseminations. However, it may be costly.

7.2.3.1.3.6. Heat strength

Physical activity increases during oestrus, in addition there are other behavioural changes, such as standing heat and mounting behavior. These signs are used to detect oestrus and can be used to calculate traits such as interval between calving and resumption of oestrus. Tail paint (on the tail head) or colour ampoules attached to the tail head are used in some countries to aid oestrus detection. For larger herds, tail painting is used as a tool to aid insemination rather than resumption of oestrus detection. For example, pedometers and more sophisticated activity monitors are now being used routinely on many farms as part of a management package. As cows become more active when in oestrus, the pedometer information needs to be compared to a baseline for the same cow and algorithms have been developed to interpret the data collected. The efficiency of oestrus detection rate has been reported to range between 50 and 100% depending on the criteria of success (At-Taras and Spahr, 2001). The gold-standard of oestrus detection are still progesterone measurements and imperfect concordance between pedometer and progesterone determined oestrus has been determined because activity monitors will not detect silent behavioural oestrus (Lovendahl and Chagunda, 2010). However, clearly there is an advantage in both progesterone and activity determined oestrus as they do not require farm observations.

7.2.3.1.3.7. Culling data

Culling data and culling reasons are important information especially if traits referring to longer time intervals (i.e. particularly those referring to calving dates) are used. Information on cows or heifers culled because of fertility disorders are of use, especially to remove bias arising from cows disappearing from the recording system i.e. a bull can have a biased proof if a lot of his daughters are culled for infertility and this is not recorded.

In the absence of accurate culling data, a useful proxy for monitoring fertility at the herd level is the proportion of animals failing to conceive by 300 days post calving. Cows not served by 300 days most likely reflect non-fertility culls, whereas cows that have been served and fail to conceive are more likely to reflect culls as a result of failure to conceive given that the majority of involuntary culls and decisions on planned culling occur in early lactation prior to the start of the breeding season.
7.2.3.1.3.8. Metabolic stress and body condition

Metabolic stress is defined as the degree of metabolic load that distorts normal physiological function. A distortion of normal physiological function may be temporary infertility, where the metabolic load is too great for the cow to invest in reproduction (future pregnancy) when the current lactation is not sustainable. Metabolic load is reflected by the stability of energy balance, which Veerkamp et al. (2001) suggested was related to traits such as milk yield, body condition score (BCS) and live weight (LWT).

By itself live weight is not a particularly good measure of energy balance, as tall thin cows may have weights similar to smaller cows in better condition. Therefore, BCS has been favoured as an indicator for energy balance. Cows with low BCS may have health problems, such as metritis, which may be the underlying problem for poor fertility. However, most studies worldwide have shown that BCS is a good indicator of female fertility, as cows that are mobilize body tissue may be more likely to use this energy to sustain lactation instead of invest in a pregnancy. Therefore, BCS has been found to be suitable to be incorporated into selection indexes for fertility, such as in New Zealand (Harris et al., 2007). BCS is sometimes measured as part of the linear type assessment in pedigree and progeny testing herds it can also be measured by the farmer. However, in some situations, use of BCS as a predictor trait for fertility has been found to be limited (Gredler et al., 2008).

7.2.3.2. Sources of data

Female fertility data originates from different data sources which differ considerably with respect to information content and specificity; for example from veterinary practices, laboratories, milk recording organizations, breed associations and farms etc. Therefore, ideally, the data source should be clearly indicated whenever information on fertility status is collected and analyzed. When data from different sources are combined, the origin of data must be taken into account. Regardless of the data source, it is desirable to have as few steps as possible from initial data recording.

7.2.3.2.1. Milk-recording

Initiation of lactation requires a calving date to be recorded for a cow. Calving dates are generally collected by organizations that are responsible for recording milk production, based on dates reported by the farmer, or more commonly gathered during the registration of births in countries operating mandatory birth registration systems. Calving dates are the most basic source of data available for evaluation of female fertility and can be used to determine calving intervals (defined as the number of days between two consecutive calvings).

Content:
- Calving dates.
- Culling reasons.

Advantages:
- Covers both cyclicity and conception.
- No additional effort for recording and therefore can be used as an easy first-step into evaluating fertility.
- Possible use of already-established data flow (reporting of calving).
Disadvantages:
- Missing dates for cows with problems around calving that do not enter the herd for milk recording.
- Only available for cows, not for heifers.
- Calving interval data may be censored, as cows that are infertile are often culled before calving again. If specific culling reasons are available, then information on animals that are culled for infertility can be a very useful addition to calving interval data, as the least fertile cows (i.e. cows culled for infertility) can be distinguished from cows culled for other reasons.

7.2.3.2.2. AI organisations or producers
AI organisations and other AI operators record insemination dates and the AI sire used for the insemination. Inseminations can either be recorded in a log book and later transferred to a computer or directly into a computer (sometimes handheld device).

Content:
- Information on inseminations (date of insemination, sire/origin of semen, semen batch, inseminator e.g. technician or member of farm staff).
- Sexed semen, embryo transfer, straw splitting etc. should be noted.
- Interventions such as synchrony should also be recorded, as it is possible that this may affect analysis results.

Advantages:
- If logistics for collection of insemination data are established, data can be collected from many farms.
- A broad range of measures of fertility can be calculated from insemination dates (often with calving dates) see Table 1. These measures can cover conception and cyclicity.

Disadvantages:
- If logistics for collection of insemination data are not established, considerable efforts may be needed to set-up recording.
- Completeness of recording may vary, especially if there are no legal documentation requirements.
- In situations where farmers often use AI for a set period of time followed by natural mating to farm bulls, some mating dates will be missing.

7.2.3.2.3. Veterinarians
Veterinarians are often involved in monitoring herd fertility. Pregnancy diagnosis or pregnancy testing is practiced and recorded by many veterinary practices to confirm a pregnancy. Uterine palpation per rectum or ultrasonography at around day 60 of conception is a valuable source of data because it is more accurate than non-return rates. Treatment for fertility disorders should also be recorded. From the economic point of view, a cow with good fertility without any treatments needed may be clearly preferred over a cow that was treated several times before it got pregnant.

Content:
- Pregnancy status.
- Diagnoses of fertility disorders.
Advantages:
• Direct information on fertility, which is not covered by calving and insemination data.

Disadvantages:
• Veterinary support and training needed to ensure data quality and consistency in diagnosis and definitions.
• Completeness of recording may vary depending on work peaks on the farm.
• Accurate animal identification may be an issue, as the data may be used (by the veterinary practice) to assess herd-level fertility rather than individual cow fertility.
• Data on pregnancy diagnosis may only be available for a subset of the herd.

7.2.3.2.4. On-farm computer software

Multiple herd management software packages are available for dairy farmers to record their own data. Some of this software interacts with the milk-recording organizations via standard interfaces, i.e. there are automatic exchanges of data between the central database and the computer on the farm. Farmers can enter calving, insemination, culling and pregnancy test information themselves. For genetic evaluation purposes, it is important that all the data is entered. Information on natural matings (if applicable) should also be recorded where possible and practical, which may not be the case for very large herds.

Content:
• Insemination data.
• Calving data.
• Pregnancy test results.

Advantages:
• No additional effort for recording.
• Continuous recording.

Disadvantages:
• Very often only software solutions within farm, difficulties of standardized export of data, although many software packages ensure data exchange with the genetic evaluation unit is possible.
• Trait definitions may differ between systems, requiring source-specific data handling.
• Incompleteness of insemination data, for example in some cases only the last successful insemination may be recorded for management purposes.

7.2.4. Data security

Data security is a universally important issue when collecting and using field data.

The legal framework for use of fertility data has to be considered according to national requirements and data privacy standards. The owner of the farm on which the data are recorded is the owner of the data, and must enter into formal agreements before data are collected, transferred, or analyzed.
7.2.5. Documentation

Documentation is the precondition of use of fertility data for management and breeding purposes.

Pre-requisite information:
- Unique animal identification of both the cow and service sire.
- Unique herd identification.
- Ancestry or pedigree information (at the very least the cow's sire should be recorded).
- Birth registration.
- A central database (Often data is recorded on the farm's computer(s) and then uploaded to the milk recording agency who then transfer the data to a central database. Alternatively, data can exchange directly between the farm computer and the central database).

Useful additional documentation:
- Individual identification of the recording person.
- Details on respective fertility event.
- Artificial insemination or natural service.
- Type of semen used (e.g. sexed semen, fresh semen).
- Type of recording and method of data transfer (software used for on-farm recording, online transmission).

The systematic use and appropriate interpretation of fertility data requires that different types of information can be combined such as date of birth, sex, breed, sire and dam, farm/ herd; calving dates, and performance records. Therefore, unique identification of the individual animals used for the fertility database must be consistent with the animal ID used in existing databases (for more details see the "ICAR rules, standards and guidelines on methods of identification").

Data that can be used to calculate female fertility measures can originate from a number of sources including farm software, milk-recording organisations, veterinarians, breed societies and laboratories. Ideally, as much data as possible should be recorded electronically, as this reduces transcription errors. As long as data is as error free as possible, the origin of data is less important. However, it is preferable for data to be transferred to a central database in as few steps as possible and as quickly as possible. Genetic evaluation of young bulls relies on early information on fertility being available.

7.2.6. Recording of female fertility

Stepwise decision support for recording fertility

In setting up a recording scheme or using data for genetic evaluation of fertility, the data that is currently captured needs to be considered in addition to implementing strategies for including other data. For example, calving dates and consequently calving interval, is the most basic measure of fertility. Then, insemination dates can be added, to calculate interval traits and non-return rates.
Ideally, pregnancy test results should also be recorded as these can be used as early indicators of conception. Finally, or in some cases alternatively, other predictors, such as fertility disorders, type traits, culling reasons and measures derived from hormones assays can also be added.

1. If only data from a milk recording organization is available then calving interval can be measured as the interval between 2 successive calvings.

2. If insemination data is available then days to first service (DFS), non-return (NR), number of services per conception (SPC), first to last service interval (FLI), calving to last insemination (CLI), days open (DOP) can be measured. Conception within 42 days of the planned start of mating and presented for mating within 21 days of the planned start of mating are measures suitable for seasonal systems and require a day when inseminations were started in the breeding season to be identified. Similarly first service submission can be used if a voluntary wait period is defined.

3. If information about fertility disorders (diagnoses) are available, the information about cows with e.g. cystic ovaries, silent heat, metritis, retained placenta or puerperal diagnoses can be included in an fertility index.

4. If pregnancy test/diagnosis data is available, then conception or pregnancy to the first (or second) insemination can be calculated, or in seasonal systems, conception within 42 days of the planned start of mating.

5. If type data is recorded regularly across parities, body condition score (a measure of fatness and metabolic status) can be evaluated. The limitation with condition score as part of a type classification scheme is that it is generally only recorded once, often on only selected cows, and therefore its usefulness may be limited.
6. If there are research herds or dedicated nucleus herds available, then commencement of luteal activity can be measured on a subset of animals (reference population). If these animals are also genotyped, then a genomic prediction equation can be calculated that can be applied to animals with genotypes but not phenotypes.

7.2.7. Data quality

7.2.7.1. General aspects

Recorded data should always be accompanied by a full description of the recording program.

- If herds were selected how was this done?
- How were the people involved in recording (e.g., veterinarians, and farmers) selected and instructed? Any standardized recording protocol used?
- What types of recording forms or (computer) programs were used? - What type of equipment was used?

Is there any selection of animals within herds? Consistency, completeness and timeliness of the recording and representativeness of the data compared to the national population is of utmost importance. The amount of information and the data structure determine the accuracy of the data; measures of this accuracy should always be provided.

7.2.7.2. General quality checks

National evaluation centers are encouraged to devise simple methods to check for logical inconsistencies in the data. Examples of data checks include:

- The recording farm must be registered or have a valid herd-testing identification.
- The animal must be registered to the respective farm at the time of the fertility event.
- The date of the fertility event must refer to a living animal (must occur between the birth and culling dates), and may not be in the future.
- A particular insemination must be plausible. For example are the insemination dates impossible? (e.g. before the calving or birth date)

7.2.8. Continuity of data flow. Keys to long-term success

Regardless of the sources of fertility data included, long-term acceptance of the recording system and success of the fertility improvement program will rely on the sustained motivation of all parties involved. Quantifying the benefits of data recording of these data is important. For example, data can be useful information for herd management, but also genetic evaluation and integration of these traits into selection programs.
7.2.9. Trait definition

7.2.9.1. Calving interval

Calving interval is the number of days between two consecutive calvings. Calving interval covers both return to cyclicity and conception, however its main disadvantage is that it is sometimes biased because cows with the worst fertility are often culled early and hence do not re-calve. Calving interval is also available later than many other measures of fertility, so is not as useful for selection decisions.

7.2.9.2. Days Open

Days open is the interval between calving and the last insemination date. It is similar to calving interval provided the cow conceives to the last insemination, in which case days open is calving interval minus the gestation length. The USA currently calculates daughter pregnancy rate as 21/(Days Open - voluntary waiting period + 11). The voluntary waiting period is the period after calving that a farmer deliberately does not inseminate the cow.

7.2.9.3. Non-return rate

Non-return rate is a binary measure of whether a new mating or insemination event occurs after the first insemination within a time period. Frequently studied intervals are 28 days (NR28), 56 days (NR56) or 90 days (NR90). The reference period recommended by Interbull is 56 days. This trait can be evaluated for both heifers and cows.

7.2.9.4. Interval from calving to first insemination

The number of days between calving and first insemination is sometimes influenced by management aspects and this needs to be considered in fertility evaluations. However, it does provide a measure of return to cyclicity post-calving. However, it does not provide information on conception (Table 1).

7.2.9.5. Interval between 1st insemination and conception

The number of days between first insemination and positive pregnancy diagnosis.

7.2.9.6. Conception rate

Success or failure to conceive after each AI (this can be evaluated for heifers and cows)

7.2.9.7. Calving rate, e.g. 42 or 56 days, from planned start of calving (seasonal systems)

The binary measure of whether a cow returns 42 or 56 days from the herd's planned start of mating. It is generally confirmed by the presence of a subsequent calving date. A herd's planned start of mating is when artificial inseminations for the herd commence.
7.2.9.8. Number of inseminations per series

The number of inseminations in a lactation or within a certain time period (this can be evaluated for heifers and cows).

7.2.9.9. Heat strength

A subjective scale is often used for recording of heat strength. This scale could be divided in different ways and could have various numbers of classes, but the classes should be ordered in intensity. As an example, the Swedish system has a five-point scale (very weak, weak, clear signs, strong, very strong heat signs) where each point is described in more detail regarding physical signs of the vulva and mounting/being mounted.

7.2.9.10. Submission rate

The percentage of cows mated in a fixed number of days after the herd’s start of mating. On an individual cow basis, recording is a binary score i.e. AI’d within a period of days from the herd's start of mating.

7.2.9.11. Fertility disorders - treatments for fertility disorders

Information on specific fertility disorders can provide valuable information for evaluation of female fertility. Recording details can be found in the ICAR Health guidelines.

7.2.9.12. Body condition score

The Body Condition Score (BCS) measures the fatness of the cow, especially in the region of the loin, hip, pinbone, and tailhead areas. Change in BCS in early lactation may be a better indicator of fertility compared with single observations of BCS per parity. To consider change in BCS it has to be recorded at least twice in early lactation and requires the dates of measurement.

7.2.9.13. Overview over traits

For monitoring the health status of dairy cows, an assessment of fertility is also useful to ensure that a complete picture of the health of the herd is available. For more information see the ICAR Health Guidelines.

7.2.10. Use of data

7.2.10.1. Improvement of management (individual farm level)

Although these guidelines focus mainly on evaluation of female fertility for genetic improvement, information is also very useful for on-farm decision-support. Routinely recording of fertility data allows the presentation of key figures for veterinary herd management.
7.2.10.1.1. Farmers

Optimized herd management is important for financially successful farming

Results of recording can be presented per individual animal or about cohorts and distinguish between retrospective "outputs" such as calving index and "inputs" such as number of services, results of pregnancy diagnosis in order to analyze overall performance (Breen et al., 2009).

However, for short term decisions (e.g. whether to continue to inseminate or not) on-farm recording of fertility is probably the only practical solution. More sophisticated decision support may include correction of the observed level for systematic environmental effects (such as parity or stage in lactation) and time analysis. Fertility reports summarizing the fertility performance of age-groups within the dairy herd also allows farmers to benchmark their farm to others.

Timely availability of fertility information is valuable and supplements routine performance recording for optimized fertility management of the herd. Therefore, fertility data statistics should be added to existing farm reports provided by milk recording organizations. Examples from Austria are found in the Austrian Ministry of Health (2010).

Immediate reactions

It is important that farmers and veterinarians have quick and easy access to herd fertility data. Only then can acute fertility problems, which may be related to management, be detected and addressed promptly. An Internet-based tool may be very helpful for timely recording and access to data. Lists of actions with animals ready to be inseminated or pregnancy tested are helpful.

Long term adjustments

Less-detailed reports summarizing data over longer time periods (e.g., one year) may be compiled to provide an overview of the general fertility status of the herd. Such summary reports will facilitate monitoring of developments within farm over time, as well as comparisons among farms on district and/or province level (Breen et al., 2009; Austrian Ministry of Health, 2010). Publication of key figures on female fertility at herd level will provide decision support at the tactical level. A general recommendation is to present recent averages (last year), but also to present trend over several years. If available, it is advised to include a comparison of the averages with a mean of a larger group of (similar) farms. For example, the average days open might be compared with the average days open for all farms in the same region or with the same milk production level.

Farm averages might also be specified for different groups of animals at the farm. For example, days open might be presented as an average for first lactation cows versus later parity animals. This denotes which groups require specific attention in the preventive management.

Definitions of benchmarks are valuable, and for improvement of the general fertility status it is important to place target oriented measures.

7.2.10.2. Monitoring of the health status (population level)

Government bodies and other organizations involved in animal health issues are very interested in monitoring the health status of the cattle population. Consumers also are increasingly concerned about aspects of food safety and animal welfare. Regardless of which sources of health information
Table 1. Various traits used or possible to use and their potential relation to various aspects of cow fertility.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Return to cyclicity</th>
<th>Oestrus signs</th>
<th>Prob. of conception</th>
<th>Ability to keep embryo</th>
<th>Seasonal</th>
<th>Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval between two consecutive calvings (calving interval)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Interval from calving to first insemination</td>
<td>++</td>
<td>+</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Submission rate: e.g., interval from planned start of mating to first insemination</td>
<td>+ +</td>
<td>+</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Interval from calving to first luteal activity</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Body condition score, live weight change during early lact., energy balance</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Non-return rate (56, 128, .. days)</td>
<td>++</td>
<td>+</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Conception to 1st insemination (determined with pregnancy diagnosis)</td>
<td>+ +</td>
<td>+</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Calving rate (e.g. 42 or 56 days) from planned start of calving</td>
<td>+ +</td>
<td>+</td>
<td>+</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Number of ins. per series</td>
<td>+</td>
<td>+ +</td>
<td>+</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Interval from first ins. to conception (or last insemination)</td>
<td>+</td>
<td>+ +</td>
<td>+</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Interval between inseminations</td>
<td>+</td>
<td>( + )</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Heat strength</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Treatments for fertility problems</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Days open, interval from calving to conception (or last insemination)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

The number of + indicates how well the measure relates to the aspect of fertility
✓ indicates the suitability of the measure to the production system
are used, national monitoring programs may be developed to meet the demands of authorities, consumers and producers. The latter may particularly benefit from increased consumer confidence in safe and responsible food production.

7.2.10.3. Interbull

Fertility data is also important for providing genetic evaluations, both within country and between countries. The following section is from the Interbull website (www-interbull.slu.se/Female_fert/framesida-fert.htm) and are the traits that the Interbull Steering committee chose in August 2007 to become part of MACE evaluations of fertility. Interbull considers female fertility traits classified as follows:

- **T1 (HC):** Maiden (H)eifer's ability to (C)onceive. A measure of confirmed conception, such as conception rate (CR), will be considered for this trait group. In the absence of confirmed conception an alternative measure, such as interval first-last insemination (FL), interval first insemination-conception (FC), number of inseminations (NI), or non-return rate (NR, preferably NR56) can be submitted.

- **T2 (CR):** Lactating (C)ow's ability to (R)ecycle after calving. The interval calving-first insemination (CF) is an example for this ability. In the absence of such a trait, a measure of the interval calving-conception, such as days open (DO) or calving interval (CI) can be submitted.

- **T3 (C1):** Lactating (C)ow's ability to conceive (1), expressed as a rate trait. Traits like conception rate (CR) and non-return rate (NR, preferably NR56) will be considered for this trait group.

- **T4 (C2):** Lactating (C)ow's ability to conceive (2), expressed as an interval trait. The interval first insemination-conception (FC) or interval first-last insemination (FL) will be considered for this trait group. As an alternative, number of inseminations (NI) can be submitted. In the absence of any of these traits, a measure of interval calving-conception such as days open (DO), or calving interval (CI) can be submitted. All countries are expected to submit data for this trait group, and as a last resort the trait submitted under T3 can be submitted for T4 as well.

- **T5 (IT):** Lactating cow's measurements of (I)nterval (T)raits calving-conception, such as days open (DO) and calving interval (CI).

Based on the above trait definitions the following traits have been submitted for international genetic evaluation of female fertility traits.

7.2.11. Literature


7.2.12. Acknowledgments

This document is the result of the work of the ICAR Functional Traits Working Group. The members of this working group are, in alphabetical order:

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- Katharina Stock, VIT, Germany.
- Erling Strandberg, Swedish University of Agricultural Science, Uppsala, Sweden.

The working group acknowledges the valuable contributions and support in improving this document of Brian Wickham (ICAR) and Pavel Bucek (Czech-Moravian Breeders' Corporation), Stephanie Minery (Idele, France), Pascal Salvetti (UNCEIA), Oscar Gonzalez-Recio and Mekonnen Haile-Mariam (DEPI, Melbourne, Australia) and John Morton (Jemora, Geelong, Australia).
SECTION 7.3 - GUIDELINES FOR RECORDING, EVALUATION AND GENETIC IMPROVEMENT OF UDDER HEALTH

7.3.1 General concepts

7.3.1.1 Reader instructions

These guidelines are written in a schematic way. Enumeration is bulleted and important information is shown in text boxes. Important words are printed bold in the text.

The aim of these guidelines is to provide dairy cattle breeders involved in breeding programmes with a stepwise decision-support procedure establishing good practices in recording and evaluation of udder health (and correlated traits). These guidelines are prepared such that they can be useful both when a first start to the breeding programme is to be made, or when an existing breeding programme is to be updated. In addition, these guidelines supply basic information for breeders not familiar (inexperienced or ‘lay-persons’) with (biological and genetic) backgrounds of udder health and correlated traits.

7.3.2 Aim of these guidelines

Stepwise decision-support in developing a recording and evaluation system for udder health, to support a genetic improvement scheme in dairy cattle.

7.3.3 Structure of these guidelines

These guidelines are divided in four parts:
1. General introduction including a summary of the main principles.
2. Background information on udder health and correlated traits.
3. Stepwise decision-support for recording udder health and correlated traits.
4. Stepwise decision-support for genetic evaluation of udder health and correlated traits.

The experienced animal breeder using these guidelines should read chapter 1 and is advised to read the text boxes of chapter 2. The inexperienced user is advised to read the full text of chapter 2.

7.3.4 General introduction

A healthy udder can be best defined as an udder that is ‘free from mastitis’. Mastitis is an inflammatory response, generally presumed to be caused by a bacterium.

A healthy udder is an udder free from inflammatory responses to microorganisms.

Mastitis is generally considered as the most costly disease in dairy cattle because of its high incidence and its physiological effects on e.g. milk production. In many countries breeding for a better production in dairy cattle has been practised for years already. This selection for highly
productive dairy cows has been successful. However, together with a production increase, generally udder health has become worse. Production traits are unfavourably correlated with subclinical and clinical mastitis incidence.

A decreased udder health is an unfavourable phenomenon, because of several costs of mastitis like e.g. veterinary treatment, loss in milk production and untimely involuntary culling. Mastitis also implies impaired animal welfare.

**It is important to reduce the incidence of mastitis, because of production efficiency and animal welfare**

There is little hope that mastitis will be eradicated or an effective vaccine developed. The disease is much too complex. However, reducing the incidence of this disease is possible. An important component in reducing the incidence of mastitis is breeding for a better resistance. Dairy cattle breeding should properly **balanced selection** emphasis on production traits (milk and beef) and functional traits (such as fertility, workability, health, longevity, feed efficiency). This requires good practices for recording and evaluation of all traits - see table for an overview. These guidelines support establishing good practices for recording and evaluation of udder health. Decision-support for other trait groups will be subject of other guidelines developed by the ICAR working group on Functional Traits.

Operational situation breeding value prediction to be aimed for in dairy cattle genetic improvement schemes (source Proceedings International Workshop on Genetic Improvement of Functional Traits in cattle (GIFT) - breeding goals and selection schemes (7-9 November 1999, Wageningen, INTERBULL bulletin no. 23, page 221.)
<table>
<thead>
<tr>
<th>Trait group</th>
<th>Trait</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Milk production</strong></td>
<td>Milk/carrier kg</td>
</tr>
<tr>
<td></td>
<td>Fat kg or %</td>
</tr>
<tr>
<td></td>
<td>Protein kg or %</td>
</tr>
<tr>
<td></td>
<td>Milk quality</td>
</tr>
<tr>
<td></td>
<td>e.g., k-casein</td>
</tr>
<tr>
<td><strong>Beef production</strong></td>
<td>Daily gain/final weight</td>
</tr>
<tr>
<td></td>
<td>Dressing or Retail %</td>
</tr>
<tr>
<td></td>
<td>Muscularity</td>
</tr>
<tr>
<td></td>
<td>Fatness, marbling</td>
</tr>
<tr>
<td><strong>Calving ease</strong></td>
<td>Direct effect</td>
</tr>
<tr>
<td></td>
<td>Maternal effect</td>
</tr>
<tr>
<td><strong>Still birth</strong></td>
<td>a.o. Udder depth, teat placement</td>
</tr>
<tr>
<td></td>
<td>Somatic Cell Score</td>
</tr>
<tr>
<td></td>
<td>Clinical incidence</td>
</tr>
<tr>
<td><strong>Female Fertility</strong></td>
<td>Non-return rate</td>
</tr>
<tr>
<td></td>
<td>Interval Calving – 1\textsuperscript{st} insemination</td>
</tr>
<tr>
<td></td>
<td>Age 1\textsuperscript{st} calving, heat detectability, luteal activity</td>
</tr>
<tr>
<td><strong>Male Fertility</strong></td>
<td>Conformation</td>
</tr>
<tr>
<td></td>
<td>Locomotion</td>
</tr>
<tr>
<td></td>
<td>Clinical Incidence</td>
</tr>
<tr>
<td><strong>Feet &amp; Legs problems</strong></td>
<td>Foot angle, Rear legs set</td>
</tr>
<tr>
<td></td>
<td>Milk speed, ability, leakage</td>
</tr>
<tr>
<td></td>
<td>Temperament/Character</td>
</tr>
<tr>
<td><strong>Workability</strong></td>
<td>Udder conformation</td>
</tr>
<tr>
<td></td>
<td>Somatic Cell Score</td>
</tr>
<tr>
<td></td>
<td>Clinical incidence</td>
</tr>
<tr>
<td><strong>Longevity</strong></td>
<td>Functional, residual</td>
</tr>
<tr>
<td><strong>Other diseases</strong></td>
<td>Ketosis, metabolic problems</td>
</tr>
<tr>
<td><strong>Persistency</strong></td>
<td>Mature weight</td>
</tr>
<tr>
<td><strong>Metabolis stress/Feed efficiency</strong></td>
<td>Feed intake capacity</td>
</tr>
<tr>
<td></td>
<td>Condition Score</td>
</tr>
<tr>
<td></td>
<td>Energy Balance</td>
</tr>
</tbody>
</table>
7.3.5 Recording

Selection on udder health starts with recording. Only by recording it is possible to differentiate in (predicted) breeding values for udder health between potential selection candidates. Mastitis can be recorded directly and indirectly.

Directly recorded mastitis is for example the number of clinical mastitis incidents per cow per lactation. The same can be done with subclinical mastitis, but this is mostly put on a par with recording of somatic cell count. Other traits for indirectly recording mastitis are milkability and udder conformation traits (e.g. udder depth, fore udder attachment, teat length).

### Recording udder health

<table>
<thead>
<tr>
<th>Direct</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical mastitis incidents</td>
<td>Somatic cell count</td>
</tr>
<tr>
<td>Subclinical mastitis incidents</td>
<td>Milkability</td>
</tr>
<tr>
<td></td>
<td>Udder conformation traits</td>
</tr>
</tbody>
</table>

Clinical mastitis is an outer visual or perceptible sign of an inflammatory response of the udder: painful, red, swollen udder. The inflammatory response can also be recognised by abnormal milk, or a general illness of the cow, with fever. Sub-clinical mastitis is also an inflammatory response of the udder, but without outer visual or perceptible signs of the udder. An incident of sub-clinical mastitis is detectable with indicators like conductivity of the milk, NAG-ase, cytokines and somatic cell count in the milk.

7.3.6 Prerequisites

Recording and evaluation of udder health requires measuring direct and indirect traits, but also basic information is necessary. With an existing breeding programme to be updated with udder health, this prerequisite information is generally available, which might not be the case when starting with a new breeding programme.

7.3.7 Prerequisite information

- Unique animal identification and registration.
- Unique herd identification and registration.
- Individual animal pedigree information.
- Birth registration.
- A well functioning central database.
- Milk recording system (time information and logistics of sampling milk samples).
7.3.8 Evaluation

The recorded data from different farms should be combined to serve as a basis for a genetic evaluation of potential selection candidates in the genetic improvement scheme (per region, country or internationally). A genetic evaluation requires data to be recorded in a uniform manner. There should be ample data for reliable breeding value estimation. The quality of genetic improvement depends on the quality of these estimated breeding values.

On the basis of the estimated breeding values, selection candidates will be ranked. Estimated breeding values will be available per (recorded) trait, or as a combined ‘udder health index’. Such an udder health index will be a weighted summation of estimated breeding values for recorded (direct and indirect) traits. A ranking of selection candidates on an udder health index facilitates a selection on those animals that contribute mostly to improve udder health, i.e., reduced mastitis incidence. Together with indexes for other important trait groups, the udder health index can be combined towards a broader, general merit or performance index used for overall ranking of selection candidates.

7.3.8.1 Example sire evaluation in the Netherlands

The table below shows the top 10 of bulls marketed world-wide with the highest estimated breeding value (EBV) for udder health (May 2002). This is on the basis of the calculations of the national Dutch organization for cattle breeding (NVO). The formula below shows the calculation of the breeding values for udder health:

\[
EBV_{uH} = -6.603 \times EBV_{SCC} - 0.193 \times (EBV_{ms} - 100) + 0.173 \times (EBV_{ud} - 100) + 0.065 \times (EBV_{fua} - 100) - 0.108 \times (EBV_{tl} - 100) + 100
\]

where \( EBV_{uH} \) : EBV for udder health, \( EBV_{SCC} \) : EBV for somatic cell count at 2log-scale; \( EBV_{ms} \) : EBV for milking speed; \( EBV_{ud} \) : EBV for udder depth; \( EBV_{fua} \) : EBV for fore udder attachment; \( EBV_{tl} \) : EBV for teat length

<table>
<thead>
<tr>
<th>Name bull</th>
<th>Durable Performance Sum</th>
<th>Total Score Conformation</th>
<th>Udder health index</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUNTOR MAGIC</td>
<td>52</td>
<td>107</td>
<td>115</td>
</tr>
<tr>
<td>CAROL PRELUDE MTOTO ET</td>
<td>217</td>
<td>112</td>
<td>111</td>
</tr>
<tr>
<td>WRANADA KING ARTHUR</td>
<td>97</td>
<td>109</td>
<td>111</td>
</tr>
<tr>
<td>CAERNARVON THOR JUDSON-ET</td>
<td>87</td>
<td>107</td>
<td>111</td>
</tr>
<tr>
<td>MAR-GAR CHOICE SALEM-ET *TL</td>
<td>65</td>
<td>108</td>
<td>111</td>
</tr>
<tr>
<td>PRATER</td>
<td>51</td>
<td>112</td>
<td>111</td>
</tr>
<tr>
<td>RAMOS</td>
<td>192</td>
<td>108</td>
<td>110</td>
</tr>
<tr>
<td>DS-KIRBYVILLE MORGAN-ET</td>
<td>165</td>
<td>108</td>
<td>110</td>
</tr>
<tr>
<td>WHITTAIL VALLEY ZEST ET</td>
<td>158</td>
<td>104</td>
<td>110</td>
</tr>
<tr>
<td>V CENTA</td>
<td>129</td>
<td>112</td>
<td>110</td>
</tr>
</tbody>
</table>
The Durable Performance Sum (DPS) is the Dutch basis for the overall ranking of bulls. The components of the DPS are production, health and durability. The Total Score is the total score of the conformation of the bulls. The components for this trait are type, udder conformation and feet & legs.

### 7.3.8.2 Example sire evaluation in Sweden

Estimated breeding values for Swedish bulls for production, health and other functional Traits, sorted on mastitis (February 2002).

<table>
<thead>
<tr>
<th>Name</th>
<th>Total Merit Index</th>
<th>Production traits</th>
<th>Health traits</th>
<th>Functional traits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Prod index</td>
<td>Milk kg</td>
<td>Protein kg</td>
</tr>
<tr>
<td>G Ross</td>
<td>14</td>
<td>107</td>
<td>103</td>
<td>106</td>
</tr>
<tr>
<td>Botans</td>
<td>18</td>
<td>119</td>
<td>113</td>
<td>119</td>
</tr>
<tr>
<td>Storåfors</td>
<td>12</td>
<td>108</td>
<td>105</td>
<td>108</td>
</tr>
<tr>
<td>Inlag-ET</td>
<td>13</td>
<td>106</td>
<td>106</td>
<td>106</td>
</tr>
<tr>
<td>Torpane</td>
<td>11</td>
<td>101</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Flaka</td>
<td>21</td>
<td>111</td>
<td>112</td>
<td>111</td>
</tr>
<tr>
<td>Bredåker</td>
<td>14</td>
<td>106</td>
<td>100</td>
<td>105</td>
</tr>
<tr>
<td>Brattbacka</td>
<td>14</td>
<td>108</td>
<td>95</td>
<td>107</td>
</tr>
<tr>
<td>Stensjö-ET</td>
<td>20</td>
<td>118</td>
<td>115</td>
<td>117</td>
</tr>
</tbody>
</table>
7.3.2 Detailed Information on udder health

7.3.2.1 Reader instruction

This chapter (number 2.0) gives background information on udder health and correlated traits. It is about direct (clinical mastitis) and indirect traits (somatic cell count, milkability and udder conformation traits). For the experienced reader reading only the bold printed words and text boxes should be sufficient.

7.3.2.2 Infection and defence

The first line of defence against an infection of microorganisms is the mechanical prevention of the mammary gland. This mechanical prevention is opposite to the ease of microorganisms to enter the teat canal: the easier the entrance, the weaker the mechanical prevention. The quality of this defence is related to the milkability and the udder conformation traits, like e.g. teat length and udder depth. However, when microorganisms enter the mammary gland, then the immune system causes an attraction of leukocytes to the place of infection, which results in an enlarged somatic cell count. So, a short term increase in somatic cell count with or without accompanying clinical signs are on one hand a symptom of a failing first line of defence, but on the other hand indicating an appropriate immunological reaction. The picture below shows the infection process, together with the destruction of a milk-secreting cell.
Section 7 - Guidelines for recording of functional traits

Mastitis causing bacteria

Contagious mastitis
- primary source: udders of infected cows,
- is spread to other cows primarily at milking time,
- results in high bulk tank SCC.

is caused by:
- *Streptococcus agalactiae* (> 40% of all infections),
- *Staphylococcus aureus* (30 - 40% of all infections).

The *S. aureus* bacterium is hardly eradicable, but can be reduced to less than 5% of the cows in a herd. The *S. agalactiae* is fully eradicable from a herd.

Environmental mastitis
- primary source: the environment of the cow
- high rate of clinical mastitis (especially the lower resistant cows, e.g. early lactation)
- individual SCC is not necessarily high (less than 300,000 is possible)

is caused by:
- environmental *streptococci* (5 - 10% of all infections):
  - *Streptococcus uberis*
  - *Streptococcus bovis*
  - *Streptococcus dysgalactiae*
  - *Enterococcus faecium*
  - *Enterococcus faecalis*
- Coliforms (< 1% of all infections):
  - *Escherichia coli*
  - *Klebsiella pneumoniae*
  - *Klebsiella oxytoca*
7.3.2.3 Clinical and subclinical mastitis

Mastitis can be subdivided in clinical and subclinical mastitis. Clinical mastitis is mastitis with outer visual or perceptible signs of the udder or the milk. Clinical mastitis is observed as abnormal milk, like flaky, clotted and / or “watery” milk. Possible perceptible signs on the udder are redness, painfulness and swollenness with fever.

Subclinical mastitis is not perceptible directly by a farmer or veterinarian, but is detectable with indicators. The most used indicator is the number of somatic cells per ml milk (somatic cell count). Other, less practised physiological indicators of subclinical mastitis are electrical conductivity of the milk, N-acetyl-ß-D-glucosaminidase, bovine serum albumin, antitrypsin, sodium, potassium and lactose content.

The somatic cell count is the most widely accepted criterion for indicating the udder health status of a dairy herd. An enlarged number of somatic cells in milk, which is unfavourable, points to a defence reaction.

Somatic cells in milk are primarily leukocytes or white blood cells along with sloughed epithelial or milk secreting cells. White blood cells are present in milk in response to tissue damage and/or clinical and subclinical mastitis infections. These cell numbers increase in milk as the cow’s immune system works to repair damaged tissues and combat mastitis-causing organisms. As the degree of damage or the severity of infections increase, so does the level of white blood cells. Epithelial cells are always present in milk at low levels. They are there as a result of a natural process inside the udder whereby new cells automatically replace old tissue cells. Epithelial cells result in normal milk SCC levels of <50,000.
The recommended industry standard for bulk SCC on delivery is one that is consistently <200,000. Many herds, which are successful in maintaining a herd SCC <100,000, have minimal to no mastitis infections.

**The somatic cell count is the number of somatic cells per millilitre of milk.**

Normal milk has less than 200,000 cells per millilitre.

So, somatic cells are partly white blood cells or **body defence cells** whose primary functions are to eliminate infections and repair tissue damage. Somatic cell levels or numbers in the mammary gland do not reflect the whole pool of cells that can be recruited from the blood to fight infections. Somatic cells are sent in high numbers only when and where they are needed. Therefore, high SCC indicates mammary infection. A certain number of cells is necessary once an infection invades the udder. Together with a favourite low SCC, the **speed of cell recruitment** to the mammary gland and the cell competency are the major factors in infection prevention.

### 7.3.2.4 Aspects of recording clinical and sub-clinical mastitis

Recording clinical mastitis is possible but not common practice (yet). Scandinavian countries are the only countries that include mastitis incidence directly in their national recording and evaluation programs. However, other countries are working on a national recording and evaluation scheme for mastitis incidence as well. Reasons for increased interest in recording clinical mastitis are in

- Veterinary farm management support (i.e., identification of diseased animals and establishing treatment procedure).
- National veterinary policy-making (i.e., drugs regulations and preventive epidemiological measures).
- Citizens’ and consumers’ concerns about animal health and welfare and product quality and safety (i.e., chain management, product labelling).
- Genetic improvement (i.e., monitoring genetic level of the population and selection and mating strategies).

It is to be emphasised that recording of clinical mastitis is difficult, as it requires a clear definition (as given in these guidelines), an accurate administration with for example dates of incidence and (unique) cow numbers. It is also important that the reasons for recording are made clear to stakeholders and that information is not only gathered centrally, but also processed to obtain clear information for farm management support to be reported back to the farmer.

The (phenotypic) occurrence of clinical or subclinical mastitis is influenced by the genetic merit of the animal (its breeding value) and by environmental effects. When considering the total phenotypic variance between animals, for clinical mastitis about 2-5 % is because of genetic differences between the animals. The remaining differences between animals are because of different environmental influences and measuring errors. Known systematic environmental influences are for example in parity of the cow or stage in lactation. An evaluation of udder health traits will have to carefully consider these systematic environmental influences.
On-farm management decision-support

Although these guidelines focus on evaluation of udder health for genetic improvement, information is also very useful for on-farm decision-support. Routinely recording of clinical incidents and somatic cell count allows the presentation of key figures for veterinary herd management.

**Operational - individual animal level**

Results of recording can be presented per individual animal. To support decision making, a note can accompany the presentation of the recording level when the level is above a certain threshold. For example, a SCC above 200,000 indicates that the cow may suffer from subclinical mastitis and requires treatment or it is advised to perform a bacteriological culturing. An additional listing might provide a direct overview of cows with attention levels for which further action is advised.

More sophisticated decision support may include correction of the observed level for systematic environmental effects (such as parity or stage in lactation) and time analysis.

Mastitis caused by different bacteria requires different preventive and curative measurements to be taken. Therefore, information from bacteriological culturing is generally very important in operational farm management.

**Tactical - herd level**

Publication of key figures on mastitis incidence, bacteriological culturing and SCC at herd level will provide decision support at the tactical term. A general recommendation is to present recent averages, but also to present the course of the averages over a longer time period. If available, it is advised to include a comparison of the averages with a mean of a larger group of (similar) farms. For example, the average on SCC might be compared with the average bulk somatic cell count for all farms delivering milk to the same factory.

Farm averages might also be specified for different groups of animals at the farm. For example, SCC might be presented as an average for first lactation females versus later parity animals. This denotes which groups require specific attention in the preventive and curative management.
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7.3.2.4.1 Health card

In Norway, Finland and Denmark each individual cow has a health card, which is updated each time the veterinarian treats the animal. For example in Norway is a strict regulation of drugs such that all antibiotic treatments are carried out by the veterinary, and the farmer is not allowed treating his own animals. Completeness and consistency requires a very accurate administration; a condition in order to let a health card system be useful for breeding programs.

7.3.2.4.2 Quality control

In the Netherlands, it is now included in the ‘chain control on quality of milk’ that the farm is regularly visited by a veterinarian to record health status of the cows. This gives a ‘test-day’ comparison of all cows in the herd. This information can possibly be used for national veterinarian monitoring programmes and for selection programmes.

In many countries a reliable recording of clinical mastitis incidents is hard to achieve, which makes this trait not the first step in developing an udder health index. Somatic cell count (SCC) is genetically highly correlated with clinical mastitis: 0.60-0.70. This means, that when analysing field data, an observed high level of SCC is generally accompanied by a clinical mastitis event. In other words, although milk of healthy cows also shows variance in SCC, in day-to-day field data, most of the variance in SCC is caused by clinical mastitis events.

Given its high correlation to clinical mastitis, SCC is an appropriate indicator of udder health, as:

- somatic cell counts can be routinely recorded in most milk recording systems, giving better opportunities of accurate, complete and standardised observations;
- about 10-15% of the observed variation in SCC is caused by differences in breeding values of the animals, which is higher than in clinical mastitis;
- it also reflects incidence of subclinical intramammary infections.
Bulk somatic cell count

Sofar, we have considered SCC on animal level. In farm management also the average bulk somatic cell count (BSCC) is of interest. In many countries the BSCC is a basis for milk price payment by the dairy industry. The BSCC can also play a role in decision-support. High BSCC herds mainly deal with high levels of contagious, invasive organisms, which are mostly subclinical. Many cows are infected and substantial udder damage and milk losses are caused. When these infections become clinical, they are usually mild. Environmental infections are rarely seen because they are opportunists and cannot compete with the highly invasive organisms. Low SCC herds have low levels of contagious, invasive pathogens. Thus, when they do have infections, they are usually environmental. Environmental infections are very vivid, with a severe illness and a possible death as a result. Environmental infections are not invasive, but opportunistic, thus most animals who get these are usually suppressed or heavily stressed, e.g. early lactation animals. A good management from the farmer can reduce the number of environmental infections.

The upper 95% confidence limit for somatic cell counts in uninfected cows, in three different parities, in dependence on days in milk (Source: Schepers et al., 1997).
Section 7 - Guidelines for recording of functional traits

Mastitis incidence (%)

Frequency distribution of clinical mastitis incidents according to lactation stage (Source: Schepers, 1996)

Percentage of cows in different SCC-classes (x 1000; year 2000 calvings, Australia) per lactation (Source: Hiemstra, 2001).
7.3.2.5 Relevance or lowering SCC

The importance of reducing clinical mastitis seems clear (high costs and impaired welfare), the importance of reducing subclinical mastitis might seem less obvious. However, there are several reasons for reducing the amount of subclinical mastitis (an increased number of somatic cells in milk (SCC)) in dairy cattle, like:

1. Daughters of sires that transmit the lowest somatic cell score (log-transformation of somatic cell count) have lower incidence of clinical mastitis and fewer clinical episodes during first and second lactation.
2. Decreased somatic cell count (SCC) has been shown to improve dairy product quality, shelf life and cheese yield. Increased SCC decreases cheese yield in two ways:
   • by decreasing the amount of casein as a percentage of total protein in milk and
   • by decreasing the efficiency of conversion of casein into cheese.
3. High SCC in milk affects the price of milk in many payment systems that are based on milk quality.
4. High SCC milk has a reduced flavour score because of an increase in salts.

7.3.2.5.1 Advantages of lowering somatic cell count

- clinical mastitis: low incidence and few episodes,
- improved dairy product quality,
- higher milk prices.

7.3.2.5.2 Natural defense system

Part of the somatic cells is white blood cells - they are an essential part of the cow’s immune system. Trying to lower the incidence of cases with highly increased somatic cell count (as an indicator that a defense reaction was necessary) is advised. Trying to lower somatic cell count below natural levels in milk of healthy cows is not advised. An essential part of the natural defense system is also the speed of white blood cells recruitment.

7.3.2.6 Milkability

There is an unfavourable genetic correlation between milkability (milking speed, milking ease or milk flow) and somatic cell count. Faster milking cows tend to have a higher lactation somatic cell count. In general, an unfavourable genetic correlation between milkability (i.e., milking speed) and udder health is assumed. This is explained by a possibly easier mechanical entry of pathogens into the udder associated with an easier exit of milk out of the udder ant teat canal.

However, some remarks are to be made with respect to this correlation between milkability and udder health. **Non-linearity.** The genetic correlation is assumed to be non-linear. This means that at low and mediate levels of milking speed there is no influence on udder health. Only with extremely high milking speed, also observed as leakage of milk before milking time, the teat canal is too wide facilitating easy entrance of microorganisms.
Section 7 - Guidelines for recording of functional traits

Figure: A generalised representation of the milk flow curve (source: Dodenhoff et al., 2000).

Complete draining with milking. With each milking, the last fraction of milk contains 3 to 10 times more cells than the first fraction. This however depends on the completeness of withdrawing milk from the udder, which itself is again related to milking speed. A higher milking speed, facilitates a more complete draining of the udder causing a higher SCC. This supports the suggestion that milking speed is unfavourably correlated with SCC but not with clinical mastitis.

Another important point is that milking speed is associated with the farmer’s labour time for milking. Increased milking speed per cow implies decreased costs for electrical power and decreased wear on milking equipment. Combining the two main aspects

1. reducing milking speed, or more specifically leakage as wanted because of udder health and
2. increasing milking speed because of reducing labour time

makes that milking speed is a trait with an intermediate, optimum level.

Recording of milking speed can be practised with advanced equipment. This advanced equipment can be:

1) an additional equipment to be installed at regular intervals or at specific recording herds as part of a (national) recording programme for milking speed, or
2) an integral part of the milking system at the farm, together with for example recording of milk conductivity, giving an integral, operational decision-support for the farmer in detecting cows with udder health problems.
An overall subjective scoring of milking speed can also be practised. The farmer can make a linear scoring of 1 very slow to 5 very fast (see also chapter 3).

### 7.3.2.7 Udder conformation traits

Linear udder conformation is part of the recommended conformation recording in dairy cattle as approved by the World Holstein Friesian Federation (WHFF) and ICAR (see section 5.1 of the ICAR guidelines as available www.icar.org). Approved standard traits are:

- **Fore udder attachment**
- **Median suspensory ligament**
- **Teat placement**
- **Rear udder height**
- **Udder depth**
- **Teat length**

A full description of these traits is given in Chapter 3. The reason for approval of this set of traits is based on the fact that each of these traits can have a predictive value for udder health, or the trait influences workability (and thus milking time). We therefore also recommend recording of udder conformation according to the ICAR/WHFF-recommendations.

Based on literature studies some indicative relative importance of the traits can be given. The udder conformation trait with the largest influence on udder health is the udder depth. Shallow udders appear to be obviously healthier than deep udders. A reason why shallow udders are healthier may be that deep udders have an increased exposure to pathogenic bacteria and are more likely to be injured.

Fore udder attachment also has an important influence on the udder health together with teat length. Probably again the main aspect here is that improved udder conformation (better attachment and shorter teats) decreases exposure to pathogens.

Again, also other traits are of importance, but the genetic relationship with udder health may be lower, and different traits may provide similar genetic information. This generally causes udder health indexes to be based on a limited number of udder conformation traits only.

### Example age effect on udder conformation

*The influence of age on udder conformation in Holstein Friesian and Jersey*  
(Source: Oldenbroek et al., 1993).

<table>
<thead>
<tr>
<th>Breed</th>
<th>Trait (cm)</th>
<th>Lactation number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Holstein</td>
<td>Distance rear udder-floor</td>
<td>60.5</td>
</tr>
<tr>
<td></td>
<td>Distance between front teath</td>
<td>18.1</td>
</tr>
<tr>
<td>Jersey</td>
<td>Distance rear udder-floor</td>
<td>51.2</td>
</tr>
<tr>
<td></td>
<td>Distance between front teath</td>
<td>14.2</td>
</tr>
</tbody>
</table>
Udder conformation changes over lifetime of the animal. Moreover, selection of cows favours (directly or indirectly) survival of cows with better udder conformation. This implies, that either observations are to be adjusted for age effects, or observations used for genetic evaluation are to be taken from a specified age only. In general, (inter)national evaluations are based on observations during first lactation only.

7.3.2.8 Summary

The most complete udder health index includes direct and indirect udder health traits. An example of a direct trait is the inclusion of clinical mastitis in the index as happens in the Scandinavian countries. In some other countries, like The Netherlands, Canada and the United States, only indirect traits are used in the udder health index. These indirect traits can be subdivided in three main groups: somatic cell count, milkability and udder conformation traits.

1. Recording clinical mastitis directly by a farmer or veterinarian: outer visual signs on the udder or the milk.
2. Recording subclinical mastitis: not visual directly, but only perceptible by indicators. The most frequently used indicator is the number of somatic cells in milk (SCC), which can be routinely recorded parallel to milk recording.

Good recording practices udder health index

<table>
<thead>
<tr>
<th>Direct</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical</td>
<td>Subclinical</td>
</tr>
<tr>
<td>Milkability</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

3. Recording udder conformation. There are several udder conformation traits with an influence on udder health. The most important one by far is udder depth, followed by fore udder attachment and teat length.
4. Recording milkability (i.e., milking speed) by actual measurement or (linear) appraisal by the farmer. Milkability is an optimum trait: high milking speed is favourable as it reduces labour time for milking, but it increases leakage of milk and thus bacterial invasion of the teat canal.
7.3.3 Decision-support for health recording

7.3.3.1 Reader instruction

This chapter gives a stepwise description of the possibilities to record udder health and correlated indicator traits. The starting-point is a situation in which not many efforts have been done yet, to improve udder health. In each step, a description is given on “What?” to record, by “Who?” this is done, and “When?”. 

**7.3.2.2 Interbull recommendation animal ID**

Each animal’s ID should be unique to that animal, given to the animal at birth, never be used again for any other animal, and be used throughout the life of the animal in the country of birth and also by all other countries. The following information should be provided for each animal:

- Breed code
- Country of birth code
- Sex code
- Animal code

<table>
<thead>
<tr>
<th>Breed code</th>
<th>Character 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country of birth code</td>
<td>Character 3</td>
</tr>
<tr>
<td>Sex code</td>
<td>Character 1</td>
</tr>
<tr>
<td>Animal code</td>
<td>Character 12</td>
</tr>
</tbody>
</table>

**7.3.2.3 INTERBULL recommendation pedigree information**

Birth date and sire and dam IDs should be recorded for all animals. Genetic evaluation centers should, in cooperation with other interested parties, keep track and report percentage of animals with missing ID and pedigree information. The overall quantitative measure of data quality should include percentage of sire and dam identified animals or alternatively percentage of missing ID’s. Measures should be adopted to reduce the percentage of non-parent identified animals and missing birth information to very low numbers and ideally to zero. Examples of such measures are supervision of natural matings and artificial inseminations, avoidance of mixed semen, monitoring parturitions, comparison of birth date with calving date of dam, taking bull’s ID from AI straws, etc. If there is the slightest doubt about parentage of a calf, utilization of genetic...
7.3.3.2 Step 0 - Prerequisites

Before an udder health system can be developed, a number of prerequisites should be accounted for:

- Unique animal identification and registration.
- Unique herd identification and registration.
- Individual animal pedigree information.
- Birth registration.
- A well functioning central database.
- Milk recording system (time information and logistics of sampling milk samples).

For these prerequisites in general, we refer to INTERBULL bulletin no. 28 (2001). Two aspects of these INTERBULL recommendations, animal ID and pedigree information, are cited below.

7.3.3.2.1 General definitions

A lactation period is considered to commence on the day the animal gives birth. A lactation period is considered to end the day the animal ceases to give milk (goes dry). The lactation number refers to the number of the last lactation period started by the animal. The number of days in lactation denotes the time span between calendar date of the mastitis incident and the day the last lactation period commenced. The number of days in lactation may be negative when the incident occurs during the dry-period proceeding next calving. For more detailed information on the definition of lactation period, please see general ICAR guidelines (www.icar.org, Guidelines section 2.1 Appendix D).

7.3.3.3 Step 1 - Somatic cell count using milk recording systems

What? In a milk recording system, with regular intervals milk samples are taken per cow. Samples are being gathered and taken to an official laboratorium for analysis on contents of fat and protein. In addition, milk samples can be used for among others analysis of milk urea or somatic cell count.

Somatic cell count (SCC) in milk samples is obtained using Coulter Counter or Fossomatic equipment. Standardised procedures are available from the International Dairy Federation (www.idf.org). In milk of first parity cows, SCC ranges from 50,000-100,000 cells per ml from healthy udders to >1,000,000 cells per ml from udder quarters having an inflammatory infection. A current IDF standard is that subclinical mastitis is diagnosed in udders with milk having a SCC >200,000 cells per ml.

SCC can be presented either in absolute SCC or in classes based on the absolute SCC. As the distribution of absolute SCC is very skewed, generally a log-transformation is applied to a Somatic Cell Score (SCS). Other log-transformations are also used, sometimes including a correction of SCC for milk yield and effects like season and parity. SCS again can be analysed as a linear trait or used to define classes.

SCC and SCS are generally recorded on a periodical basis, especially when included in the regular milk-recording scheme. Per record, the unique animal number and day of sampling are to be supplied. When recorded on a periodical basis, animals just starting their lactation may be included. Milk in the first week of lactation has a strongly augmented level of SCC and records on animals less then 5 days in lactation are generally ignored in further analyses.
**Who?** Milk samples are taken either by an officer of the milk recording organisation or by the farmer. Logistics of handling samples (from the farmer to the laboratories) are generally organised by the milk recording organisation. It is important that these logistics include a strict unique identification of herd and individual cow number with each milk sample. Lab results will be transferred to the milk recording organisation, the last one also taking care of reporting the results in an informative way to the farmer.  

**When?** Sampling of milk of individual cows for analysis of fat and protein content, and thus also for SCC, is generally done with a three-, four- or five-weeks interval. With common milking systems, twice a day, sampling includes both morning and evening milking. With automated milking systems (robotic milking), sampling can be automatically performed on a 24-hours basis, taking samples from each visit of the cow to the robot.  

**7.3.3.4 Step 2 - Udder conformation**  

**What?** There are several characteristics that can be measured on the conformation of the udder. The most common ones are fore udder attachment, front teat placement, teat length, udder depth, rear udder height and median suspensory ligament (ICAR/WHFF; www.icar.org, Guidelines Section 5.1). Scoring these traits happens by scaling from 1 to 9. The figures below show the possibilities:
Section 7 - Guidelines for recording of functional traits

Fore udder attachment (FUA)

1 loose
5
9 tight

Front teat placement (FTP)

1 wide
5
9 narrow

Teat length (TL)

1 short
5
9 long
Udder depth (UD) (code 1 is lower than hock)

2 deep

5

9 shallow

Rear udder height (RUH)

1 low

5

9 high

Median suspensory ligament (MSL)

1 weak

5

9 strong
A report per cow is made of the six udder conformation traits mentioned above. An example of such a report is stated below:

<table>
<thead>
<tr>
<th>Cow number</th>
<th>Fore udder attachment</th>
<th>Front teat placement</th>
<th>Teat length</th>
<th>Udder depth</th>
<th>Rear udder height</th>
<th>Median suspensory ligament</th>
</tr>
</thead>
<tbody>
<tr>
<td>154389505385</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>6</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>154389505392</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>154389505404</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>154389505413</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Who? Specialised inspectors score the udder conformation from the data processing organisation. Their specialism can be guaranteed through regular meetings, where new standards can come up for discussion. The WHFF organises international standardisation of inspectors for the Holstein Friesian breed. The inspectors bring the records to the data processing organisation, where the records will be processed, stored and used for evaluation. Again, it is important that the reports include a strict unique identification of herd and individual cow number. The inspectors also leave a copy of the report with the farmer.

In order to let the udder conformation information be useful for estimating udder health, linkage of the udder conformation data to the SCC-information should be warranted.

When? In most current conformation scoring systems, only the cows in their first lactation are scored. This makes scoring at least once a year necessary, assuming a calving interval of 12 months. However, it would be better to score more than once a year, for example once per 9 months. A heifer with a calving interval of 11 months will be dried off after 9 months. Such a heifer can be missed, when scoring only once per 12 months is performed.

7.3.3.5 Step 3 - Milking speed

What? The milkability (or milking speed) can be measured routinely on a large scale by subjectively scoring (the milking speed of certain small numbers of cows can be measured with advanced equipment). A milkability-form contains the individual cows together with the possibilities “very slow, slow, average, fast or very fast milking”. An example of a milkability-form is stated below:
Who? The milkability-forms have to be filled up by the farmer. The farmer can send the form to the milk recording organisation or give the form to the officer of the milk recording organisation during the milk recording. After this the information can be used for the evaluation. Again, it is important that the forms include a strict unique identification of herd and individual cow number.

In order to let the milkability information be useful for estimating udder health, linkage of the milkability data to the SCC-information should be warranted.

When? As the milking speed does not really change over lactations, estimating the milking speed only in the cow’s first lactation is sufficient. Again, assuming a 12 months calving interval, makes a scoring of the milking speed once a year necessary.

7.3.3.6 Step 4 - Clinical mastitis incidence

What? In recording of udder health, the following general trait definition is recommended (following IDF recommendations):

- **Clinical mastitis** = inflammatory response of the udder: painful, red, swollen udder, with fever. This results in abnormal milk, and possibly outer visual or perceptible signs of the udder. Besides the cow can show a general illness.

- **Healthy udder** = absence of clinical or sub-clinical mastitis.
### Example of form for farmers recording mastitis incidents

<table>
<thead>
<tr>
<th>Person scoring</th>
<th>Farmer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organisation</td>
<td>TOP-COW-BRED</td>
</tr>
<tr>
<td>Herd</td>
<td>Hiemstra-dairy UBN 3459678</td>
</tr>
<tr>
<td>Period of inspection</td>
<td>January-June, 2002</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ear tag number</th>
<th>Date</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>cow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0538</td>
<td>January 26</td>
<td>Extremely clotted and watery “milk”</td>
</tr>
<tr>
<td>0576</td>
<td>February 5</td>
<td></td>
</tr>
<tr>
<td>0529</td>
<td>April 17</td>
<td>Teat injury</td>
</tr>
<tr>
<td>0541</td>
<td>May 31</td>
<td>Culled June 2nd</td>
</tr>
<tr>
<td>0602</td>
<td>June 2</td>
<td>Veterinary treatment</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Who?
A veterinarian or the farmer can record clinical mastitis incidence. The obtained information has to be processed (at the farm, by the veterinary service, or e.g., the milk recording organisation) and sent to a central database, which can be done by telephone or computer either from the farm directly or from the processing organisation.

### When?
Except for some specific infections during the growing period, mastitis is related to the lactation of the adult female. Individual mastitis incidents are to be recorded specifying calendar date, and a database link (using a unique animal number) then will have to provide lactation number and number of days in lactation. For this purpose the database will have to include birth date and calving dates of the individual animals.

The incidence of mastitis is generally expressed per lactation period, specifying lactation period number (or parity of the cow). Standardised length of the lactation period is 305 days. However, for mastitis incidence a standardised period of 15 days prior to calving until 210 days after calving is advised (or to date of culling if less than 210 days after calving).

Clinical mastitis can be recorded on a daily basis, i.e., all (new) incidents are registered when they are (first) observed and/or when they are (first) treated. Cows having no incidents are afterwards coded ‘healthy’. Clinical mastitis can also be recorded on a periodical basis, e.g. by a veterinarian visiting the farm monthly, coding all animals momentary diseased or healthy.

Additional information on mastitis incidence may be obtained from culling reasons. Culling reason potentially makes it possible to identify cows with mastitis that are culled instead of treated. When the culling reason is mastitis, this can be considered as an additional incident.

With registration on a daily basis, it becomes feasible to define the length of the incident. However, this requires very careful observation and registration. An incident may be defined as ‘repeated’ when the observation or veterinary treatment is 3 days or longer after the former observation or treatment. Other additional information on udder health is in recording the quarter.
### Examples

<table>
<thead>
<tr>
<th>Specification data</th>
<th>Specification definition</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norwegian Red, first parity</td>
<td>Clinical mastitis (0/1) - 15-210 days, including culling reasons</td>
<td>Heringstad <em>et al.</em> 2001 (Livestock Production Science, 67: 265-272)</td>
</tr>
</tbody>
</table>

### 7.3.3.6.1 Summarising mastitis

Basic observation: clinical mastitis, subclinical mastitis, healthy.

To be coded as:
- clinical vs (2) subclinical vs (0) healthy, or
- clinical vs (0) subclinical + healthy, or
- clinical + subclinical vs (0) healthy.

Primary data is unique cow number + observation mastitis + calendar date. This allows combination with other herd data, pedigree data, reproduction and milk recording data. This also allows calculation of a contemporary group mean (e.g., based on all animals in the same herd and parity).

Other aspects are:
- recording of incidents per lactation period -10 to 210 days in lactation
- repeated observation when 3 days or longer after last observation
- inclusion of culling for mastitis as additional incident.

### 7.3.3.6.2 Other udder health information

- Bacteriological culturing of milk samples to find the specific bacterium responsible for the inflammation (e.g., *Staphylococcus Aureus*, coliform, *Streptococcus agalactiae*) - recommendations on standard methodology are provided by the IDF
- removal of teats, teat injuries - there are standards for scoring of teat injuries, but these are not included in any official guideline

For the recording of subclinical mastitis, we can also use measurements others than SCC, either from on-line recording in the milking parlour or from centralised analysis of milk samples. In these recommendations, no further attention is paid to conductivity of milk, NAG-ase, and cytokines. A lot of work in this area is in progress and some of it is already implemented in automated milking systems - for further information we refer to information of the ICAR Sub-Committee on Meters and Jars.
7.3.3.7 Step 5 - Data quality

Recorded data should always be accompanied by a full description of the recording programme.
- How were herds selected?
- How were recording persons (e.g., veterinarians, and farmers) selected and instructed? Any standardised recording protocol used?
- What types of recording forms or (computer) programs are used? - What type of equipment is used?
- Is there any (change of) selection of animals within herds?

Each record should at least include a unique individual animal number, and the recording date. In case of mastitis, also a unique identification of person responsible for the recording is to be included. The unique individual animal number should facilitate a data link to a pedigree file (e.g., sire), milk recording file (e.g., calving date, birth date) and to a unique herd number. When this data links can not be established, each record on mastitis and somatic cell count should also include pedigree, birth date, calving date and parity and unique herd number.

After completion of recording, precise specification is required of any data checking, adjustment and selection steps. Examples:
- What types of data checks are practised? (E.g., does the unique number exist for a living animal, or is recording date within a known lactation period?)
- Are averages and standard deviations within herds or per recording person standardised?
- Is a minimum of records per herd, per animal or whatever applied before data analysis is started?

Consistency and completeness of the recording and representativeness of the data is of utmost importance. Any doubt on this is to be included in a discussion on the results. The amount of information and the data structure determine the accuracy of the result; measures of this accuracy should always be provided.

For general information on data quality, we refer to INTERBULL bulletin no. 28, and the reports of the ICAR working group on Data Quality.
7.3.4 Decision-support for genetic evaluation

7.3.4.1 Genetic evaluation

Information from a single farm can be combined with information from other farms to serve as a basis for a genetic evaluation (per region, country, or breeding organisation, or even internationally). A first prerequisite is of course that information is recorded in a uniform manner. A second prerequisite is a (national) database with appropriate data logistics to combine pedigree files (herd book, identification and registration), milk recording files and files with reproductive data.

7.3.4.2 Presentation of genetic evaluations

It is recommended that breeding values on udder health for marketed sires are available on a routinely basis, i.e., included in a listing of marketed sires by official organisations. The udder health index might be considered one of the major sub-indexes. The udder health index itself should preferably be composed of predicted breeding values for direct traits and predicted breeding values for indirect, indicator traits (i.e., udder conformation, SCS and milk flow). Combination of direct and indirect information maximises accuracy of selection on resistance towards clinical and subclinical mastitis. In turn, the udder health index should be used to compose an overall performance index, for an overall ranking of animals.

The udder health index can be presented (1) either in absolute units (e.g., monetary units or % of diseased daughters) or in relative terms, and (2) using either an observed or standardised standard deviation, and (3) relative to either an absolute or relative genetic basis (e.g., as a deviation from 100). It is recommended that a uniform basis of presenting indexes for functional traits is chosen per country or breeding organisation.

Within the udder health index, the weighting of predicted breeding values (PBVs) for direct and predictor traits is to be based on the information content - dependent on relationship between trait and udder health, and the accuracy of the PBVs (i.e., the number of underlying observations). As the information contents generally differ per sire, relative weighting within the udder health index should be performed on an individual sire basis.

Weighting of the udder health index as part of an overall ranking index is to be based on the relative (economic, ecological and social-cultural) value of genetically improved udder health relative to other traits.
Section 7 - Guidelines for recording of functional traits
SECTION 8 - DATA DEFINITION AND DATA TRANSFER

SECTION 8.1 - ICAR GUIDELINES FOR STRAW IDENTIFICATION FOR BOVINE SEMEN

8.1.1 Object of the guidelines

The guidelines define the minimum information to be printed on a bovine semen straw. If additional information is to be printed, general recommendations are also given in order to help the users.

8.1.2 Field of application

The guidelines apply to bovine semen straws used for international trade, for either fresh or deep-frozen semen.

8.1.3 Definitions

To code the identification of semen in bars and print it on semen straws for an use on field during the insemination act by AI technicians or farmers in do it yourself, following recommendations have to be implemented:

1. “2a” means two digits with an alphanumeric format.
2. “3n” means three digits with a numeric format.
3. “Bovine” means domestic animals of the genera *Bos*, *Bubalus* and *Bison* (include in particular the bovine species *Bos taurus*, Zebu *Bos indicus*, Indian buffalo *Bubulus bubalis*, American bison *Bison bison* and European bison *Bison bonasus*).
4. “Bull” means a bovine male as defined above.
5. “Ejaculate” means the semen released by one ejaculation.
6. “Collection” means the entire successive ejaculates from the same donor in the same day.
Section 8 - Data definition and data transfer

7. “Collection sequence for a given location and a given day” means the rank of the ejaculate within the bull collection (/n) or for all the bulls (/nn). It is also called charge number.

8. “Semen collection centre” means an approved and supervised establishment in which semen is collected and processed for use in artificial insemination.

9. “Semen processing centre” means an establishment in which semen is processed for use in artificial insemination.

10. “ISO country code” refers to the 2a list of codes ISO 3166.

11. “International identification” means a unique registration number provided by the country for all the bovine animals and preceded with the ISO country code.

12. “Bull code” means any code used to identify the bull for the management.

13. “Uniform bull code” means the unique identification used by NAAB comprising the so-called “stud code” (3n), the breed (2a) and a number (5n) unique within the “stud” and the breed.

14. "Bar code" means a system for coding alphanumeric numbers in bars deciphered by reader.

15. "Batch of semen" means a group of semen straws produced from ejaculate(s) of a specific bull, on a specific day, in a Semen Collection Centre (SCC), with the same specific treatment (ie extenders, sexing, specific dilution...).

16. "Batch identification" means a unique number to identify a batch of semen within a SCC either a serial number or combination of bull ID, collection date, ejaculate number. The Batch identification format is left to the action of SCC.

17. "Stud or marketing code" means a unique code assign by the NAAB (National Association of Animal Breeders) to identify SCC or AI marketing organisation. A fee is paid at first registration and then each year in case of commercial activity in the US.

18. "Barcode number" means a stud or marketing code + batch identification.

8.1.4 Straw Identification

8.1.4.1 Summary of the straw identification as a minimum requirement

- semen collection or processing centre code;
- breed (2a);
- identification of the bull;
- collection code (YYDDD).

8.1.4.2 Printing

The printer should be an ink jet printer to ensure the legibility of the information.

8.1.4.3 Order

Guidelines do not address the order of the information.
8.1.5 Information related with the semen collection or processing centre

The collection or processing centre from which semen is issued should be identified with a code. According to legal basis or to industry agreement this code should be either the collection code or the processing code. Within a country, centre codes printed on straws is either processing or collection and this information is available on reference lists.

If the semen is intended to be used within the European Union (EU), according to the Directive 88/407, the code should be the official EU code assigned for the approved “semen collection centre”. Outside of the EU another code to identify the processing centre can be used, for example the “stud code” assigned by the NAAB.

8.1.6 Information related to the bull

8.1.6.1 Breed

The recommended format is 2a. The ICAR short list of the most relevant breeds for the international trade in semen is attached to these guidelines. The breed code can be presented alone or as an integrated part of the uniform bull code.

8.1.6.2 Identification of the bull

It can be either the Interbull international identification code or a world-wide unique bull code. The international identification comprises the ISO country code (2a) and a registration number of the bull within the country (max 12n), for instance FR1234567890. This international identification is used for any purpose including traceability. It may or may not be the HB number. If a bull code is used, it must be cross-referenced on the transport documents with the international identification of the bull.

This bull code can be:

- The “uniform bull code” from NAAB (example 132H012345).
- A unique national bull number preceded by the ISO country code (example FR12345).

8.1.7 Information related with the semen

8.1.8.1 Collection code

It is recommended to print the collection date with the Julian format “YYDDD” where YY is the two last digits of the year (99, 01) and DDD is the day number (from 001 to 366). The collection sequence is considered as an additional information, but if it is printed, it should be adjusted to the date separated with a slash “YYDDD/1”. 
8.1.7.2 Format for additional information

A) **Name.** Either the short name (commercial name) or the full name can be used.

B) **Collection sequence.** It should be adjusted to the date separated with a slash “YYDDD/1”.

C) **Compulsory information.** Within the EU, semen produced has to be labelled with its IBR status. The format for this has to be defined by the European Commission and will be part of this recommendation as soon as it is available.

8.1.8 **Barcode Identification of straw**

To code the identification of semen in bars and print it on semen straws for an use on field during the insemination act by AI technicians or farmers in do it yourself, following recommendations have to be implemented.

8.1.8.1 **General rules**

- Barcode doesn't substitute for official visible identification of semen straws that is printed according to ICAR Guidelines, Section 8.1.4.1.

- Barcode with the system 128C (see point 1 at 8.1.9.6) is highly recommended.

- The barcode must be as short as possible because it's the principal factor to obtain a high percentage of success when reading it. According to the state of art in 2008, for an easy reading on field, a maximal number of 13 digits is suggested.

- Barcode is recommended to contain only numeric characters (see point 2 at 8.1.9.6).

- Some characteristics of the straws (ie colour…) affects the readability of the barcode. So it's recommended to test straws before use with barcode.

- The barcode number (definition 8.1.3) refers to an unique ID for any batch of semen (definition 8.1.2).

- The format of this number
  - Refers for its first 3 digits to an unique reference number of SCC allocated by ICAR as described in 8.1.8.2 and defined in 8.1.3
  - Refers for the other digits to an unique batch identification as defined in 8.1.3.

- The list of ID of SCC utilising a barcode system is maintained by ICAR. This list is unique in the world and consistent with the list of SCC ID (Stud and marketing codes) allocated by the NAAB.

8.1.8.2 **Allocation of ID of SCC and publishing barcode format**

- Any SCC utilising a barcode system for international usage has to inform ICAR. ICAR will allocate a unique ID to the SCC.

- SCC provides ICAR with the ID stud or marketing code allocated by the NAAB if it already has one.

- An allocated ID will be valid for 20 years after the day when the SCC stops its activity to guaranty its uniqueness in bar coding. It doesn't change if the SCC modifies its system of barcode.
At the same time, the SCC informs ICAR of the format of the barcode number. ICAR publishes this format on the web site and renders it accessible to any user (§4).

ICAR and NAAB manage together the system of allocation of ID SCC and fix various problems arising in using an unique ID for the 2 organisations:

8.1.8.3 Management of barcodes within SCC and for the movements of semen

Any SCC running a barcode system maintains a data base where any barcode number on straw is cross referenced with the official data printed on straws (ICAR Guidelines, section 8.1). Optional information may also be attached to the data base.

Any client receiving semen may get from its supplier (distributor, AI Company…) the necessary data to cross reference barcode number with the official straw identification in accordance with the ICAR guidelines (Section 8.1) and eventually optional requested information.

After reading it is highly recommended that the barcode number is stored in the user data base as a raw data.

8.1.9 Explanatory notes
Comments on the recommendation

8.1.9.1 History of the discussions
Several attempts have been made to define an international recommendation for straw identification from which are the following:

- ICAR proposal of September 1995
- IFAB proposal of June 1998
- QualiVet proposal of November 1998

All these approaches were to define precisely the entire sequence to be printed on the straw and tried to combine the requests of the different countries. As a result, the previous statements resulted in rather long identification and eventually failed to reach a full agreement from the different countries.

The actual recommendation tries more to set up the principle of the identification rather than to reach a full agreement on the sequence printed on the straws.

Basic ideas were:

- The straw should not be considered like a database by itself.
- The minimum information for official recording purposes is ‘centre/bull/date’ and for field recording by the technician ‘bull/date’.
- For ease of use by the technician on farm and accuracy, the number of data items should be kept as few as possible and in large print.
8.1.9.2 Semen collection centre

The “semen collection centre” is a specific facility for the collection of bull semen and should not be confused or replaced by the ‘owner identification’.

It is the approved and supervised “semen collection centre” which should be under an obligation to ensure that the semen has been obtained from animals whose health status is such as to ensure that the risk of spread of animal disease is eliminated, and has been collected, processed, stored and transported in accordance with hygienic rules and rules which preserve its health status.

8.1.9.3 Collection code

Printing a date instead of a code is advisable for transparency to the customer.

Most people prefer having a “real” date like “11 March 99” than a Julian date YYDDD comprising year + day in the year.

The main reason why the Julian format was chosen was the ambiguity of the information 02/05/03 that could be naturally interpreted in different countries as DDMMYY YYMMDY or MMDDYY. Another reason is the compactness of the Julian format (5n) and the ease of reading with the sequence number (99032/1).

The collection sequence is considered as additional information because lots of centres mix the ejaculates of the same collection and thus do not want to systematically print “/1” for nothing.

8.1.9.4 Name

Some people support a short name that is easy to read for the technician and others prefers a full name to avoid confusion between bulls. No agreement could be reached for the format.

8.1.9.5 Identification

The international identification is up to now the only identification universally accepted world-wide. It was logical to recommend that this be the minimum printed on the straw. But since this identification is long, it is not practical to read it in liquid nitrogen neither to record it on farm for the insemination. Every country is thus using either the bull name or a bull code. An agreement was reached to not impose the international identification for those countries used to managing unique bull codes, but it can also be used when required.

8.1.9.6 Barcode identification of straw

1. We choose to recommend the type of barcode for several reasons: readers are not able to read all the types of barcodes and the 128 C type is compact (about 17 mm long for a 10 digit numeric barcode and 23 to 25 mm long for a 13 digit numeric code). However as technologies advances this recommendation may change.

2. In a barcode 128C, alphanumeric characters take 3 to 4 times more space than numeric characters. Considering the elements to write on a straw, numeric characters are presently more compatible with the available space.
SECTION 8.2 - PROCEDURE TO HANDLE BREED CODES ON SEMEN STRAWS

8.2.1 Article 1

The general purpose of the list of breed codes is to facilitate traceability of semen that is traded across country borders. The code should thus be used to identify the breed of the bull on semen straws that are used in another country than the country of origin (sampling).

8.2.2 Article 2

The breed codes printed on straws do not apply:

• to identification of breeds in the international genetic evaluations for bulls offered by Interbull.

• to procedures of registration of the progeny: the use of the breed code printed on the straw doesn’t make provision for the breed of the calf born out of the insemination using the semen unit nor it’s registration in the Herd-Book of the breed of the sire.

8.2.3 Article 3

Breeds can be added to the code list, provided semen from bulls of the breed is exported in a significant number and to a significant number of countries.

In 2004 “significant number” means that more than 10,000 doses have been exported in more than 3 countries. These figures may change according to the experience in processing such demands; then new rules will be published.

8.2.4 Article 4

Any party requesting that a breed is added to the list of codes should provide unequivocal evidence that:

1. The breed does not belong to a breed already on the list.

2. The breed is recognized as a separate breed, e.g. recognized by a breed society.

3. There is significant international exchange of genetic material from the breed, e.g. by showing country of origin, number of doses (semen straws) produced in country of origin, number of doses (semen straws) exported, according to article 3.

8.2.5 Article 5

Any party requesting that a (local) breed is added to an already existing group of breeds should provide unequivocal evidence that the request is warranted. The request should be seconded by at least one other party representing a breed already included in the group.
8.2.6 Article 6

New breed codes should be unique and should be assigned based primarily on the name and/or abbreviation of the breed used in the country of origin. The second character in the breed code should be exchanged if the most logical 2-character code is already in use.

8.2.7 Article 7

The list of breed codes is maintained by the Interbull Centre. Requests for updating or adding breed codes should be submitted to the Interbull Centre by e-mail, fax or letter. Requests, and results of requests, should be officially announced on the Interbull web-site accommodating the breed code list.

8.2.8 Article 8

This procedure is published and up-dated on the ICAR web site as an annex of the chapter "straw-identification".

8.2.9 Article 9

If a requesting party disagrees with the result of the procedure handled as describe before it may submit the case to ICAR board, that will make the final decision.
SECTION 9.1 PART 1 – GENETIC EVALUATION SYSTEMS IN DAIRY CATTLE

The present Guidelines are based on “INTERBULL Guidelines for National and International Genetic Evaluation Systems in Dairy Cattle with Special Focus on Production Traits” (INTERBULL Bulletin 28) and the latest INTERBULL survey (INTERBULL Bulletin 24), “National Genetic Evaluation Programmes for Dairy Production Traits Practiced in INTERBULL Member Countries 1999 2000” with information on GES in 36 organisations from 31 countries (available through www.interbull.org). They deal only with production traits but the same principles can in most cases be equally well applied to other traits.

In this document Genetic Evaluation System (GES) is meant to include all aspects from population structure and data collection to publication of results. Each and every statistical treatment of the data that has a genetic breeding motivation or justification is an integrated part of GES.

The purpose of this set of guidelines is to facilitate a higher degree of harmonisation in the things that can be harmonised and to encourage documentation of the things that cannot be harmonised at this juncture of time. These guidelines should increase the quality and accuracy of evaluations at the national and international level. The aim is also to increase clarity in showing the biological and statistical reasons for what is done in national GES.

Recommendations presented here should also be viewed holistically as a coherent system. Every specific recommendation presupposes acceptance and adherence to many other such specific recommendations. Therefore, and as an example, when “unique identification of all animals” is recommended in one section, then all further reference to “animals” is to be interpreted as “uniquely identified animals”.

1. National genetic evaluation centres should keep official, up to date and detailed documentation on all aspects of their GES. Documentation on all aspects of GES should also be placed on the Internet. They should update their GES in a cost effective manner as the theoretical developments and computer capacity permit and place information on any change on Internet as soon as it has taken place.
9.1.1 Pre-evaluation steps

9.1.1.1 Assignment to a breed of evaluation

2. All countries are recommended to establish national GES for all of their locally and internationally recognised breeds. Assignment of an animal to a specific breed is justified if 75% of the animal’s genes originate from that breed (or both sire and maternal grandsire are from the breed of evaluation).

9.1.1.2 Animal identification

3. All animals should be identified and registered in accordance with the ICAR Rules, Standards and Guidelines on Methods of Identification (Section 1.1 of the International Agreement on Animal Recording and ICAR Guidelines).

4. Each animal’s ID should be unique to that animal, given to the animal at birth, never be used again for any other animal, and be used throughout the life of the animal in the country of birth and also by all other countries. The following information should be provided for each animal:

<table>
<thead>
<tr>
<th>Breed code</th>
<th>Character 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country of birth code</td>
<td>Character 3</td>
</tr>
<tr>
<td>Sex code</td>
<td>Character 1</td>
</tr>
<tr>
<td>Animal code</td>
<td>Character 12</td>
</tr>
</tbody>
</table>

5. All parts of an animal ID should be kept intact. If, for any reason, modification of the original animal ID is necessary, it should be considered as a re-registration and fully documented by a cross-reference table relating the original (and intact) animal ID and the new animal ID.

9.1.1.3 Pedigree information

6. The parentage of an animal shall be recorded by identifying and recording the service sire and the served animal at the time of service, as provided for in ICAR Rules on Parentage Recording.

7. Genetic evaluation centres should, in co-operation with other interested parties, keep track and report percentage of animals with missing ID and pedigree information. The overall quantitative measures of data quality should include percentage of sire and dam identified animals or alternatively percentage of missing IDs.

8. The doubtful pedigree and birth information should be set to unknown (set parent ID to zero).

9. To ensure sufficient pedigree information it is recommended that, even if production traits/records are not available, the pedigree information from the animals born within a period equivalent to a Minimum of 3 generation intervals is included in the evaluations.
9.1.1.4 Genetic defects

10. The information that the animal is a carrier of genetic defects defined by the International Breed Association concerned should be made available internationally as soon as possible after their existence is discovered.

9.1.1.5 Sire categories

11. Countries should clearly and correctly describe different sire categories, that is to distinguish between domestically proven bulls vs. imported bulls, young bulls with first batch of daughters vs. proven bulls with second batch of daughters, and most important of all between NS bulls vs. AI bulls. Quantitative measures should be employed to define AI bulls. Responsible organisations are recommended to strive for establishing daughters in a large number of herds (preferably > 10) for young AI bulls.

12. Young bulls may be used in simultaneous progeny testing in two or more countries with large enough number of daughters in each country to warrant an independent official evaluation. These bulls should clearly be classified as “simultaneously progeny tested bulls”.

9.1.1.6 Traits of evaluation

13. Direct measurement of traits and utilisation of the metric system is encouraged. Recording organisations should adopt recording schemes that ensure accurate collection and reporting of all data. It is recommended that national genetic evaluation centres provide detailed definitions of traits on their web sites. The definitions should include all data checks and edits, such as range of acceptable phenotypic values, age, parity, etc.

9.1.1.7 Data requirements for various traits of interest

14. Records of all animals with known Animal ID should be included in the genetic evaluations.

15. All records should be accompanied by relevant dates (birth, calving, etc.).

16. All records should be accompanied by sufficient information for formation of contemporary groups, such as herd and geographical location of the herd (e.g. region). Information on internationally standardised methods of recording should be included. An example for the production traits is ICAR A4, A6, B4, etc.

17. All other relevant information, depending on the trait of interest, should accompany the number of milkings per day, production system (e.g. Alpine pasture, total mixed ration (TMR) or grazing), methods for estimation of 24 hour and 305 day yields, extension methods, adjustment methods etc.

18. Number of years of production data to be included in the evaluations should desirably be equal to at least 3 generation intervals (e.g. 15 years) of consistently recorded data.
9.1.1.8 Number of lactations included

19. Number of lactations to be included in the evaluations is recommended to be at least three. Breeding values should be produced for the whole lactation period, separately for different lactations. Separate breeding values should then be combined into one single composite breeding value for each trait for the whole life, in which different lactations are given separate weights based on each lactation’s economic value.

9.1.1.9 Data quality

20. It is desirable that all data related to all animals (herd book, insemination, milk recording, veterinary practices, etc.), irrespective of their sources, be available to the genetic evaluation centres in form of an integrated database. A complete documentation of data checks, including data edits conducted by milk recording organisations, is essential. All member organisations / countries should adopt quantitative measures of assessing data quality. National genetic evaluation centres should devise simple methods of checking for detection of outliers and exclusion of logical inconsistencies in the input data. Biological improbabilities should also be checked. Extra precautions should be employed so that no inadvertent selection of data or introduction of bias becomes possible. Poor quality data should be excluded from genetic evaluations. Complete documentation of all procedures to check and edit the data is very important. National genetic evaluation centres are encouraged to have quality assurance systems implemented.

9.1.1.10 Inclusion and extension of records

21. Different kinds of lactations, *i.e.* records in progress, records from culled cows, records of dried off cows (*i.e.* lactations of cows remaining in the herd but terminated artificially because of a new pregnancy or any other management reasons), naturally terminated lactations shorter than 305 days and finally, lactations longer than 305 days should be identified in the system and treated differently.

22. All records with e≥45 DIM or two test days should be included in the evaluations. Extension or lack thereof should be decided upon after enough scientific/empirical justifications have been established for each kind of lactation. Records in progress and short lactations from culled cows should normally be extended. Lactations of cows dried off before 305 days and naturally terminated lactations shorter than 305 days may be extended provided adjustment for days open and / or current calving interval have not been satisfactory. Data from lactations longer than 305 days should be cut at 305 days.

23. Extension methods and factors should be re evaluated continually to ensure that they are up to date and that no unplanned selection of data occurs. Extension factors should be re estimated at least every 5 years. Different kinds of lactations should be extended using the same extension method and different extension factors. Extension rules and methods should be the same across lactations. When ever the data span over many years the extension rules and factors should be appropriate and specific to the various time periods.
9.1.1.11 Pre-adjustment of records

24. All effects should preferably be accounted for in the evaluation model. If records are to be pre adjusted, it is more justifiable to do so for those environmental effects that are in need of multiplicative adjustments. Effects in need of additive adjustments should be considered in the model. In any case, adjustment should be made to the population mean and not to an extreme class. Pre adjustment factors should be updated as often as possible (at least once per generation), and be specific to different time periods.

9.1.2 Evaluation step

9.1.2.1 Statistical treatment and effects in the genetic evaluation model

25. Organisations responsible for national GES should strive for simplicity of the analysis model and avoid amendments that reduce simplicity and clarity of the analysis model. The best model should be decided upon considering the fit and predictive ability of the model.

26. Decision on statistical treatments and effects in model should take into consideration several factors, such as:
   a)  How large are (contemporary) group sizes?
   b)  Are the estimates of parameters constant over time?
   c)  Are multiplicative adjustment factors necessary?
   d)  What are the consequences of the environmental effects being adjusted for or included in the model for components of variance?
   e)  Is the effect to be estimated from data or from the main random effects included in the model (breeding values, residuals)?
   f)  What are effects of different combination of parameters on the degree of freedom and of the fit of the model?

27. In considering an effect as fixed or random the following should be taken into consideration:
   •  If there is enough evidence to suggest that the effect is non randomly associated with the main random effect;
   •  If number of levels is small;
   •  If size of groups is large;
   •  If the effect has a repeating nature;
   •  If the effect is used to elucidate the time trend.

28. For the choice of evaluation model for milk production traits the following set of priorities is recommended:
   a)  An animal model in contrast to a sire model;
   b)  A within lactation multiple trait model in contrast to a within lactation single trait model;
   c)  A multiple lactation model in contrast to a single lactation model;
   d)  A multiple trait multiple lactation model in contrast to a single trait repeatability model;
   e)  A test day model in contrast to a lactation model.
EXPLANATORY NOTE:
The above recommendation almost exclusively deals with milk production traits and does not take into consideration many aspects of genetic analysis models for other traits. The guiding principle is to choose a model that is more capable of utilising (or exposing) the genetic variation. It translates into choice of models that have either theoretical superiority or enable us to obtain an estimate of an animal’s breeding value that encompass a larger proportion of animal’s genome and/or life time. INTERBULL recommends adherence to superior theoretical models and encourages identification of the practical circumstances under which the theoretical expectations are not realised.

9.1.2.2 Model’s unbiasedness

29. For the purpose of international genetic evaluations unbiasedness should be considered as the most important single criteria, although some degree of compromise can be envisaged for the national genetic evaluation, for example to avoid high prediction error variance.

9.1.2.3 Genetic parameters

30. Phenotypic and genetic parameters should be estimated as often as possible and definitely, at least, once per generation. All aspects of estimation procedures for estimation of variance components (data structure, method and model of estimation, effects included in the model and so on) should be as similar as possible to the estimation procedures for breeding values.

9.1.2.4 Use of phantom parent groups

31. The evaluation procedure should be certain to group unknown parents according to breed, country of origin, selection path and birth date or some other method to establish time trends. The procedures used for formation of phantom parent groups must give special attention to imported animals in order to evaluate correctly these in the national GES. Phantom parent groups should have a minimum size of 10-20 animals, although larger groups may be necessary for traits with low heritability.

9.1.3 Post-evaluation steps

9.1.3.1 Criteria for official publication of evaluation

32. In general, evaluation results should be accompanied by reliabilities for EBVs and considered as official for all animals entering national GES. For randomly sampled young bulls a minimum Effective Daughter Contribution (EDC, visit www.interbull.org for more information) of 10 is recommended. Official publications of individual EBV by national genetic evaluation centers should include the most recent figures or information on:
   a) Effective daughters contribution or number of daughters and their distribution over herds (e.g. number of daughters and herds, highest percentage of daughters in a single herd, etc);
   b) Number or percentage of freshened daughters being excluded from the evaluations and also the number or percentage of evaluated daughters being culled before 305 days in the first lactation or alternatively before the second lactation. When lactations in progress are
extended and used, the percentage of records in progress (RIP) should be given. For national GES practicing a test day model average number of days in milk (DIM) for daughters of a bull is considered to be equivalent to %RIP in a lactation model;
c) The theoretically expected reliability of the evaluation;
d) The type of evaluation, i.e. whether the evaluation is a result of regular Artificial Insemination service (i.e. planned progeny testing program) or not. For AI proofs a distinction must be made between (1) those of domestic young sampling bulls; (2) those of simultaneously progeny tested young bulls; (3) those based on the second batch of daughters of already proven bulls, and (4) those resulting from use of imported semen (see also the section on Sire categories);
e) Breed and definition of the genetic base.

9.1.3.2 System validation
33. GES should be validated by data checks, checks of phenotypic values, and comparisons of breeding values, etc.
34. The three INTERBULL trend validation methods I, II and III should be used for validation of national evaluations. Monitoring and examination of Mendelian sampling and residuals could also be utilized.

9.1.3.3 Expression of genetic evaluation
35. The use of absolute EBVs is recommended, though the use of RBVs for domestic use and composite traits or indices may continue. However, in order to facilitate the international use of domestically published breeding values, in addition to the domestically used method of expression, all traits should be expressed as absolute Estimated Breeding Values (EBV), in the metric system (if applicable). Such values relate directly to the additive genetic value of the animal itself as well as to actual amounts of products.
36. Evaluation centers should provide detailed information on the definition and statistical properties (including descriptive statistics) of EBVs and RBVs on their web sites.

9.1.3.4 Genetic base
37. INTERBULL’s recommendation for definition of genetic base at the national level for production traits is to utilize information of cows born at the onset of specific 5 year periods as is outlined below. Thus, member countries should endeavor to:
a) Use cows;
b) Use birth year;
c) Use all animals that entered national GES;
d) Use average genetic merit (EB V);
e) Use stepwise change of genetic base;
f) Change the base in the years ending with 0 or 5;
g) Use cows born 5 years before the onset of the new 5 year period;
h) Change the base in the first evaluation in the years ending with 0 or 5.
38. For designation of genetic base the following convention should be followed: 1) A letter indicating breed of evaluation (e.g. A, B, G, H, J, or S for different breeds); 2) Two digits indicating the year of base established (e.g. 00 for year 2000); 3) A letter indicating type of animals included (e.g. C, or B, for cows or bulls); 4) A letter indicating the event used (e.g. B, or C, for birth or calving); and finally 5) Two digits to indicate the event’s year (e.g. 95 for year 1995).

9.1.3.5 Number of evaluations per year

39. It is recommended that national GES be scheduled to be able to provide current and up to date inputs to the INTERBULL evaluations, which currently are performed four times per year (in February, May, August and November).

9.1.3.6 Advertising genetic merit

40. Genetic evaluation centres are encouraged to establish and enforce code of ethics for the use of their evaluations.

41. Publication of genetic evaluations should include at least the following:
   a. Source (genetic evaluation centre) of evaluation and country of scale, if appropriate.
   b. Date of evaluation and genetic base definition.
   c. Evaluation expression, e.g. EBV, PTA, RBV.
   d. Evaluation units, e.g. kg, lbs.
   e. Reliability.

42. Evaluations should be presented in the same units they are published in by the evaluation centre that provide them. In no case shall official units or expressions be manipulated.

9.1.3.7 Use of indexes

43. Countries are encouraged to have separate indices for different categories of traits, and for total economic merit.

9.1.3.8 Anticipated change

44. Genetic evaluation centers are encouraged to set up a long term, contingency timetable for possible future changes in all aspects of their GES. These timetables are expected to be announced world wide well in advance so that other genetic evaluation centers can accommodate to the changes.

9.1.3.9 Web site

45. National genetic evaluation centers and other relevant organizations should set up internet information sites that contain a complete documentation of the whole GES (including tables of overall statistics and EBVs of AI bulls). The information contents of these home pages are expected to be, at least, as detailed as the information published by INTERBULL in INTERBULL Bulletin 24 (visit www.interbull.org). Those parts of GES that are concerned with the processes (the way the
data are treated) are recommended to be available in English in addition to the native language. National genetic evaluation centers should regularly update their links on the Interbull’s home page.

9.1.4 International evaluation

9.1.4.1 Comparison of animal evaluations

46. Data used for comparison of animal evaluations across countries or international genetic evaluations should be checked for possible errors and/or inconsistencies by the national genetic evaluation centers involved.

47. International comparisons are recommended to utilize Interbull genetic evaluation results for all country-breed-trait combinations where such exists.

48. For those country-breed-trait combinations that an Interbull evaluation does not exist, utilization of the MACE (Multiple-trait Across Country Evaluation) methodology is recommended.

49. Ease of application may necessitate the use of conversion equations developed from simple regression analysis of bulls' progeny in two countries, i.e. a bulls' performance in one country is predicted from its performance in another.

50. A simultaneous sire evaluation for the same bull in several countries is an important factor needed to convert breeding values from one country to another. It is therefore highly desirable that simultaneous and joint progeny testing of young bulls is promoted widely.

9.1.4.2 Minimum correlations and trait harmonization

51. If the correlation between two countries is lower than $\rho = 0.70$ the countries involved are recommended to investigate all possible causes of low correlation, especially to examine if trait definition, genetic evaluation model and problems associated with IDs are contributing to the low correlation. In such cases action to harmonize GES in the countries involved should be taken.

9.1.4.3 Validity of MACE results

52. Always the latest available national results should be used for the MACE analysis. New genetic correlations should be preferably estimated each time the breeding values are estimated, but certainly whenever:

- The change in sire variance in any of the countries involved is more than 5% compared to the previous evaluation.

- A change in methodology, base etc has occurred in either of the countries involved;

- There is a substantial increase/change in number of bulls with evaluations in either of the countries.
9.1.4.4 INTERBULL evaluations

53. The specific requirements for participation in INTERBULL international genetic evaluations are regulated by the INTERBULL code of practice, with amendments.

9.1.4.5 Publication of INTERBULL (MACE) evaluations

54. Status of the INTERBULL evaluations in each country and whether they are considered official or not, is decided upon by national genetic evaluation centers. Publication and advertisement of INTERBULL evaluations is regulated by INTERBULL’s “Code of Practice” and especially through the “Advertising Guidelines”.

55. Publication of INTERBULL evaluation results, *i.e.* EBVs for all bulls (irrespective of their origin) in the domestic scale is the responsibility of the national genetic evaluation centers. These are expected to make the results available to all domestic and foreign interested parties in all countries participating in INTERBULL evaluations. As is the case for publication of national genetic evaluation results, EBV’s for all bulls should be published together with the reliabilities for the estimates.
SECTION 10.1 - ICAR TESTING AND CERTIFICATION PROCEDURES FOR ID DEVICES

10.1.1 Foreword

This section provides a general introduction to the principles and procedures developed for testing and certification of animal identification devices by ICAR.

On June 22, 2007 ISO appointed ICAR as the Registration Authority (RA) competent to register manufacturer codes used in the radio frequency identification (RFID) of animals in accordance with ISO 11784 and ISO 11785.

ICAR has administrative procedures in place for testing the conformance of RFID devices in respect to ISO 11784 and ISO 11785. Only those results emanating from accredited and RA-approved test centres are recognized. In addition, ICAR offers evaluations on various quality and performance features of those same devices subjected to the ICAR conformance test and these evaluations are also available for conventional plastic eartags.

10.1.2 Test categories

Testing of identification devices can be subdivided into three main categories (Table 1).

A. RFID Conformance test (ISO 24631-1)
   Conformance testing is required to demonstrate electronic transponders meet the specifications and standards in ISO 11784 and ISO 11785. The submission of identification devices to conformance testing is obligatory before they can be used in the official identification of animals.
   Conformance tests are coordinated by Service-ICAR. Acting as the Registration Authority (RA) on behalf of ISO, ICAR issues a Certificate of Conformance for RFID devices conforming with ISO 11784 and ISO 11785.

B. RFID Performance test (ISO 24631-3)
   Performance testing is an evaluation of the following characteristics of an RFID device: modulation amplitude, bit length stability, minimum activation field strength resonance frequency and amplitudevoltage response (Vss). These RFID performance test results are not subject to pass or fail criteria but provide useful additional information on device behaviour when communicating with...
a reader. Acting as the Registration Authority (RA) on behalf of ISO, ICAR evaluates RFID devices through the RFID performance test and issues an evaluation report to the submitting manufacturer accordingly.

C. Device composition and environmental performance test (ICAR)
ICAR offers a device composition and environmental performance test for both conventional plastic and RFID ear tags. The objective of these tests is to give extensive information on device durability and performance in diverse animal management conditions. Procedures will vary depending on the device type. ICAR issues an evaluation report and ICAR certificate for devices in accordance with the specifications of the respective ICAR standards described in sections 10.7 and 10.8.

<table>
<thead>
<tr>
<th>Test Category</th>
<th>Test Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Application&lt;br&gt;(for any kind or combination of identification devices)</td>
</tr>
<tr>
<td>Laboratory Test</td>
<td>Transponder conformance&lt;br&gt;(granting of manufacturer code)</td>
</tr>
<tr>
<td>Conformance ISO 24631-1</td>
<td>Transponder performance</td>
</tr>
<tr>
<td>Performance ISO 24631-3</td>
<td>Extended laboratory test&lt;br&gt;(for any kind or combination of identification devices)</td>
</tr>
</tbody>
</table>

### 10.1.3 Scope and formal steps for achieving an ICAR certification of identification devices

This section describes and summarises the ICAR rules and procedures applied in the testing of identification devices including both RFID devices and conventional plastic ear tags. ICAR certification of identification devices is outlined below and illustrated in Tables 1 and 2.

- A manufacturer applies for a test or re-test of an identification device. The application consists of a letter and an application form, which should be sent to the Service-ICAR secretariat.
- The application forms are available on the ICAR website (www.icar.org/pages/ICAR_certification/animal_identification_application_for_testing.htm).
- Service-ICAR confirmation of admittance to participate and issuance of test contract.
- Financial transactions between manufacturers, test centres and ICAR are coordinated by Service-ICAR.
- The manufacturer will send all the necessary devices and accessories to the test centre carrying out the tests. The devices and accessories remain the property of ICAR.
- The test centre will test the devices as described in the respective test protocols.
- The test centre will prepare a confidential report of the test results and will send the report to the Service-ICAR secretariat.
- Service-ICAR will send the test report to the manufacturer and, in the case of a successful Conformance test result, an official ICAR letter of certification signed by the Secretary General of ICAR will also be sent to the manufacturer. For other tests not subjected to pass or fail criteria, an official ICAR letter acknowledging the completion of those evaluation will be sent to the manufacturer.

- ICAR will publish all ICAR certified products along with their test reference number(s) on the ICAR website. When the validity of the ICAR certification has expired for an RFID device, the device will be moved from the ICAR certified products webpage to the webpage listing RA registered devices only. A photograph of the identification device will accompany the the online product list on both the ICAR certified webpage and the ICAR registered only webpage.

**Table 2. Steps, actions and responsibilities to receive ICAR certification.**

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Application for participation in testing of devices</td>
<td>Manufacturer or dealer of identification device</td>
</tr>
<tr>
<td>2</td>
<td>Confirmation of admittance to participate and issuance of test contract</td>
<td>Service-ICAR</td>
</tr>
<tr>
<td>3</td>
<td>Testing and report compilation</td>
<td>ICAR test centres</td>
</tr>
<tr>
<td>4</td>
<td>Advice of test results to the device submitting entity</td>
<td>Service-ICAR</td>
</tr>
<tr>
<td>5</td>
<td>ICAR certification</td>
<td>ICAR</td>
</tr>
</tbody>
</table>

### 10.1.4 Test centres

Test procedures must be conducted by accredited and RA approved test centres. Each test is contracted by Service-ICAR to a specific test centre. The test centre is obliged to act according to the procedures laid down within the test protocols. In addition, all details associated with the testing phase, including the test results must be kept strictly confidential. Test centres are regularly monitored by the ICAR Sub-Committee for Animal Identification.

### 10.1.5 Publication of test results

ICAR certifications and advice of successful and / or completed tests will be published on the ICAR website ([www.icar.org](http://www.icar.org)).

### 10.1.6 Conditions for the use of ICAR certificates

Every certificate issued by ICAR is valid for 5 years and commits the manufacturer to a list of validation conditions.

If a device is certified by ICAR, the manufacturer may publish the certification of its device. ICAR certification does not guarantee the device is suitable for all environments.
While an ICAR certificate is valid for 5 years, the registration of an RFID device is unlimited and all registered RFID devices will be listed on the ICAR website.

**Note:** A manufacturer must not use the ICAR logo for any purpose.
SECTION 10.2 - RADIO FREQUENCY IDENTIFICATION OF ANIMALS: ISO 11784 AND ISO 11785 - CONFORMANCE OF TRANSPONDERS INCLUDING GRANTING OF USE OF MANUFACTURER CODE

10.2.1 Foreword

ISO 11785 defines the test protocols for evaluating and verifying both the conformance and performance of RFID devices and ISO 11784 the code structure. Only those results emanating from accredited and RA-approved test centres are recognized.

10.2.2 Introduction

ISO 11784 and ISO 11785 cover four RFID device types used for animal identification:

1. Injectables: a small transponder able to be injected into an animal's body. The transponder is encapsulated in a biocompatible and non porous material, e.g. glass.

2. Ear tag: a plastic covered transponder able to be fixed to an animal's ear using a locking mechanism which prevents the device from being removed without damaging it and rendering it unusable.

3. Ruminal bolus: a transponder placed into a high specific gravity container orally administered to a ruminant animal where the device remains in the stomach of the animal due its high specific gravity which prevents its passing through the animal's digestive system.

4. Tag attachment: a transponder covered by a primary protection layer but without its own locking system and is used only as an attachment to a visual ear tag or to another means of external animal identification, e.g. leg tag, collar, etc.

The tests carried out by ICAR as RA are recognised by the Federation of European Companion Animals Veterinary Association (FECAVA) and WSAVA (World Small Animal Veterinarian Association) and as such can be applied to companion animals also.

The fee for all tests will be borne by the applicant.

10.2.3 References

| ISO 11784 | Agricultural equipment - Radio frequency identification of animals - Code structure |
| ISO 11785 | Agricultural equipment - Radio frequency identification of animals - Technical concept |
| ISO 3166 | Codes for the representation of names of countries and their subdivisions |

The latest version of ISO Standards will always apply and these Standards can be downloaded from the ISO website (www.iso.org).
10.2.4 Procedures for verifying the ISO conformance of transponders

Application

A manufacturer can apply for:

A. a full test; or
B. a limited test; or
C. a listing update.

A. A full test is mandatory in the following cases:
- When a non-RA registered manufacturer applies for a test.
- When a RA registered manufacturer uses a new silicon chip (Integrated Circuit) or implements new technology (HDX or FDX-B) in the transponder;
- When a RA registered manufacturer changes the coil technology (ferrite coils vs. air coils).

B. A limited test is applicable in the following cases:
- When a RA registered manufacturer inserts an ICAR certified transponder into a different primary transponder package.
- When a RA registered manufacturer uses the silicon chip of an ICAR certified transponder with different coil dimensions.
- When a RA registered manufacturer inserts an ICAR certified transponder with its original primary packaging into a different secondary packaging, e.g. a glass transponder into a bolus or a glass transponder into an ear tag.

C. A listing update is applicable in the following case:
- When a RA registered manufacturer intends to use an ICAR certified transponder without any modification. In this case the applicant must deliver a copy of the original test report along with a written confirmation from the ICAR registered manufacturer who originally submitted the transponder under question for certification by ICAR.

To apply for an ISO transponder conformance test the manufacturer has to complete the test application form given in Section 10, Annex A1 accompanied with a letter of the applicant. The application for a manufacturer code (Annex A2) together with the signed "Code of conduct" (Annex A3) have to be submitted by the manufacturer to the RA only when he applies for an RFID conformance test for the first time. By signing the application form and the code of conduct the manufacturer agrees to fulfil the conditions described in this document and to accept the charges for this procedure. The application form for a RFID transponder performance test is given in Annex A4.

The application forms can be obtained from the Service-ICAR secretariat or from ICAR's website Section 10 Annexes available at the following URL:


The completed application must be emailed in PDF format to the Service-ICAR secretariat. The email address of the Service-ICAR secretariat is: manufacturers@icar.org.

The manufacturer has the right to choose their preferred ICAR accredited test centre. The manufacturer is required to send:
- 50 transponders to the test centre for a full test, or
- 10 transponders for a limited test, or
- 10 transponders for a listing update.

The submitted transponders must have the ICAR test code of 999 or the existing manufacturer’s code for a full test. The manufacturer can freely choose the transponder codes, but duplicate codes are not allowed. The manufacturer must provide a list of the transponder codes in decimal format. For the Device composition and environmental performance test the manufacturer must provide additional transponders as specified in Section 10.8.

The test centre will test the transponders for compliance with ISO 11784 and ISO 11785 and, when appropriate, with the ICAR standard for device composition and environmental performance. All tested transponders must be readable by the laboratory reference transceiver. The codes read by the laboratory reference transceiver must comply with ISO 11784 and the identification codes must be on the list of codes provided by the manufacturer.

The test centre will prepare a confidential report of the test results and will send the report to the Service-ICAR secretariat. For a limited test or a listing update, the test report will contain only a summary of the test results.

Service-ICAR will send the test report to the manufacturer and, in the case of a successful Conformance test result, an official ICAR letter of certification signed by the ICAR Secretary General will also be sent to the manufacturer with a copy to the ISO/TC23/SC19/WG3 secretariat.

ICAR as RA issues a product code for each type of transponder successfully tested, including the listing update.

All electronic transponders submitted in an application will be kept by the test centre as reference transponders.

ICAR as RA maintains a public register on the ICAR website which lists all products registered and ICAR certified. A photograph of the certified device is included in the listing.

### 10.2.4.1 Conditions for the right to use an ICAR certificate for transponders (conformance test)

Upon successful completion of the Conformance test, ICAR will grant a device certificate valid for five years and a certification reference number.

The ICAR certification of a transponder confirms the transponder’s compliance with the code structure and the technical concepts given in ISO 11784 and ISO 11785.
The manufacturer must maintain a database register of all ICAR certified transponders sold. The manufacturer must require the initial purchasers of their ICAR certified transponders to also maintain a database register of their purchased product and require all subsequent purchasers to do the same until the transponder is applied to an animal.

The ICAR certificate is valid only for the transponder successfully tested and certified by ICAR. A manufacturer must not utilise the ICAR certificate and / or the certification reference number for a transponder:

1. Which is not manufactured by them; and / or
2. Which does not comply in all respects with the ICAR certificate and the certification reference number, including (but not limited to):
   • Maintaining identical packaging (both primary and secondary) of the certified transponder;
   • Maintaining identical technology and manufacturer of the certified transponder;
   • Maintaining the identical transponder to the certified transponder;
3. Which utilises the manufacturer code of another manufacturer;
4. Which is supplied to or intended to be supplied to a person (“the receiver”) who will market the transponder as if manufactured by them, unless:
   • The receiver has obtained ICAR registration under this process; and
   • The transponder bears either the shared manufacturer code or the unshared manufacturer code of the receiver.

Once the ICAR certification has been granted, the manufacturer will be responsible to:

1. Keep an accurate and detailed log of all changes to their product and this log must be available to ICAR upon request. This log must include details of in-house performance measurements and Quality Assurance testing showing the amended product has maintained or enhanced its quality and performance.
2. Submit the product for re-certification before the expiration of its current ICAR certification. The manufacturer must submit this product no earlier than 6 months before the expiration of the certificate and no later than 5 months before the expiration of the certificate.
3. Understand that ICAR may take sample products from the marketplace and test its conformance against the conformance of the device the manufacturer originally submitted should ICAR suspect a breach of the signed ICAR Code of Conduct or a product change that has not been subjected to the tests outlined in Section 10.2.4 of this document.

Should the manufacturer fail to meet any or all of the above conditions for the use of the ICAR certificate, actions may be taken by ICAR as detailed in www.icar.org/pages/Sub_Committees/animal_identification/animal_identific_misuse_complain.htm

In cases of disputes regarding the conditions listed above or the use of an ICAR certificate, the decision of ICAR as RA will be binding.
ICAR as RA will distribute an advice notice regarding any manufacturer that distributes transponders in conflict with the certificate procedure.

**10.2.5 Granting and use of a manufacturer code**

According to ISO 11784 "... it is a national responsibility to ensure the uniqueness of the national identification code". Where countries have not undertaken efforts to set up a procedure for the allocation and registration of the national identification code, a manufacturer code must be used instead of a country code to ensure a worldwide uniqueness of identification codes. ISO has appointed ICAR as the RA to allocate manufacturer codes in conformance with ISO 11784.

**10.2.5.1 Application of shared and unshared manufacturer code**

**Shared manufacturer code**

A manufacturer code can be granted to more than one manufacturer and this code is known as a shared manufacturer code. A shared manufacturer code can be granted by ICAR as RA if the manufacturer's RFID device has successfully completed a full conformance test. When a shared manufacturer code is granted, ICAR as RA also allocates a restricted set of identification codes for exclusive use with the shared manufacturer code. The identification codes allocated in combination with the shared manufacturer code are unique. ICAR as RA must ensure this uniqueness by applying appropriate procedures for the assignment and registration of allocated identification codes. If necessary, additional sets of identification codes can be assigned to the manufacturer by request. The size of the sets of allocated identification codes is determined on consensual agreement with the manufacturer and ICAR.

**Unshared manufacturer code**

An unshared manufacturer code will only be granted to a manufacturer providing proof to the Registration Authority that during two consecutive years the company has sold a minimum of one million (ICAR certified) transponders per year. This proof must be sourced from their sales records and certified by their external auditor of accounts or a notary public.

**10.2.5.2 Manufacturer Code Application Procedure**

A manufacturer can apply for a manufacturer code using the application form given in Annex A2 of this document. The application form can also be obtained from the Service-ICAR secretariat or from ICAR's website, also available at: www.icar.org/pages/ICAR_certification/animal_identification_application_for_testing.htm.

The application must consist of a letter, a completed test application form (Annex A1) and the signed "Code of conduct" (Annex A3). By signing the application form and the code of conduct the manufacturer agrees to fulfil the conditions described in this document and to accept the charges for this procedure.

The completed application must be emailed in PDF format to the Service-ICAR secretariat. The email address of the Service-ICAR secretariat is: manufacturers@icar.org
The Service-ICAR secretariat will inform the manufacturer of the acceptance or rejection of their application. A copy of this communication will also be sent to the secretariat of ISO/TC23/SC19/WG3.

ICAR maintains a public register listing all registered manufacturers and the shared/unshared manufacturer codes granted.

**10.2.5.3 Conditions for the right to use the manufacturer code**

The manufacturer can only use their manufacturer code for products registered by ICAR as RA. In disputes regarding the conditions of manufacturer code use, the decision of ISO/TC 23/SC19 will be binding.

For further reference, ISO 11784 can be downloaded from the ISO website (www.iso.org).

**10.2.5.4 The use of Manufacturer codes and Country codes**

Manufacturer codes (900-998 series) should only be used in connection with electronic identification (RFID) devices, in accordance with ISO 11784 and section 10 of these Guidelines, including Annex 10.2.2 Code of Conduct for RFID device manufacturers.

Where a competent national authority has assumed the responsibility for ensuring and maintaining the uniqueness of the RFID identification code for a specific species in that country, the ISO 3166 3-digit numeric country code may be used in place of the manufacturer code in the electronic identity or RFID of that specific species of animal.

The use of manufacturer codes in the International Identity used for genetic evaluation purposes is discouraged (Section 9.1.1.2).
SECTION 10.3 - ISO 11784/11785 - CONFORMANCE OF SYNCHRONIZING AND NON-SYNCHRONIZING TRANSCIEVERS

10.3.1 Scope

This section outlines the procedures to verify the compliance of RFID transceivers to the operating characteristics outlined in ISO 11784 and ISO 11785. ISO details the protocols for evaluating transceivers.

10.3.2 References

| ISO 11784 | Agricultural equipment - Radio frequency identification of animals - Code structure |
| ISO 11785 | Agricultural equipment - Radio frequency identification of animals - Technical concept |

ISO sets out the procedures for evaluating synchronising transceivers. Another document ("Conformance evaluation of RFID devices, Part 3: Conformance test for non-synchronising transceivers for reading ISO 11784/11785 transponders") deals with non-synchronising transceivers, which read at least FDX-B and HDX transponders.

10.3.3 References

The titles of standards referred to in this document are as follows:

| ISO 11784 | Agricultural equipment – Radio frequency identification of animals - Code structure |
| ISO 11785 | Agricultural equipment – Radio frequency identification of animals - Technical concept |
| ISO 3166 | Codes for the representation of names of countries |

The latest version of ISO Standards will always apply and these Standards can be downloaded from the ISO website (www.iso.org).

NOTE

Please be advised that the previous Sections 10.4, 10.5 and 10.6 have been deleted and their content included into the new Sections. This explain the lacking of these Sections in this version of the Guidelines. The headings of the Sections 10.7 and 10.8 remain unchanged to keep the citations correct.
SECTION 10.7 - TESTING AND CERTIFICATION OF PERMANENT IDENTIFICATION DEVICES.
PART 1: CONVENTIONAL PERMANENT PLASTIC EAR TAGS WITH OR WITHOUT MACHINE READABLE PRINTING

10.7.1 Introduction

This section will guide the manufacturer through the steps of initially obtaining and then retaining ICAR certification for a conventional permanent plastic ear tag.

The ICAR procedures for testing the performance and reliability of permanent identification devices considers, but is not limited, to the following issues:

- Ease of application and use
- Efficiency of animal recognition
- Durability and tamperproof quality
- Animal welfare and human health

The following procedures focus on testing the ear tag design, the print quality and, if requested, the ear tag machine readability.

The testing procedure is composed of three distinct phases:

- Phase 1: Manufacturer's application (Section 10.7.5.1)
- Phase 2: Preliminary Assessment (Section 10.7.5.3)
- Phase 3: Laboratory Test - Technical Evaluation (Section 10.7.5.4)

These test procedures must be carried out by an ICAR accredited test laboratory. The fees for these test procedures will be borne by the device manufacturer.

When an ear tag is certified by ICAR, the manufacturer will be authorized to state that tags of that particular design and printing method are ICAR certified. ICAR certification does not imply that the tag is suitable for all environments or that its machine-readable characteristics are satisfactory for all uses. It is the manufacturer's responsibility to comply with the requirements of the relevant jurisdictions.

A successfully tested product can have its certification withdrawn if the product fails to comply with the requirements described in this section. ICAR and/or national authorities may randomly take samples of certified tags from the market and subject them to testing to ensure certified ear tags continue to meet ICAR certification criteria. The manufacturer will be required to meet the costs of these assessments should the product fail to meet ICAR standards.

The manufacturer must advise ICAR of any sub-standard performance of ICAR certified products not in accordance with their previous test results. The manufacturer must also inform ICAR of any change to the composition or the print quality of a certified ear tag.

Users of ear tags and / or potential users of ear tags are encouraged to access the list of certified tags found on the ICAR website (www.icar.org/pages/certified_eartags.htm).
10.7.2 Scope

This section describes the evaluation procedures for measuring the composition and the performance of conventional permanent plastic ear tags which may include machine readable printing.

When a manufacturer submits an ear tag to ICAR for testing, they may also choose to have the machine readability of the ear tag evaluated according to this protocol. If no request is made to evaluate the machine readable printing of the submitted ear tag, then only the visual readability will be evaluated.

Successful completion of the procedures described in this section will result in the ICAR certification of the ear tag as a device recommended by ICAR for animal identification purposes. ICAR certified ear tags are published on the ICAR website as certified visual identification devices.

10.7.3 References

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 175</td>
<td>Resistance of thermoplastics to liquids</td>
</tr>
<tr>
<td>EN 1122</td>
<td>Plastics - Determination of cadmium - Wet decomposition method</td>
</tr>
<tr>
<td>ISO 1817</td>
<td>Resistance of vulcanized elastomers to liquids</td>
</tr>
<tr>
<td>ISO 4650</td>
<td>Rubber - Identification - Infrared spectrometric method</td>
</tr>
<tr>
<td>ISO 9924</td>
<td>Determination of composition of vulcanized elastomers</td>
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<tr>
<td>ISO 11357</td>
<td>Plastics - Differential scanning calorimetry (DSC)</td>
</tr>
<tr>
<td>ISO 9352</td>
<td>Plastics - Determination of resistance to wear by abrasive wheels</td>
</tr>
<tr>
<td>ISO 527-1</td>
<td>Plastics - Determination of tensile properties part 1: General principles</td>
</tr>
<tr>
<td>ISO 37</td>
<td>Rubber, vulcanized or thermoplastic - Determination of tensile stress-strain properties</td>
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<td>ISO 4611</td>
<td>Plastics - Determination of the effects of exposure to damp heat, water spray and salt mist</td>
</tr>
<tr>
<td>EN ISO 4892-2</td>
<td>Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps</td>
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<tr>
<td>EN ISO 4892-3</td>
<td>Plastics - Methods of exposure to laboratory light sources - Part 3: Fluorescent UV lamps</td>
</tr>
<tr>
<td>ISO 15416</td>
<td>Information technology - Automatic identification and data capture techniques - Bar code print quality test specification; linear symbols</td>
</tr>
<tr>
<td>ISO 11664-4</td>
<td>Colorimetry - Part 4: CIE 1976 L<em>a</em>b* Colour space</td>
</tr>
<tr>
<td>ISO 7724</td>
<td>Paints and Varnishes – Colorimetry</td>
</tr>
</tbody>
</table>

The latest version of the above references will always apply.
10.7.4 Definitions

10.7.4.1 Certification code
A certification code is an alpha-numeric code consisting of "C" (for certified), followed by three numbers. The certification code is used to identify and register an ear tag model that has successfully passed the testing procedure. This code may be embossed on all ICAR certified ear tags for official identification. The placement of the certification code on the ear tag should conform to the relevant jurisdictional requirements in whatever locality the ear tag is sold.

10.7.4.2 Certified ear tag
A certified ear tag is an ear tag described in the Application Form that was submitted to the ICAR accredited test centre where it successfully passed the testing procedures and was thus certified by ICAR.

10.7.4.3 Ear tag
An ear tag is deemed to be composed of three principal features:

1. The front plate which is often, but not always, the "female" component of an ear tag combination. The front plate is designated as such because it will be in the front of the animal's ear when the ear tag combination is applied correctly.

2. The rear plate which is often, but not always, the "male" component of an ear tag combination. The rear plate is designated as such because it will be at the back of the animal's ear when the ear tag combination is applied correctly.

3. The locking mechanism which comprises of the locking gap in the female component of an ear tag and the pin of the male component of the ear tag combination.

10.7.4.4 Manufacturer
The manufacturer is the company or person submitting the application for the testing of an ear tag and has accepted the ICAR conditions for certification of conventional permanent plastic ear tags as outlined in Section 10.7.5.3.6.

10.7.4.5 Reference colour
The colour of the ear tags used in the laboratory tests must be yellow and the colour of the printing must be black. The manufacturer must print a uniform solid block 10mm x 10mm in the same colour as the colour of the printing on the tag.

10.7.4.6 Reference number
Printing must be composed of four different and predefined figures (from 0 to 9) as outlined in Annex B2. The font style and size must replicate precisely the font style and size the manufacturer commonly uses on that tag within the market.
For the ear tags where machine readability will be assessed a 12 digit barcode must be printed on the tags in addition to the reference number. The 12 digit barcode consists of the three numbers of the test code as defined in 10.7.4.6 followed by zeroes and the reference number.

10.7.4.7 Test code

The test code is an alpha-numeric code consisting of "T" (for tested), followed by 3 numbers. The test code is used to identify and register an ear tag model being tested in the field under the approval procedure. This code must be printed or engraved on all ear tags undergoing testing during the approval procedure.

10.7.4.8 Tested Ear tag

A tested ear tag is an ear tag described in the Application Form that was submitted to the ICAR accredited test centre and subsequently tested.

10.7.5 ICAR testing and certification procedure

10.7.5.1 Phase 1: Manufacturer's application

To submit an ear tag for ICAR testing within the scope of the tests described in this section, the manufacturer must complete an application and email it in PDF format to the Service-ICAR secretariat. The email address of the Service-ICAR secretariat is: manufacturers@icar.org

The application must consist of:

- A letter of application,
- An Application Form (Annex B1), and
- Material Safety Data Sheets (MSDS) for the compounds used in the manufacturing of the ear tag. These documents may also be known as Safety Data Sheets (SDS). (An anonymised MSDS or SDS is acceptable.)

Copies of the required application form can be obtained from the ICAR website or from the ICAR secretariat.

When a manufacturer chooses to have the machine readable printing on the ear tag evaluated, the manufacturer must indicate this choice on the completed Application Form. The application should also specify the symbols (language) used on the tag, e.g. Quick Response (QR) Model 2, Data Matrix (DM) ECC 200, Aztec, Code 128, Code 39 or Interleaved 2 of 5. The applicant should also indicate if the AIM (Automatic Identification Manufacturers International Inc) quality standards (code dimensions) have been met.

By signing the application form, the manufacturer agrees to fulfil the conditions of ICAR testing, certification and payment obligations and also acknowledges the ongoing monitoring and assessments for certified ear tags.
10.7.5.2 Phase 2: Preliminary assessment

To assess conformance of the ear tags with the information given in the application form and to also detect any major failure, e.g. damage of the tag at application, possible unlocking without deformation, inappropriate animal welfare design etc., the ear tags will be submitted to a Preliminary Assessment.

10.7.5.2.1 Manufacturer requirements

At the commencement of the Preliminary assessment the manufacturer must deliver:
1. A sample of 120 ear tags marked with the reference printing applied using the same technique and style as used (or intended to be used) in the commercially marketed tags. Note: Tags used in this phase are likely to be destroyed during testing.
2. An additional 10 male components (pins) used to check reusability of broken and/or unfastened female ear tags.
3. Two pairs of tag applicators or equivalent devices supplied for the application of tags to animals.

10.7.5.2.2 Ear tag design

Ear tags shall have smooth, rounded corners and no sharp edges or protrusions specifically on the shaft of the piercing pin. The following measurements will be taken:
1. The weight of the complete locked ear tag.
2. The dimensions of the front and rear plate (height, width and thickness).
3. The pin (length and diameter).
4. The entrance hole of the cap.

Values and observations potentially impacting on animal welfare will be reported.

10.7.5.2.3 Locking mechanism checks

The primary purpose of these tests is to verify that the male to female locking mechanism, once correctly applied using the supplied applicator, cannot be subsequently dismantled in such a way that would allow the tag to be re-used. A locked ear tag should be tamperproof so tampering with the locked tag will render the tag unusable.

10.7.5.2.4 Application test

The application evaluation will be carried out using two groups of tags:
Group 1: 80 tags with the front and rear tag components locked together but without being inserted through ears.
Group 2: 40 tags applied and locked into ears obtained post slaughter.

The performance level required for the 120 ear tags shall be:
• Successful locking of the front and rear tag components of all ear tags.
• No breakage of any tag component at locking.
• No deformation of any tag component after locking.
• No unlocking without breakage or irreparable damage to the ear tag.

The test centre will also check the rotation of the tag components on the locked tags. The following characterisation will be used:
• Tag components rotate freely.
• Tag components rotate but not freely.
• Tag components do not rotate.

10.7.5.2.5 Resistance of the locking system

The 80 ear tags of Group 1 will be divided into four groups of 20 tags. These four groups will be subjected to increasing forces to determine the force required to cause breakage or unfastening of the ear tag. The forces will be applied at a speed rate of 500 mm/min. The force applied to cause breakage or unfastening of each ear tag will be recorded. Broken or unfastened tags must not be re-useable.

- Group 1: axial test at ambient conditions (21°C ± 2°C)
- Group 2: axial test at 80°C ± 2°C, the forces will be applied immediately after the tags are removed from the heating or climatic chamber
- Group 3: transverse test at ambient conditions (21°C ± 2°C)
- Group 4: transverse test at 80°C ± 2°C, the forces will be applied immediately after the tags are removed from the heating or climatic chamber.

Requirements
• Broken or unfastened tags must not be re-useable.
• At ambient conditions, axially tested tags designed to be used in cattle shall not break or unfasten with the application of a force lower than 280 Newton.
• At ambient conditions, axially tested tags designed to be used in sheep and / or goats shall not break or unfasten with the application of a force lower than 200 Newton.
• The number of tags unlocked without breakage or sustaining permanent damage during the transverse test is recorded, and broken or unfastened tags must not be re-useable.

10.7.5.2.6 Conclusion of the Preliminary assessment

The test centre will prepare a comprehensive report detailing the results of the submitted ear tag's performance in the Phase 2 Preliminary Assessment. This report will be submitted to ICAR who will then forward the test report to the manufacturer.
If the Phase 2 testing is successful, then the manufacturer will be asked to confirm their willingness to proceed to the Phase 3 Laboratory test.
If a device has not performed satisfactorily, ICAR will provide the manufacturer with the test report and indicate the reasons for the tag's failure.
10.7.5.3 Phase 3: Laboratory Test - Technical Evaluation

10.7.5.3.1 Assigning a test centre

Following the successful completion of the Preliminary Assessment and the decision of the manufacturer to proceed to the Phase 3 Laboratory Test, Service-ICAR will assign one of the accredited test centres to carry out the Phase 3 Laboratory Test.

10.7.5.3.2 Granting of a test code

A specific test code will be allocated by ICAR for the ear tag undergoing testing. The manufacturer will be advised of the test code and the manufacturer must print or engrave this code on each ear tag produced for the Phase 3 Laboratory Test.

10.7.5.3.3 Manufacturer requirements

At the commencement of Phase 3, the manufacturer must deliver the following items to the assigned test centre (in addition to the items listed in Section 10.7.5.2.1):

- 200 yellow ear tags with the test code number and the reference printing applied (including the uniform solid block described in 10.7.4.4). For tags where the machine readability is to be assessed, a 12 digit barcode must also be printed on the ear tag. Note: the manufacturer will be allocated 25 reference numbers to print on the 200 ear tags, i.e. 8 tags per reference number (Annex B2).
- A statement specifying the nature of the polymer used for the ear tag, e.g. thermoplastic elastomers, vulcanized elastomer etc.

10.7.5.3.4 Test procedures

10.7.5.3.4.1 Assessment of descriptive parameters

The parameters describing the ear tag will be assessed and compared to the information provided in the Application Form to ensure accuracy of description.

10.7.5.3.4.1.1 Weight and dimensions

The following measurements will be taken:

1. The weight of the complete locked ear tag
2. The dimensions of the front and rear plate (height, width and thickness)
3. The pin (length and diameter)
4. The entrance hole of the cap

The results of these measurements will be compared to the Preliminary Assessment test report to ensure the accuracy of the samples.
10.7.5.3.4.1.2 Composition

Because ear tags are attached to "food producing" animals, they must meet specific requirements set down by international laws and regulations. In addition to these requirements, substances affecting animal, human or environmental health need to be detected. As such, certain chemical and physical composition traits of the ear tag will be evaluated.

This evaluation will involve 20 ear tags.

10.7.5.3.4.1.2.1 Characteristics of the ear tag plate plastic

To characterise the basic component of the plastic raw material, one ear tag plate is submitted to an Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy analysis. Sample preparation is not necessary as the ear tag plate is pressed directly against the ATR-crystal. After analysis, the resulting ATR spectrum will be compared with characteristic spectra stored in specific databases.

Following this analysis, a material sample is submitted to a Differential Scanning calorimetry (DSC) analysis to analyse the thermal characteristics of the material as per ISO 11357. This analysis allows the detection of overlapping IR curves, e.g. if an additional component of minor quality was used to stretch the main component. The test is performed in two heat-up phases:

- Phase 1: 30°C - 200°C to obtain information about post cross linking of the plastic material to detect processing effects
- Phase 2: 30°C - 400°C to analyse the thermal parameters.

10.7.5.3.4.1.2.2 Harmful substances

Pigmented plastics may contain critical heavy metals which must be recorded. These metals are: Cadmium (Cd), lead (Pb), mercury (Hg) and chromium (Cr). If chromium is detected, an additional analysis of carcinogenic hexavalent chromium will be done. The following limit values must not be exceeded:

- Cadmium: 100 mg/kg
- Lead: 10 mg/kg
- Mercury: 1 mg/kg
- Chromium: 10 mg/kg (Chromate (Cr VI): < 1 mg/kg)
10.7.5.3.4.2 Pre-treatments

Various treatments are required to prepare tags for the testing of particular characteristics and are outlined in the following sections. These pre-treatments and ensuing performance assessments are summarized in the following table:

<table>
<thead>
<tr>
<th></th>
<th>New tags</th>
<th>UV/rain aged tags</th>
<th>Damp heat/cold aged tags</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Untreated</td>
<td>Acid bath</td>
<td>Alkaline bath</td>
</tr>
<tr>
<td>Visual readability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typography</td>
<td>×</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour contrast</td>
<td></td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Machine readability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barcode scanning</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Barcode quality check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance of the locking system</td>
<td>×</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10.7.5.3.4.2.1 Acid bath treatment

Five ear tags are immersed for 3 weeks in a 50°C acid liquid (acetic acid, pH = 3) to ensure compliance with ISO 175 for thermoplastics and ISO 1817 for vulcanized elastomers. This test will only be done on ear tags made of plastic materials other than polyurethane (PU).

10.7.5.3.4.2.2 Alkaline bath treatment

Five ear tags are immersed for 3 weeks in a 50°C alkaline liquid (sodium hydroxide, pH = 12) to ensure compliance with ISO 175 for thermoplastics and ISO 1817 for vulcanized elastomers. This test will only be done on ear tags made of plastic materials other than polyurethane (PU).

10.7.5.3.4.2.3 Ageing by damp heat and cold

In accordance with ISO 4611, 40 ear tags are placed into alternating cycles of 12 hours damp heat (40°C ± 2° / 95% RH) and 12 hours cold (-25°C ± 2°) for a duration of 3 weeks in a climatic chamber.

10.7.5.3.4.2.4 Resistance to artificial ageing

In accordance with EN ISO 4892-2, procedure A/cycle 1 (Table 3), 40 ear tags are tested against resistance to sunlight. The exposure chamber will be fitted with xenon-arc lamps according to EN ISO 4892-2 and operated continuously for 1,000 hours. These 1000 hours will consist of repeated cycles of 102 minutes of radiant exposure followed by 18 minutes of combined irradiation and rain simulation. The irradiance level of the xenon-arc lamps will be 60 W/m² (at 300-400 nm).
10.7.5.3.4.3 Performance Assessment

10.7.5.3.4.3.1 Typography readability

Five new, untreated tags and five tags from the following two treatment groups will be selected for assessment:

- Group 1: Artificially aged tags not subjected to the abrasive treatment
- Group 2: Artificially aged tags subjected to the abrasive treatment

Five randomly chosen numbers as given in Annex 10.7.2 will be printed on five white pages of paper. The font size, print style and character spacing will replicate that used for the ear tags.

The test tags and the pages with the printed numbers will be placed on a vertical surface (viewing surface) at head height in an appropriately lit laboratory room. Five assessors will stand 15 metres from the viewing surface and then commence walking towards it. Each assessor will attempt to read the numbers on the different ear tags and pages and the distance at which each device (ear tag or page) can be read without error will be recorded on the evaluation sheet.

The mean reading distance for both the pages and the ear tags will be separately calculated for each assessor and for the average of the assessors.

The following requirements must be met:

- New, untreated tags: The mean distance at which the reference printing is read on the ear tags must be at least 80% of the mean distance at which the pages are read.
- Artificially aged tags with and without the abrasive treatment: The mean distance at which the reference printing is read for the ear tags must be at least 65% of the mean distance at which the pages are read.

10.7.5.3.4.3.2 Evaluation of colour contrast change

The colour difference of the ear tag plates and of the laser printing is measured and compared between three new ear tags and three artificially aged ear tags by use of spectral photometric measuring equipment according to ISO 7724.

After artificial ageing, the change in colour must be less than delta E* of 10 CIELAB units.

10.7.5.3.4.3.3 Evaluation of machine readability (optional)

This evaluation will occur if the manufacturer requests the machine readability testing in the Application Form (10.7.5.1).
Section 10 - Testing and certification of devices used in animal identification

For ear tags with linear barcodes, the "Quiet Zone" or margin at each end of the barcode must be at least 5mm. The height of the barcode must be at least 8mm.

10.7.5.3.4.3.3.1 Barcode scanning

The ear tags subjected to the Phase 3 treatments will be scanned with three different handheld barcode readers. The barcode readers used for this test will be published on the ICAR website.

The treated ear tags will be scanned in sequence and after the initial ear tag is successfully read, the second tag is scanned until successfully read. Each ear tag will be scanned a maximum of four times. This procedure is repeated for each tag in the treatment group and after the last tag is scanned, the scanning is recommenced (Run 2) with the first tag. A total of 60 scans per treatment and reader type will be conducted to obtain sufficient data to assess performance.

The number of scans required to successfully read each tag (e.g. one, two, three or four) in each run is recorded.

The scanning success rate of tags from each treatment group is expressed in a percentage value and based on the number of scans required for a successful read. The performance of the tag is assessed against the minimum performance standards shown below:

<table>
<thead>
<tr>
<th>No. of scans required</th>
<th>Proportion of tags successfully read at each scan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>95 %</td>
</tr>
<tr>
<td>2</td>
<td>98 %</td>
</tr>
<tr>
<td>3</td>
<td>99.7 %</td>
</tr>
</tbody>
</table>

The scanning performance achieved for each treatment is included in the ICAR report sent to Service-ICAR at the conclusion of the laboratory tests.

10.7.5.3.4.3.3.2 Barcode Print Quality Assessment

Print quality assessment will be undertaken on ten new, untreated tags using the protocols described below. Using an ISO 15426-1 barcode verifier the linear barcodes are assessed for print quality according to ISO 15416. Every ear tag will be scanned ten times to build average grades.

An ANSI scale of A (highly satisfactory) to F (unsatisfactory) will be used to grade the print quality for each characteristic. When determining the overall print quality, the final score for the code on a tag is the worst grade recorded for any of the assessed characteristics. Failure reasons will be given in the test report.

The following linear barcode print quality specifications must be met:

- Decode (the only grades used are A and F): A
- Decodability: minimum D meaning >25%
- Check Character (if available): OK
- Symbol Contrast (Rmax - Rmin): minimum D meaning >25%
In the print contrast component of the test for 2D barcodes, the QR code and DM symbols are assessed for print quality using a barcode verifier that complies with the AIM International standards, Section "M" under Matrix Code Print Quality Guideline. A scale of A (highly satisfactory) to F (unsatisfactory) will be used to grade the print quality for each characteristic. When determining the overall print quality, the final score for the code on a tag is the worst grade recorded for any of the assessed characteristics.

The following 2D barcode print quality specifications must be met:

- Decode (the only grades used are A and F): A
- Symbol contrast: minimum D, meaning >25%
- Print growth X axis and Y axis: A/A, A/B or B/A
- Axial non-uniformity: A

The standard of symbols must be no more than one print quality grade below that for each parameter on an unused tag without treatment.

**10.7.5.3.4.3.3 Evaluation of the resistance of the locking system**

30 new, untreated ear tags, 30 artificially aged ear tags and 30 ear tags submitted to the damp heat and cold treatment will be subjected to increasing forces to determine the force required to cause breakage or unfastening of the ear tag.

The test is performed at -25°C (± 2°C), 21°C (± 2°C) and 55°C (± 2°C) combined with 50% RH (when the temperature is greater than 0°C) with 10 ear tags from the three treatment variations.

The forces will be applied at a rate of 500 mm/min immediately after the tags are removed from the climatic chamber. The force applied to cause breakage or unfastening of each ear tag will be recorded. Broken or unfastened tags must not be re-useable. At 21°C (± 2°C), no breakage or unfastening of an untreated ear tag should occur in:

- tags designed to be used in cattle with the application of a force lower than 280 Newton
- tags designed to be used in sheep and / or goats with the application of a force lower than 200 Newton

Additionally, the distortion occurring in the ear tag at the time of breakage or unfastening will be recorded during the tensile tests as an indicator for any changes in the mechanical properties of the plastic after exposure to the artificial ageing and the damp heat/cold treatments.

**10.7.5.3.5 Conclusion of the laboratory test**

The test centre will prepare a test report and will submit it to Service-ICAR which will then forward it to the ICAR Sub-Committee for Animal Identification for comment. All information collected during the laboratory tests will remain confidential and only disclosed to the manufacturer of that ear tag.

Upon the successful completion of the Phase 3 Laboratory Testing, ICAR will send the test report and an official letter to the manufacturer granting ICAR certification for that ear tag.

If the manufacturer had requested an evaluation on the machine readability of the ear tag, then this evaluation will also be included in the test report.
Each test report on a successfully tested tag will include a summary sheet with an evaluation of the appropriate suitability of the ear tag for various production systems and/or environmental conditions. If the Phase 3 Laboratory Test results are unsatisfactory, ICAR will send the manufacturer the test report indicating the reasons for the failure.

10.7.5.3.6 ICAR conditions for certification of conventional permanent plastic ear tags

1. Upon successful completion of the ICAR test procedures described in this Section 10.7, ICAR will grant a device certificate valid for five years and a certification reference number.

2. This certification is valid only for the specific plastic ear tag type successfully tested and certified by ICAR.

3. A manufacturer cannot utilise the ICAR certification for a plastic ear tag:
   a. Which is not manufactured by them; or
   b. Which does not comply in all respects to the ICAR certification which includes maintaining an identical tag type to the certified tag.

4. Once the ICAR certificate has been granted, the manufacturer will be responsible to:
   a. Keep an accurate and detailed log of all changes to their product and this log must be available to ICAR upon request. This log must include details of in-house performance measurements and Quality Assurance testing showing the product has maintained or enhanced its quality, performance and material composition.
   b. Submit the product for re-certification before the expiration of its current ICAR certification. The manufacturer must submit this product no earlier than 6 months before the expiration of the certificate and no later than 5 months before the expiration of the certificate.
   c. Understand that ICAR may take sample products from the market and test its conformance against the conformance of the device the manufacturer originally submitted should ICAR suspect a breach of the signed ICAR Code of Conduct or a product change that has not been subjected to the tests outlined in Section 10.2.4 of this document.

5. Should the manufacturer fail to meet any or all the above certification conditions ICAR may withdraw the certification.

6. In disputes regarding the conditions above or the use of a certificate, the decision of ICAR will be binding.

7. ICAR will distribute an advice notice regarding any manufacturer distributing product in conflict with the testing and certification procedures outlined in this Section 10.7
SECTION 10.8 - TESTING AND CERTIFICATION OF PERMANENT IDENTIFICATION DEVICES.
PART 2: EXTERNAL RFID DEVICES

10.8.1 Introduction

This section will guide the manufacturer through the steps of initially obtaining and then retaining ICAR certification for an external permanent radio frequency identification (RFID) device. The ICAR procedure for testing the performance and reliability of external permanent RFID devices considers, but is not limited to the following issues:

- Ease of application and use.
- Efficiency of animal recognition.
- Durability and tamperproof quality.
- Animal welfare and human health.

Only external RFID devices designed as permanent electronic identification devices are covered in this Section 10.8.

The testing procedure is composed of three distinct phases:
1. Phase 1: Manufacturer's Application (Section 10.8.5.1)
2. Phase 2: Preliminary Assessment (Section 10.8.5.3)
3. Phase 3: Laboratory Test - Technical Evaluation (Section 10.8.5.4)

These test procedures must be carried out by an ICAR approved test laboratory. The fees for these test procedures will be borne by the device manufacturer.

A tested and certified product can have its certificate withdrawn if the product fails to comply with the requirements described in this section. ICAR and/or national authorities may randomly take samples of certified tags from the market and subject them to appropriate testing to ensure certified ear tags continue to meet ICAR standards. The manufacturer will be required to meet the costs of these assessments should the product fail to meet ICAR standards.

The manufacturer must advise ICAR of any sub-standard performance of ICAR certified products not in accordance with their previous test results. The manufacturer must also inform ICAR of any change to the composition of a certified RFID device.

ICAR certification does not imply that the external RFID device is suitable for all environments or that its read performance is satisfactory for all uses. Where RFID devices are intended for use in animal identification schemes, it is the manufacturer responsibility to comply with the requirements of the relevant jurisdiction.

Users of external RFID devices and/or potential users of external RFID devices are encouraged to access the list of certified RFID devices found on the ICAR website (www.service-icar.com/manufacturer_complete.php).

10.8.2 Scope

This section describes the evaluation procedures for measuring the composition and the performance of external RFID devices.
Successful completion of the procedures described in this section will result in the ICAR certification of the tested RFID device as a device recommended by ICAR for animal identification purposes. ICAR certified RFID devices are published on the ICAR website.

### 10.8.3 References

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 1122</td>
<td>Plastics - Determination of cadmium - Wet decomposition method</td>
</tr>
<tr>
<td>ISO 4650</td>
<td>Rubber - Identification - Infrared spectrometric method</td>
</tr>
<tr>
<td>ISO 9924</td>
<td>Determination of composition of vulcanized elastomers</td>
</tr>
<tr>
<td>ISO 11357</td>
<td>Plastics - Differential scanning calorimetry (DSC)</td>
</tr>
<tr>
<td>ISO 527-1</td>
<td>Plastics - Determination of tensile properties part 1: General principles</td>
</tr>
<tr>
<td>ISO 37</td>
<td>Rubber, vulcanized or thermoplastic - Determination of tensile stress-strain properties</td>
</tr>
<tr>
<td>ISO 11664-4</td>
<td>Colorimetry - Part 4: CIE 1976 L<em>a</em>b* Colour space</td>
</tr>
<tr>
<td>ISO 7724</td>
<td>Paints and Varnishes – Colorimetry</td>
</tr>
<tr>
<td>EN ISO 4892-2</td>
<td>Plastics - Methods of exposure to laboratory light sources Part 2: Xenon-arc lamps</td>
</tr>
<tr>
<td>EN/IEC 60068-2-1</td>
<td>Environmental testing - Part 2-1: Tests - Test A: Cold</td>
</tr>
<tr>
<td>EN/IEC 60068-2-2</td>
<td>Environmental testing - Part 2-2: Tests - Test B: Dry heat</td>
</tr>
<tr>
<td>EN/IEC 60068-2-32</td>
<td>Environmental testing - Part 2-32: Tests - Test Ed: Free fall</td>
</tr>
<tr>
<td>ISO 4611</td>
<td>Plastics - Determination of the effects of exposure to damp heat, water spray and salt mist</td>
</tr>
<tr>
<td>ISO 11785</td>
<td>Radio frequency identification of animals - Technical concept</td>
</tr>
<tr>
<td>ISO 24631-1</td>
<td>Radio frequency identification of animals - Part 1: Evaluation of conformance of RFID transponders with ISO 11784 and ISO 11785</td>
</tr>
</tbody>
</table>

The latest version of the above references will always apply.

### 10.8.4 Definitions

#### 10.8.4.1 Certification code

A certification code is an alpha-numeric consisting of "C" (for certified), followed by three numbers. The certification code is used to identify and register an RFID device that has successfully completed the testing procedure. This code may be embossed or printed on all ICAR certified RFID devices for official identification. The placement of the certification code should conform to the relevant jurisdictional requirements in whatever the locality the RFID device is sold.
10.8.4.2 Certified RFID device

A certified RFID device is an RFID device described in the Application Form that was submitted to the ICAR accredited test centre where it successfully passed the testing procedures and was thus certified by ICAR.

10.8.4.3 Manufacturer

The manufacturer is the company or person submitting the application for the testing of an RFID device and has accepted the conditions of ICAR for the certification of external RFID devices as outlined in Section 10.8.5.3.7.

10.8.4.4 Reference colour

The colour of the external RFID device used in the laboratory tests must be yellow and the colour of the printing must be black. On the test samples, preferably on the rear part, the manufacturer must print a uniform solid block of 10mm x 10mm in the same colour as the colour of the printing on the device. Should the surface area of the device be too small to accommodate the printing of a 10mm x 10mm solid block, then a uniform solid block of 5mm x 20mm is acceptable. This printing may be on the female tag plate or on the male tag plate (sometimes known as the pin).

10.8.4.5 Reference ID codes

The transponders of the RFID devices submitted to the laboratory test must be programmed with the test code of 999 followed by zeroes and a sequential numerical code as per the following:

- For the Phase 2 Preliminary Assessment, the sequential numerical code range will be: 001 - 120.
- For the Phase 3 Laboratory Test, the sequential numerical code range will be: 201 - 400.
- The reference ID code programmed into each transponder must be printed on the front part of each device. The font style and size must replicate precisely the font style and size the manufacturer commonly uses on that device within the market. This font size and style must be specified in the application form (Annex 10.8.2).

10.8.4.6 RFID ear tag

An RFID ear tag is a radio frequency identification (RFID) external device able to be fixed to an animal’s ear and deemed to be composed of three principal features:

1. The front part which is often, but not always, the “female” component of an ear tag combination. The front part is designated as such because it will be in the front of the animal’s ear when the ear tag combination is applied correctly. It will often, but not always, contain the transponder.

2. The rear plate which is often, but not always, the “male” component of an ear tag combination. The rear plate is designated as such because it will be at the back of the animal’s ear when the ear tag combination is applied correctly.

3. The locking mechanism which comprises of the locking gap in the female component of an ear tag and the pin of the male component of an ear tag combination.
10.8.4.7 RFID leg tag

An RFID leg tag is a radio frequency identification (RFID) external device able to be permanently fastened to an animal’s lower leg.

10.8.4.8 Tested RFID device

A tested RFID device is a device described in the Application Form that was submitted to the ICAR approved test centre and subsequently tested.

10.8.5 ICAR Testing and Certification Procedure

10.8.5.1 Manufacturer’s Application

To submit an external RFID device for ICAR testing within the scope of the tests described in this section, the manufacturer must complete an application and email it in PDF format to the Service-ICAR secretariat. The email address of the Service-ICAR secretariat is: manufacturers@icar.org

The application must consist of:

- A letter of application.
- An Application Form (Annex C1), and
- Material Safety Data Sheets (MSDS) for the compounds used in the manufacturing of the ear external RFID device. These documents may also be known as Safety Data Sheets (SDS).

Copies of the required application form can be obtained from the ICAR website or from the ICAR secretariat.

By signing the application form, the manufacturer agrees to fulfil the conditions of ICAR testing, certification and payment obligations and also acknowledges the ongoing monitoring and assessments applicable for certified RFID devices.

10.8.5.2 Phase 2: Preliminary Assessment

10.8.5.2.1 Manufacturer requirements

At the commencement of the Preliminary Assessment the manufacturer must deliver:

1. A sample of 120 RFID devices programmed with the reference ID codes and the reference printing. The printing must be applied using the same technique and style as used (or intended to be used) in the commercially marketed devices. Note: Devices used in this phase are likely to be destroyed during testing.

2. An additional 10 male components (pins) used to check reusability of broken and / or unfastened female devices.

3. Two pairs of device applicators or equivalent devices supplied for the application of devices to animals.
10.8.5.2.2 Test procedures

10.8.5.2.2.1 RFID ear tags

To assess the conformance of the RFID ear tags with the information given in the application form and to also detect any major failure e.g. electronic non-readability, damage of the tag at application, possible unlocking without deformation, inappropriate animal welfare design etc., the ear tags will be submitted to a Preliminary Assessment.

10.8.5.2.2.1.1 Ear tag design

RFID ear tags shall have smooth, rounded corners and no sharp edges or protrusions specifically on the shaft of the piercing pin. The following measurements will be taken:
1. The weight of the complete locked ear tag.
2. The dimensions of the front and rear plate (height, width and thickness).
3. The pin (length and diameter).
4. The entrance hole of the cap.

Values and observations potential impacting on animal welfare will be reported.

10.8.5.2.2.1.2 Electronic readability check

Every submitted RFID ear tag will be read with an ICAR approved handheld reader to ensure the reference ID codes transmitted meet the requirements outlined in 10.8.4.7.

10.8.5.2.2.1.3 Locking mechanism checks

The primary purpose of these tests is to verify that the male to female locking mechanism, once correctly applied using the supplied applicator, cannot be subsequently dismantled in such a way that would allow the tag to be re-used. A locked ear tag should be tamperproof so tampering with the locked tag will render the tag unusable.

10.8.5.2.2.1.4 Application test

The application evaluation will be carried out using two groups of tags:
- **RFID ear tags classified as flag tags (extended front plates):**
  - Group 1: 80 tags with the front and rear tag components locked together but without being inserted through ears
  - Group 2: 40 tags applied and locked into ears obtained post slaughter
- **RFID ear tags not classified as flag tags:**
  - Group 1: 40 tags with the front and rear tag components locked together but without being inserted through ears
  - Group 2: 40 tags applied and locked into ears obtained post slaughter
The performance level required for the submitted ear tags shall be:

- Successful locking of the front and rear tag components of all ear tags.
- No breakage of any tag component at locking.
- No deformation of any tag component after locking.
- No unlocking without breakage or irreparable damage to the ear tag.

The test centre will also check the rotation of the tag components on the locked tags. The following characterisation will be used:

- Tag components rotate freely.
- Tag components rotate but not freely.
- Tag components do not rotate.

### 10.8.5.2.2.1.5 Resistance of the locking system

#### 10.8.5.2.2.1.5.1 Flag Tags

The 80 RFID ear tags of Group 1 will be divided into four sub-groups of 20 tags. Those four sub-groups will be subjected to increasing forces to determine the force required to cause breakage or unfastening of the ear tag. The forces will be applied at a speed rate of 500 mm/min. The force applied to cause breakage or unfastening of each ear tag will be recorded. Broken or unfastened tags must not be re-useable.

- Group 1: axial test at ambient conditions 21°C (± 2°C).
- Group 2: axial test at 80°C (± 2°C); the forces will be applied immediately after the tags are removed from the heating or climatic chamber.
- Group 3: transverse test at ambient conditions 21°C (± 2°C).
- Group 4: transverse test at 80°C (± 2°C).

#### Requirements

- Broken or unfastened tags must not be re-useable.
- At ambient conditions, axially tested tags designed to be used in cattle shall not break or unfasten with the application of a force lower than 280 Newton.
- At ambient conditions, axially tested tags designed to be used in sheep and/or goats shall not break or unfasten with the application of a force lower than 200 Newton.
- The number of tags unlocked without breakage or sustaining permanent damage during the transverse test is recorded, and broken or unfastened tags must not be re-usable.

#### 10.8.5.2.2.1.5.2 Ear tags not classified as flag tags

The 40 RFID ear tags of Group 1 will be divided into two sub-groups of 20 tags. Those two sub-groups will be subjected to increasing forces to determine the force required to cause breakage or unfastening of the ear tag. The forces will be applied at a speed rate of 500 mm/min. The force applied to cause breakage or unfastening of each ear tag will be recorded. Broken or unfastened tags must not be re-useable.
• Group 1: axial test at ambient conditions 21°C (± 2°).
• Group 2: axial test at 80°C (± 2°); the forces will be applied immediately after the tags are removed from the heating or climatic chamber.

Requirements
• Broken or unfastened tags must not be re-useable.
• At ambient conditions, axially tested tags designed to be used in cattle shall not break or unfasten with the application of a force lower than 280 Newton.
• At ambient conditions, axially tested tags designed to be used in sheep and / or goats shall not break or unfasten with the application of a force lower than 200 Newton.

10.8.5.2.2 RFID leg tags
To assess conformance of the RFID leg tags with the information given in the application form and to also detect any major failure e.g. electronic non-readability, damage of the device at application, inappropriate animal welfare design etc., the leg tags will be submitted to a Preliminary Assessment.

10.8.5.2.2.1 Leg tag design
RFID leg tags shall have smooth, rounded corners and no sharp edges or protrusions. The following measurements will be taken:
1. The weight of the leg tag
2. The dimensions of the leg tag (length, width and thickness)
3. The adjustable diameter
Values and observations potentially impacting on animal welfare will be reported.

10.8.5.2.2.2 Electronic readability check
Every submitted RFID leg tag will be read with an ICAR approved handheld reader to ensure the reference ID codes transmitted meet the requirements outlined in 10.8.4.7.

10.8.5.2.2.3 Conclusion of the Preliminary assessment
The test centre will prepare a comprehensive report detailing the results of the submitted external RFID devices' performance in the Phase 2 Preliminary Assessment. This report will be submitted to ICAR who will then forward the test report to the manufacturer.
If the Phase 2 testing is successful, then the manufacturer will be asked to confirm their willingness to proceed to the Phase 3 Laboratory Test.
If a device has not performed satisfactorily, ICAR will provide the manufacturer with the test report and indicate the reasons for the device's failure.
10.8.5.3 Laboratory Test - Technical Evaluation

10.8.5.3.1 Assigning a Test Centre

Following the successful completion of the Preliminary Assessment and the decision of the manufacturer to proceed to the Phase 3 Laboratory Test, Service-ICAR will assign one of its approved test centres to carry out the Phase 3 Laboratory Tests. The manufacturer's preferred approved test centre may be taken into consideration.

10.8.5.3.2 Granting of a Test Code

A specific test code will be allocated by ICAR for the RFID device undergoing testing. The manufacturer will be advised of the test code and the manufacturer must print or engrave this code on each device produced for the Phase 3 Laboratory Test.

10.8.5.3.3 Manufacturer Requirements

At the commencement of Phase 3, the manufacturer must deliver the following items to the assigned test centre (in addition to the items listed in Section 10.8.5.2.1):

- 200 external RFID devices programmed with the reference ID codes and the reference printing. One tag applicator or an equivalent device supplied for the application of devices to animals.
- A statement specifying the nature of the polymer used for the RFID device, e.g. thermoplastic elastomers, vulcanized elastomer etc.

10.8.5.3.4 Assessment of descriptive parameters

The parameters describing the RFID device will be assessed and compared to the information provided in the Application Form and, if applicable, the Preliminary Assessment report to ensure accuracy of description.

10.8.5.3.4.1 Weight and dimensions

The following measurements will be taken from five of the submitted RFID devices:

1. RFID ear tags: the measurements as listed in 10.8.5.2.2.1.1
2. RFID leg tags: the measurements as listed in 10.8.5.2.2.2.1

10.8.5.3.4.2 Composition

Because external RFID devices are attached to "food producing" animals, they must meet specific requirements set down by international laws and regulations. In addition to these requirements, substances affecting animal, human or environmental health need to be detected.

This evaluation will involve 20 RFID devices.
10.8.5.3.4.2.1 Characteristics of the plastic of the ear or leg tag

To characterise the basic component of the plastic raw material, one device is submitted to an Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy analysis. If the RFID ear tag contains a flag (an extended plate), the ear tag plate is pressed directly against the ATR-crystal. With leg tags or ear tags without a flag, the laboratory will determine if sample preparation is necessary. After analysis, the resulting ATR spectrum will be compared with characteristic spectra stored in specific databases.

Following this analysis, a material sample is submitted to a Differential Scanning calorimetry (DSC) analysis to analyse the thermal characteristics of the material as per ISO 11357. This analysis allows the detection of overlapping IR curves, e.g. if an additional component of minor quality was used to stretch the main component. The test is performed in two heat-up phases:

- Phase 1: 30°C - 200°C to obtain information about post cross linking of the plastic material to detect processing effects
- Phase 2: 30°C - 400°C to analyse the thermal parameters.

Melting point and glass transition temperatures are recorded to indicate the specific thermal characteristics of the plastic material.

10.8.5.3.4.2.2 Harmful substances

Pigmented plastics may contain critical heavy metals which must be recorded. These metals are: Cadmium (Cd), lead (Pb), mercury (Hg) and chromium (Cr). If chromium is detected, an additional analysis of carcinogenic hexavalent chromium will be done. The following limit values must not be exceeded:

- Cadmium: 100 mg/kg
- Lead: 10 mg/kg
- Mercury: 1 mg/kg
- Chromium: 10 mg/kg (Chromate (Cr VI): < 1 mg/kg)

10.8.5.3.5 Performance assessment

The tests described in this section are designed to determine the stability and endurance of the RFID devices.
The performance assessments are summarized in the following table:

<table>
<thead>
<tr>
<th></th>
<th>Electronic ear tags</th>
<th>Electronic leg tags</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New Artificially aged Damp heat treated New</td>
<td></td>
</tr>
<tr>
<td>Artificial ageing (ISO 4892-2, A/1)</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Free fall (IEC 60068-2-32)</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Cold (IEC 60068-2-2-1)</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Dry heat (IEC 60068-2-2)</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Damp heat (ISO 4611)</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Tensile test of the locking system</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Visual readability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typography (flag tags only)</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Colour contrast change</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td>Electronic readability (ISO 24631-1, ISO 24631-3)*</td>
<td>×</td>
<td></td>
</tr>
</tbody>
</table>

A readability test is performed after every environmental test.

**10.8.5.3.5.1 Initial readability test**

Every RFID device will be read before starting any environmental test. The readability test is done according to ISO 24631-1 and 24631-3. Identification number (ID code), resonance frequency, minimum activation field strength and all relevant performance parameters are measured and recorded. The recorded values will be used as the reference for every following read test.

**10.8.5.3.5.2 Resistance to artificial ageing**

In accordance with EN ISO 4892-2, procedure A/cycle 1 (Table 3), 40 ear tags are tested against resistance to sunlight. The exposure chamber will be fitted with xenon-arc lamps according to EN ISO 4892-2 and operated continuously for 1,000 hours. These 1000 hours will consist of repeated cycles of 102 minutes of radiant exposure followed by 18 minutes of combined irradiation and rain simulation. The irradiance level of the xenon-arc lamps will be 60 W/m² (at 300-400 nm).

Upon completion of the artificial aging treatment, a readability test is performed according to ISO 24631-1 and ISO 24631-3 on 20 randomly chosen devices to ensure every tag, as a whole, has survived the procedure with the transponder in situ and remains compliant with ISO 11784 and ISO 11785. The measured values are compared to those of the initial test.

**10.8.5.3.5.3 Resistance to tensile loading**

This test applies to RFID ear tags only.

This test is done using 30 new ear tags, 30 artificially aged tags and 30 tags submitted to damp heat treatment. The test is performed at -25°C (± 2°), 21°C (± 2°) and 55°C (± 2°) combined with 50% RH (when the temperature is greater than 0°C) with every 10 ear tags from the three treatment variations.
To test the tensile strength of the locking mechanism the ear tag is affixed to a test jig simulating its application and attempts are made to remove the ear tag by subjecting it to increasing forces. The class 1 tensile test machine shall operate at a speed rate of 500 mm/min and be capable of generating loads of up to 1,000 N. An increasing load will be applied in axial direction. The maximum load and the effect(s) of the tensile force on the appearance and/or efficacy of the ear tags will be recorded. Broken or unfastened tags must not be re-useable.

Requirements

- At ambient conditions (21°C ± 2°), ear tags designed to be used in cattle shall not break or unfasten with application of a force lower than 280 Newton.
- At ambient conditions (21°C ± 2°), ear tags designed to be used in sheep and / or goats shall not break or unfasten with the application of a force lower than 200 Newton.
- The minimum breaking force applies to devices irrespective of treatments (artificial aging, damp heat, etc.)

10.8.5.3.5.4 Resistance to impact of free fall

When tested in accordance with IEC 60068-2-32 the RFID device shall not split or crack after falling 1000 mm onto a concrete surface The test conditions are as follows:

1. The tag component containing the transponder is levelled in 3 attitudes (horizontally, vertically top and bottom) and dropped twice in each attitude.
2. The above test is carried out on three new and three artificially aged devices.
3. The test shall be carried out at a temperature of 21°C (± 3°) and at ambient humidity. The test is repeated again after an hour's storage at -20°C (± 2°) immediately after removing off the climatic chamber.

After the free fall test, a readability test is performed according to ISO 24631-1 and ISO 24631-3 on the tested RFID devices to ensure every device has survived the procedure with the transponder in situ and remains compliant with ISO 11784 and ISO 11785. The measured values are compared to those of the initial test.

10.8.5.3.5.5 Resistance to cold

In accordance with IEC 60068-2-1, 10 new tags are exposed to a constant climate of -25°C (± 2°) for 24 hours. Directly after removing the samples from the climatic chamber a readability test is performed according to ISO 24631-1 and ISO 24631-3 on the tested RFID devices to ensure every device has survived the procedure with the transponder in situ with no change in performance. The measured values are compared to those of the initial test.

10.8.5.3.5.6 Resistance to dry heat

In accordance with IEC 60068-2-2, 10 new tags are exposed to a constant climate of 55°C (± 3°) for 24 hours.
Directly after removing the samples from the climatic chamber a readability test is performed according to ISO 24631-1 and ISO 24631-3 on the tested RFID devices to ensure every device has survived the procedure with the transponder in situ with no change in performance. The measured values are compared to those of the initial test.

10.8.5.3.5.7 Resistance to damp heat and cold

In accordance with ISO 4611, 40 ear tags are placed into alternating cycles of 12 hours damp heat (40°C ± 2° / 95% RH) and 12 hours cold (-25°C ± 2°) for a duration of 3 weeks in a climatic chamber.

Upon completion of this test, a readability test is performed on 10 ear tags according to ISO 24631-1 and ISO 24631-3 on the tested RFID devices to ensure every device has survived the procedure with the transponder in situ with no change in performance. The measured values are compared to those of the initial test.

10.8.5.3.5.8 Typography readability

This test applies to RFID ear tags classified as flag tags only.

Five new ear tags and five artificially aged tags will be selected for assessment.

Five randomly chosen numbers as given in Annex 10.7.2 will be printed on five white pages of paper. The font size, print style and character spacing will replicate that used for the ear tags.

The test tags and the pages with the printed numbers will be placed on a vertical surface (viewing surface) at head height in an appropriately lit laboratory room. Five assessors will stand 15 metres from the viewing surface and then commence walking towards it. Each assessor will attempt to read the numbers on the different ear tags and pages and the distance at which each device (ear tag or page) can be read without error will be recorded on the evaluation sheet.

The mean reading distance for both the pages and the ear tags will be separately calculated for each assessor and for the average of the assessors.

The following requirements must be met:

- New, untreated tags: The mean distance at which the reference printing is read on the ear tags must be at least 80 % of the mean distance at which the pages are read.
- Artificially aged tags: The mean distance at which the reference printing is read for the ear tags must be at least 65 % of the mean distance at which the pages are read.

10.8.5.3.5.9 Evaluation of colour contrast change

The colour difference of the ear tag plates and of the laser printing is measured and compared between three new ear tags and three artificially aged ear tags by use of spectral photometric measuring equipment according to ISO 7724.

After artificial ageing, the change in colour must be less than delta E of 10 CIELAB units.
10.8.5.3.6 Conclusion of the laboratory tests

The test centre will prepare a test report and will submit it to Service-ICAR which will then forward it to the ICAR Sub-Committee for Animal Identification for comment. All information collected during the laboratory tests will remain confidential and only disclosed to the manufacturer of that RFID device.

Upon the successful completion of the Phase 3 Laboratory Testing, ICAR will send the test report and an official letter to the manufacturer granting ICAR certification for that RFID device.

Each test report on a successfully tested RFID device will include a summary sheet with an evaluation of the appropriate suitability of the RFID device for various production systems and/or environmental conditions.

If the Phase 3 Laboratory Test results are unsatisfactory, ICAR will send the manufacturer a test report indicating the reasons for the failure.

10.8.5.3.7 ICAR conditions for certification of permanent external RFID devices

1. Upon successful completion of the ICAR test procedures described in this Section 10.8, ICAR will grant a device certificate valid for five years and a certification reference number.

2. The certification is valid only for the specific external RFID device type successfully tested and certified by ICAR.

3. A manufacturer cannot utilise the ICAR certification for an RFID device:
   a. Which is not manufactured by them; or
   b. Which does not comply in all respects to the ICAR certification (but not limited to):
      i. Maintaining identical technology and the manufacturer of the certified tag;
      ii. Maintaining an identical RFID device to the certified tag;

4. Once the ICAR certification has been granted, the manufacturer will be responsible to:
   a. Keep an accurate and detailed log of all changes to their product and this log must be available to ICAR upon request. This log must include details of in-house performance measurements and Quality Assurance testing showing the product has maintained or enhanced its quality, performance and material composition.
   b. Submit the product for re-certification before the expiration of its current ICAR certification. The manufacturer must submit this product no earlier than 6 months before the expiration of the certificate and no later than 5 months before the expiration of the certificate.
   c. Understand that within the 5 year timeframe, ICAR may take sample products from the market and test its conformance against the conformance of the device the manufacturer originally submitted should ICAR suspect a breach of the signed ICAR Code of Conduct or a product change that has not been subjected to the tests outlined in Section 10.2.4 of this document.
5. Should the manufacturer fail to meet any or all above certificate conditions ICAR may withdraw the certification.

6. In disputes regarding the conditions above or the use of a certificate, the decision of ICAR will be binding.

7. ICAR will distribute an advice notice regarding any manufacturer distributing RFID devices in conflict with the testing and certification procedures outlined in this Section 10.8.

**LIST OF ICAR CERTIFIED DEVICES**

The following is the list of ICAR Certified devices

- The updated list of ICAR Manufacturers’ Code is available on web at: www.service-icar.com/manufacturer_codes/Manufacturers_DB/manufacturer_codes_main.asp

- The updated list of ICAR certified transceivers conforming to ISO11784/11785 (Synchronising transceivers) is available on the web at: www.icar.org/pages/Transceivers_synchronising.htm

- The updated list of ICAR certified non-synchronising transceivers capable of reading transponders conforming to ISO 11784/11785 is available on the web at: www.icar.org/pages/Transceivers_Not_synchronising.htm

- The updated list of ICAR certified “Permanent plastic eartags” for cattle, sheep, goats and swineis available on web at: www.icar.org/pages/certified_eartags.htm
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.
Section 11 - Testing, approval and checking of milk recording devices

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 6690 Milking Machine Installations. Mechanical testing.
- ISO 20966 Automatic Milking Installations - Requirements and testing.
- 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

### 11.3 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.

<table>
<thead>
<tr>
<th>Species</th>
<th>Interval</th>
<th>Minimal scale representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>primary: 1.0 kg</td>
<td>10 mm / kg</td>
</tr>
<tr>
<td></td>
<td>secondary: 0.2 kg</td>
<td></td>
</tr>
<tr>
<td>Buffalo</td>
<td>primary: 1.0 kg</td>
<td>25 mm / kg</td>
</tr>
<tr>
<td></td>
<td>secondary: 0.2 kg</td>
<td></td>
</tr>
<tr>
<td>Goat &amp; sheep</td>
<td>primary: 1.0 kg</td>
<td>40 mm / kg or liter</td>
</tr>
<tr>
<td></td>
<td>secondary: 0.1 kg</td>
<td></td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Species</th>
<th>Milk yield</th>
<th>Fat percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Standard deviation&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cattle</td>
<td>2 - 10 kg</td>
<td>0.50 kg</td>
</tr>
<tr>
<td></td>
<td>&gt; 10 kg</td>
<td>5 %</td>
</tr>
<tr>
<td>Buffalo</td>
<td>1 - 6 kg</td>
<td>0.30 kg</td>
</tr>
<tr>
<td></td>
<td>&gt; 6 kg</td>
<td>5 %</td>
</tr>
<tr>
<td>Goat and Sheep</td>
<td>0.3 - 0.8 kg</td>
<td>0.04 kg</td>
</tr>
<tr>
<td></td>
<td>&gt; 0.8 kg</td>
<td>5 %</td>
</tr>
</tbody>
</table>

<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).

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Range</th>
<th>Standard deviation</th>
<th>Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat</td>
<td>2.0-6.0 g/100g</td>
<td>0.25 g/100g</td>
<td>0.13 g/100g</td>
</tr>
<tr>
<td></td>
<td>5.0-14.0 g/100g</td>
<td>0.25 g/100g</td>
<td>0.25 g/100g</td>
</tr>
<tr>
<td>Protein</td>
<td>2.5-4.5 g/100g</td>
<td>0.25 g/100g</td>
<td>0.13 g/100g</td>
</tr>
<tr>
<td></td>
<td>4.0-6.0 g/100g</td>
<td>0.25 g/100g</td>
<td>0.25 g/100g</td>
</tr>
</tbody>
</table>

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).

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Range</th>
<th>Standard deviation</th>
<th>Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactose</td>
<td>4.0-5.5 g/100g</td>
<td>0.25 g/100g</td>
<td>0.13 g/100g</td>
</tr>
<tr>
<td>Urea</td>
<td>10 – 7 mg/100g</td>
<td>15.0 mg/100 g</td>
<td>3.0 mg/100 g</td>
</tr>
<tr>
<td>SCC</td>
<td>0-2000</td>
<td>25 %</td>
<td>13 %</td>
</tr>
</tbody>
</table>

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.
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- 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.
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>
<thead>
<tr>
<th>Species</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Goat and/or sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td># on list with serial numbers</td>
<td>50</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td># of devices for laboratory test</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td># of devices for field test</td>
<td>8</td>
<td>8</td>
<td>4 / species</td>
</tr>
<tr>
<td># of farms for the field test</td>
<td>2</td>
<td>2</td>
<td>1 / species</td>
</tr>
<tr>
<td># of reserve devices</td>
<td>1 (optional)</td>
<td>1 (optional)</td>
<td>1 (optional)</td>
</tr>
</tbody>
</table>

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 parlour 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.

<table>
<thead>
<tr>
<th></th>
<th>Laboratory</th>
<th>Parlor</th>
<th>Robot</th>
</tr>
</thead>
<tbody>
<tr>
<td># on list with serial numbers</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td># of devices for laboratory test</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td># of devices for field test</td>
<td></td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td># of farms for the field test</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td># of reserve devices</td>
<td></td>
<td>1 (optional)</td>
<td></td>
</tr>
</tbody>
</table>

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 tests.

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.
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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 ± 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 ±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>
<thead>
<tr>
<th>Species</th>
<th>Flow rate (kg/min)</th>
<th>Air bleeds (l free air/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>5</td>
<td>0, 4, 12, 20, 30</td>
</tr>
<tr>
<td>Buffalo</td>
<td>2.5</td>
<td>0, 4, 12, 20, 30</td>
</tr>
<tr>
<td>Goat and sheep</td>
<td>2</td>
<td>0, 4, 8, 16, 30</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Species</th>
<th>Flow rate (kg/min)</th>
<th>Positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>5</td>
<td>Horizontal, 5 degrees to left, right, front and back</td>
</tr>
<tr>
<td>Buffalo</td>
<td>2.5</td>
<td>Horizontal, 5 degrees to left, right, front and back</td>
</tr>
<tr>
<td>Goat and sheep</td>
<td>2</td>
<td>Horizontal, 5 degrees to left, right, front and back</td>
</tr>
</tbody>
</table>

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 of the milk recording device

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>
<thead>
<tr>
<th>Species</th>
<th>Milk production (reference)</th>
<th>Fat percentage (reference)</th>
<th>Protein percentage (reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>2 – 40 kg</td>
<td>2 – 7 %</td>
<td>2.5 - 5 %</td>
</tr>
<tr>
<td>Buffalo</td>
<td>1 – 15 kg</td>
<td>3 – 15 %</td>
<td>3 - 8 %</td>
</tr>
<tr>
<td>Goat</td>
<td>0.3 – 6 kg</td>
<td>2 – 8 %</td>
<td>3 - 7 %</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.3 – 6 kg</td>
<td>2 - 12%</td>
<td>3 – 8 %</td>
</tr>
</tbody>
</table>

*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 MRDa). 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_meters.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 parlour or an extended parlour 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 to the numbers of the places in the parlour.

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**

**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 (wear and tear) 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 as prescribed in section 11.6.2.1 below.

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.

11.6.2.1 Computerized solutions for periodic checking

It is here assumed that all of the computerized methods presented below adhere to and respect the following statements:

a. If the computerized methods are applied as outlined then they can replace the annual routine accuracy test. The requirement is to run these statistical checks at least once per year but for best practice in quality assurance it is recommended to run this more frequently throughout the year, for instance at time of milk recording visits.

b. These methods have to be used for routine test only and not for the installation test.

c. While the computerized method will identify deviating meters it does not replace the aspect of routine meter maintenance as recommended by the manufacturer.

Other methods / procedures than the following ones can be subjected by the manufacturers, member organizations or software suppliers, but they must be approved by ICAR.
11.6.2.1.1 Several milking stand installations

Use of expected milk yield - Principles

A comparison between expected milk yield and milk yield measured by the milk meter is used to estimate whether a milk meter is out of calibration or not. The expected milk yield can be estimated from various calculations (see table 11.7). When the calculation uses a "herd factor" (calculations n°2 and n°4), it increases the accuracy of expected yield estimation (see table 11.8 in appendix 6.1). There are no significant differences between calculations using a herd factor and no significant differences between 5 to 10 milkings / days for one type of calculation. Thus, the best compromise between accuracy and data amount is the calculation from last 5 milkings at Mn (nth milking of the day) corrected by a herd factor (i.e. calculation n°4 in table 11.7).

Step 1: Calculation of expected milk yield

Table 11.7. Expected milk yield calculations

<table>
<thead>
<tr>
<th>Table 11.7. Expected milk yield calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yields average on the last X days and time elapsed since last milking:</td>
</tr>
<tr>
<td>[ \frac{\sum_{i=1}^{X} (y_{1i} + y_{2i})}{X} \times \text{time elapsed from last milking} ]</td>
</tr>
<tr>
<td>2. Yields average on the last X days and time elapsed since last milking * “herd factor”:</td>
</tr>
<tr>
<td>[ \left( \frac{\sum_{i=1}^{X} (y_{1i} + y_{2i})}{X} \right) \times \text{time elapsed from last milking} \times \left[ \frac{\sum_{i=1}^{X} (h_{1i} + h_{2i})}{X} \right] ]</td>
</tr>
<tr>
<td>3. Yields average on the last X milkings at Mn</td>
</tr>
<tr>
<td>[ \frac{\sum_{i=1}^{X} y_{ni}}{X} ]</td>
</tr>
<tr>
<td>4. Yields average on the last X milkings at Mn * “herd factor”</td>
</tr>
<tr>
<td>[ \frac{\sum_{i=1}^{X} y_{ni}}{X} \times \left( \frac{\sum_{i=1}^{X} h_{ni}}{X} \right) ]</td>
</tr>
</tbody>
</table>

with:
\[ y_i \]: milk yield of a cow at milking M1 (= first milking) or M2 (= second milking).
\[ y_{ni} \]: milk yield of cow n at milking Mn (n=1 or 2)
\[ h_i \]: milk yield average of the herd at milking M1 or M2
\[ h_{ni} \]: milk yield average of the herd at milking Mn (n=1 or 2)
\[ X \]: number of days / milkings

**NB**: The previous calculations of expected milk yield and examples are also possible with three (3) or four (4) milkings per day.
Step 2: Calculation of cow deviation
For each cow, an expected milk yield is calculated. Then, the difference between the expected milk yield and the yield measured by the milk meter is calculated.
Cow Deviation (kg) = Measured yield (kg) - Expected yield (kg)

Step 3: Calculation of the milk meter deviation for one milking
For each milk meter, the deviation is calculated as following.

\[
\text{Deviation} \, (\%) = \frac{\text{sum of cow deviations (kg) for this milk meter}}{\text{sum of Expected yields (kg) of these cows for this milk meter}} \times 100
\]

Step 4: Average deviation calculation for one milk meter
The average deviation is calculated from a minimum of at least 9 consecutive milkings with a recommended maximum of 20 milkings. It is desired to have an equal representation of milkings in calculation of average meter deviation. For herds milking three times daily, 9 consecutive milkings representing three days is the required minimum for calculation of the average meter deviation. The same logic would apply to herds milking four times daily.

Decision rule
If the average deviation of the milk meter is within the range of ± 3%, the milk meter’s calibration is considered as correct.
If the average deviation exceeds these limits, the milk meter’s calibration shall be confirmed with the manufacturer manual calibration test (11.6.2.1) or with a milking test (11.6.1.1).
If more than 20% of the milk meters of the installation are out of the deviation limits with this method, it is recommended to perform a manual calibration test on all of them.

Use conditions/requirements
The use of this method requires reliable electronic cow identification. There must be as well a connection between the milking parlour, the identified cows and the computer.
The method can be used for validation of meters if the milking parlour has at least 8 milking stands. If less than 8 stands in the parlour then the method and results can only for be used as a qualitative tool to indicate to the technician the meters that require attention.
The random distribution of the cows over the stands increases the accuracy of the method.
Before 30 days of lactation, milk yields are not stationary enough to estimate a reliable expected yield (Pérochon et al., 1996). Thus, these data must be deleted before the calculation. Consequently, it is recommended not to use this method in the calving period (if grouped calvings).
Milk yields equal to 0 are considered as being unusual and are deleted before the calculation.
In step 3, before to calculate the milk meter deviation, a relative difference between the expected milk yield and the yield measured by the milk meter is calculated for each cow. If this difference is higher than 30% or lower than -30%, the data is deleted.

Relative cow deviation (%) = \frac{\text{Measured yield (kg)} - \text{Expected yield (kg)}}{\text{Expected yield (kg)}} \times 100

An application example of this method is situated in appendix 6.1.

### 11.6.2.1.2 Model of De Mol and André (2009)

#### Principles

This method uses a Dynamic Linear Model (DLM, West & Harrison, 1989). The average milk yield per stand and milking session is calculated over all milkings on that stand. The resulting stand average is compared with the overall average. The deviation will be close to zero for a properly working meter. A DLM is based on a comparison per milking session of the average per stand with the overall average. This model is described here:

\[
\text{Deviation}_{ms} = \text{AveYield}_{ms} - \text{AveYield}_m
\]  

(1)

with:

- \text{Deviation}_{ms}: deviation for milking session m and stand s (kg)
- \text{AveYield}_{ms}: average milk yield for milking session m and stand s (kg)
- \text{AveYield}_m: average milk yield for milking session m (kg)

It is assumed that the stand deviation is a factor relative to the average milk yield for a milking session:

\[
\text{Deviation}_{ms} = \mu_{ms} \times \text{AveYield}_m
\]  

(2)

The stand deviation factor \(\mu_{ms}\) will be close to zero if the milk meter is recording correctly, positive if the milk meter recordings are too high or negative if the milk meter recordings are too low.

A formulation with an observation equation and system equation is needed for the application of DLM (Dynamic Linear Model).

The observation equation is:

\[
Y_t = F_t \theta_t + v_t, \quad v_t \sim N[0, V_t]
\]  

(3)

with:

- \(Y_t\): observation vector
- \(\theta_t\): parameter vector describing the state of the system
- \(F_t\): design matrix describing the relation between the state and the observation
- \(v_t\): observational error
The system equation is:

\[
\theta_t = G_t \theta_{t-1} + \omega_t, \quad \omega_t \sim N(0, W_t)
\]  

(4)

with:

- \(G_t\): system matrix, describing the relation between the current and the previous state parameters
- \(\omega_t\): system error

This model is applied for each stand \(s\) and milking session \(m\) (\(t \equiv m\)) with the following implementation:

\[
Y_m = \text{Deviation}_{ms} - \text{the observed deviation for stand } s \text{ and milking session } m \text{ (kg)}
\]

\[
\theta_m = \mu_{ms} - \text{the stand deviation factor}
\]

\[
F_m = \text{AveYield}_m - \text{average milk yield for milking session } m \text{ (kg)}
\]

\[
G_m = I - \text{identity matrix, assuming that the state is locally constant}
\]

With this implementation, the observation equation (3) states that the stand deviation factor of the overall average is observed. The system equation (4) states that it is expected that the factor does not change in time. The model estimates the stand deviation factor per stand after each milking session.

**Decision rule**

An alert is given when the stand deviation factor differs significantly from zero using a significance level of 0.05. When it is the case, the milk meter calibration shall be confirmed with the manufacturer manual calibration test (11.6.2.1) or with a milking test (11.6.1.1).

If more than 20% of the milk meters are out of calibration with this method, it is recommended to proceed to a manual calibration test on all of them.

**Use conditions/requirements**

This model is fitted with a procedure for analyzing Dynamic Linear Models ((DLM’s) - by way of example only this model used a statistical package by Genstat (Payne et al., 2006). The number of milkings is used as a weighting factor, discount factors are used to regulate the adaptation speed. The discount factors have been chosen such that the likelihood of the fitted model is maximal and the serial correlation of the observation errors is low.

The use of this model requires a connection between the milking parlour and the computer. The random distribution of the cows over the stands increases the accuracy of the method. This model will not work if the cows are divided over the stands based on production characteristics. Milkings with zero yield must be excluded from the statistical analysis.

**11.6.2.1.3 Model of Trinderup (2009)**

**Principles**

The effect of different factors (date, milking time and days in milk) on milk yield is estimated. A statistical treatment on the residuals reveals if a milk meter is out of calibration or not. The model is described as following:
Step 1: Model of the lactation curve per cow

\[ Y_i = \alpha_i(\text{Date}_i) + \alpha_2(\text{Milking}_i) + \beta_3^1 \text{DIM}_i + \beta_3^2 \text{DIM}^2_i + \beta_3^3 \text{DIM}^3_i + \beta_4^1/\text{DIM}_i + \beta_5(\text{Milking}_i) \text{DIM}_i + \beta_6(\text{Milking}_i) \text{DIM}^2_i + \beta_7(\text{Milking}_i) \text{DIM}^3_i + \beta_8(\text{Milking}_i) \text{DIM}^3_i + \beta_9(\text{Milking}_i) \text{DIM}^3_i + \alpha(\text{Cow}_i) + \varepsilon_i \]

with:
- \( Y_i \): observed milk yield (kg)
- \( \text{Cow}_i \): cow identification
- \( \text{Date}_i \): date of milking
- \( \text{DIM}_i \): days in milk
- \( \text{Milking}_i \): classification of milking according to time of day (two times: am/pm; three times: am/pm/night)
- \( \varepsilon_i \): residual (kg)

Step 2:
The residuals per milk meter are smoothed as an average over a period of 4 days. The deviation between the mean residuals of any given milk meter and the mean residuals of all other milk meters is calculated.

Decision rule
If the deviation of the milk meter is within the range of ± 3%, the milk meter's calibration is considered as correct.

If the deviation exceeds these limits, the milk meter calibration shall be confirmed with the manufacturer manual calibration test (11.6.2.1) or with a milking test (11.6.1.1).

If more than 20% of the milk meters are out of the deviation limits with this method, it is recommended to proceed to a manual calibration test on all of them.

Use conditions/requirements
The application of this model requires a statistical software.

The model was developed to be used for data from minimum 30 days. If the herd is milked two times per day it is equivalent to 60 milkings, if the herd is milked three times per day it is equivalent to 90 milkings.

The use of this model requires reliable electronic cow identification. There must be as well a connection between the milking parlour, the identified cows and the computer.

The model can be used for milking parlours with at least 8 milking stands.

For a higher reliability, it is recommended that the cows are distributed randomly over the milking stands.

N.B.: If data from a shorter period is to be used, the model can be reduced. For example if only 4 days of data is used, the model in step 1 can be reduced to:

\[ Y_i = \alpha_2(\text{Milking}_i) + \beta_3(\text{Milking}_i) \text{DIM}_i + \alpha(\text{Cow}_i) + \varepsilon_i \]
11.6.2.1.4 Automatic Milking Systems (AMS) Comparison between robot milk meter and the tank

Principles
A comparison between the milk weight collected in the tank and the sum of milk weights measured by the milk meter of the robot and sent to the tank between 2 milk collections is used for estimating if the milk meter is out of calibration or not.

- Step 1: Calculation of the milk meter deviation for one collection
- Step 2: Average deviation calculation

The average deviation is calculated from a minimum of at least 3 collections and with a recommended maximum of 5 collections.

In case of irregular collection dates and times, we recommend calculating the average deviation by this way (rather than an average of deviations calculated in step 1):

\[
\text{Average deviation (\%) = } \frac{\sum_{i=1}^{X} (\text{milk weighed by AMS milk meter})}{\sum_{i=1}^{X} (\text{Collected milk})} \times 100
\]

With:
X = milk collection number (= 3 to 5)

Decision rule
If the average deviation of the milk meter is within the range of ±3%, the calibration of the milk meter is considered as correct.

If the deviation exceeds these limits, the milk meter’s calibration shall be confirmed with the manufacturer manual calibration test (11.6.2.1) or with a milking test (11.6.1.1).

Use conditions / requirements
The use of this method requires knowing the milk destination of milk weights measured by the milk meter. It also requires the dates and exact times of milk collections and a reliable cow identification.

The gauge precision of the tank and the tank level need to be checked at least once a year.

To apply this method, the tank volume needs to be converted into a weight. At 4°C, the mean milk density used is 1.0340 (Ueda, 1999).

N.B.: The method can be used for validation of meters if the AMS has 1 box only. If more than 1 box then the method and results can only for be used as a qualitative tool to indicate the overall deviation of boxes to the technician.

An application example of this method is situated in Appendix 6.2
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.

11.7.1 Test day policy utilizing proper recording practices when using electronic milk meters and electronic ID simultaneously

11.7.1.1 Definition

On test day, utilizing on-farm electronic milk meters with on-farm electronic identification (hereby addressed as ID) information, it has been substantiated numerous times that not all ID programs are complete, accurate and successful. Realizing that there are currently on-farm electronic milk metering devices standards that are in place it is the intent of this publication to substantiate the proper use and guidelines of electronic ID usage on test-day to give the most accurate and precise information possible for use in genetic evaluations and management practices.

11.7.1.2 Examples of proper recording systems/practices on test day

First group of cows entering milking parlor all need to be visually identified and cross-referenced to the electronic ID system; henceforth two stalls are randomly selected to observe on each group to insure proper ID test day procedures - to substantiate verification of visual observation a paper trail or computer notebook protocol would be used to insure accuracy.
First group of cows entering milking parlor all need to be visually identified and cross-referenced to the electronic ID system; henceforth every fifth group is visually identified to insure proper ID for test day procedures - to substantiate verification of visual observation a paper trail or computer notebook protocol would be used to insure accuracy.

First group of cows entering milking parlor all need to be visually identified and cross-referenced to the electronic ID system; henceforth each first and last animal is visually identified to insure proper ID for test day procedures - to substantiate verification of visual observation a paper trail or computer notebook protocol would be used to insure accuracy.

It is advisable that if there are any misidentified animals then proper notification needs to be made to the dairy producer as to the problem discovered and the entire test day needs to be completed using visual identification until the problem is corrected.

### 11.7.1.3 Validation

It is advisable the electronic ID system should have inbuilt validation checks/software to ensure each row has the correct cow sequence. Such checks would include but not limited to:

- "Cross out" check - in the event cow A is "read" by sensor but withdraws her head and is "passed out" by another cow B, then when cow A enters properly the sequence is corrected….

- "Random Check" - the system can be programmed on recording day so that the electronic system selects a % of units at random on each row for checking - operator must verify cow at the selected units (accept button) and only when all selected units are "accepted" is the row allowed out….

- "Narrow Entrance funnel" - as most errors occur at entry-gate to row, it is advisable for parlor installations to have entrance funnel of "one cow length" thereby distancing the jostling activity from sensors.

Note. Experts from manufacturers should be consulted here to decide and agree on the best way to "build" quality checks into the system.

### 11.7.2 Test day policy utilizing proper recording practices when obtaining milk samples on individual animals

#### 11.7.2.1 Definition

On test day, various sample vial recordings are used in the world-wide marketplace that adhere to proper test day procedures; however as has been identified by various entities, shortcuts are being made that limit proper identification of samples with individual cows on test day. With the milk sample platform being used for disease, genetics, DNA, and health tests along with the routine component test day requirements it is essential that all milk samples collected on test day be properly identified to the corresponding animal that it is collected from using proper collecting procedures.
11.7.2.2 Examples of proper recording of sample vials on test day

Each animal is recorded on sample vial with name or number corresponding to animal ID that is used on-farm that corresponds with proper laboratory practice procedures.
Each animal is recorded on sample vial using bar graph information systems that corresponds with proper laboratory practice procedures.
Each animal is recorded on sample vial via RFID chip installed or embedded within the sample vial that corresponds with proper laboratory practice procedures.
It is advisable that every sample vial is properly identified with the corresponding correct cow ID in whatever system is approved for proper usage that will follow proper laboratory practice procedures.
SECTION 12 - GUIDELINES FOR QUALITY ASSURANCE ON DHI ANALYSIS

12.1 Field of application

These guidelines concern methods for fat, protein, lactose, urea and somatic cells determinations in individual cow, goats and ewes milk. Milk samples are in most cases preserved with chemical substances. This will be taken into account in the procedures.

They define:

- Authorised reference methods.
- Approved routine instrumental methods.
- Recommendations for sample quality.
- Recommendations for quality control of analyses.

12.2 Analytical methods

12.2.1 Reference methods

The wording "reference methods" designates the methods used to calibrate the instrumental (routine) methods.

The reference methods should be internationally standardised methods (i.e. ISO, IDF, AOAC methods); although practical arrangements are permitted (see note below). The reference methods are listed in Annex 2.

Note: Reference transfers

1. Rapid chemical methods can be used instead of a more time consuming reference method as far as results have shown to be equivalent to those from reference methods (i.e. Gerber method for fat, Amido Black method for protein).

2. Master instruments (indirect rapid methods) may be used to produce "reference values" for other instruments and for other laboratories in case of a system with centralised calibration. Instrumental values may be considered equivalent to the values of the method used as reference for the calibration. Application of a centralised calibration concept must take into account sensitivity of routine methods to matrix effects (milk composition).
12.3 Routine (Instrumental) methods

Routine methods should be either standardised methods, or methods which have received an official approval from the national DHI organisation on the basis of a performance evaluation by an expert laboratory and using a standardised protocol, or methods approved at the international level by ICAR. With this respect, conditions and procedure of evaluation, as well as requirements for ICAR approval, are defined in a standard protocol approved by ICAR as relevant for the purpose of milk recording.

12.4 Specific recommendations for DHI milk samples

The sample quality is the first major requirement for a consistent analytical result. Good quality samples are a prerequisite to establish whether analytical quality requirements are met.

12.4.1 Bottles

In general terms, vials and stoppers must be suitable for their purpose (to bring milk without loss or damage to laboratories). For instance, a too large empty volume above the milk may facilitate churning during transport, especially with non-refrigerated milk. A too small empty volume above the milk may give rise to problems with mixing. Fat loss may occur with imperfectly tight stoppers.

12.4.2 Preservatives

Preservation of milk recording samples using chemical compounds should:

- maintain the physical and chemical properties of the milk during the period running from sampling to analysis in the usual temperature and transport conditions;
- not prevent from performing reference analysis, as the possibility of control remains to the laboratories;
- have no effect on the results of analysis with the reference methods and no or only a limited effect on the routine instrument response (a limited effect can be compensated for through calibration).
- be innocuous to DHI and laboratory staff according to local health regulations;
- be innocuous to environment according to local environmental regulations.

Notes

1. Sample preservation is promoted working with clean milking and sampling equipment, by storage of samples at cool temperatures during limited time with a minimum of handling.
2. Appropriate preservatives are mentioned in relevant standards with guidance (ISO 9622 | IDF 141 and ISO 13366 | IDF 148). Nevertheless, in general care must be taken for:
   - preservative excipient: depending on the excipient - generally salts - various effects can be observed for applied formulations where none exists in the pure form (case of potassium dichromate and bronopol in milk by mid infra red spectrometry);
   - some dyes which are used as colour tracer may interfere with the instrumental response (absorption of light or dye-binding with DNA). The accuracy of the sensitivity of a method may therefore be reduced. These dyes should be avoided.
12.5 Quality control for DHI laboratories

12.5.1 Quality control on reference methods

Any systematic error on reference method leads to an overall systematic error on routine results. This type of error which may exist between laboratories within a country (or organisation) and between countries, co-operating within international frameworks such as ICAR, justifies performance evaluations at both levels, national and international.

12.5.1.1 External control

Every DHI routine laboratory should be involved in an interlaboratory proficiency study (IPS) scheme. Proficiency testing should be organised preferably by a national reference or pivot laboratory appointed for that by the national DHI organisation. The reference laboratory will provide analytical precision traceability by its regular participation in international proficiency trials.

Note:
In situations where there are not sufficient laboratories to implement a national scheme, the laboratory can join PT schemes organised by a national or an international PT provider or the national DHI PT scheme of a neighbouring country. As far as possible, it should be aimed at establishing and maintaining a link for traceability with the international level.

The minimum frequency for participation in interlaboratory proficiency studies should be 4 times a year.

National reference laboratories should take part in international proficiency studies at a minimum frequency of once a year. Nevertheless, a more frequent participation is advised.

In the particular case of centralised calibration and control system, where only the reference laboratory performs reference methods, participation of routine laboratories in proficiency testing for reference is no longer necessary.

These trials are to be organised according to international standards, or failing that, international guidelines or agreements as indicated in section 12.5.1.

12.5.1.2 Internal control

Reference materials (RMs) are advised for use to check the exactness and the stability of reference methods used between two consecutive proficiency testing by comparison with nominal values. They will be used preferably when reference for calibration of routine methods are carried out (i.e. weekly).

They can be:

- Certified reference materials (CRMs) produced by a recognised official organisation.
- Secondary reference materials (SRMs) prepared by an external supplier.
- In-house reference materials (IRMs) prepared by the laboratory itself, where traceability is established with CRMs, SRMs or interlaboratory proficiency studies.
Whatever the choice made by the laboratory, CRMs and SRMs are to be produced and provided in QA conditions and according to international standards, or failing that, international guidelines or agreements as indicated in section 12.5.1.

IRMs constitute the simplest case of a single producer/user for own purposes. Therefore one is only concerned by production and quality control requirements. The laboratory then requires to meet with the demands from its own QA system, thereby referring to relevant parts of available guides.

12.5.2 Quality control on routine methods

Routine methods provide the results effectively used for DHI purposes and, therefore, their consistency has to be checked. For this, reference is made to the standard ISO 8196 | IDF 128 (Part II).

12.5.2.1 External control

A periodical control of the accuracy must be applied by an national expert laboratory, either through individual external control (IEC), by comparison of routine methods to reference analysis on samples representative of the laboratory area, or through interlaboratory proficiency studies when it has been clearly demonstrated that a single calibration can be used for all the laboratories. In the latter case, recommendations of section 12.4.1.1 and 12.5.1 are to be followed. The minimum frequency recommended is 4 times a year.

Repeatability and suitability of calibration are the main parameters to be checked. Depending on the experimental design, additional aspects can be evaluated such as sample preservation and instrumental parameters such as linearity and intercorrections.

12.5.2.2 Internal control

Irrespectively of the parameter, an internal quality control on routine methods has to be carried out in routine testing at the laboratory.

In general the standard ISO 8196 | IDF 128 does not define limits to fulfil for each method and/or milk component. Therefore specific standards have to be applied where they exist:

- Fat, protein and lactose (mid infra-red spectrometry): ISO 9622 | IDF 141.
- Somatic cell count: ISO 13366 | IDF 148;
- Urea (mid infra-red spectrometry): next update of ISO 9622 | IDF 141.

Preparation of pilot samples, used for monitoring instrument stability, should be made under quality assurance (i.e. quality control for homogeneity and preservation), thereby referring to relevant indications of international standards/guides for reference materials.

According to ISO 8196 | IDF 128, the major stages of control can be summarised as follows:

- Repeatability.
- Daily and short-term stability of instrument.
- Calibration.
In addition, checkings related to instrumental aspects are recommended in specific standards:

- Carry-over effect (all methods).
- Linearity (all methods).
- Zero-setting (all methods).
- Intercorrections (infra-red).
- Homogenisation (infra-red).

It is advised to fulfil requirements about frequencies and limits reported in Annex I.

12.6 **Requirements for analytical quality control and quality assurance tools**

12.6.1 **Compliance with International standards, Guidelines and Agreements**

12.6.1.1 **Interlaboratory proficiency studies**

Interlaboratory proficiency trials are to be organised in quality assurance conditions, according to international standards, or failing that, international guidelines or agreements.

At the editing date of the present documents, one can refer to:

- ISO Guide 43.
- ILAC-G13.
- ISO Standard 13528.

12.6.1.2 **Reference materials**

Reference materials used for DHI analytical purposes are to be produced in quality assurance conditions, according to international standards, or failing that, international guidelines or agreements.

At the editing date of the documents, one can refer to:

- ISO Guide 34.
- ILAC-G9.
- ILAC-G12.

12.6.2 **Choice of AQA service suppliers**

Choice of Analytical Quality Assurance (AQA) service suppliers - i.e. proficiency testing and reference material - by DHI laboratories is to be made in tight relation to the existence of a quality assurance system for the services production and supply as part of the overall DHI AQA system.

Services suppliers should operate under quality assurance and be able to provide documented proof of that.
Section 12 - Quality assurance on DHI analysis

Service suppliers should submit themselves to a periodical independent audit, i.e. a third party, in order to have the conformity of its QA system judged. These audits can be carried out by accreditation assessors, commissions of user representatives, experts (employed by or consultant) acting in the name of the DHI national organisation, provided that their competence and independence are guaranteed and that the audits are conducted in line with ISO and ILAC recommendations.

**Note**

These requirements are covered by accreditation. The latter is highly recommended in particular for specialised (inter)professional or commercial organisations dealing with large AQA lab service activities. In every case, notably for those countries where such an accreditation is not (yet) possible or for small and emerging organisations, the implementation of an in-house QA system remains the minimum base required.
Foreword

The present document was elaborated by a joint working group of representatives from different working parties of ICAR so as to cope with different aspects related to milk analysis on the farm for milk recording purposes. This working party on On-farm Milk Analysis (WP OMA) was created in Summer 2007 and held its first meeting on 27 November 2007 when the programme of work was adopted. The document was reviewed and commented in June 2008 in Niagara Falls-USA and was amended with the comments and complements received since.

The present document is modular in several aspects dealt with in ICAR working parties, such as identification, milk measurement, milk analysis, milk recording data, etc. It contains the identified elements needed to account for on-farm analysis in milk recording. Those elements should be further included at their proper places in existing ICAR guidelines.

(O. Leray, Actilait
Chairman of the ICAR Sub-Committee on Milk analysis)

13.1 Introduction

For many decades milk recording analysis is performed in specialised milk testing laboratories equipped with automated instrumentation for rapid testing. Those laboratories have implemented quality control and quality assurance procedures according to international standards as ISO/IEC 17025 and ISO 9001, proof of which can be given through accreditation and/or certification by competent bodies.

The last decade has shown the advent of portable analytical devices and analytical modules for direct in-line/on-flow analysis on-farm. As with centralized analysis, these analytical units are to be adequately managed in terms of quality control and quality assurance when delivering data for an official milk recording system.

On-farm analysis is generally being developed and implemented with direct farm management purposes in mind. However, use by/for official milk recording is envisaged. It is therefore essential that analytical devices can respond to both the needs for individual and collective interests.
An analytical quality assurance (AQA) frame has been designed by ICAR for milk analysis in laboratories. This frame defines general recommendations to be followed by organisation to get ICAR approval or certification for milk analysis.

In the forthcoming situation official milk recording data will be obtained from different analytical systems in different conditions, ICAR should therefore complement the existing AQA system so as to assure quality and precision of recording data in working with various analytical systems.

A frame is needed as a safeguard for quality to the users and as a practical tool to manufacturers who can find adequate technical indications or targets. It should be defined by ICAR through adequate guidelines dealing with the respective aspects related to milk recording analysis.

Under these circumstances, the ability of the equipment to meet with the performance criteria and clear recommendations for its practical application and proper quality assurance measures are a task for the manufacturers of the analytical devices, milk producers are responsible for a proper use, milk recording organisations for supervision on the execution of routine analysis in different places.

13.2 Outline

On-farm analytical devices are generally integrated with systems for animal identification, milk measurement and sampling.

Although made at first for farm milk production management, collected data are also expected to be exported and used for collective purposes or connected to other external systems making necessary compatible records under standard formats.

The introduction of on-farm analysis comes along with a higher frequency of milk analysis. As a consequence, the methods of lactation calculation have to be adapted. Specific recommendations are needed with the implementation on automated milking systems (AMS), more particularly to assure the representativeness of the outcome.

Devices developed for on-farm analysis should be robust for tougher conditions than in a laboratory with regard to temperature, humidity, shocks, etc. The strive for more robustness and stability at a lower price than in the laboratory may end up in lower performance in terms of precision.

A somewhat lower performance as compared to laboratory instruments is acceptable with more frequent analysis since estimate uncertainty can be reduced by averaging. However, situations with a systematic bias should be avoided. So, it is essential to define the accuracy limits for compositional analysis in milk recording.

The frame to draw should provide proper elements for ICAR agreement including on-farm measurement system validation and minimum quality control and quality assurance procedures necessary to provide sufficient accuracy in milk recording data.

Similarly to classical former devices, the on-farm analytical devices should be accounted for in a quality assurance system for milk production and genetic evaluation through compliance with international ICAR guidelines.

Therefore this document defines:

1. Various possible situations with on-farm analysis.
2. Acceptable limits for precision and accuracy for on-farm analytical devices.
3. Conditions to fulfil for evaluation and ICAR approval.
4. Conditions and check limits for quality control.
5. Compatibility with existing systems (identification, data record/transfer, lactation calculation).
   a. Identification.
   b. Animal data recording.
   c. Lactation calculation.
   d. Milking machine parameters.

13.3 Terms and definitions

13.3.1 Milk analyser
Analytical device specifically dedicated to the analysis of milk. It is generally used for instrumental automated methods in laboratories and by extension applies also to milk analytical devices installed on-farm.

13.3.2 On-farm milk analyser
Milk analyser installed on the farm that is used either to detect or to quantify various components or characteristics in milk.

Note: Milk analysis so performed can be considered as the result of the direct measurement of a representative sample of the whole milking performed through a specific sampling device or the result of the integration of successive serial in-line measurements of milk component(s) in weighted proportion to the total quantity of milk produced.

13.3.3 At-line milk analyser
Milk analyser installed beside a production line that is used once a representative sample of the whole milking is obtained. Such devices are likely to be located close to the milking unit but not exclusively. They can have similar characteristics as those used in laboratories and in extreme cases be an element of an on-farm laboratory. The number of analysers is independent of the number of milking units but related to the number of samples to be analysed.

Note: Also called off-line analysers

13.3.4 In-line milk analyser
Milk analyser installed in the production line (i.e. milk pipeline). Analysis may be performed during the milking process (real time) or at the end on a representative aliquot sample of the whole milking (differed time).

Note: Also called on-line analysers


13.3.5 Real time milk analyser

Milk analyser that analyses milk in real time during milking using sensors in contact with milk flow. Repeated milk scanning combines composition (concentration), flow rate and time measurements in order to provide estimates of component quantities and concentrations at the end of every individual milking.

It may be either an in-line analyser or a single multiplexed at-line analyser connected to milking units through individual in-line sensors and a connection network (e.g. wires or optical fibres).

13.3.6 Accuracy

Extent of correctness of an estimate obtained with the analytical method. Also called overall accuracy, it is expressed through a standard deviation that combines both random error (precision) and systematic error of the method. The part independent from calibration and precision errors, so-called 'accuracy of estimate', is a characteristic of alternative methods of analysis. Overall accuracy enables estimating the measurement uncertainty.

13.3.7 Measurement uncertainty

Uncertainty (so-called expanded uncertainty) of measurement is related to overall accuracy of the method. It expresses the range of occurrence of a result through its standard deviation (standard uncertainty) and a coverage factor k for a given probability (usually k=2 for a 95% probability). It is presumed that the resulting error is normally distributed.

13.3.8 Natural day-to-day variation

Usual variation of a production parameter (e.g. milk yield, composition) observed between days in normal production conditions, in the absence of sudden interferences (e.g. health, feeding), for an individual animal. It is characterised by the between days (so-called day-to-day) standard deviation for the production parameter, where measured with reference methods for sampling and analysis (i.e. manual sampling and chemical analysis)

Note: It is normally estimated through extensive measurements with, per animal, significant numbers of successive day-to-day records throughout representative periods of time of one or more lactations. Statistical analysis should exclude strong erratic deviation obviously different from the average trend of residuals, significant shifts related to changes in herd (e.g. feeding, housing) and compensate for the natural drift of the average trend specific to each animal that occurs during lactation. Robust standard deviation estimates can be calculated from meta-analysis of data of a number of animals and representative lactation periods.
13.4 Quality assurance - Requirements for the purpose of official milk recording

The milk recording chain should be set under control with formal engagement of different partners as shown in Figure 1. Respective commitments refer to recommendations/requirements described in ICAR guidelines. This scheme is also valid to the case of off-farm analysis for which recommendations already exist.

13.4.1 Manufacturers

Manufacturers should propose analytical devices responding to minimum characteristics defined by ICAR.

Characteristics to comply with are:

13.4.1.1 Adaptation to milking environment

- Robustness (shock and water proof)
- Ruggedness (response sensitivity to environment factors)
- Dimensions, shape, positioning (no hampering, harmless, sanitary construction)
- Temperature variation (extreme temperature proof)

13.4.1.2 Analytical characteristics

- Repeatability
- Day-to-day stability (reproducibility)
- Accuracy
- Selectivity or matrix effects (interactions, interference)

13.4.1.3 Facilities

- Calibration setting and control
- Milk sampling
- Setting automation
- Sample/animal identification
- Recording/exporting data

13.5 Milk recording organisation

13.5.1 Quality assurance system for on-farm analysis

A milk recording organisation should commit for implementing analytical quality assurance in compliance with recommendations given in relevant ICAR guidelines.
13.5.2 Approval of on-farm milk analyzer

On-farm analytical devices should have been evaluated according to recommendations in a relevant ICAR protocol and be approved before being used.

13.5.3 Approval of reference material providers

Reference material providers should be either accredited/certified or at least work under quality assurance with regular audit of the milk recording organisation.

13.6 Milk producers

13.6.1 Commitment in quality control of analysis

A milk producer should commit for implementing quality control in compliance with recommendations given in relevant ICAR guidelines.

13.6.2 Commitment for manufacturer servicing

A milk producer should commit for implementing regular servicing on on-farm devices according to manufacturer’s recommended procedures.

Figure 13.1. Contributors in the analytical process in milk recording and the chain of commitments for AQA. Arrows indicates the direction of commitments: actually existing (continuous), needed for OMA purposes (broken) and where ICAR guidelines should rule (dotted).
13.7 Definitions of different situations

Three different situations are identified with regard to sampling and milk analysis that defines three analytical devices categories with specific recommendations/requirements:

13.7.1 In-laboratory analysis

As related to the actual situation of milk recording analysis it is already covered by ICAR’s guidelines and analytical quality assurance system of ICAR. Sampling and analysis are separated and respective measurement devices must fulfil limits for accuracy stated by ICAR.

The existing guidelines for milk recording analysis provide basic conditions for analytical data quality in laboratories and constitute a reference frame to be met by alternative analytical systems in order to maintain consistence and compliance throughout space and time in milk recording analysis.

13.7.2 On-farm/at-line analysis

Sampling and analysis are performed separately. Sampling devices can be used as well in off-farm analysis as in the classical (former) system and should therefore fulfil the same requirements and accuracy limits as already stated in ICAR guidelines.

At-line analysers allow more frequent milk analysis by farmers. Therefore a lower accuracy at the level of the individual result can be accepted. Specific conditions and accuracy limits have to be established for that.

In case that an at-line analyser is used to replace the laboratory system at a usual record frequency, for instance where the sample transportation to laboratories is impractical, it should comply with the ICAR guidelines for laboratory analysers.

13.7.3 On-farm/in-line analysis

Also here, in case compositional analysis is performed more frequently than in the classical system, a lower accuracy for the individual result will suffice. Specific conditions and relevant accuracy limits are to be established for that.

13.8 Bases and conditions of equivalence with the classical system

13.8.1 Objectives

To establish limits for accuracy of composition analysis that provide sufficient measurement precision:

- For milk producers to manage day-to-day milk production.
- For milk recording organisation to maintain sufficient accuracy in estimating genetic indicators.

To establish consistence and correspondence between different measuring systems with regard to measurement uncertainty that enables comparison within time and space.
13.8.2 Maximum limits for composition measurement accuracy

13.8.2.1 Rationales

The accuracy of the analytical device must allow an adequate monitoring of significant day-to-day production changes. Compositional information of interest is that outside the regular natural variation related to normal physiological and milking conditions. Therefore, the accuracy of the analytical device should be better than the natural day-to-day fluctuation of the measured criteria to achieve statistical significance.

The variation in fat concentration is used to calculate maximum statistical limits for precision and accuracy from that stated for laboratory analysers. The calculated values serve to establish limits for the evaluation of new milk analysers and quality control in routine testing.

13.8.2.2 Natural day-to-day (or between day) fat content variation

Regular natural day-to-day variation is expressed through the standard deviation $\sigma_{\text{BDC}}$. Maximum acceptable limits established from convergent experiment observations are $L\sigma_{\text{BDC}} = 0.25 \text{ g/100 g}$ or when expressed as a confidence interval $\pm 2L\sigma_{\text{BDC}} = 0.5 \text{ g/100g}$.

13.8.2.3 Statistical bases

13.8.2.3.1 Measurement error

Every individual milk composition result $C$ can be defined as:

$$C = T + e_{\text{BDC}} + e_{S} + e_{A}$$

where

$T$ = True unknown value

$e_{\text{BDC}}$ = Between days error of milk composition (natural)

$e_{S}$ = Error of the sampler (sampling error)

$e_{A}$ = Error of the analyser (analytical error)

Which results in the breakdown of the variance as:

$$\sigma_{C}^2 = \sigma_{\text{BDC}}^2 + \sigma_{S}^2 + \sigma_{A}^2 \quad (1)$$

where $\sigma_{S}^2 + \sigma_{A}^2$ expresses the overall error of measurement.

Further subscripts $l$ and $f$ differentiate same parameters for at-laboratory and on-farm analysis respectively.

13.8.2.3.2 Maximum acceptable analytical error $\sigma_{A}$

The error of measurement at farm should be lower or equal to the error resulting from natural day-to-day variation:
\[
\sigma_{FS}^2 + \sigma_{FA}^2 \leq \sigma_{BDC}^2 \iff \sigma_{FA} \leq (\sigma_{BDC}^2 - \sigma_{FS}^2)^{1/2} \tag{2}
\]

where

- \(\sigma_{BDC}\) = Between days standard deviation of concentration.
- \(\sigma_{FA}\) = Standard deviation of analytical measurement at farm.
- \(\sigma_{FS}\) = Standard deviation of sampling at farm.

From relation (2) the upper limit of \(\sigma_{FA}\) is

\[
L_\sigma_{FA} = (L_\sigma_{BDC}^2 - L_\sigma_{FS}^2)^{1/2} \tag{3}
\]

a - At-line measurement. From the limit \(L_\sigma_{LS} = L_\sigma_{FS}\) in Table 13.1, the limit is \(L_\sigma_{FA} = 0.23\) g/100 g

b - In-line measurement. With sampling \(\sigma_{FS} = 0\), \(L_\sigma_{FA} = L_\sigma_{BDC}\) and the limit \(L_\sigma_{FA} = 0.25\) g/100 g

Note: Sampling error may exist somewhere also with in-line analysers but at the end it is included into the analytical error hence it is set to zero in the formula.

### Table 13.1. Limits of measurement error \((L_\sigma)\) derived from ICAR guidelines.

<table>
<thead>
<tr>
<th>Components of error</th>
<th>Limits of standard uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition analysis (F, P, L): from ICAR Guidelines for DHI analyses and ISO 8196-2:</td>
<td>(L_\sigma_{LA} = 0.103) g/100 g (L_\sigma_{LA} = (L_\sigma_{R}^2 + L_\sigma_{y,x}^2)^{1/2}) (L_\sigma_{R} = 0.025) and (L_\sigma_{y,x} = 0.10) g/100 g</td>
</tr>
<tr>
<td>Sampling error on fat concentration from ICAR Guidelines for sampling devices and ISO 8196-2:</td>
<td>(L_\sigma_{LS} = 0.103) g/100 g (2.5 %) (L_\sigma_{LS} = (L_\sigma_{d}^2 + L_\sigma_{f}^2)^{1/2}) (L_\sigma_{d}^2 = 0.05/2 = 0.025) and (L_\sigma_{f} = 0.10) g/100 g</td>
</tr>
<tr>
<td>Day-to-day variation of composition (% fat) from experiments</td>
<td>(L_\sigma_{BDC} = 0.25) g/100 g or (\pm 0.5) g/100 g</td>
</tr>
<tr>
<td>Milk record composition (fat) estimates from equation (1)</td>
<td>(L_\sigma_{LC} = 0.38) g/100 g (L_\sigma_{LC} = (L_\sigma_{BDC}^2 + L_\sigma_{LS}^2 + L_\sigma_{LA}^2)^{1/2})</td>
</tr>
</tbody>
</table>

### 13.8.2.3.3 Statistical limits for instrument evaluation and quality control

The limits of statistical parameters used for instrument evaluation and quality control are calculated through multiplying the limit for laboratory analysis by a correspondence factor or equivalence factor \((FE)\) defined as the ratio between the limit of the standard deviation of analytical measurement at the farm, \(L_\sigma_{FA}\), and the limit of the standard deviation of analytical measurement at the laboratory, \(L_\sigma_{LA}\):

\[
FE = L_\sigma_{FA} / L_\sigma_{LA}
\]

thus giving

a - At-line measurement : \(FE = 2.3\) lowered down to 2

b - In-line measurement : \(FE = 2.5\)
Note: For at-line analysers FE is lowered down to 2 in order to comply with the limit even in case of possible underestimation of accuracy of sampler and/or analyser devices when they are found at the specified limits. Samplers and analysers may be supplied by different manufacturers, therefore the responsibilities in limiting the overall measurement error are shared between them.

This differentiates three classes of analytical devices for milk recording with different accuracy requirements and different level of agreement for use:

Category 1: Laboratory milk analyser FE = 1
Category 2: On-farm milk analyser at-line FE = 2
Category 3: On-farm milk analyser in-line FE = 2.5

Calculated limits for statistical parameters relevant for method characterisation and quality control are reported in Tables 13.3 and 13.4 respectively.

13.8.2.3.4 Minimum number of recordings for uncertainty equivalence in composition recording

This paragraph relates to the uncertainty of composition estimate C. It compares on-lab and on-farm analysis in order to determine the minimum number of independent recordings per animal needed on-farm that would achieve, by averaging, the same uncertainty in composition estimate as with one record, or, equivalently, the minimum record number ratio of on-farm analysis to laboratory analysis required for a lactation.

From equation (1) applied to on-farm and laboratory analysis, lower or equal error in estimating animal data on-farm is achieved through

\[ \frac{\sigma_{FC}^2}{n_{FA}} \leq \frac{\sigma_{LC}^2}{n_{LA}} \iff \frac{(\sigma_{BDC}^2 + \sigma_{FS}^2 + \sigma_{FA}^2)}{n_{FA}} \leq \frac{(\sigma_{BDC}^2 + \sigma_{LS}^2 + \sigma_{LA}^2)}{n_{LA}} \] \tag{4}

or

\[ \frac{\sigma_{FC}^2}{N} \leq \frac{\sigma_{LC}^2}{\sigma_{LC}^2} \iff \frac{(\sigma_{BDC}^2 + \sigma_{FS}^2 + \sigma_{FA}^2)}{N} \leq \frac{(\sigma_{BDC}^2 + \sigma_{LS}^2 + \sigma_{LA}^2)} \] \tag{5}

with \( N = \frac{n_{FA}}{n_{LA}} \)

\[ N \geq \left[ \frac{(\sigma_{BDC}^2 + \sigma_{FS}^2 + \sigma_{FA}^2)}{(\sigma_{BDC}^2 + \sigma_{LS}^2 + \sigma_{LA}^2)} \right] \]

By setting values at their limits and combining (3)
\[ N \geq \frac{(2 \cdot \sigma_{\text{BD}}^2)}{(L \cdot \sigma_{\text{BD}}^2 + L \cdot \sigma_{\text{LS}}^2 + L \cdot \sigma_{\text{LA}}^2)} \]

From existing limits (Table 13.1), \[ N \geq \frac{(2 \cdot 0.25^2)}{(0.25^2 + 0.10^2 + 0.10^2)} = 1.5 \]

Thus with analytical devices fulfilling the limits stated, \( N = 2 \) recording on-farm is sufficient to provide uncertainty of the average result equivalent to the outcome of laboratory testing. Throughout the whole lactation, the required number of milk recordings in order to achieve equivalence is given by multiplying the usual total number by a factor of 1.5.

### 13.9 Evaluation protocol for ICAR approval

The general principle of two subsequent test phases remains.

#### 13.9.1 Phase 1 - Test bed in-lab evaluation

The first part of the ICAR document related to Phase 1 is relevant for on-farm analytical devices minding adjusting limits of compliance for accuracy stated in Table 13.3. Some parts may not be relevant for some devices; therefore they are used only where justified by the instrument principle. Specific approaches are needed for in-line real time devices and specific complementary requirements are foreseen for in-line real time devices with regard to consistence of sensor signal and final results.

#### 13.9.2 Phase 2 - On-farm evaluation

Items pertaining to preservation and milk ageing are not relevant for in-line analysers but can be so for at-line analysers in case milk analysis is delayed after the milking. The paragraph Practical convenience is valid for all devices.

Specific facilities are necessary to allow proper representative milk sampling for reference analysis. For in-line analysers, milk pipetting/intake device to sensors should permit to check analytical response for calibration in quality control checking. There are parts of the requirements to manufacturers (13.14.1) as they are indispensable for a proper analyser monitoring.

#### 13.9.3 Particularities of in-line/real time analysers

Analytical characteristics are assessed for each instrument (per milking unit) and for the whole milking system in the parlour (including all the analytical devices). Every milking device must comply individually to acceptable limits as well as the system with regard to overall accuracy. If individual milkings show similar precision and accuracy figures, the merging is possible in order to produce average values that characterise the whole system.

**Precision (repeatability and reproducibility)**

A direct evaluation of precision is hampered in natural milking conditions since animal milking cannot be replicated with qualitatively and quantitatively identical milk production (and identical milk release), hence cannot be analysed twice.
Indirect strategies may be used as, for instance, implemented at the sensor level to measure intermediate elements of precision and calculate final precision figures as indicated in the following. Their application is much dependent on the principle and facilities of the devices.

**Note:** Use of artificial udder and adequately preserved milk may be an option to evaluate precision of parts or the whole measuring system. Extreme care is then necessary in preserving milk integrity and imitating natural milk release conditions (temperature, fat gradient). Options may be prior hand milking recycled twice or identical milk portions of fresh commingled milking. Artificial udder material should not retain any part of milk or milk component (negative internal wall slope, nonwetable coating).

**Accuracy**
Comparisons to relevant reference methods allow determining accuracy characteristics according to ISO 8196.

**Table 13.2. Component of quality control of DHI analysis.**

<table>
<thead>
<tr>
<th>Control</th>
<th>Frequencies</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference methods:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- External control</td>
<td>Quarterly</td>
<td>IPS</td>
</tr>
<tr>
<td>- Internal control</td>
<td>Weekly (calibration check)</td>
<td>CRMs, SRMs, IRMs</td>
</tr>
<tr>
<td><strong>Routine methods:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- External control</td>
<td>Quarterly</td>
<td>IPS/IEC</td>
</tr>
<tr>
<td>- Internal control</td>
<td>According to Table 13.4</td>
<td>IRMs/ECMs</td>
</tr>
</tbody>
</table>

IPS: Inter-comparison Proficiency Study (at lab and on-farm devices).
IEC: Individual External Control.
CRMs: Certified Reference Materials.
SRMs: Secondary Reference Materials.
IRMs: In-house Reference Materials (control, monitoring, calibration).
ECMs: External Control Materials (service suppliers).

External quality control is implemented by a competent body, thereby linking to systems which are implemented with professional laboratories.

**13.9.3.1 Preliminary fittings**

Preliminary fittings are generally specific for off-line milk analysers. Nevertheless, these characteristics should also be checked on individual sensors for in-line real time devices. Same test procedures as for off-line analysers remain valid for in-line devices where milk portions can be analysed at the sensor level using an adequate intake device. Appropriate adjustment is the responsibility of the manufacturer.
Table 13.3. Precision and accuracy limits for test bed evaluations of milk analysers in milk recording.

<table>
<thead>
<tr>
<th>Component</th>
<th>Fat</th>
<th>Protein</th>
<th>Lactose</th>
<th>Urea</th>
<th>SCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Units</td>
<td>g/100 g</td>
<td>g/100 g</td>
<td>g/100 g</td>
<td>mg/100 g</td>
<td>10^6 cells/ml</td>
</tr>
<tr>
<td>Range</td>
<td>Total</td>
<td>4.0 - 5.5</td>
<td>10.0 - 70.0</td>
<td>0 - 2000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>0 - 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>2.0 - 6.0</td>
<td>2.5 - 4.5</td>
<td>100-1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>5.0 - 14.0</td>
<td>4.0 - 7.0</td>
<td>&gt; 1000</td>
<td></td>
</tr>
</tbody>
</table>

| Sample number | Animals (Na) | 100 | 100 | 100 | 100 | 100 |
|               | Herds (Nh)   | 5   | 5   | 5   | 5   | 5   |

<table>
<thead>
<tr>
<th>Milk analytical devices</th>
<th>Laboratory</th>
<th>On-farm At-line</th>
<th>On-farm In-line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equivalence Factor</td>
<td>FE</td>
<td>x 1</td>
<td>x 2</td>
</tr>
<tr>
<td>Component</td>
<td>F-P-L</td>
<td>Urea</td>
<td>SCC</td>
</tr>
<tr>
<td>Units</td>
<td>g/100 g</td>
<td>mg/100 g</td>
<td>percent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Repeatability</th>
<th>Standard deviation (sr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Total range</td>
<td>4%</td>
</tr>
<tr>
<td>- Low</td>
<td>8%</td>
</tr>
<tr>
<td>- Medium</td>
<td>0.014</td>
</tr>
<tr>
<td>- High</td>
<td>0.028</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Within lab reproducibility</th>
<th>Standard deviation (sR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Total range</td>
<td>5%</td>
</tr>
<tr>
<td>- Low</td>
<td>10%</td>
</tr>
<tr>
<td>- Medium</td>
<td>0.028</td>
</tr>
<tr>
<td>- High</td>
<td>0.056</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Animal sample SD (sy,x)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Total range</td>
<td>10%</td>
</tr>
<tr>
<td>- Low</td>
<td>6%</td>
</tr>
<tr>
<td>- Medium</td>
<td>0.20</td>
</tr>
<tr>
<td>- High</td>
<td>0.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calibration</th>
<th>Mean bias (μ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Total range</td>
<td>±1.2</td>
</tr>
<tr>
<td>- Medium</td>
<td>±0.05</td>
</tr>
<tr>
<td>- High</td>
<td>±0.10</td>
</tr>
</tbody>
</table>

| Slope (b) | 1±0.05 | 1±0.10 | 1±0.05 | 1±0.10 | 1±0.10 | 1±0.10 | 1±0.13 | 1±0.13 |

Where relevant i.e. for inlined differed time analysis.
No larger tolerance by the usual factor 2 for sheep and goat to maintain accuracy with no more numerous records.
Compared to manufacturer calibration.
13.9.3.2 Repeatability

Milking the same milk cannot be performed twice per cow, therefore repeatability is measured at the sensor level with milk samples homogeneously sampled during the milking. It is associated to a complementary check for result consistency by comparing the mean sensor result to the value recorded during the milking. The standard deviation $\sigma_{rs}$ of the ranges between duplicates gives the repeatability standard deviation of the sensor while the standard deviation $\sigma_d$ of differences provides the repeatability standard deviation $\sigma_r$ of the instrument through $\sigma_r = (\sigma_d^2 - \sigma_{rs}^2/2)^{1/2}$

This figure is made for all the devices by averaging the repeatability variance in order to obtain the repeatability standard deviation of the system.

The values obtained are compared to limits stated in table 13.3.

13.9.3.3 Reproducibility

Milking the same milk cannot be performed twice per cow, therefore reproducibility is measured at the sensor level with milk samples homogeneously sampled during the milking. It is associated to a complementary check for result consistency by comparing the mean sensor result to the value recorded during the milking.

The representative sample is analysed in duplicate on every device (sensor) of the system. Then to calculate from duplicate results the repeatability $\sigma_{rs}$ of all the sensors, the standard deviation of means of duplicates $\sigma_{\bar{X}}$ and the standard deviation between devices $\sigma_a = (\sigma_{\bar{X}}^2 - \sigma_{rs}^2/2)^{1/2}$

For all the devices the reproducibility standard deviation of the individual device $\sigma_{Rd}$ is obtained through

$$\sigma_{Rd} = (\sigma_a^2 + \sigma_{rs}^2)^{1/2}$$

The repeatability standard deviation of the system is obtained by averaging the reproducibility variances.

a. **Within milking (system) reproducibility.** The same milk samples are repeatedly analysed by all the sensors of the system during the same milking.

b. **Between milking (device) reproducibility.** Every milk sample is stored under appropriate conditions (temperature, preservative) and re-analysed on the same sensor for 10 successive milkings.

The values obtained are compared to limits stated in Table 13.3.

13.9.3.4 Accuracy

The accuracy of every instrument in the parlour and the total accuracy of the system should be evaluated through comparison with results obtained with a relevant reference method by a competent (accredited) laboratory. Accuracy standard deviation is calculated according to the ICAR protocol for milk analyser evaluation (or ISO 8196).

Since only one measurement per recording is possible, the accuracy measured covers all the sources of errors (repeatability, within-device reproducibility, accuracy of estimates, trueness (bias)).
Biases between analysers can be approached by re-analysing the same milk samples at the sensor levels but this does only provide information on the sensor calibration without covering milk measuring/sampling.

### 13.9.3.5 Carry over
A real time analysis system is not subjected to carry over effect, due to the large amount of milk passing through the system.

### 13.9.4 Fitting facilities

#### 13.9.4.1 Milk sampling device
A sampling system should allow representative milk sampling needed for:

- Possible other analysis of components or characteristics not measured with the on-farm device.
- Quality control comparisons.

The minimum sample volume should allow the performance of quality control analysis, that includes minimum duplicate milk re-testing through the device or performing appropriate chemical analysis as reference for calibration. It should not be lower than 30 ml.

#### 13.9.4.2 Intake piping device for external sample
The analytical device should allow analysing samples from external sources so that calibration check/adjustment will be possible through known (reference) samples.

The maximum volumes consumed per test should allow re-testing milk obtained from the sampling device. It should preferably not exceed 10 ml.

Otherwise the manufacturer should provide appropriate alternative procedures for quality control and calibration.

#### 13.9.4.3 Periodical rinsing and zeroing
Cleaning/rinsing process for the flow system should exist to be performed at a chosen frequency in order to avoid milk component layer accumulation on sensors and maintain stability in the instrument response.

Zero check/adjustment should be applicable before every herd milking and at a chosen frequency during testing series.

#### 13.9.4.4 Security levels for adjustment
- **1st level of access.** Open to milking operator (with possible locking-unlocking for security). Simple adjustment with standard pilot sample(s) before the milking (analysis, validation vs assigned values, testing).
• **2nd level of access.** To secure specific fittings (e.g. calibration), a part of the device interface can be kept locked. It can be open to the milking operator and service engineers under conditions.

Any other relevant recommendations of existing ICAR guidelines shall be fulfilled.

### 13.9.4.5 Robustness / ruggedness

- **Humidity, water.** The device should be waterproof or in any case should resist to humidity / water conditions in the place of functioning (milking parlour, AMS, other).
- **Temperature.** The device should function within the range of temperatures that prevail in the location of functioning (milking parlour, AMS, other). Analytical response should not be influenced by temperature conditions/variations.
- **Acids/alkalis.** The device should be insensitive to possible exposure of chemicals (e.g. detergents) used in the place of functioning.
- **Physical shocks, vibrations.** The device should be insensitive or protected against possible physical shocks (mishandling, animal, etc) or vibrations (e.g. pump) in the place of functioning.
- **Size and shape.** The device should be adapted to the milking device and environment (milking parlour, AMS) so that milking operation can be carried easily with no physical hampering. Small size and smooth shapes avoiding angles where clothes can catch on are preferable.
- **Effect of milking machine.** The same parameters as for milk yield recording devices should be investigated and should not influence significantly recording results in the range of their usual variations. (e.g. flow rate, vacuum, position on the pipeline, etc).

Any other relevant recommendations of existing ICAR guidelines shall be fulfilled.

### 13.9.4.6 Cleaning

Cleaning of the analytical device should be performed at the end of milking. Recovery of initial zero values is an adequate indicator of the appropriateness of cleaning and rinsing of the system. Cleaning of derivations for sampling and milk measurement control should be achieved with the whole milking system. Special emphasis is given on possible growth and accumulation of micro-organisms (avoid dead corners) and further contamination of milk from insufficient cleaning.

Any other relevant recommendations of existing ICAR guidelines shall be fulfilled.

### 13.9.4.7 Servicing

Servicing operations should be well documented and either provided by manufacturers or made possible by users minding specific training. Easy and quick replacement of entire parts of the system should allow resolving problems in real time without hampering the whole milking.

Any other relevant recommendations of existing ICAR guidelines shall be fulfilled.
13.10 Quality control and calibration

13.10.1 General recommendations

Implementation of quality control is mandatory for official milk recording and in every other case where recorded data are used for a collective purpose. Otherwise it is strongly recommended for the sole farm management use.

Components of quality control listed in ICAR Recording Guidelines (Section 12) are applicable at appropriate frequencies in places were analyses are performed according to Table 13.2.

13.10.2 Internal quality control on on-farm analysers

Internal quality control is meant here to assure official milk recording data for genetic performance meaning that any analytical data used for official milk record should be surrounded by appropriate quality checks. For official milk recording purposes, the following recommendations constitute requirements. For any other purposes they constitute a guidance to users.

13.10.2.1 Nature, frequencies and limits

On-farm analysers shall be used for a recording frequency twice or more the frequency with a laboratory system. If they are used at the same frequency as in a laboratory system, they should fulfil the accuracy limits for laboratory analysers and have been validated as an analyser of Category 1.

Internal quality control follows the general scheme designed for laboratory analysers provided to fulfil appropriate minimum frequencies and maximum limits for checks relevant with the category of instrument (Table 13.4).

13.10.2.2 External reference material

Checks must be rapid and easy, making use of known samples for calibration and internal checks. Where no specific reference values are needed (i.e. control samples, carry over), samples can be prepared from local farm milk.

13.10.2.3 Internal quality control implementation

13.10.2.3.1 Instrumental fittings

Provided recommendations are only indicative as some facilities and sources of deviation - such as homogenisation and carry over - may not exist in the instrument. Indications of manufacturers are to be followed. Adequate procedures can be found in the ICAR protocol for milk analyser evaluation according to ISO 8196.

For in-line real time analysers automated check facilities should be installed in the device in order to facilitate and shorten check operations before milking. It should include adequate recording of obtained data for quality control traceability and further maintenance by the manufacturer.
## Table 13.4 Quality control – Minimum frequencies and maximum limits (tentative).

<table>
<thead>
<tr>
<th>Instrumental fittings</th>
<th>Laboratory</th>
<th>On-farm At-line</th>
<th>On-farm In-line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homogenization</td>
<td>Monthly</td>
<td>Yearly</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Carry-over</td>
<td>Monthly</td>
<td>Yearly</td>
<td>Not relevant</td>
</tr>
<tr>
<td>Linearity (curving)</td>
<td>Quarterly</td>
<td>Yearly</td>
<td>Yearly</td>
</tr>
<tr>
<td>Interconnection</td>
<td>Quarterly</td>
<td>Yearly</td>
<td>Yearly</td>
</tr>
<tr>
<td>Consistency (n samples)</td>
<td>Yearly</td>
<td>Yearly</td>
<td>Yearly</td>
</tr>
</tbody>
</table>

### Calibration

- **Mean bias**
  - **Weekly**
    - Start-up: 0.04 ± 0.02, 14%
    - Start-up/end: 0.08 ± 0.04, 28%
    - Start-up/end: 0.10 ± 0.05, 35%
  - **Quarterly**
    - Session: 1.00 ± 0.05, 10%
    - Session/day: 1.00 ± 0.10, 20%

- **Slope**
  - **Quarterly**
    - 1.00 ± 0.02, 2%
    - 1.00 ± 0.05, 5%
    - 1.00 ± 0.10, 10%
    - 1.00 +/− 0.05, 2%

- **Repeatability limit (r)**
  - **Start-up**
    - 0.04 ± 0.05, 14%
  - **End**
    - 0.08 ± 0.10, 28%
  - **Session/day**
    - 0.10 ± 0.17, 35%

- **Repeatability SD (sr)**
  - **20 sessions**
    - 0.02 ± 0.05, 10%
  - **20 sessions**
    - 0.05 ± 0.10, 13%

- **Reproducibility limit (R)**
  - **Session/day**
    - 0.14 ± 0.17, 35%

- **Reproducibility SD (sR)**
  - **20 sessions**
    - 0.05 ± 0.10, 13%

- **Zero-setting**
  - **4/day**
    - 5 000 SC/ml ± 0.03
    - 10 000 SC/ml ± 0.03

---

**Note:** For species with significantly higher concentration in fat and protein (i.e., sheep, buffalo, particular goat and cow breeds), it is appropriate to adjust those limits in proportion of respective mean levels hence to multiply by average species/average cow. For sheep a factor 2 is found suitable.
13.10.2.3.2 Zero setting and stability of calibration line

For at-line analysers, the stability of the calibration line should be checked at the beginning of every analytical session using known materials at low and medium levels of the components. The nature of the check material depends on the device and the choice of the manufacturer. For instance:

- The medium material can be a long term preserved milk or a standard liquid or a solid material (e.g. filter) giving results at a similar average level as milk.
- The low (zero) level material can be pure water or a standard zero solution or a solid material (e.g. filter).

Concentration target values are those determined by simultaneous analysis with calibration samples or by comparison with the former control milk sample until the next calibration. During checking, materials are to be analysed minimum in duplicate and mean values obtained should comply with the tolerance interval stated in Table 13.4 for zero setting and daily calibration. For real time analysers similar automated tests with sensors should be installed in the device to assure users about the stability of the system. Permanent stable material can be installed as integral part of the device.

13.10.2.3.3 Repeatability and daily stability

For at-line analysers, perform duplicate analyses of a control sample (13.10.2.3.3) at the beginning and the end of every analytical session:

- The range between duplicates should not exceed the values $r$ stated in Table 13.4 for repeatability.
- The range between the four replicates of the analytical session should not exceed the values $R$ stated in Table 13.4 for reproducibility.

Periodical summaries and calculation of repeatability and reproducibility standard deviations throughout a rolling period (e.g. last 20 sessions) can provide deeper information on the regularity of the method and elements to estimate the measurement uncertainty of the on-farm device. $sr$ and $sR$ values should comply with relevant limits in Table 13.4. For real time analysers similar automated tests with sensors should assure users about the stability of the system. 13.10.2.3.3 and 13.10.2.3.4 can be conducted together.

13.10.2.3.4 Calibration and accuracy

For at-line analysers same procedures as for laboratory analysers can apply. Calibration should be periodically checked using milk sample sets with known reference values appropriate for the method. They can be milk sampled at the farm and analysed with reference methods or adequate samples provided by external suppliers and recognised by the milk recording organisation.

For in-line real time analysers calibration can only be checked using milk samples analysed later on with appropriate methods, which can be either a reference method or a milk analyser suitably calibrated. However it cannot be performed in short delays due to required milk sampling and reference analyses performed by a competent party (e.g. accredited laboratory).
Calibration should be checked and adjusted minimum quarterly for at-line analysers and yearly for in-line analysers. Slope and bias values of the calibration line should be within the limits in Table 13.4. Accuracy should be checked against reference methods minimum yearly and comply with accuracy limits for individual animals in Table 13.3.

Note: Checking calibration of sensors is not easy on-farm and cannot provide the total information of the device calibration in case final results combine test scans and milk quantity measurements. It should be reserved to maintenance.

13.10.2.3.5 Measurement consistency

For specific in-line real time analysers that combine a number of measurements, assessing consistence between the final result and the response of the scanning sensor allows checking proper functioning of the measuring system, including milk flow rate, milk composition, milking time combined in the final result.

At a yearly frequency, every milking of every animal is sampled with the sampling device of in-line analysers and re-analysed through the analytical sensor used for calibration.

The difference $d_c$ between the measurement results and the result of the sensor should not exceed the reproducibility value $R$ of Table 13.4 and the average of $n$ differences be outside $\pm 2\left(\frac{sR^2 + sR^2}{\sqrt{n}}\right)^{1/2}$.

13.11 Requirements related to milking systems (Sub-Committee on Recording Devices)

13.11.1 Evaluation of In-line real time analysers

13.11.1.1 General

The accuracy of in-line analysers should be evaluated in the condition of configuration and with associated devices as distributed by the manufacturer.

The milking population used for evaluation should be representative for the largest population (with regard to milk production and composition) the analyser is intended for so as to illustrate that high animal performances can be properly measured.

Since a same milking cannot be performed twice per animal:

- Neither repeatability nor reproducibility (between days and between devices) checks can be implemented on-farm for routine quality control hence are of less interest to users. Since then their evaluation can be performed only in the evaluator laboratory through adapted methodologies and remains optional.
- Accuracy measurement should include random errors of repeatability, between consecutive days and between devices reproducibility.

Where adapted procedures, for instance use of preserved milk or substitutes to mimic replications, are to be used, it should have been prior clearly demonstrated that these adequately reproduce the milking conditions with fresh milk, so as not to introduce possible deviation or misinterpretation.
In any aspect of the evaluation, approved reference procedures and methods for representative milk measuring and sampling (whole milking in the bucket according to ICAR) and analytical methods (ISO | IDF methods) should be applied.

13.11.1.2 Evaluation of the effect of the milking machine on accuracy

13.11.1.2.1 Laboratory tests

The role of laboratory tests is to ensure that the tested device is not influenced by the milking machine and flow rate of milk.
That means the influence of:

- Milk flow rates on results of a milk of known composition, for instance 1, 3, 5, and 9 kg/min at a given milking vacuum and air inlet at the claw.
- Different vacuum levels such as 40, 45 and 50 kPa at a given milk flow rate and air inlet.
- Different air inlet such as 0, 8, 12 and 20 l/min at a given milk flow rate and vacuum level.
- Tilting (except otherwise stated by the manufacturer). If a maximum tilting is stipulated it should be tested for accuracy of the device at a given milk flow rate, vacuum level and air inlet.

In addition, according to ISO standard 5707 real time analysers should not cause any vacuum drop greater than 5 kPa at a milk flow of 5 kg/min beneath the teat during milking for cows. Thus it is to measure the vacuum drop due to the device compared with no device fitted on the LMT 5 kg/min.

Note: For application to other species with different milk yield and composition, such as goat, sheep and buffalo, other tests involving different parameters shall be carried out.

13.11.1.2.2 Field tests

Field test are necessary in order to ensure that accuracy is the same whatever is the milk flow and the milk composition. Tests should be carried out at least on four devices in two different farms as described for milk meters.

13.12 Data records and data management

Because of many different well-established data transfer standards at national level, it is not possible for ICAR to define an international standard. Different data transfer protocols (XML, CSV, ADIS, etc.) as well as different national data dictionaries are used. ICAR will only confine these standards with defining the necessary content of the data records. Existing international standards like ISO, ICAR or ISOagriNET should be used. Therefore, ICAR gives only definitions how to handle data without submitting a statement about transfer protocols and data dictionaries.

Information can be transmitted on farm (e.g. from the analyzing unit to a processing computer, e.g. from a processing computer to a herd management computer, etc.) or between business partners like farmers, milk laboratories, milk recording organizations and IT centres. For data management and data transfer, each milking has to be reported during the sampling period with one data record. Data items like farm ID, animal ID, date, time, session milk yield and abnormal end of the milking must be included for each milking during this sampling period. In addition, an average 7 day milk yield as calculated by the farm management software should be reported.
Minimum data transfer requirement is to transmit the information registered in table 13.5. These information are necessary to calculate a 24 hour, a 48 hour, a 96 hour, etc. milk yield as regulated in national or international guidelines (mandatory items) (Example 1). If milk content values are broken down by an analysing unit, the items presented in table 2 must be added to the data record as defined in table 13.5 (optional items) (Example 2). In addition, milk sample bottles can be used to control the results of the installed analysing unit by official laboratory results. In this case, the milk sample bottle has to be identified clearly to combine the results of the installed analysing unit with the results of this bottle. One data record must then include the mandatory information of table 13.5, the results of the installed analysing unit as defined in table 13.6 and one of the unique identification alternatives of a milk sample bottle as described in table 13.7 (optional and conditional items) (Example 3).

Generally, the manufacturers of analysing units have to ensure that all information is transferred using one record for each animal and each milking.

Table 13.5. Entity of on-farm analysis of milk content, mandatory items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Data type</th>
<th>Length</th>
<th>Decimal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm ID</td>
<td>N</td>
<td>15</td>
<td>0</td>
<td>Farm identification number (official (in law) farm identification number or farm number given by milk recording organization)</td>
</tr>
<tr>
<td>Animal ID</td>
<td>N</td>
<td>15</td>
<td>0</td>
<td>Official (in law) animal identification number on national or regional level</td>
</tr>
<tr>
<td>Date</td>
<td>N</td>
<td>8</td>
<td>0</td>
<td>(Starting) date of milking Yyyymmdd (year, month, day)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(20071127 = 27th november 2007)</td>
</tr>
<tr>
<td>Time</td>
<td>N</td>
<td>6</td>
<td>0</td>
<td>Starting time of milking hhmmss (hour, minute, second)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(140145 = 14:01:45)</td>
</tr>
<tr>
<td>Session milk yield</td>
<td>N</td>
<td>3</td>
<td>1</td>
<td>Individual milk weight (in kg), given by the animal during the milking</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(178 = 17.8 kg)</td>
</tr>
<tr>
<td>Abnormal end of the milking</td>
<td>AN</td>
<td>1</td>
<td>0</td>
<td>T or F,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>T = True, F = False</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(if false, then normal milking, if true, then milking was aborted)</td>
</tr>
<tr>
<td>7 day milk yield</td>
<td>N</td>
<td>3</td>
<td>1</td>
<td>7 day average, as calculated by the management software (in kg)</td>
</tr>
</tbody>
</table>

**ANALYSIS**

1Data type: N = Numeric, AN = Alpha numeric
2Animal ID in accordance with ISO standard 11784 are composed of a country code (a) and national identification code (b)
   (a) ‘country code’ means a 3 digit numeric code representing the name of the country in accordance with ISO standard 3166
   (b) ‘national identification code’ means a 12 digit numeric code to identify an individual animal at national level;
        if the national identification code is less than 12 digits, the space between the national identification code and the country code shall be completed with zeros
3Each value which is detected in the analysing unit should be submitted following the configuration of Table 13.5.
Table 13.6 gives an overview about feasible analysis values.

Table 13.6: Examples for analysed values, optional items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Data type</th>
<th>Length</th>
<th>Decimal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat percent</td>
<td>Numeric</td>
<td>4</td>
<td>2</td>
<td>Fat percent (in %), (0421 = 4.21 %)</td>
</tr>
<tr>
<td>Protein percent</td>
<td>Numeric</td>
<td>4</td>
<td>2</td>
<td>Protein percent (in %), (0389 = 3.89 %)</td>
</tr>
<tr>
<td>Lactose percent</td>
<td>Numeric</td>
<td>4</td>
<td>2</td>
<td>Lactose percent (in %), (0485 = 4.85 %)</td>
</tr>
<tr>
<td>Somatic cell count</td>
<td>Numeric</td>
<td>5</td>
<td>0</td>
<td>Somatic cells in thousand, (00195 = 195,000)</td>
</tr>
<tr>
<td>Urea</td>
<td>Numeric</td>
<td>3</td>
<td>0</td>
<td>Urea (in ppm), (224 = 224 ppm)</td>
</tr>
</tbody>
</table>

**OTHERS**

If more samples per cow per recording day are analysed, results for each sample must be reported. These can be presented either as single results or as an average of n samples. If one sample per cow is fat-corrected according to national or international standards, the corrected values are reported.

*Other items (other values) have to be authorised by ICAR to define a data transfer standard.*

The possibility for submitting bottles to a milk testing laboratory must be taken into account (e.g. control of the analysing units, e.g. official milk recording, etc.). The bottles must be identified clearly. This unique identification can be achieved by using:

- a bar code, or
- a data chip (e.g. RFID), or
- a sample bottle ID, or
- a unique number for sample box including the sample bottle number.

For this reason, the record should be extended as described in tables 13.7a up to 13.7d (alternative).
Example 1: Minimum data transfer requirement - recording the milk yield

Two cows (DK 1 12 321 51235 and AT 05 1235 4123) at farm 276031239512354 were milked at 27th November 2007 around 2:00 p.m. (automatic milking system). Fat, protein, lactose, somatic cell count and urea were not (!) analysed automatically by the installed analysing unit. No milk samples in bottles collected. The data records must include:
Animal DK 1 12 321 51235:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>farm ID</td>
<td>276031239512354</td>
</tr>
<tr>
<td>animal ID</td>
<td>208011232151235</td>
</tr>
<tr>
<td>date</td>
<td>20071127</td>
</tr>
<tr>
<td>time</td>
<td>140145</td>
</tr>
<tr>
<td>session milk yield</td>
<td>178</td>
</tr>
<tr>
<td>abnorm. end milk. sess.</td>
<td>F</td>
</tr>
<tr>
<td>7 day milk yield</td>
<td>532</td>
</tr>
</tbody>
</table>

Animal AT 05 1235 4123:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>farm ID</td>
<td>276031239512354</td>
</tr>
<tr>
<td>animal ID</td>
<td>040000512354123</td>
</tr>
<tr>
<td>date</td>
<td>20071127</td>
</tr>
<tr>
<td>time</td>
<td>141852</td>
</tr>
<tr>
<td>milk yield</td>
<td>106</td>
</tr>
<tr>
<td>abnorm. end milk. sess.</td>
<td>F</td>
</tr>
<tr>
<td>7 day milk yield</td>
<td>213</td>
</tr>
</tbody>
</table>

Example 2: Analysing unit is producing milk content results, no 'official' collection of milk sample bottles

Two cows (DK 1 12 321 51235 and AT 05 1235 4123) at farm 276031239512354 were analysed by an on-farm analysing unit at 27th November 2007 around 2:00 p.m. (automatic milking system). Fat, protein, lactose, somatic cell count and urea were analysed automatically by the installed analysing unit. No milk samples in bottles collected. The data records must include:

Animal DK 1 12 321 51235:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>farm ID</td>
<td>276031239512354</td>
</tr>
<tr>
<td>animal ID</td>
<td>208011232151235</td>
</tr>
<tr>
<td>date</td>
<td>20071127</td>
</tr>
<tr>
<td>time</td>
<td>140145</td>
</tr>
<tr>
<td>milk yield</td>
<td>178</td>
</tr>
<tr>
<td>abnorm. end milk. sess.</td>
<td>F</td>
</tr>
<tr>
<td>7 day milk yield</td>
<td>532</td>
</tr>
<tr>
<td>fat percent</td>
<td>0421</td>
</tr>
<tr>
<td>protein percent</td>
<td>0389</td>
</tr>
<tr>
<td>lactose percent</td>
<td>0485</td>
</tr>
<tr>
<td>somatic cell count</td>
<td>00195</td>
</tr>
<tr>
<td>urea</td>
<td>220</td>
</tr>
</tbody>
</table>
Example 3: Analysing unit is producing milk content results, 'official' collection of milk sample bottles

Two cows (DK 1 12 321 51235 and AT 05 1235 4123) at farm 276031239512354 were analysed by an on-farm analysing unit at 27th November 2007 around 2:00 p.m. (automatic milking system). Fat, protein, lactose, somatic cell count and urea were analysed automatically by the installed analysing unit. Milk sample bottles with bar code identification were collected. The data records should include:

Animal DK 1 12 321 51235:

<table>
<thead>
<tr>
<th>farm ID</th>
<th>276031239512354</th>
</tr>
</thead>
<tbody>
<tr>
<td>animal ID</td>
<td>208011232151235</td>
</tr>
<tr>
<td>date</td>
<td>20071127</td>
</tr>
<tr>
<td>time</td>
<td>140145</td>
</tr>
<tr>
<td>milk yield</td>
<td>178</td>
</tr>
<tr>
<td>abnorm. end milk. sess.</td>
<td>F</td>
</tr>
<tr>
<td>7 day milk yield</td>
<td>532</td>
</tr>
<tr>
<td>fat percent</td>
<td>0421</td>
</tr>
<tr>
<td>protein percent</td>
<td>0389</td>
</tr>
<tr>
<td>lactose percent</td>
<td>0485</td>
</tr>
<tr>
<td>somatic cell count</td>
<td>00195</td>
</tr>
<tr>
<td>urea</td>
<td>220</td>
</tr>
<tr>
<td>bar code</td>
<td>5863252147</td>
</tr>
</tbody>
</table>
Animal AT 05 1235 4123:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>farm ID</td>
<td>276031239512354</td>
</tr>
<tr>
<td>animal ID</td>
<td>040000512354123</td>
</tr>
<tr>
<td>date</td>
<td>20071127</td>
</tr>
<tr>
<td>time</td>
<td>141852</td>
</tr>
<tr>
<td>milk yield</td>
<td>106</td>
</tr>
<tr>
<td>abnorm. end milk. sess.</td>
<td>F</td>
</tr>
<tr>
<td>7 day milk yield</td>
<td>213</td>
</tr>
<tr>
<td>fat percent</td>
<td>0409</td>
</tr>
<tr>
<td>protein percent</td>
<td>0372</td>
</tr>
<tr>
<td>lactose percent</td>
<td>0475</td>
</tr>
<tr>
<td>somatic cell count</td>
<td>08918</td>
</tr>
<tr>
<td>urea</td>
<td>190</td>
</tr>
</tbody>
</table>

1 Instead of bar code identification of the sample bottles it is possible to use data chips, sample bottle IDs or sample box number including sample bottle number.
13.13 - Approval procedure for milk analysers in milk recording

Disclaimer: Through this procedure and using these protocols, ICAR recognises and confirms to users that the method evaluated in these conditions and fulfilling the technical requirements is appropriate for the use and purposes of milk recording, so allowing ICAR members to refer to that recognition - so-called ICAR approval - with no more need for complementary evaluations (unless it be locally demanded). This approval for use covers the field of application and the instrument configuration tested during the evaluation and cannot constitute itself an agreement for any use other than milk recording within ICAR.

Foreword

The international ICAR approval for milk analysers was launched in 2002 as applicable as soon as an analyser is successfully evaluated according to ICAR agreed protocols and locally approved in three different countries.

This international approval procedure is here to complement and to take into account the case of an evaluation directly organised by ICAR that allows manufacturers not to go through the preliminary three local or national stages.

Additional new procedures complete the initial protocol for the evaluation of milk analysers. This includes broadening the scope to non-automated milk analysers (i.e. manually served) that can be used as master instrument for calibration purposes, and also to new analysers that do not differ from a former ICAR approved version of a same manufacturer.

13.13.1. ICAR approval procedures

ICAR recognizes two ways to achieve the international approval of a milk analyser by ICAR, both being based on the international Standard ISO 8296-3 | IDF 128-3:

13.13.1.1 Independent national evaluations

As described in the international standard, the procedure relates to already existing national evaluations and approvals obtained in three different countries. This process allows an instrument to progressively go towards an international validation through successive national evaluations and in the end obtain the ICAR approval as the international recognition of fit-for-purpose.

Advantages lie in spreading evaluation costs over a longer period of time and limiting possible risks of non-compliance to one evaluation.

Details of the procedure are given in Annex A.

13.13.1.2 International evaluation

This is based on three independent evaluations in different countries but without going through national evaluations and approvals. It is organised and monitored by an international organisation, i.e. ICAR. Thus the experiments can be organised and performed simultaneously or closely in time. This procedure may result in a direct approval granted by ICAR.
The advantage for manufacturers is a reduction in administration in that only one ICAR application is required. Manufacturers can also rely on the organiser to propose approved laboratories to perform work in suitable countries.

The risk is that any possible instrument modification (e.g. to overcome a possible technical weakness/failure) will need to be applied to each of the instruments under evaluation with the related consequences for delays and costs.

Details of the procedure are given in Annex B.

13.13.2. References for the evaluation

13.13.2.1 Reference document

The following international standard applies.


This ISO-IDF standard is applicable to any alternative quantitative methods of milk analysis. It confirms and completes the content of the former ICAR protocol “Protocol for the evaluation of milk analysers for ICAR approval” from which it derives, thus making it also recognized outside of the ICAR sphere.

13.13.2.2 Complement for manual milk analysers

The field of application of ICAR approval also includes non-automated milk analysers (manual) that can be found suitable for use as master instruments for lab monitoring and calibration transfer.

For such devices, the ISO recommendation for the second phase of evaluation on the need for an assessment in two routine laboratories for two months should be replaced by the need for an assessment in one laboratory for two months.

13.13.2.3 Complement for new versions of already approved milk analysers

This part refers to the case where the configuration of the instrument is changed (e.g. upgrading for higher testing speed rate) or the analyser submitted for approval is an updated version (more attractive, with more or improved features for users) of a former model where there is no (claim for) significant change either in analytical principle, in main instrument parts, in their functions and in accompanying utensils for the execution of the measurements.

Proof must be brought clearly demonstrating that the new instrument does not actually differ with regard to the analytical performance, therefore verifying that the precision and the accuracy are not significantly modified. This can be verified through adequate comparisons with an instrument of a former ICAR approved version.
The standard protocol of ISO 8196-3 | IDF 128-3 should be applied for all usual checks of the compulsory part provided, but replacing the reference method(s) by a milk analyser of the former ICAR approved version.

Both instruments should be calibrated with the same calibration materials. Compliance should be assessed through the mean difference (not statistically different from zero), the slope (not statistically different from 1,00) and the standard deviation of differences $s_d$ and the standard deviation of repeatability $s_r$ (both not statistically different from the limit of standard deviation of repeatability $\sigma_r$).

Details of the protocol and compliance limits are given in Annex C.

A positive conclusion on equivalent performance can result in an extension of ICAR approval to the new analyser version.

Conclusion on poorer performances, i.e. beyond the stated limits, would indicate non equivalent devices hence verification should revert to the standard evaluation according to the ISO-IDF protocol with, as a follow-up, the evaluation and assessment of accuracy against the reference method.

### 13.13.3. Type of evaluation

The choice of evaluation type (between 13.2.2.1, 13.2.2.2, 13.2.2.3) depends on the technical characteristics of the device and prior granted approval.

Both complements 13.2.2.2 and 13.2.2.3 do not exclude each other and can be used in conjunction, for instance for manual devices deriving from an already approved automated routine device.

The manufacturer may choose for the evaluation method based on technical, strategic and economical criteria. The simplified protocol mentioned in 13.2.2.3 can revert to applying a full protocol where the technical characteristics do not fit with the similarity pre-requisite or the evaluation results do not comply with the stated limits.

Therefore, before undertaking any evaluation process - especially through the three independent national evaluation method according to clause 13.2.1.1 - the manufacturer is advised to check with ICAR the suitable type of evaluation by submitting instrument characteristics to the ICAR Secretariat. The ICAR Secretariat will advise the manufacturer on the adequate protocol(s) after consultation with the MA SC. The form in Annex G (or similar) will be used.

In the case that the ICAR international evaluation is chosen, ICAR will decide on the suitable protocol prior to the organisation of the evaluation.
13.14 Requirements related to animal identification
(Sub-Committee on Animal Identification) - See 13.11

13.15 Requirements related to lactation calculation (Lactation Calculation Working Group) - Under development

13.16 Requirements related to recording data (Animal Recording Data Working Group) - See 13.11
SECTION 14 - GUIDELINES FOR ALPACA AND CASHMERE GOAT IDENTIFICATION AND THEIR FIBRE STANDARDS

SECTION 14.1 - ICAR RULES, STANDARDS AND GUIDELINES ON METHODS OF ALPACA IDENTIFICATION

14.1.1 ICAR general rules on alpaca identification

1. The recorded alpaca identity must be the animal’s official identity in the member country and must be unique to that animal.

2. Where the identity of an individual animal is not unique, the record must so state (e.g. flock identities for goats/sheep). The identity number used for a flock or herd must be unique for that flock or herd.

3. The alpaca’s identity must be visible.

4. The alpaca’s identity should be unique and never be re-used.

5. The alpaca’s identification device/ method, must comply with legislative requirements.

6. Alpacas, which lose their identity device must be re-identified and, wherever possible, with their original number, provided that there is evidence that the alpaca is being correctly identified (where this is not possible, a cross reference to the original number must be maintained).

14.1.2 ICAR standard methods of alpaca identification

1. The alpacas identity number may be attached to the alpaca by a tag, tattoo, sketch, photo, brand or electronic device.

2. Alpacas moving from one member country to another should, wherever possible, continue to be identified using their original identity number and name.

3. In the case of imported alpacas, where the number has to be changed, the official records should also show the original number and name. The original number and name must be reported in Export Certificates, AI Catalogues and in catalogues of important shows and sales.

4. Where an alpaca is identified using an implanted ‘electronic device, the alpaca must be marked in a way which indicates the presence of an “electronic identification” device.
**14.1.3 Record of Identification methods**

1. The member organisation must maintain a record of the approved identification methods used in the member country.

2. The member organisation must determine, within the constraints of the member country legislation, the identification methods to be used on recorded alpacas and herds or flocks.

**14.4 ICAR Standards for alpaca identities**

1. The alpaca identity number will be a maximum of 12 digits (including check digits where used) and the three digit numeric code representing the name of the country in accordance with ISO 3166 shall be added to identify the country of origin. Three digit numeric ISO codes must be used for data transfer and storage. In printed documents the ISO alpha country code should be used.

2. For electronic identification standards see Appendices in this publication.

**SECTION 14.2 - GUIDELINES FOR ALPACA SHEARING MANAGEMENT, FIBRE HARVESTING AND GRADING**

According to the auto certification methodology yet applied in other advanced fibre animal breeding systems, alpaca fleece collection critical points have been identified in shearing fleece management, fibre harvesting and classification where with easy procedures, a suitable product for the next processing step can be obtained. Through the present procedure, the possible defects that may be found in the end product can be easily individuated and corrected localizing the error of management in the previous step of the alpaca fibre processing chain. (Or because it is possible to locate exactly where the defect has been done).

The principal critical point of the present action are organized in 6 distinct steps:

- Alpaca clip preparation standard
- Structural needs.
- Preparation of the proper shearing.
- Proper shearing.
- Grading and classing.
- Packaging and transport.

The characteristics that done good alpaca fibre products qualities for the textile industry, strictly joint to the shearing management, fleece harvesting and fibre grading and classification, are:

- The finesse (expressed in fibre average diameter -µm).
- The finesse homogeneity (expressed in average diameter Coefficient of Variation - C.V. %).
- The length (expressed in millimeters - mm).
- The length homogeneity (expressed in hauteur Coefficient of Variation - CVH).
- The presence of medullated fibre (expressed in percentage %).
- The presence of impurities (expressed in greasy yields and percentage of vegetable matter presence - %).
- The colour.

For the fleece harvesting the follow structures and equipment are utilized:
• Rest area before the shearing.
• Shearing area.
• Clip in the strict sense of the word.
• Grading areas.
• Proper grading equipment.
• Packaging and baling area.

The final goal of a correct management of the different steps of the fibre/fleece shearing, harvesting and grading are:
• The manufacturers can benefit of raw material easily and with confidence.
• Maximizing the financial return (profit).

14.2.1 Guidelines

Guidelines are the behaviors required during the shearing period and the organization of the different structure within the different working areas.

Step 1: Alpaca clip preparation

Before the alpaca enter in the clip areas the follow cautions have to be taken into account:

• Keep the alpaca in rest paddock near to the clip area,
• Keep the alpaca dry,
• Divide the alpaca in different groups according to the color, age and sex, in order to shear first the white alpaca, more young and with the finesses fibers. This is the way to obtain the more homogeneous lots for color and quality (finesse).

The choice of the shearing period is the one of the more difficult period in the alpaca fibre production life. The shearing seasonal period will have chose according to follow different aspects:

a. Environmental conditions - the alpaca clip in cold and windy period will obliged the alpaca management and feeding inside with dry and concentrate food for 10 days at least,

b. Reproduction activities - the alpaca clip after the delivery or during the breeding season increase the fleece stain and reduce fleece and fibre yield.

c. Pasture vegetative phase - alpaca will have to be clipped before the pasture will produce the seeds, because they are the main reasons of the fleece contamination and depreciation. The vegetable matter, especially seeds, is impossible to remove during the different steps of textile process.

Step 2: Structural needs

The Pens

In order to reduce the extraneous materials in the fleece, all the farm pens where the alpaca live have to be free by:

• Bales, ropes, twines and strings for the hay packaging.
• Wastes.
• Equipments useless as old beams or old machineries.
• Wires, barbed wires, old sandpapers, screws, nails, bolts and chains.
• Cigarettes end.
The presence of these materials produces no end of troubles for the textile industry, since a strong economic devaluation of the end products and sometime the breaking of the textile processing machineries.

**The clip shed area**

A shed should be utilized only for the alpaca clip. In the present structure all the shearing activities will be carried out and the area will have to be divided physically in three distinct areas:

1. **Alpaca handling area.** Where the alpaca rest before to be bring in the clip area. Present sector have to be totally separate from the other two areas. It is necessary: to prevent draught and rain, to cover the floor with elevated wooden floorboard and to provide suitable ventilation.

2. **Clip area.** Where the alpaca undergo the shearing. Also the clip area has to be completely divided by the other two areas and to be covered by wooden floorboard. Every time the different alpaca shearing group, divided for finesse and color changes a carefully cleaning have to be done. Finally all the device necessary to immobilize the alpaca have to be done of no contaminant materials (i.e. cotton), in order to avoid especially synthetics fibers contamination.

3. **Fleece Grading Area.** Where the single whole fleece are separated and graded in different finesse categories. An appropriate artificial or natural light have to be foreseen in the fleece grading areas; the grading table has to be single separated wood board made in order to favor the impurities falling-out. For each fibre categories have to be available clean or new sacks.

Inside the shed area the follow main hygienic rules have to be observed:
- Before the shearing, removing all the rubbishes and washing carefully the shed area when is empty.
- Providing at the shearing staff all the equipments to clean the shoes (scrapers, tanks with cleansing and / or disinfectant liquid).
- No smoking inside the clip area.
- No eat food.
- Forbidden all the alpaca paws grooming and especially the cutting nails.

**Step 3: Clip preparation**

Before to begin the real alpaca clip, all the hygienic rules above described have to be respected. All the alpaca must to go without food for at least 4 hours and they will present at the shearing according to pre - determinate categories (age, sex, color etc.)

Finally the bags, where the shearing and grading fleeces will be collected, will have to be checked inside in order to avoid the presence of rubbish and contaminant materials.
Step 4: Clip in the strict sense of the word

The alpaca clip method will have to perform according to the uses and methods of the local available shearers. Whatever will be the methods, the shearers will have:

- To be careful to separate before the less valuable fleeces fractions (feet and belly parts)
- To obtain the fleece intact as much as possible, in order to make easier the next fleece grading
- To avoid absolutely the double cut during the shearing, the consequence is a great average length variation of the fleece fibre that produces a heavy depreciation of the products.

After shearing, alpaca shepherd have to be careful to avoid the direct exposure of the animal at sunbeams or at currents of air in order to prevent sunburn and catching cold.

Step 5: Grading and classification

The principal grading aim is to offer fibre product in such way as the textile factories, before to start the process, have not to make further selection and cleaning procedure. The results are the elimination of adding costs and a better quality of the end product.

The main cares to carry out in the present step are:

- The fleeces have not to be rested in the floor
- As sheared, the fleeces have to be put soon in the grading tables,
- Grading table has to be cleaned after the grading of each fleece.

The fleeces obtained are classified for:

- Finesses
- Colour
- Length
- Presence of medullated fibre or kemp
- For the dirty fibers are foreseen special category- (Stained).

Each fibre category has to be identified by suitable codes which have to be affixed on packaging.
Alpaca fibre classification proposal

<table>
<thead>
<tr>
<th>Finesse Category</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 20 microns</td>
<td>&lt; 20 µm</td>
<td>SP</td>
</tr>
<tr>
<td>Between 20 and 25 microns</td>
<td>&gt;20 µm and &lt; 25 µm</td>
<td>F</td>
</tr>
<tr>
<td>Between 25 and 30 microns</td>
<td>&gt;25 µm and &lt; 30 µm</td>
<td>M</td>
</tr>
<tr>
<td>Over 30 microns</td>
<td>&gt; 30 µm</td>
<td>S</td>
</tr>
<tr>
<td>Stained</td>
<td></td>
<td>STD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Color</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>W</td>
</tr>
<tr>
<td>Light brown</td>
<td>FN</td>
</tr>
<tr>
<td>Brown</td>
<td>B</td>
</tr>
<tr>
<td>Dark brown</td>
<td>DB</td>
</tr>
<tr>
<td>Black</td>
<td>BLk</td>
</tr>
<tr>
<td>Light and dark gray</td>
<td>G</td>
</tr>
<tr>
<td>Pink gray</td>
<td>RG</td>
</tr>
<tr>
<td>Spotting brown</td>
<td>MTB</td>
</tr>
<tr>
<td>Spotting black</td>
<td>MTBLK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 85 mm &lt; 160 mm</td>
<td>A.A.A.</td>
</tr>
<tr>
<td>&gt; 40 mm &lt; 85 mm</td>
<td>A.A.</td>
</tr>
<tr>
<td>&lt; 40 mm</td>
<td>A.</td>
</tr>
<tr>
<td>&gt; 160 mm</td>
<td>O.G.</td>
</tr>
</tbody>
</table>

Medullation

Very heavy medullated fibre should be separated from the finesse category and included in the category (S)

Step 6: Raw material packaging and labeling

There are different packaging methods. In any case any methods will be utilize, the bags have not to be stained and their self have not to be reason of contamination (i.e. plastic bags).

Generally strong envelops are preferred, where the fleeces can be well pressed and easy to store.

In any case each bag must to have an individual label in which is described two kind of information, one referred to the farms:

1. Animal code number.
2. Farm name.
3. Farm address.
4. Telephone number.

and another one referred at the fibre:

1. Finesse category (code)
2. Color (code)
3. Length (code)
4. Shearing year
5. The fibers average diameter when laboratory analyses have been carried out

**Label example**

<table>
<thead>
<tr>
<th>Farm data</th>
</tr>
</thead>
</table>
| Animal code N. ..........................................
| Farm Name .............................................
| Farm address.......................................... |
| .......................................................... |
| Telephone N. ........../ ............... |

<table>
<thead>
<tr>
<th>Fibre data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finesse Category ......................................</td>
</tr>
<tr>
<td>Colour .................................................</td>
</tr>
<tr>
<td>Length .................................................</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shearing year</th>
</tr>
</thead>
<tbody>
<tr>
<td>..................</td>
</tr>
</tbody>
</table>
SECTION 14.3 - ICAR RULES, STANDARDS AND GUIDELINES ON METHODS OF CASHMERE GOAT IDENTIFICATION

14.3.1. ICAR general rules on cashmere goat identification

1. The recorded cashmere goat identity must be the animal’s official identity in the member country and must be unique to that animal.
2. Where the identity of an individual animal is not unique, the record must so state. The identity number used for a flock or herd must be unique for that flock or herd.
3. The cashmere goat’s identity must be visible.
4. The cashmere goat’s identity should be unique and never be re-used.
5. The cashmere goat’s identification device/method must comply with legislative requirements.
6. Cashmere goats that lose their identity device must be re-identified and, wherever possible, with their original number, provided that there is evidence that the cashmere goat is being correctly identified (where this is not possible, a cross reference to the original number must be maintained).

14.3.2. ICAR standard methods of cashmere goat identification

The cashmere goat’s identity number may be attached to the animal by a tag, tattoo, sketch, photo, brand or electronic device.

1. Cashmere goats moving from one member country to another should continue to be identified using their original identity number and name wherever possible.
2. In the case of imported cashmere goats, where the number has to be changed, the official records should also show the original number and name. The original number and name must be reported in export certificates, AI catalogs and in catalogs of important shows and sales.
3. Where a cashmere goat is identified using an implanted electronic device, the animal must be marked in a way that indicates the presence of an electronic identification device.

14.3.3. Record of identification methods

1. The member organisation must maintain a record of the approved identification methods used in the member country.
2. The member organisation must determine, within the constraints of the member country legislation, the identification methods to be used on recorded cashmere goats and herds or flocks.
14.3.4. ICAR standards for cashmere identities

1. The cashmere goat's identity number will be a maximum of 12 digits (including check digits, where used) and the three-digit numeric code representing the name of the country, in accordance with ISO 3166, shall be added to identify the country of origin. Three-digit numeric ISO codes must be used for data transfer and storage. In printed documents, the ISO alpha country code should be used.

2. For electronic identification standards, see Appendices in this publication.

SECTION 14.4 - ICAR RULES, STANDARDS AND GUIDELINES ON CASHMERE COMBING MANAGEMENT, FIBRE HARVESTING AND GRADING

According to the CCFMI (Cashmere and Camel Hair Manufacturers Institute), cashmere is defined as:
• The fine (dehaired) undercoat fibres produced by a cashmere goat (Capra hircus laniger).
• The fibre is generally non-medullated and has a mean maximum diameter of 19 microns. The co-efficient of variation around the mean shall not exceed 24%. There can be no more than 3% (by weight) of cashmere fibres over 30 microns. (Reference IWTO Test Method B).

Cashmere Fleece Collection Critical Control Points (CFCCCP) have been identified according to the auto-certification methodology currently applied in other advanced fibre animal breeding systems. The application of CFCCCP utilising simple procedures in animal husbandry, fleece combing management, fibre harvesting and classification, provides conditions to optimise quality of product for the next step in the processing chain. It will also allow the identification of sources of defects, which are detected in end products and localise the individual system failures and errors in management occurring in previous steps of the chain.

Because cashmere production derives from a double fleece structure and the cashmere fibre is represented by the undercoat, it should be noted that cashmere harvesting can be carried out using two different methods: the shearing method and the combing method. In the current guidelines, the combing method is referenced because it is the most widely used method in the main producing areas of China and Mongolia.

14.4.1 Critical control points

The principal critical control points are organised in six distinct steps:
• Standardising of cashmere harvesting preparation.
• Structural needs.
• Preparation for harvesting.
• Harvesting process.
• Grading and classifying.
• Packaging and transport.
In order to define the quality of cashmere fibre products for the textile industry, the parameters and their methods of measurement are:

- Fineness (fibre average diameter - \( \mu m \))
- Homogeneity (fibre diameter coefficient of variation - C.V. %)
- Staple length (fibre average length - mm)
- Medullation (percentage %) or comfort factor
- Dark fibre in white fleece and white fibre in coloured fleece contaminations (number of dark-white fibres/10g)
- Impurities (greasy yields and percentage content of vegetable matter - %)
- Colour.

In order to maximise a cashmere harvesting, attention should be paid to the following:

- Rest area for cashmere goat before harvesting
- Harvesting area
- Procedures for cashmere harvesting
- Grading areas
- Equipment for grading
- Packaging and baling area.

The final goals for the correct management of the different steps of the fibre/fleece harvesting and grading processes are:

- Optimising the quality (fineness and uniformity) of the raw material and providing confidence in its use for manufacturers
- Maximising the financial return and profit.

14.4.2. Guidelines for cashmere harvesting

These guidelines describe the recommended management of actions during the shearing period and the organisation of the different working environments.

14.4.2.1 Step 1: Goat harvesting preparation

Before entering the harvesting areas, the goats should be:

- Kept dry and in a rest paddock close to the harvesting area.
- Divided into groups according to age, sex and colour of cashmere, with emphasis on separating the fleeces from the white cashmere and from the younger animals with the finest fibres. This is the best way to maximise homogeneity in colour and quality.

The timing of the harvesting period requires serious consideration in the production of cashmere goat fibre. Because cashmere is produced seasonally and production is strictly correlated to photoperiod inversion, the shearing period must be chosen according to the following aspects:

- Spring season suitability - when the activity of the secondary follicles stops and the undercoat is more easily removed by combing.
- Environmental conditions - goats must be housed indoors when it is cold and windy after clipping; kept dry, and fed with the best food for at least 10 days.
14.4.2.2 Step 2: Structural needs

The pens
In order to reduce contamination in the fleece by extraneous materials, goat pens must be free of:

- Hay bales; ropes, twine and string for hay baling.
- Rubbish.
- Unused equipment, such as old beams or machinery.
- Wire and barbed wire; old sandpaper, screws, nails, bolts and chains
- Cigarette butts.

The presence of these materials causes major problems for the textile industry and greatly reduces the economic value of the end products, sometimes even causing costly damage to textile processing machinery.

The harvesting shed area
A shed should be used specifically for goat harvesting. It should be divided into four areas:

1. **The goat handling area** is where the goats rest before being brought into the clip area. It must be totally separate from the other three areas and must also be protected from draughts and rain and have suitable ventilation.

2. **The clip area** is where the goats undergo the shearing of the outer coat or guard hair. This area must be completely separated from the other three areas, have elevated wooden floorboards and suitable ventilation. Careful cleaning and classification of fibre fineness and colour after shearing each different goat group is necessary, before shearing of the next group with different cashmere characteristics commences. Anything used to restrain the goats must contain non-contaminating materials (e.g. no polypropylene ropes), in order to avoid contamination with synthetics fibres.

3. **The combing area** is where the goats undergo specific cashmere harvesting through precision combing. This area must be completely separated from the other three areas - especially the clip area, where the possibility of hair and kemp contamination is very high. As for the previous area, careful cleaning needs to be done after shearing is completed for each different goat group. Anything used to restrain the goat must contain non-contaminating materials. The area must have elevated wooden floorboards and suitable ventilation.

4. **The cashmere grading area** is where the whole fleeces are separated and graded according to fineness. An appropriate artificial or natural light must be provided in the cashmere grading area; the grading table must be constructed of single wooden planks that are slightly separated to allow impurities to fall through. Clean, previously used sacks or new sacks must be available for each fibre category.

Inside the shed area, the following important rules of hygiene must be observed:

- Before harvesting: remove all rubbish and carefully wash the empty shed area.
- Harvesting staff must be provided with equipment to clean their shoes (scrapers, containers with cleansing and/or disinfectant liquid).
- Smoking inside the clip area is not permitted.
- Eating is not permitted.
- Grooming of goat feet and cutting of nails is not permitted.
14.4.2.3 Step 3: Preparation for cashmere harvesting

Before harvesting cashmere goats begins, the hygiene rules above must be adhered to. All goats must go without food for at least four hours beforehand, and they must be presented for harvesting according to pre-determined categories (age, sex, colour etc.)

The age categories are as follows:

<table>
<thead>
<tr>
<th>Age Category</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>From birth to 6 months</td>
<td>Baby</td>
</tr>
<tr>
<td>From 6 months to 1.5 years</td>
<td>1st combing</td>
</tr>
<tr>
<td>2 years</td>
<td>2nd combing</td>
</tr>
<tr>
<td>From 3 to 5 years</td>
<td>3rd, 4th and 5th combing</td>
</tr>
<tr>
<td>Older than 6 years</td>
<td>6th combing and more</td>
</tr>
</tbody>
</table>

Finally, the bags in which the graded cashmere will be collected must be checked to ensure they contain no rubbish or contaminant materials.

14.4.2.4 Step 4: Harvesting process

Cashmere harvesting must be undertaken using the combing method. The process consists of two specific actions:

- Cutting of the outer coat, or guard hair.
- Combing.

When performing these two actions, the farmer must:

- Carefully separate the two actions: outer coat clip and combing
- Avoid clipping the upper part of the cashmere during the cutting of the guard hair
- Comb the under coat according to the different parts of the body (see Figure 1): firstly, the areas of greater fineness between parts of sections 1, 2, 3 and the whole of section 5, which is from the front of the rump to the scapular spine and ribs areas; secondly, the other remaining sections. The less valuable cashmere fractions (feet and belly parts) are combed at the end.

![Figure 1](image)
After combing, farmers must be careful to avoid exposing the goats to cold air, in order to prevent hypothermia.

14.4.2.5 Step 5: Grading and classification

The principal aim of grading is to be able to supply manufacturers with cashmere lots that require no additional grading and cleaning before processing begins, and to provide them with assurance of the various lots’ characteristics in terms of fineness, C.V. %, length and yield. Good grading and handling practices result in the elimination of unnecessary costs and a better quality end product. In this step:

- Harvested cashmere must be placed immediately on the grading tables and not be allowed to remain on the floor.
- Grading tables must be cleaned after each fleece is graded.

Fleeces are graded according to:

- Fineness.
- Colour.
- Length.
- Percentage of kemp (guard hair).
- Contamination of dark fibre in white cashmere and white fibre in coloured cashmere.
- Contamination by external material (vegetable, polypropylene, etc.).

Each lot must be identified by the appropriate codes, which must be attached to the packaging. Packaging must be made of cotton or nylon. NO POLYPROPYLENE material is to be used for either bags or ropes.

14.4.2.5.1 Cashmere fibre classification proposal

14.4.2.5.1.1 Fineness categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Fibre Diameter (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 13,5</td>
<td></td>
</tr>
<tr>
<td>Between 13,5-14,5</td>
<td></td>
</tr>
<tr>
<td>Between 14,5-15,2</td>
<td></td>
</tr>
<tr>
<td>Between 15,2-15,5</td>
<td></td>
</tr>
<tr>
<td>Between 15,5-16,00</td>
<td></td>
</tr>
<tr>
<td>Between 16,00-17,00</td>
<td></td>
</tr>
<tr>
<td>Between 17,00-18,00</td>
<td></td>
</tr>
<tr>
<td>Between 18,00-19,00</td>
<td></td>
</tr>
<tr>
<td>&gt;19,00</td>
<td>No cashmere</td>
</tr>
</tbody>
</table>
14.4.2.5.1.2 Colour

<table>
<thead>
<tr>
<th>Type</th>
<th>Code</th>
<th>Range</th>
<th>Sub-code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural white</td>
<td>W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White x white</td>
<td>WW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>BLK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown</td>
<td>B</td>
<td>Dark</td>
<td>B – Dk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self</td>
<td>B – Slf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light</td>
<td>B – Lgt</td>
</tr>
<tr>
<td>Light fawn</td>
<td>LF</td>
<td>Dark</td>
<td>GR – Dk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self</td>
<td>GR – Slf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light</td>
<td>GR – Lgt</td>
</tr>
<tr>
<td>Grey (Black)</td>
<td>GR</td>
<td>Dark</td>
<td>RN – Dk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self</td>
<td>RN – Slf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light</td>
<td>RN – Lgt</td>
</tr>
<tr>
<td>Roan (Brown)</td>
<td>RN</td>
<td>Dark</td>
<td>PK – Dk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self</td>
<td>PK – Slf</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light</td>
<td>PK – Lgt</td>
</tr>
<tr>
<td>Pink (Light Fawn)</td>
<td>PK</td>
<td>Dark</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Light</td>
<td></td>
</tr>
</tbody>
</table>

14.4.2.5.1.3 Down length

- > 60 mm A
- > 50 mm < 60 mm B
- > 45 mm < 50 mm C
- > 40 mm < 45 mm D
- > 35 mm < 40 mm E
- > 25 mm < 35 mm F
- > 20 mm < 25 mm G
- < 20 mm H

14.4.2.6 Step 6: Raw material packaging and labelling

There are several different packaging methods. Such methods require clean bags that are not stained and do not introduce contaminants (i.e. man-made fibres such as polyester, polypropylene and synthetic fibres, other than nylon).

Generally, bags made of strong material are preferred, so fleeces can be firmly pressed and are easy to store. The bags must be made of natural materials (i.e. cotton, hemp, jute and other cellulose fibres); among the synthetic man-made fibres, only nylon (polyamide 6 and 6.6) can be approved.

Each bag must also have a label stating two types of information. One refers to the source farms and consists of:
• Lot code.
• Farm name.
• Farm address.
• Farm telephone number.

The other refers to the cashmere as follows:
• Cashmere goat category (code).
• Harvesting body area (upper or down).
• Colour (code).
• Length (mm).
• Combing year.
• The average diameter of fibres when laboratory analyses have been carried out.

**Label example**

<table>
<thead>
<tr>
<th>Farm data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot code ..........................................................</td>
</tr>
<tr>
<td>Farm name ..................................................................</td>
</tr>
<tr>
<td>...........................................................................</td>
</tr>
<tr>
<td>Farm address ................................................................</td>
</tr>
<tr>
<td>...........................................................................</td>
</tr>
<tr>
<td>...........................................................................</td>
</tr>
<tr>
<td>Telephone no. ........../............................................</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cashmere data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cashmere goat category ........................................</td>
</tr>
<tr>
<td>Harvesting body area ..........................................</td>
</tr>
<tr>
<td>Colour ..............................................................</td>
</tr>
</tbody>
</table>
15.1. SCOPE AND OBJECTIVES

The objective of this document is:

- Harmonization of the definitions of exchanged data in order to be able to exchange information between heterogeneous information systems.
- Development of global consensual data dictionaries for livestock.
- Development and installation of standardized systems to support data exchange between information systems and farm equipments.

The purpose is to define the data exchange process for miscellaneous farm equipment and to describe in detail the business processes as well as the exchanged data.

The document does not deal with the technical implementation issues. The message syntax (ADIS, XML...), interchange protocols (http, SOAP, etc.), the platform and the implementation language (J2EE, Java, etc.) or architectural constraints (security, reliability, redundancy, etc.) do not fall within its scope.

The guideline gives:

- Business rules useful for organizing and structuring the partners interchanges.
- Precise definitions for data to be exchanged.

The guideline is as much as possible independent from particular technique of implementation: ADI/ADED, XML...

15.2. METHODOLOGY

15.2.1. General

The method is based on UML (Unified Modeling Language) which is widespread used all over the world today.

Business modeling as well as data models of interchanged data fully complies with the UNCEFACT requirements for the document "Business requirements specification" (BRS).
15.2.2. Main steps

The method consists in the following phases:

• Business modeling
• Data models of interchanged data

15.2.3. Description of the step of business modelling

The objectives are to get:

• Clear and precise definition of the business process.
• Definition of the business actors.
• Definition of the different activities in relation with data exchange.
• Identification of information interchange flows.

15.2.4. Description of the step data modelling of Interchanged data

The objectives are to get:

• The exchanged data model.
• Definition of each exchanged data element according its:
  • **Mult.**: multiplicity of the element with as possible values:
    - 1: mandatory, 1 time
    - 0..1: optional, 1 time
    - 1..n: mandatory multiple times
    - 0..n: optional, multiple times
  • **Business term**: name of the element.
  • **Rel.**: the element can consist in a simple element or a complex one referring to another entity:
    - Att: the element is an attribute of the entity
    - Ass: the element is in association with another entity
  • **Type**: the type of element according the UML data type (see annex)
  • **Description**: description or definition of the element.
  • **Format**: only for attributes, according the following:
    - string(x): character field, maximum length x
    - numeric(x,y): numeric field, length is x + y. If "y" is present it must be greater than zero, and the decimal field separator must be present. A sign "+" or "+" can be the first character.
    - Default sign is "+".
    - Date format: ccyymmdd
    - Time format: hhmmss where hh is from 00 to 24.
15.3. BUSINESS CONTEXT

The main activities of livestock farming may be distributed in the following categories:

- Feeding.
- Milking.
- Reproduction.
- Health.

More and more of these activities are partly or totally automated: automatic milking systems, heat detectors, automatic feeders...

Sensors embedded by these devices measure and record more and more data from the animals on one hand and on the other hand the automated processes require more and more data which are registered by farm management information systems.

In parallel, more and more farmers are using PC for information systems and data bases for farm management. These data bases may be managed either at farms or remote from farms through Internet. Henceforth, many of recording organizations provide farmers with data bases for herd management from different sources. These databases are also used by advisors.

Furthermore, the increasing use of genomics for breeding value estimation makes possible the calculation for new traits of high economical importance from data collected by on farm device.

The joint development of automated process, of farm management information systems as well as genomic breeding value evaluation, increase the importance of electronic data exchange between on farm automatic devices and information systems.

To meet these new needs, electronic data exchange should be massive, automated, permanent and without delay.

As the needs from farmers are similar everywhere and as many of the companies which are manufacturing farm equipments are international, the more efficient way to address electronic data exchange issues is global level.

This guideline starts addressing the main activities which are defined and represented in the form of a UML use case diagrams (Figure1).

As future versions of this guideline will deal with a relatively high number of activities it is necessary to group them together consistently in "Process Area", at the moment:

- "Milking".
- "Feeding"

Processes area are represented in the form of a UML package diagrams (Figure 1)

Process areas belong to a Business Area: Herd management

Herd management is a part of a Business Domain: Agriculture.
Section 15- Electronic data exchange for livestock

15.4. GENERAL PRINCIPLES

15.4.1. Data transfer management

15.4.1.1. Recipients

Data should be transferred to one or several information systems (e.g. farm management information system, recording organisation information system, consultant’s information system...). The information systems should be either located on the farm or remote from the farm.

15.4.1.2. Transfer procedure

The equipment starts the transfer.

Transfers should not require any manual operation.

Transfers should be permanent either just after the completion of a task of the equipment (e.g. a milking session...) or at a pre-defined moment (e.g. every hour...).

During a transfer all the data which have not been yet transferred previously should be transferred whatever the delay between the transfer and the moment of their capture.

A transfer to an information system is completed when the equipment received an acknowledgment of completeness from the information system. The acknowledgment deals only with data transmission, it does not deal with data processing after the transmission. Data transfer may have been successful but data may have been processed totally or partly by the information system after the transfer.

The status of the data in regards to the transfer to a particular information system (transferred / not transferred) should be managed by the equipment according to the information systems; data may have been transferred successfully to one information system and not to the others.

15.4.1.3. Responsibilities

The errors resulting from data processing should be solved according an agreement between the operator of the equipment and the manager of the information system.
Transfer is the responsibility of the operator of the equipment until he has not received an acknowledgment from the information system.
Data processing is the responsibility of the manager of the information system from the time of the acknowledgment has been sent to the equipment.

15.4.2. Animal Identification and animal number

15.4.2.1. Supported standards

The amount and the frequency of exchanged data require a shared and reliable animal identification. As the same animal may have at the same time several animal numbers for different purposes (e.g. for equipments, for authorities, for herd book keeping...) and as some animal numbers may change during his lifetime the following principles should be followed:
1. The animal number to be transferred should be that is stored by the transponder used by the equipment.
2. The animal number should be in accordance with one of the following standard:
   - Six digits number in accordance with ISO standards 11788-2 registered by a transponder provided under the responsibility of the equipment manufacturer.
   - 15 digits number starting with 3 digits for the manufacturer code in accordance with the ISO standard 11784 registered by an ICAR approved transponder.
   - 15 digits numbers starting with 3 digits for the country code in accordance with the ISO standard 11784 registered by ICAR approved transponder.

15.4.2.2. Responsibilities

It is the duty of the responsible of the information system to bring the appropriate changes to allow data processing with the above standards for animal number.
When the information system and the equipment are using two different types of animal number, it is the duty of the responsible of the information system to provide the farmers with appropriate procedures to manage cross references between the different animal numbers. It is the duty of the farmers to update the cross references between the different numbers.

15.5. GENERAL PRINCIPLES FOR MESSAGE MODELLING

15.5.1. General

The different messages consist in three elements (see figure 2):
- Message header.
- Animal.
- A set of data dealing with animal information which may be either:
  - Milk session result.
  - Animal Feeding Results.
Section 15 - Electronic data exchange for livestock

15.5.2. Message header

15.5.2.1. Data model: MessageHeader

See figure 3.

The sender of each message should be identified. He is unique. The sender is the actor responsible for the content of the message.

The recipients may be multiple because the same message may be sent simultaneously to different information system: farm management information, breeding organisations, consultant’s...
15.5.2.2. Entity description: ExchangedMessageDetails

The entity contains the general information (party, date…) about the message.

<table>
<thead>
<tr>
<th>Multi.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MessageIdentification</td>
<td>Att</td>
<td>Identifier</td>
<td>The unique number assigned by the issuer to identify a message.</td>
<td>string(6)</td>
</tr>
<tr>
<td>1</td>
<td>MessageIssueDateTime</td>
<td>Att</td>
<td>DateTime</td>
<td>The date and the time where the message is issued.</td>
<td></td>
</tr>
<tr>
<td>0..1</td>
<td>MessageLineNumber</td>
<td>Att</td>
<td>Quantity</td>
<td>Number of message lines.</td>
<td>numeric(6)</td>
</tr>
<tr>
<td>1</td>
<td>MessageType</td>
<td>Att</td>
<td>Code</td>
<td>The message type is described as an enumeration</td>
<td>string(3)</td>
</tr>
<tr>
<td>1</td>
<td>Sender</td>
<td>Ass</td>
<td>SenderSpecifiedParty</td>
<td>Organization or person responsible for the content of the message.</td>
<td></td>
</tr>
<tr>
<td>1..n</td>
<td>Recipient</td>
<td>Ass</td>
<td>RecipientSpecifiedParty</td>
<td>Organization or person responsible for processing the message.</td>
<td></td>
</tr>
<tr>
<td>1..n</td>
<td>Animal</td>
<td>Ass</td>
<td>Refer</td>
<td>Animal identification</td>
<td></td>
</tr>
</tbody>
</table>
15.5.2.3. Entity description: SpecifiedPartyDetails

The entity contains the name and the identifier of a party which may be either the sender or the recipient.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SpecifiedPartyIdentification</td>
<td>Att</td>
<td>Identifier</td>
<td>Identify the specified party</td>
<td>Footnote 1</td>
</tr>
<tr>
<td>1</td>
<td>SpecifiedPartyName</td>
<td>Att</td>
<td>Name</td>
<td>Name expressed as text.</td>
<td>Footnote 2</td>
</tr>
<tr>
<td>1</td>
<td>SpecifiedPartyCountryCode</td>
<td>Att</td>
<td>Identifier</td>
<td>The ISO Country code (2 char code ISO 3166-1-Alpha-2)</td>
<td>String(2)</td>
</tr>
</tbody>
</table>

Footnote 1: See UN/CEFACT specification core component.
Footnote 2: See UN/CEFACT specification core component.

15.5.2.4. Entity description: MessageTypeEnumeration

The entity contains the enumeration of the different types of messages.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MessageType</td>
<td>Att</td>
<td>Code</td>
<td>The different types of messages are given by a code set</td>
<td>string(3)</td>
</tr>
<tr>
<td>1</td>
<td>MessageTypeCreation</td>
<td>Att</td>
<td>Date</td>
<td>Date of creation of the type</td>
<td></td>
</tr>
<tr>
<td>0..1</td>
<td>MessageTypeCreation</td>
<td>Att</td>
<td>Date</td>
<td>Date of suppression of the type</td>
<td></td>
</tr>
</tbody>
</table>

15.5.3. Animal

15.5.3.1. Data model: animal

The animal description (see figure 4) consists in:
- The description of the animal number which is used by the device.
- The location of the animal during the measurements.

One animal should refer to one location.
Different types of location are possible.
The different types of animal identification are given by an enumeration.

```
AnimalIdentificationDetail
- AnimalIdentification
- AnimalIdentificationType
- AnimalSpecies

Located
- 1..* 1

Location
- countryCode
- HoldingIdentification
- Detail
- LocationName

Enum: AnimalIdentificationType
- AnimalIdentificationType
- CodeCreationDate
- CodeRemovalDate
```

Figure 4. Diagram of the data model of "Animal"
15.5.3.2. Entity description: AnimalIdentificationDetail

The entity contains the animal identification number and its type.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AnimalIdentification</td>
<td>Att</td>
<td>Identifier</td>
<td>Animal number.</td>
<td>string(15)</td>
</tr>
<tr>
<td>1</td>
<td>AnimalIdentificationType</td>
<td>Att</td>
<td>Code</td>
<td>The type of identification is described as an enumeration.</td>
<td>string(3)</td>
</tr>
<tr>
<td>1</td>
<td>AnimalSpecie</td>
<td>Att</td>
<td>Code</td>
<td>Species of the animal (bovine, ovine...)</td>
<td>string(2)</td>
</tr>
<tr>
<td>0..1</td>
<td>AnimalSecIdentification</td>
<td>Att</td>
<td>Code</td>
<td>Secondary Animal number like “on farm numbers” to detect animal id changes</td>
<td>string(15)</td>
</tr>
<tr>
<td>0..1</td>
<td>AnimalSecIdentificationType</td>
<td>Att</td>
<td>Code</td>
<td>The type of secondary animal identification</td>
<td>string(3)</td>
</tr>
<tr>
<td>1</td>
<td>AnimalName</td>
<td>Att</td>
<td>Identifier</td>
<td>Name of the animal to detect animal id changes</td>
<td>String(24)</td>
</tr>
<tr>
<td>1</td>
<td>Location</td>
<td>Att</td>
<td>located</td>
<td>Location identifier of the animal during data collection</td>
<td>String(15)</td>
</tr>
<tr>
<td>0..n</td>
<td>MilkingSessionResults</td>
<td>Ass</td>
<td>Produce</td>
<td>The results for a given animal for a given milking session</td>
<td></td>
</tr>
<tr>
<td>0..n</td>
<td>AnimalFeedingResults</td>
<td>Ass</td>
<td>Consume</td>
<td>The quantity of feed consumed by a given animal for a given period.</td>
<td></td>
</tr>
</tbody>
</table>

15.5.3.3. Entity description: Location

The entity contains the description of the location of the animal during the measurements and the type of the location.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CountryCode</td>
<td>Att</td>
<td>Code</td>
<td>The ISO Country code (2 char code ISO 3166-1-Alpha-2) of the location.</td>
<td>string(2)</td>
</tr>
<tr>
<td>1</td>
<td>HoldingIdentification</td>
<td>Att</td>
<td>Identifier</td>
<td>Describe the holding or the premise for which the data is to be provided.</td>
<td>string(12)</td>
</tr>
<tr>
<td>0..1</td>
<td>DetailHolding</td>
<td>Att</td>
<td>Identifier</td>
<td>The detail of the holding is described by a sequence of sub addresses separated by dots (e.g. “1.17.28”)a</td>
<td>string(25)</td>
</tr>
<tr>
<td>0..1</td>
<td>LocationName</td>
<td>Att</td>
<td>Name</td>
<td>Name expressed as text.</td>
<td>string(24)</td>
</tr>
</tbody>
</table>

*aSee ADED data element 901002*

15.5.3.4. Enumeration description: AnimalIdentificationType.

The enumeration contains the list of the types for animal identification which may be used.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AnimalIdentificationType</td>
<td>Att</td>
<td>Identifier</td>
<td>4 char for the type of animal ID.</td>
<td>string(4)</td>
</tr>
<tr>
<td>1</td>
<td>CodeCreationDate</td>
<td>Att</td>
<td>Date</td>
<td>Date for the creation of the type</td>
<td></td>
</tr>
<tr>
<td>0..1</td>
<td>CodeRemovalDate</td>
<td>Att</td>
<td>Date</td>
<td>Date for the suppression of the type</td>
<td></td>
</tr>
</tbody>
</table>
15.5.3.5. Code set: AnimalIdentificationType

<table>
<thead>
<tr>
<th>AnimalIdentificationType</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAN</td>
<td>Farm animal number according ISO 11788-2*</td>
</tr>
<tr>
<td>ISM</td>
<td>Animal ISO code with a manufacturer code according ISO 11784</td>
</tr>
<tr>
<td>ISC</td>
<td>Animal code with a country code from a transponder according ISO 11784</td>
</tr>
</tbody>
</table>

*See ADED data element 900070

15.5.4. Device

15.5.4.1. Definition

The device can be a device for milking or feeding measurements.

15.5.4.2. Entity description: Device

This entity gives the identification of the device used for measures.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1..1</td>
<td>DeviceId</td>
<td>Att</td>
<td>Identifier</td>
<td>Will be compiled from the MAC address and an additional four-digit number for possible hidden devices. If there is no hidden device, 000 is used. The MAC address and consecutive number are separated by a minus sign.</td>
<td>string(17)</td>
</tr>
<tr>
<td>1..1</td>
<td>DeviceType</td>
<td>Att</td>
<td>Code</td>
<td>Milking or feeding device. See code set.</td>
<td>string(3)</td>
</tr>
<tr>
<td>1..1</td>
<td>DeviceNameVersion</td>
<td>Att</td>
<td>Name</td>
<td>Hardware version of device. Each manufacturer is free to define a hardware version.</td>
<td>string(20)</td>
</tr>
<tr>
<td>1..1</td>
<td>ManufacturerID</td>
<td>Att</td>
<td>Identifier</td>
<td>ISO 17532 manufacturer ID structure: country code: national manufacturer number. Country code: ISO 3 166-1 numeric, 3 digits. National manufacturer number: 12 digits.</td>
<td>string(15)</td>
</tr>
</tbody>
</table>

15.5.4.3. Code set description: DeviceType

<table>
<thead>
<tr>
<th>DeviceType</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIL</td>
<td>Milking device.</td>
</tr>
<tr>
<td>FEE</td>
<td>Feeding device.</td>
</tr>
</tbody>
</table>
15.6. EXCHANGED DATA OF THE PROCESS "COLLECTMILK"

15.6.1. Business modelling

15.6.1.1. Business collaboration overall description

The use case (see Figure 5) deals with data exchange with automatic or semi automatic milking system.

The use case is a part a wider business process which includes:

- Determine if milk must be collected.
- Link responder to cow.
- Milking equipment calibration.
- …

The results are:

1. Sending of milking session results to specified information systems.
2. Milk samples linked to a milking session.

The actors of the process are (see the above diagram):

1. "Operator" gives the list of cows to be sampled and the characteristics of sampling session (1 sample per cow or 1 sample per milking).

2. MilkingSystem: set of milking equipments which:
   - Collects milk
   - Fills the bottles of the samples.
   - Records data.
   - Sends the results of the milking session to the information system.

3. "InformationSystem" which store the results from the milking session.

![Diagram of the business process "CollectMilk".

Figure 5. Diagram of the business process "CollectMilk".](attachment:diagram.png)
15.6.1.2. Business collaboration in detail

The diagram below (Figure 6) gives the detail of the business collaboration. The starting event is a cow to be milked. Collect milk is a complex task. The main results are:

- Collect milk from the cow,
- Collect data of the milking session
- Collect samples of milk consistent according to the demand of the operator of the milking system (See task Register sampling parameters):

When a milking session is completed and if the milking system has to transfer data to at least one information system, a message is prepared from the data collected during the milking session (see task Message elaboration).

A specific task (see Data transfer management) determines whether messages are to be transferred. There is a transfer if there is, at least, one message to be transferred to, at least one, information system and if the transfers are permanent or at specified intervals (for instance, every hour).

In case of transfer and for each particular information system, all the messages which have not been yet sent are sent (see task Send message)

When the milking equipment receives the acknowledgment from the information system, the status of data is update’. (See task Message status update). If there is no acknowledgement, the transfer is not completed and this exception has to be processed (see task Data transfer management)

The information system receives the messages (see task Receive message’) and processes the content of the messages (See task Message processing’).

15.6.2. Exchanged messages

15.6.2.1. Overall data model for the message

See overall message model in figure 2.

15.6.2.2. Data model: MilkingSessionResult

MilkingSessionResult gives the data collected during one milking session for one cow.

The Figure 6 gives the detail of the data model.

For one milking session, results from the different quarters may be recorded. The entity QuarterMilking gives the results of the milking session for each quarter. These results are optional.

For one milking session, MilkComponents gives the value of the particular analysis for the milk collected during a milking session. A wide range of miscellaneous analysis may be undertaken for one milking session: fat percentage, protein percentage, somatic cell count, lactose, urea… . These results are optional.

When samples have been taken for the milk session, Sample gives the identification of the bottles which contain the milk sample of this milking for that cow.
Figure 6. Tasks and activities of the business process “CollectMilk”.

International Agreement on Recording Practices
15.6.2.3. Entity description: TotalMilkingResult

The entity gives all the results of one milking session for one cow.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>StartingTime</td>
<td>Att</td>
<td>Date/Time</td>
<td>Starting time of milking</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>MilkingResultType</td>
<td>Att</td>
<td>Code</td>
<td>Type of milking result. See code set below</td>
<td>string(1)</td>
</tr>
<tr>
<td>1</td>
<td>MilkingDuration</td>
<td>Att</td>
<td>Duration</td>
<td>Duration of milking in seconds (ISO 3918: duration on the milking machine)</td>
<td>numeric(3)</td>
</tr>
<tr>
<td>1</td>
<td>MilkWeight</td>
<td>Att</td>
<td>Measure</td>
<td>Milk weight in Kg.</td>
<td>numeric(3.1)</td>
</tr>
<tr>
<td>1</td>
<td>ValidMilkingIndicator</td>
<td>Att</td>
<td>Code</td>
<td>Indicator of the milking session validity.</td>
<td>string(1)</td>
</tr>
<tr>
<td>0..1</td>
<td>AverageConductivity</td>
<td>Att</td>
<td>Measure</td>
<td>Average conductivity value of the milk in mS/cm</td>
<td>numeric(2.1)</td>
</tr>
<tr>
<td>0..1</td>
<td>MaxConductivity</td>
<td>Att</td>
<td>Measure</td>
<td>Maximum conductivity value of the milk in mS/cm</td>
<td>numeric(2.1)</td>
</tr>
<tr>
<td>0..1</td>
<td>AverageFlowRate</td>
<td>Att</td>
<td>Measure</td>
<td>Average flow rate for the individual milking in Kg/min</td>
<td>numeric(3.1)</td>
</tr>
<tr>
<td>0..1</td>
<td>MaxFlowRate</td>
<td>Att</td>
<td>Measure</td>
<td>Maximum flow rate for the individual milking in Kg/min</td>
<td>numeric(3.1)</td>
</tr>
<tr>
<td>1</td>
<td>MilkingParlourUnit</td>
<td>Att</td>
<td>Identifier</td>
<td>Identification of the milking parlour unit</td>
<td>string(4)</td>
</tr>
<tr>
<td>0..4</td>
<td>Distribute</td>
<td>Ass</td>
<td>Measure</td>
<td>The entity gives the device used for the measurements.</td>
<td></td>
</tr>
<tr>
<td>0..1</td>
<td>Refer</td>
<td>Ass</td>
<td>Sample</td>
<td>The entity gives the identification of the bottles which contain the sample.</td>
<td></td>
</tr>
<tr>
<td>0..n</td>
<td>Consist</td>
<td>Ass</td>
<td>Measure</td>
<td>The entity gives per component the result of the analysis.</td>
<td></td>
</tr>
</tbody>
</table>

15.6.2.4. Entity description: QuarterMilking

The entity gives results of one milking session for one quarter.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel.</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>QuarterID</td>
<td>Att</td>
<td>Code</td>
<td>Identification of the quarter for which the results apply:</td>
<td>string(2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LF = left front</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RF = right front</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>LR = left rear</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>RR = right rear</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>QuarterMilkingDuration</td>
<td>Att</td>
<td>Measure</td>
<td>Milking duration of the quarter</td>
<td>numeric(3)</td>
</tr>
<tr>
<td>1</td>
<td>QuarterMilkWeight</td>
<td>Att</td>
<td>Measure</td>
<td>Milk weight of the quarter in Kg</td>
<td>numeric(3.1)</td>
</tr>
<tr>
<td>1</td>
<td>QuarterValidMilkingIndicator</td>
<td>Att</td>
<td>Code</td>
<td>Indicator of the milking session validity.</td>
<td>string(1)</td>
</tr>
<tr>
<td>0..1</td>
<td>QuarterAverageConductivity</td>
<td>Att</td>
<td>Measure</td>
<td>Average conductivity value of the milk per quarter in mS/cm</td>
<td>numeric(2.1)</td>
</tr>
<tr>
<td>0..1</td>
<td>QuarterMaxConductivity</td>
<td>Att</td>
<td>Measure</td>
<td>Maximum conductivity value of the milk per quarter in mS/cm</td>
<td>numeric(2.1)</td>
</tr>
<tr>
<td>0..1</td>
<td>QuarterAverageFlowRate</td>
<td>Att</td>
<td>Measure</td>
<td>Average flow rate for the milking per quarter in Kg/min</td>
<td>numeric(3.1)</td>
</tr>
<tr>
<td>0..1</td>
<td>QuarterMaxFlowRate</td>
<td>Att</td>
<td>Measure</td>
<td>Maximum flow rate for the milking per quarter in Kg/min</td>
<td>numeric(3.1)</td>
</tr>
<tr>
<td>0..1</td>
<td>QuarterTemperature</td>
<td>Att</td>
<td>Measure</td>
<td>Temperature of milk in °C</td>
<td>Numeric(2.1)</td>
</tr>
</tbody>
</table>
15.6.2.5. Entity description MilkComponent

This entity gives information about milk components.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel. Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ComponentType</td>
<td>Att Identifier</td>
<td>Type of milk component measured</td>
<td>string(3)</td>
</tr>
<tr>
<td>1</td>
<td>ComponentValue</td>
<td>Att Quantity</td>
<td>The measured value of the component</td>
<td>string(12)</td>
</tr>
</tbody>
</table>

15.6.2.6. Enumeration description: ComponentType

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel. Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ComponentType</td>
<td>Att Code</td>
<td>Type of the component</td>
<td>string(3)</td>
</tr>
<tr>
<td>1</td>
<td>ComponentName</td>
<td>Att Name</td>
<td>Name of the Component</td>
<td>string(20)</td>
</tr>
<tr>
<td>1</td>
<td>ComponentUnit</td>
<td>Att Unit</td>
<td>Unit used for ComponentValue e.g. %</td>
<td>String</td>
</tr>
<tr>
<td>1</td>
<td>ComponentPrec</td>
<td>Att Precision</td>
<td>Numerical precision used for ComponentValue e.g. 3.1</td>
<td>Numeric(2,2)</td>
</tr>
<tr>
<td>0..1</td>
<td>TypeCreationDate</td>
<td>Att Date</td>
<td>Date for the creation of the type</td>
<td></td>
</tr>
<tr>
<td>0..1</td>
<td>TypeRemovalDate</td>
<td>Att Date</td>
<td>Date for the suppression of the type</td>
<td></td>
</tr>
</tbody>
</table>

15.6.2.7. Entity description: Sample

This entity gives the identification of a sample taken during the milking session.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel. Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MilkBoxNumber</td>
<td>Att Identifier</td>
<td>Milking stand or box number</td>
<td>string(4)</td>
</tr>
<tr>
<td>1</td>
<td>RackNumber</td>
<td>Att Identifier</td>
<td>Number of the sample rack</td>
<td>string(6)</td>
</tr>
<tr>
<td>0..1</td>
<td>BottleIdentifier</td>
<td>Att Identifier</td>
<td>Bottle identifiers read from barcode or RFID</td>
<td>String(20)</td>
</tr>
<tr>
<td>0..1</td>
<td>BottleIdentifierType</td>
<td>Att Code</td>
<td>Type of bottle identifier</td>
<td>String(1)</td>
</tr>
<tr>
<td>0..1</td>
<td>ValidSampleFillingIndicator</td>
<td>Att Code</td>
<td>Indicator of valid sample filling compared with expected value. See code set.</td>
<td>String(1)</td>
</tr>
</tbody>
</table>

15.6.2.8. Code set description: Component type

<table>
<thead>
<tr>
<th>ComponentType</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAT</td>
<td>Fat percentage.</td>
</tr>
<tr>
<td>PRO</td>
<td>Protein percentage.</td>
</tr>
<tr>
<td>SCC</td>
<td>Somatic cell count.</td>
</tr>
<tr>
<td>LAC</td>
<td>Lactose.</td>
</tr>
<tr>
<td>BLD</td>
<td>Blood.</td>
</tr>
<tr>
<td>ACT</td>
<td>Acetone</td>
</tr>
<tr>
<td>URA</td>
<td>Urea</td>
</tr>
<tr>
<td>BHB</td>
<td>BHB</td>
</tr>
<tr>
<td>LDH</td>
<td>LDH</td>
</tr>
<tr>
<td>PRO</td>
<td>Progesterone</td>
</tr>
</tbody>
</table>
15.6.2.9. Code set description: MilkingResultType

<table>
<thead>
<tr>
<th>MilkingResultType</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>official milk control supplied by milk recording organization</td>
</tr>
<tr>
<td>2</td>
<td>measure of ICAR approved equipment</td>
</tr>
<tr>
<td>3</td>
<td>measure of not approved milking equipment</td>
</tr>
<tr>
<td>9</td>
<td>Expected data</td>
</tr>
</tbody>
</table>

15.6.2.10. Code set description: ValidMilkingIndicator

<table>
<thead>
<tr>
<th>ValidMilkingIndicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Successful milking ( &gt; 80% of expected milk)</td>
</tr>
<tr>
<td>1</td>
<td>Incomplete (&lt; 20% of expected milk) or interrupt milking</td>
</tr>
<tr>
<td>2</td>
<td>Milking complete but measurement value not complete (between 20 and 80%)</td>
</tr>
</tbody>
</table>

15.6.2.11. Code set description: ValidSampleIndicator

<table>
<thead>
<tr>
<th>ValidSampleIndicator</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>successful filling (&gt; 80% and &lt; 120% of expected value)</td>
</tr>
<tr>
<td>1</td>
<td>incomplete filling (&lt; 80% of expected value)</td>
</tr>
<tr>
<td>2</td>
<td>over filling (&gt; 120% of expected value)</td>
</tr>
</tbody>
</table>

15.7. EXCHANGED DATA OF THE PROCESS: ANIMALFEEDING

15.7.1. Business modelling

15.7.1.1. Business collaboration overall description

See figure 7.

The results of the process are (See figure 7):

- To feed animals individually
- To register a collection of individual animal feedings for a given farm for a given period.

The actors of the process are:

1. FeedingSystem: feeding station system contains a set of feeding stations (feeding animal individually) and a way to push and retrieve data to and from them. FeedingSystem:
   - Feeds the animals.
   - Collects data.
   - Processes collected data in message.
   - Manages transfers.
   - Sends data
2. InformationSystem which receives and processes the messages.
15.7.1.2. Business collaboration in detail

See figure 8.

When an animal activates the feeding station, the ingredients are unloaded from the silos connected directly to the feeding station (see task *Unload Ingredients From Silo*).

The feeding station feeds the animal (see task *FeedingAnimal*).

When an individual feeding is completed and if the feeding system has to transfer data to at least one information system, a message is prepared from the data collected during the feeding (see task *Message elaboration*).

A task (see *Data transfer management*) determines whether there is, at least, one message to be transferred to, at least one, information system, and whether either the transfers are permanent or are performed at specified intervals (for instance, every hour).

*FeedingSystem* sends the messages to *InformationSystem*. In case of error when the transfer has not been completed, a new attempt will be done (see task *DataTransferManagement*).

If the transfer is completed the status of the messages are updated (see task *Message Status Update*).

*InformationSystem* receives messages (see task *Receive message*). When the transfer is completed *InformationSystem* processes messages (see task *Message processing*).

15.7.2. Data model of exchanged messages

15.7.2.1. Overall data model

See overall message model in figure 9.

15.7.2.2. Data model: AnimalFeedingResults

For a given animal there is one or several feeding period.

For a given feeding period the animal receive different ingredients.
Figure 8. Task and messages of the process individual feeding.
15.7.2.3. Entity description: FeedingPeriod

The entity gives the period for which feed consumption is measured.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>StartEating</td>
<td>Att</td>
<td>Date Time</td>
<td>Beginning of feeding period</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>EndEating</td>
<td>Att</td>
<td>Date Time</td>
<td>End of feeding period</td>
<td></td>
</tr>
<tr>
<td>1..n</td>
<td>Feed</td>
<td>Ass</td>
<td>FeedingIngredient</td>
<td>The entity gives the amount of feed per ingredient.</td>
<td></td>
</tr>
</tbody>
</table>

15.7.2.4. Entity description: FeedingIngredient

The entity gives for a given period, a given animal and a given ingredient the quantity of feed.

<table>
<thead>
<tr>
<th>Mult.</th>
<th>Business term</th>
<th>Rel</th>
<th>Type</th>
<th>Description</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Identification</td>
<td>Att</td>
<td>Identifier</td>
<td>Identification of ingredient.</td>
<td>String(10)</td>
</tr>
<tr>
<td>0..1</td>
<td>Name</td>
<td>Att</td>
<td>Name</td>
<td>Name of ingredient as a text</td>
<td>String(20)</td>
</tr>
<tr>
<td>1</td>
<td>Amount²</td>
<td>Att</td>
<td>Quantity</td>
<td>Quantity in Kg</td>
<td>Numeric (3.3)</td>
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<tr>
<td>1</td>
<td>Device</td>
<td>Ass</td>
<td>Measure</td>
<td>The device which was used for animal feeding.</td>
<td></td>
</tr>
</tbody>
</table>

²See ADED 90060
15.8. REFERENCES

- UN / UNCEFACT Modeling Methodology User Guide (CEFACT / TMG/N093)
- UN / UNCEFACT Business Requirements Specifications Document Template (CEFACT/ICG/005)
- ISO 11787: Electronic data interchange between information systems in agriculture - Agricultural data interchange syntax
- ISO 17532: Stationary equipment for agriculture - Data communications network for livestock farming
- ISO 11784: Radio frequency identification of animals - Code structure
- ISO 3166 -1: Country code
# 15.9. UML DATA TYPES

<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
<th>Comment</th>
<th>Content components and supplementary components</th>
<th>Primitive type used for core components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>A particular point in the progression of dates.</td>
<td>Date. Content</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Date. Format</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Date. TimeZoneOffset</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td>Date Time</td>
<td>A particular point in the progression of time.</td>
<td>DateTime. Content</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DateTime. Format</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DateTime. TimeZoneOffset</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td>Duration</td>
<td>A period of time of a particular length without a fixed start or end time. This period of time is expressed in years, months, days, hours, minutes, seconds, and fractions of a second.</td>
<td>Duration. Content</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration. Format</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration. TimeZoneOffset</td>
<td>String</td>
<td>String</td>
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<td>Code</td>
<td>A character string (letters, figures or symbols that, for brevity and/or language independence may be used to represent or replace the definitive value of a text or property). Should not be used if the character string identifies an instance of an Object Class or an object in the real world, in which case the Representation Term identifier should be used.</td>
<td>Code. Content</td>
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<td>String</td>
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<td></td>
<td>Code. Name</td>
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<td>String</td>
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<td>Code. SchemeAgencyIdentifier</td>
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<tr>
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<td></td>
<td>Code. ListName</td>
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<td>Code. ListURI</td>
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<td></td>
<td>CodeListSchemeURI</td>
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<td>String</td>
</tr>
<tr>
<td>Identifier</td>
<td>A character string used uniquely to establish the identity of, and distinguish, one instance of an object within an identification scheme from all other objects within the same scheme.</td>
<td>Identifier. Content</td>
<td>String</td>
<td>String</td>
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<tr>
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<td></td>
<td>Identifier. SchemeIdentifier</td>
<td>String</td>
<td>String</td>
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<tr>
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<td></td>
<td>Identifier. SchemeName</td>
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<td>String</td>
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<tr>
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<td></td>
<td>Identifier. SchemeAgencyIdentifier</td>
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<td>Identifier. SchemeAgencyName</td>
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<td></td>
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<td></td>
<td></td>
<td>Identifier. SchemeURI</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td>Measure</td>
<td>A numeric value determined by measuring an object. Measures are specified with a unit of measure.</td>
<td>Measure. Content</td>
<td>Decimal</td>
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<td></td>
<td>Measure. CodeListAgencyIdentifier</td>
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<td></td>
<td></td>
<td>Measure. CodeListAgencyName</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td>Name</td>
<td>A word or phrase that constitutes the distinctive designation of a person, place, thing, or concept.</td>
<td>Name. Content</td>
<td>String</td>
<td>String</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td>String</td>
<td>String</td>
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<tr>
<td></td>
<td></td>
<td>Na. Name. CodeListLanguageAgencyName</td>
<td>String</td>
<td>String</td>
</tr>
</tbody>
</table>
15.10 ACKNOWLEDGMENTS

This document is the result the ICAR Animal data records working group whose members are: Daniel Abernethy (Australian Dairy Herd Improvement Scheme - Australia), Pavel Bucek (Czech Moravian Breeders - Czech Republic), Martin Burke (ICBF - Ireland), Johannes Frandsen (Danish Cattle Federation - Denmark), Suzanne Harding (Holstein UK - United Kingdom), Bert van't Land (CRV - Netherland), Erik Rehben (IDELE - France, chairman), Andreas Werner (LKV Baden Württemberg - Germany).

Clément Allain (IDELE), Martin Burke (ICBF), Johannes Frandsen (Danish Cattle Federation), Arnold Herbers (CRV), Leo Kool (Lely), Tom Kromwijk (Fullwood Fusion), Bert van't Land (CRV), Louise Marguin (IDELE), Sjors Meijers (Lely), Ronald Need (Fullwood Fusion), Hubert Rothfuss (GEA), Magnus Storbjorde (Delaval) and Conny Svahn (Delaval) should also be thanked for their particular contributions.
APPENDIXES
SECTION 2.2 - ANNEX 1: THE RULES AND STANDARD
OBBLIGATORY IN ALL SITUATIONS

2.2.1. Ewes to be controlled

Whenever there is (quantitative) milk recording for the recorded flock, all the ewes being exclusively milked (of the breeds or genotypes involved in the breeding programme) must be recorded i.e. milk recording is realised only when the ewe is definitively separated from its lamb(s). In the case of method E, these rules may not be respected.

2.2.2. Type and expression of milk recording

- The only obligatory milk recording is that of the quantity of milk (i.e. quantitative milk recording). That is to say, tests on the composition of the milk (or qualitative tests for fat and protein content) are optional.
- Milk may be measured by weight (grams) or volume (millilitres). The conversion factor of weight (grams) into volume (millilitres) is 1.036, which corresponds to the normal sheep milk density.
- The minimum daily milk yield tested is set at 150 g or 150 ml.
- The limit of error (standard deviation or error) is 40 g or 40 ml.
2.2.3. Frequency of milk recording visits

- **Monthly Method**

<table>
<thead>
<tr>
<th>Recording length hours</th>
<th>Average daily recording interval (±10%)</th>
<th>Symbol</th>
<th>Authenticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>30</td>
<td>4</td>
<td>A4/B4/C4/E4</td>
</tr>
</tbody>
</table>

- **Others**

<table>
<thead>
<tr>
<th>Interval Number 36</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>36</td>
<td>5</td>
<td>A5/B5/C5</td>
</tr>
<tr>
<td>Interval Number 42</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>42</td>
<td>6</td>
<td>A6/B6/C6</td>
</tr>
<tr>
<td>Alternate Milkings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>30</td>
<td>T as a second letter</td>
<td>AT/BT/CT/ET</td>
</tr>
<tr>
<td>Corrected Milkings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>30</td>
<td>C as a second letter</td>
<td>AC/BC/CC/EC</td>
</tr>
</tbody>
</table>

Interval depending on the situation of the lamblings in the flock.

**Note 1:**
- AT, BT, CT, ET: Alternating monthly test (recording of only one of the two daily milkings).
- AC, BC, CC, EC: Corrected monthly test for evening/morning differences (recording of only one of the two daily milkings), taking into account the total volume of milk produced by the whole flock over the two milkings concerned (bulk tank weights).

**Note 2:**
No set total number of recording visits per year (described by each official organisation).
We recommend that the approved organisations define, for each breed and category of ewes (age or lactation number), a production of reference per lactation, with a standard lactation length close to the average lactation length of the considered breed (according to its breeding system).
We recommend that the approved organisations define, for each breed and category of ewes (age or lactation number), a production of reference at milking-period only with both a standard suckling length and a standard milking-only length, close to the average suckling length and milking-only length of the considered breed (according to its breeding system).
APPENDIX SECTION 4 - USE OF DNA AND OTHER TECHNIQUES

SECTION 4 - ANNEX 1: QUESTIONNAIRE FOR MICROSATELLITE-BASED PARENTAGE TESTING IN CATTLE

1. ADDRESS DETAILS (fill out)

Country: ...................................................................................................................... ..
Laboratory name: ...........................................................................................................
Contact person: .............................................................................................................
Address: ...................................................................................................................... 
Telephone: .................................................................................................................... 
E-mail: ...........................................................................................................................

2. EDUCATION, TRAINING, AND EXPERIENCE OF SUPERVISOR /OPERATOR

a. Level of education of the head of the laboratory (tick the box and describe)
   Ph.D. in .............................................................................................................................
   Masters of Science in .................................................................................................
   Bachelors of Science in ..............................................................................................
   Other .........................................................................................................................
   None

b. Experience of senior operator (tick)
   More than 5 years ....................................................................................................
   More than 2 years but less than five years............................................................... 
   Less than 2 years .......................................................................................................

To be returned by e-mail to: DNA@icar.org
3. **CERTIFICATION AND EQUIPMENT**

a. Certification (tick the box and send a copy of the certification, and English translation if necessary, to ICAR Secretariat. Please note that an ISO certification is a minimum requirement!):
   - ISO17025 certification
   - ISO9001 certification
   - Other or no certification (No need to continue application in this case)

<table>
<thead>
<tr>
<th>Type of equipment</th>
<th>Date of purchase</th>
<th>Date of last revision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

4. **PARTICIPATION AND PERFORMANCE IN ISAG RING TESTS**

No ring test participation (No need to continue application in this case)
ISAG ring test participation

a. _____ Year of the last ISAG ring test

Performance in the last ISAG ring test. **Please notice:** 1. provide a copy of your ISAG certificate, when available and describe only the results obtained with the compulsory ISAG recommended microsatellites (12 microsatellites starting in ISAG 2009-10 ring test, 9 in previous ring tests); 2. to clarify the meaning of “number of genotypes,” a ring test on 20 individuals analysed with 12 microsatellites produces 240 genotypes, for example.

_____ Number of samples
_____ Number of microsatellite markers
_____ Number of correct genotypes
_____ Number of missing genotypes
    Number of incorrect genotypes
5. **MARKER SET AND NOMENCLATURE**

Use of ISAG and other marker sets (please tick box and eventually describe)

- ISAG microsatellite marker set
- Additional microsatellite markers
- Other marker panel (e.g., SNP, please specify)

Nomenclature (please tick box and eventually describe)

- ISAG
- Other (please specify)

Microsatellite markers typed on all animals

Number of animals typed with these markers
in 2008: ..............................
in 2009: ..............................
in 2010: ..............................
in 2011: ..............................
Markers typed when the set of markers previously listed does not resolve parentage:

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<th>Marker</th>
<th>PE</th>
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Number of animals typed with these markers

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<th>Year</th>
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<td></td>
</tr>
<tr>
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Power of exclusion (1 parent) for each marker used:

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<th>PE</th>
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Power of exclusion (2 parent) for each marker used:

Number of animals and breed used for the calculation of PE (2 parent)

Method (formula and reference) used to calculate PE (1 parent)

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<td>TOTAL</td>
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ISAG recommended microsatellites

<table>
<thead>
<tr>
<th>Locus</th>
<th>Primer Sequence (5’ to 3’)</th>
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| **BM1824** | Forward: GAG CAA GGT GTT TTT CCA ATC  
Reverse: CAT TCT CCA ACT GCT TCC TTG |
| **BM2113** | Forward: GCT GCC TTC TAC CAA ATA CCC  
Reverse: CTT CCT GAG AGA AGC AAC ACC |
| **INRA023** | Forward: GAG TAG AGC TAC AAG ATA AAC TTC  
Reverse: TAA CTA CAG GGT GTT AGA TGA ACT C |
| **SPS115** | Forward: AAA GTG ACA CAA CAG CTT CTC CAG  
Reverse: AAC GAG TGT CCT AGT TTG GCT GTG |
| **TGLA122** | Forward: CCC TCC TCC AGG TAA ATC AGC  
Reverse (1): AAT CAC ATG GCA AAT AAG TAC ATA  
Reverse (2): * AAT CAC ATG GCA AAT AAG TAC ATA |
| **TGLA126** | Forward: CTA ATT TAG AAT GAG AGA GGC TTC T  
Reverse: TTG GTC TCT ATT CTC TGA ATA TTC C |
| **TGLA227** | Forward: CGA ATT CCA AAT CTG TTA ATT TGC T  
Reverse: ACA GAG AGA AAC TCA ATG AAA GCA |
| **ETH10** | Forward: GTT CAG GAC TGG CCC TGC TAA CA  
Reverse: CCT CCA GCC CAC TTT CTC TTCC TC |
| **ETH225** | Forward: GAT CAC CTG GCC ACT ATT TCC T  
Reverse: ACA TGA CAG CCA GCT GCT ACT |
| **BM1818** | Forward: AGC TGG GAA TAT AAC CAA AGG  
Reverse: AGT GCT TTC AAG GTC CAT GC |
| **ETH3** | Forward: GAA CCT GCC TCT CCT GCA TTG G  
Reverse: ACT CTG CCT GTG GCC AAG TAG G |
| **TGLA53** | Forward: GCT TTC AGA AAT AGT TTG CAT TCA  
Reverse: ATC TTC ACA TGA TAT TAC AGC AGA |
SECTION 1. GENERAL INFORMATION.

1. ADDRESS DETAILS (fill out)

Country: ........................................................................................................................
Laboratory name: ...........................................................................................................
Contact person: ............................................................................................................
Address: .......................................................................................................................
Telephone: ....................................................................................................................
E-mail: ...........................................................................................................................

2. EDUCATION, TRAINING, AND EXPERIENCE OF SUPERVISOR / OPERATORS

   a. Level of education of the head of the laboratory (tick the box and describe)
      Ph.D. in ......................................................................................................................
      Masters of Science in ............................................................................................
      Bachelors of Science in .........................................................................................
      Other .....................................................................................................................
      None

   b. Experience of senior operator (tick)
      More than 5 years
      More than 2 years but less than 5 years
      Less than 2 years

3. CERTIFICATION, LABORATORY PROCEDURES, AND EQUIPMENT

   c. Certification (tick the box, describe, and send a copy of the certification, and English translation as necessary, to the ICAR Secretariat; please note that no certification is required by ICAR at the moment).

      International certification
      ..............................................................................................................................
      National certification
      ..............................................................................................................................
      No certification (certification will be a minimum requirement in the future)

To be returned by e-mail to: DNA@icar.org
d. If you have no certification, describe briefly:

Procedure for handling of samples from arrival to disposal
................................................................................................................
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Procedure for storing and retrieving information
................................................................................................................
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Procedure for control of cross-contamination
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Procedure for error and repeatability checking
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e. Equipment (describe)

<table>
<thead>
<tr>
<th>Type of equipment</th>
<th>Date of purchase</th>
<th>Date of last revision</th>
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</table>


f. Genotyping technique (describe)
................................................................................................................
................................................................................................................
................................................................................................................
................................................................................................................
2. PARTICIPATION AND PERFORMANCE IN RING TESTS

a. Participation and performance in international ring (comparison) tests (tick)
   > 2 international ring tests
   < 2 international ring tests

Most recent international ring test (tick and describe)
   ISAG
   Other (describe number of markers, samples, participating countries)
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................
   _____ Year of the most recent international ring test

Performance in the most recent international ring test (Please notice: 1. If you participated in ISAG ring tests, provide a copy of your ISAG certificate, when available, and describe only the results obtained with the ISAG recommended SNPs; 2. to clarify the meaning of “number of genotypes,” a ring test on 20 individuals analysed with 96 SNPs produces 1,920 genotypes)
   _____ Number of samples
   _____ Number of SNP markers
   _____ Number of correct genotypes
   _____ Number of missing genotypes
   _____ Number of incorrect genotypes

Previous international ring test (tick and describe)
   ISAG
   Other (describe number of markers, samples, participating countries)
   ........................................................................................................................................
   ........................................................................................................................................
   ........................................................................................................................................
   _____ Year of previous international ring test

Performance in the previous international ring test
   _____ Number of samples
   _____ Number of SNP markers
   _____ Number of correct genotypes
   _____ Number of missing genotypes
   _____ Number of incorrect genotypes

National ring tests
   > 2 national ring tests
   < 2 national ring tests
Appendix Section 4 - Use of DNA and other techniques

Most recent national ring test description

________________________ Country of the ring test
_______ Year of most recent national ring test
_______ Number of participants

Performance in most recent national ring test

_______ Number of samples
_______ Number of SNP markers
_______ Number of correct genotypes
_______ Number of missing genotypes
_______ Number of incorrect genotypes

Previous national ring test description

________________________ Country of the previous ring test
_______ Year of previous ring test
_______ Number of participants

Previous Performance in the previous national ring test

_______ Number of samples
_______ Number of SNP markers
_______ Number of correct genotypes
_______ Number of missing genotypes
_______ Number of incorrect genotypes

No ring test participation

a. MARKER SET AND NOMENCLATURE

b. Use of ISAG or other marker sets (please tick box and provide list of SNPs)
   ISAG SNP marker set
   Additional SNP markers (please specify)
   ..............................................................................................................................
   ..............................................................................................................................
   ..............................................................................................................................

   c. Nomenclature (please tick box and eventually describe)
   ISAG
   Other (please specify) .................................................................
   ..............................................................................................................................
   ..............................................................................................................................
   ..............................................................................................................................

Number of animals typed with these markers
in 2007: ............................
in 2008: ............................
in 2009: ............................
in 2010: ............................
in 2011: .............................
e. Power of exclusion (PE; 1 parent) for the SNP markers used (please send table in a separate file):

Number of animals and breed used for the calculation of PE (1 parent)
...........................................................................................................................

Method (formula and reference) used to calculate PE (1 parent)
...........................................................................................................................

__________ Combined power of exclusion

f. Power of exclusion (2 parents) for the SNP markers used (please send table in a separate file):

Number of animals and breed used for the calculation of PE (2 parents)
...........................................................................................................................

Method (formula and reference) used to calculate PE (1 parent)
...........................................................................................................................

__________ Combined power of exclusion
<table>
<thead>
<tr>
<th>SNP Name (iSelect)</th>
<th>SNP Name (BovineSNP50)</th>
<th>Sequence</th>
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</thead>
<tbody>
<tr>
<td>ARS-USMARC-Parent-AY761135-rs29003723</td>
<td>ARS-USMARC-Parent-AY761135-rs29003723</td>
<td>TTC TTTAT AGGCTT CCTC TGAAGA AGGAAACA GATT ATTCTTTCTCT TATTCATG AGAAGGTAAGA AGTTGCTTGG GTCCCCGTGAACCCCTCTGACTGCAATCAGTCTCAAACTTTAATTGCAAG</td>
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<tr>
<td>ARS-USMARC-Parent-AV761514-no-rs</td>
<td>ARS-USMARC-Parent-AV761514-no-rs</td>
<td>TAAGTACATAAGTACATATCTACTGCTTTGATCTGACTAGTTCCCCAGTCTCAGGTCT[A/G]TTTGCTGTTAATCACCAGTGAGAGAAGGTCCTACCCTATCTTAAGTGGTTCTCATATCCTC</td>
</tr>
<tr>
<td>ARS-USMARC-Parent-AV842472-rs29001941</td>
<td>ARS-USMARC-Parent-AV842472-rs29001941</td>
<td>TCTATTAATTACCTACGCAAGAAGGCAGAACTCTTCTGTCCACAAGGTCTGGCTCCATCCTGGTG[A/G]GGTGGGCAGAGAACCATGAGTTCTTGAGTAGCTCCAAGACCTATGGCATCAAGTGGCATG</td>
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<tr>
<td>ARS-USMARC-Parent-AV842473-rs29001956</td>
<td>ARS-USMARC-Parent-AV842473-rs29001956</td>
<td>AAACAGATAGTCTTTGCTCTTCAATTTAGGTCAAGGTACAATTGGACCATGAYTGAGAA[C/G]TTTAGAGGAGGGAGAGACAATATCCATGTGCAGTGGTGAAGCTGCAGCAGGTGAAATGCA</td>
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<td>ARS-USMARC-Parent-AV842474-rs29003226</td>
<td>ARS-USMARC-Parent-AV842474-rs29003226</td>
<td>AAACAGATAGTCTTTGCTCTTCAATTTAGGTCAAGGTACCATATGACATGGGAGAGAGAGAGAGAGACTATCCATCTGATG</td>
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<td>ARS-USMARC-Parent-AV842475-rs29002127</td>
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**Btau 4.0 from Baylor Build**

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<th>SNP Name (iSelect)</th>
<th>SNP Name (BovineSNP50)</th>
<th>Sequence</th>
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<tbody>
<tr>
<td>ARS-USMARC-Parent-AY761135-rs29003723</td>
<td>ARS-USMARC-Parent-AY761135-rs29003723</td>
<td>TTC TTTAT AGGCTT CCTC TGAAGA AGGAAACA GATT ATTCTTTCTCT TATTCATG AGAAGGTAAGA AGTTGCTTGG GTCCCCGTGAACCCCTCTGACTGCAATCAGTCTCAAACTTTAATTGCAAG</td>
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<td>ARS-USMARC-Parent-AV761514-no-rs</td>
<td>ARS-USMARC-Parent-AV761514-no-rs</td>
<td>TAAGTACATAAGTACATATCTACTGCTTTGATCTGACTAGTTCCCCAGTCTCAGGTCT[A/G]TTTGCTGTTAATCACCAGTGAGAGAAGGTCCTACCCTATCTTAAGTGGTTCTCATATCCTC</td>
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<td>ARS-USMARC-Parent-AV842472-rs29001941</td>
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<td>ARS-USMARC-Parent-AV842475-rs29002127</td>
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**Genome Build Version** | **Chr** | **Coordinate** | **Genome Build Version** | **Chr** | **Coordinate**
--- | --- | --- | --- | --- | ---
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<th>Genome Build Version</th>
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<td>SNP Name (BovineSNP50)</td>
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<td></td>
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<td>Sequence</td>
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<td>Genome Build Version</td>
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<td>------------------------</td>
<td>----------</td>
<td>---------------------------</td>
<td>---------------------</td>
</tr>
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<td>4</td>
<td>19</td>
</tr>
</tbody>
</table>
ANNEX 6.1: INCIDENCE OF THE CHOSEN OPTION FOR THE EXCLUSION OF SHORT RETURNS

Let be:

“N” the total number of female inseminated for the first time in a given period
“n1” to “n4” the number of returns within different intervals after the date of insemination
“n5” the number of non-returned females at Day 60

Such as \( N = n_1 + n_2 + n_3 + n_4 + n_5 \)

<table>
<thead>
<tr>
<th>n1</th>
<th>n2</th>
<th>n3</th>
<th>n4</th>
<th>n5</th>
<th>Number of females</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>3</td>
<td>17</td>
<td>18</td>
<td>24 25</td>
</tr>
<tr>
<td>24</td>
<td>25</td>
<td>60</td>
<td>61</td>
<td></td>
<td>Day of return after AI</td>
</tr>
</tbody>
</table>

If all returns are considered, 60 day NRR = \( \frac{n_5}{N} \)

If short returns are excluded, the table below illustrates the two optional calculations.

<table>
<thead>
<tr>
<th>Short returns females are considered as</th>
<th>Non-returned females (pregnant)</th>
<th>Non-inseminated females</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-60 day NRR =</td>
<td>( \frac{n_1 + n_5}{N} )</td>
<td>( \frac{n_5}{N - n_1} )</td>
</tr>
<tr>
<td>18-24 day NRR =</td>
<td>( \frac{n_1 + n_2 + n_4 + n_5}{N} )</td>
<td>( \frac{n_4 + n_5}{N - (n_1 + n_2)} )</td>
</tr>
</tbody>
</table>
ANNEX 6.2: CONSIDERATION TO CATTLE REPRODUCTIVE PHYSIOLOGY

Beginning of the interval:
- zero will consider the total of the returns.
- 3 days will eliminate short returns due to errors in oestrus detection.
- 18 days will eliminate the returns which are considered to be related to female failures rather than bull or technician failures.

End of the interval:
- 24 days will give early report although not considering late embryonic mortality.
- 90 days will give a more precise reflection of bull fertility but is a late indicator to identify unforeseen problems.
- 56 days appears as a compromise commonly chosen by AI organisations.
ANNEX 6.3: EMBRYOS STORAGE & MOVEMENTS

After being collected frozen embryos may be stored in storages centres. They may be moved from one storage centre to other centres before being transferred.

To follow embryos movements following items have to be provided:

- Embryos have to move among approved storages
  - Code of approval and address

For any in and out movement, records may be kept

- Unique embryo identification reference cross-referenced with data listed on paragraph 6.2.4.3.
- Date of arrival and previous location (collect on farm or code of the approved storage centre).
- Date of exit and destination.

Documentation accompanying embryos according to national regulation has follow the movements (data files may substitute written documents). Following items are recommended:

- Documents on embryos identification.
- IETS forms if relevant or any technical forms with data having the same purpose.
- Pedigrees.
- ISAG marker set (or blood types).
- Health certificates.
ANNEX 6.4: TESTS FOR VALIDATION OF EMBRYOS DATA

After recording data on embryo produced (or imported) or data on transferring, these data have to undergo series of test prior to be used in the genetic system. Those tests may be carried out at various levels according to the organisation and the equipment. From a general point of view, embryos related data undergo the same process as the other reproduction data such as AI. Recommendation doesn't address the way of maintaining and up dating data bases of relevant organisations.

Annex 4.1 Completeness and Integrity of data

Each item recorded must be checked against the data model to prove the intrinsic validity of data. All necessary data have to be available prior processing.

Annex 4.2 Test of coherence

Annex 4.2.1 Items on embryo produced in vivo or in vitro, or imported have to be recorded in the database prior to transferring data

Those items have to be checked against existing files to prove their coherence with existing information:

- The code of the approved team is known in the base.
- The code of the operator recorded is declared by the relevant team.
- The herd is registered.
- The donor is registered (or the genetic mother).
- The AI bull(s) are registered.

Moreover regarding the donor:
- The identification corresponds to an animal registered as a female
- If two AI are carried out on the same female on the same day an alarm message has to be edited

Annex 4.2.2 Items on embryo transfer have to be checked against existing files

Items on embryo transfer have to be checked against existing files to prove their coherence with existing information:

- The code of the approved team is known in the base
- The code of the operator recorded is declared by the relevant team
- The herd is registered
- The recipient is registered
Moreover regarding the recipient:
- The identification corresponds to an animal registered as a female.
- The female is old enough to be bred.
- The female is alive.

**Annex 4.3 Likelihood tests**

In order to secure the information likelihood tests have to be carried out:

**Annex 4.3.1 Embryos production**
- The donor was registered in the herd the day where embryos were recovered or Oocytes were collected.
- The bull was recognised as an AI bull when the semen was used.
- AI was carried out prior to embryos were recovered in vivo (exception IVF).
- The herd identified is an active one (cattle are recorded within this particular herd).

**Annex 4.3.2 Embryo transfer**
- The recipient was registered in the herd the day where embryos were transferred.
- The herd identified is an active one (cattle are recorded within this particular herd).
- Identification of transferred embryo(s) is in the data base.
ANNEX 6.5: SUMMARY OF THE SURVEY ON RECORDING AND VALIDATION OF DATA FOR EMBRYO PRODUCTION AND TRANSFER AMONG SOME ICAR MEMBER COUNTRIES

The ICAR board has set up the ICAR Working Group on AI & other relevant technologies (WG AI & ORT) in 1998 to satisfy the demand of its members. Duty of the group according to its term of reference, is to set up recommendations in order to improve world wide records used for genetic evaluations and the efficiency of the breeding schemes.

Concerning embryos and associated technologies the need it to cover systematically key aspects, that have not been tackled before. Thus it’s important to take into consideration data recording and process to recognise them as valid for genetic purposes, because:

- Embryo technology aims at producing animals from top cows of the populations.
- It is used for the management of nuclei.
- It is an outstanding tool to exchange genetic material.

Embryo technologies mainly means embryo recovering from donors (in vivo or in vitro), embryo freezing and their storage, embryo transfer. New associated technologies are becoming available such as embryo genotyping (to assess the sex, to reveal gene defects or to implement MAS on embryos) and cloning. Harmonisation of codes related to special features of embryos (sex, nuclear transfer for cloning etc.) is underway.

It is necessary to take into account constraints due to national or international legislation and the existing international systems of recording and exchange data on embryos.

- The European Union has published two decisions to lay "down the specimen pedigree certificates for the semen and embryos of pure-bred breeding animals of the bovine species... 88/ 124 /EEC" and to lay down the pedigree and zootechnical certificates by importing breeding animals, semen, ova, embryos, into the EU Decision 96 /510 /CE.
  
  Remark: this EU decision will be up-dated in 2004 (few changes compare to the previous one)

- The IETS has produced a set of forms, continuously updated since 1985, dealing with various technical matters related to embryos recovering, processing, freezing, quality control of transfer, exports etc in order to help the work of practitioner and to standardise the coding of the various technical items.

It seems that the strict implementation of regulation and guidelines in using official forms vary among countries according to the national organisations and to the requests of the clients. Nevertheless data requested for various needs are supplied. This point has to be clarified.

The survey presented below is the summary of the work done between 2003 and 2004 by the group. Members of the group are experts of the AI industry of seven countries important in the world AI and/or technically advanced in processing and utilising of AI data.
To achieve its goal the group will use the following method:

- A questionnaire was build up by the chairman and discussed by the members during a meeting to clarify the questions according to the needs. Validation occurred thanks to e-mail exchanges.
- Each member answers any question with or without the help of specialists of this issue in his home country. The individual answers will be gathered and send back to the members as soon as possible.
- It will be then put on discussion during the following meeting: explanations and clarifications will probably be necessary.
- After validation of answers a summary on the chapter will be done by the chairman and propose to the group for validation.

This material, produced by the answers from 7 countries, has been the source for an ICAR recommendation.

Following topics have to be covered:

<table>
<thead>
<tr>
<th>Topics</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General principles</td>
<td>Needs for recording</td>
</tr>
<tr>
<td>2. Recording of data</td>
<td>General organisation and information recorded</td>
</tr>
<tr>
<td></td>
<td>Various requirement among countries</td>
</tr>
<tr>
<td>3. Processing and validation</td>
<td>Data flow</td>
</tr>
<tr>
<td></td>
<td>Tests</td>
</tr>
<tr>
<td></td>
<td>Quality controls</td>
</tr>
<tr>
<td>4. Integration and use of data in the genetic data systems</td>
<td>Parentage assessing</td>
</tr>
<tr>
<td></td>
<td>Pedigree printing</td>
</tr>
</tbody>
</table>
Annex 6.5.1 General principles

From embryo production to birth of calves from those embryos following steps have to be achieved:

1. Embryos are recovered from a donor cow, inseminated by a sire or produced from an in-vitro fertilization
2. Embryos may be produced within countries or imported from an other country
3. Before they will be transferred frozen embryos may be stored and movements have to be traced
4. Embryos are transferred into recipient cows
5. Parents of born calves must be the "genetic parents": donor cow + sire
6. Embryo teams are operating in various steps of the process, several teams may be involved in the chain process
7. Embryo teams may be officially approved

Following issues are relevant to deal with data related to embryo technology:

- Teams have to render available all data relevant to the proper handling of the embryo to achieve a successful pregnancy to the practitioner in order to have a reasonable chance to get a calf after embryo transfer.
- All zootechnical data necessary to establish parentage of calves born out of the recovered embryos have to be available. Users of the technology must get them through ET teams or other bodies.
- The transfers have to be processed as the other fecundating events to establish the parentage of calves.
- A record of service or insemination, recovery of embryo freezing and/or transfer of embryo with all such events documented and recorded using standardized or approved identification and data recording procedures in order to assure correct parentage of resulting offspring.
- Embryos should be traced from their production in the farm or produced in lab to the cow uterus.

It can be added that embryos are complete genetic entities that can result in breeding animals. Many are very costly and identification must be attached to their movement accompanied by documentation because the embryo is a complete genetic entity.

Documents on health status of the donors have to be available for importing or exporting the animals. Those important data are not considered by this questionnaire because the issue is carried out by national authorities.

Annex 6.5.2 Recording of data

In most countries, forms to recover from donor cows (5 countries out of 7 that answered) or to transfer embryos into recipients (7 countries/7 countries) are harmonised, so as these used for embryo identification (5/7).

When embryos are traded pedigrees, embryos characteristics (freezing, quality) molecular information or blood typing, are always available and follow them. The same occurs when embryos are imported. (7/7)
Teams are officially approved, in general by the ministry of Agriculture. An official list is available, published by national or international bodies. Teams have to apply for the renewal of their approval and rules have been set up in this respect, using quality control procedures.

Data recorded at each step of the process are:

1. At recovering
   - Recovering reference number (5/7).
   - Date of recovering (7/7).
   - Number of donor's herd (6/7).
   - Possible sires (7/7).
   - Natural service & AI are both possible (4/5).
   - Ovum Pick Up / IVF data may be recorded (4/4).

2. Technical characteristics (IETS guidelines)
   - Age of embryos at flushing (5/7).
   - Integrity of zona pellucida (7/7).
   - Trypsine washing (7/7).
   - Development stage & quality (7/7).
   - Sex (5/7).

3. Reference numbers
   - Recovering: team (7/7)/ intra team(5) / year number(3)
   - Embryos Intra team number (2/7),year of recovering (7/7),herd(6/7),operator(7/7)

4. Transfer
   - Embryo identification (7/7).
   - Recipient (7/7).
   - Date (7/7).
   - Herd (6/7).
   - Team (7/7).

In most situations, ET teams use software, on the farm, to record and transfer ET data. That software are not harmonised within countries.

There are few efforts to harmonise straws identification for embryos.

DNA is systematically collected on donors (and sires) by persons of the approved team or vets.

Embryos and teams have access to files were data are recorded.

Embryos stocks are usually not managed by ET teams.

Very few organisations have implemented ISO procedures for embryos collection and transfer.
Annex 6.5.3 Processing and validation data

Processing and validation data used for assessment of parentage of calves born out of embryo transfers follow rules that vary according to countries.

1. In most countries, data recorded on embryos (recovering or import), are registered in the data base used for parentage assessment prior to embryo transfers. In the other countries data are in the herd book data base only at transfer. In the first situation recovering reference and embryos reference are transmitted to the data base. In the second situation there is no harmonisation within country and data transmission varies according to the individual organisations.

   Same references are transmitted when embryos are imported. Pedigrees used are those issued by the Herd-Book organisations. In any situation data and reference are available at transfer.

2. To assess parentage, transfer and embryo data have to be matched in the data base. In most situations transfer data are processed as an AI, semen references being substituted by embryos references. Transfer and embryos reference are introduced before the calf is born in the data base where parentage are established. Eventually parentages are checked with DNA markers of the calf and its parents.

   In some countries data are recorded and processed at calf birth. Then checks are carried out compulsory using DNA references to verify parentage.

3. Data recorded on embryos and transfer checked before parentage assessment for integrity and consistency are those describe in part B. Tests for consistence, coherence and likelihood are parallel to those carried out in AI processing: teams, donors, sires recipients are registered in the data base, donor and recipients were in the recorded herd when operations were carried out, recorded dates have to be in line with the biological events.

4. Criteria of validation used at birth are those used in AI processing. Age of embryo in rarely taken into consideration. If two sires are possible, decision is made by DNA- checks.

Annex 6.5.4 Integration and use of data in the genetic data systems

Herd book organisations (or the Ministry of Agriculture) are setting up rules to describe the process of parentage assessment. Those rules don't vary among Herd Books.

Embryo and transfer data are not used in the genetic system for other purposes other than pedigree classical usage in the genetic systems.

In very few countries embryos are genotyped for desirable traits (QTL), and then genotype stays with the owner of the embryos. If they are genotyped for single traits-colour-gene defects embryos owner under the behalf of ET organisation (or directly) may deliver this information etc to the Herd Book.
Annex 6.6. Central key for health data recording

An example of a very comprehensive health key that is structured hierarchically and therefore compatible with other keys for health data recording used in the different countries is found under 12.1. On Appendix Section 7 are links to information about different health keys used in different countries. This includes reduced keys based on observation of farmers as well as information on health keys based on veterinarian diagnoses used in the Nordic countries and Austria.
## Central key for health data recording

**Central key for health data recording (version 1.1, January 25, 2012)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Technical term</th>
<th>Synonyms; explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Organ diseases</td>
<td></td>
</tr>
<tr>
<td>1.01</td>
<td>Diseases of skin, subcutis and coat</td>
<td></td>
</tr>
<tr>
<td>1.01.01</td>
<td>Hereditary diseases of skin, subcutis and coat</td>
<td></td>
</tr>
<tr>
<td>1.01.01.01</td>
<td>Hereditary parakeratosis</td>
<td>Inherited disturbance of keratin production</td>
</tr>
<tr>
<td>1.01.02</td>
<td>Malformations of skin, subcutis and coat</td>
<td></td>
</tr>
<tr>
<td>1.01.02.01</td>
<td>Atrichia congenitae (congenital atrichosis)</td>
<td>Congenital hairlessness</td>
</tr>
<tr>
<td>1.01.03</td>
<td>Dermal tumors</td>
<td></td>
</tr>
<tr>
<td>1.01.04</td>
<td>Injuries of skin, subcutis and coat</td>
<td></td>
</tr>
<tr>
<td>1.01.05</td>
<td>Coat disorders</td>
<td></td>
</tr>
<tr>
<td>1.01.05.01</td>
<td>Alopecia (hair loss)</td>
<td></td>
</tr>
<tr>
<td>1.01.06</td>
<td>Acne</td>
<td>Purulent inflammation of hair follicles and sebaceous glands</td>
</tr>
<tr>
<td>1.01.07</td>
<td>Furunculosis</td>
<td>Disseminated deep purulent inflammation of hair follicles and sebaceous glands</td>
</tr>
<tr>
<td>Code</td>
<td>Technical term</td>
<td>Synonyms; explanations</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>1.01.07.01.</td>
<td>Furunculosis caudae</td>
<td>Disseminated deep purulent inflammation of hair follicles and sebaceous glands at the root of the tail</td>
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<tr>
<td>1.01.08.</td>
<td>Seborrhea / Pityriasis</td>
<td>Abnormally increased sebum production</td>
</tr>
<tr>
<td>1.01.09.</td>
<td>Eczema</td>
<td>Superficial skin rash</td>
</tr>
<tr>
<td>1.01.10.</td>
<td>Exanthema</td>
<td>Symptomatic superficial skin rash accompanying eruptive disease or fever</td>
</tr>
<tr>
<td>1.01.10.01.</td>
<td>Urticaria</td>
<td>Nettle rash, hives</td>
</tr>
<tr>
<td>1.01.11.</td>
<td>Dermatitis</td>
<td>Deep inflammation of the skin</td>
</tr>
<tr>
<td>1.01.11.01.</td>
<td>Photodermatitis</td>
<td>Photosensitive dermatitis, primary photosensitization; increased sensitivity to light with sunlight-induced inflammation of the skin</td>
</tr>
<tr>
<td>1.01.12.</td>
<td>Hyperkeratosis</td>
<td>Abnormally increased keratinization (keratin production) with dry keratin products</td>
</tr>
<tr>
<td>1.01.13.</td>
<td>Parakeratosis</td>
<td>Disturbance of keratinization (keratin production) with greasy keratin products</td>
</tr>
<tr>
<td>1.01.14.</td>
<td>Subcutaneous emphysema</td>
<td>Subcutaneous gas accumulation</td>
</tr>
<tr>
<td>1.01.15.</td>
<td>Subcutaneous edema</td>
<td>Subcutaneous accumulation of serous fluid</td>
</tr>
<tr>
<td>1.01.16.</td>
<td>Subcutaneous hematomata</td>
<td>Subcutaneous accumulation of blood</td>
</tr>
<tr>
<td>1.01.17.</td>
<td>Phlegmona</td>
<td>Inflammation of subcutaneous connective tissue</td>
</tr>
<tr>
<td>1.01.17.01.</td>
<td>Pelvic phlegmona</td>
<td>Inflammation of pelvic connective tissue</td>
</tr>
<tr>
<td>1.01.18.</td>
<td>Subcutaneous abscess</td>
<td>Subcutaneous encapsulated pus accumulation</td>
</tr>
<tr>
<td>1.01.99.</td>
<td>Other disorders of skin, subcutis and coat</td>
<td></td>
</tr>
<tr>
<td>1.02.</td>
<td>Diseases of the trunk</td>
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</tr>
<tr>
<td>1.02.01.</td>
<td>Hereditary diseases of the trunk</td>
<td></td>
</tr>
<tr>
<td>1.02.02.</td>
<td>Malformations of the trunk</td>
<td></td>
</tr>
<tr>
<td>1.02.02.01.</td>
<td>Hernia congenita (inherited herniation)</td>
<td></td>
</tr>
<tr>
<td>1.02.02.01.01.</td>
<td>Hernia umbilicalis congenita (inherited umbilical hernia)</td>
<td>Inherited navel rupture</td>
</tr>
<tr>
<td>1.02.02.01.02.</td>
<td>Hernia inguinalis congenita (inherited inguinal hernia)</td>
<td></td>
</tr>
<tr>
<td>1.02.02.01.03.</td>
<td>Hernia ventralis congenita (inherited ventral hernia)</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Technical term</td>
<td>Synonyms; explanations</td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------------------------------------------</td>
<td>----------------------------------------------</td>
</tr>
<tr>
<td>1.02.02.01.04.</td>
<td>Hernia diaphragmatica congenita (inherited diaphragmatic hernia)</td>
<td>Inherited diaphragm defects</td>
</tr>
<tr>
<td>1.02.03.</td>
<td>Tumors of the trunk</td>
<td></td>
</tr>
<tr>
<td>1.02.04.</td>
<td>Injuries of the trunk</td>
<td></td>
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<td>Ductus arteriosus Botalli persistens (patent ductus arteriosus)</td>
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<td>Thrombophlebitis (inflammation of veins with secondary thrombus formation)</td>
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<td>Thrombophlebitis arrosiva venae cavae caudalis (arrosive thrombophlebitis of caudal vena cava)</td>
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<td>Haemoglobinuria due to hyperhydratation (water poisoning)</td>
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<td>Anemia due to deficiency of components required for erythropoiesis, i.e. Formation of red blood cells</td>
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<td>Sialoadenitis (inflammation of the salivary glands)</td>
<td>Parotitis (inflammation of the parotid salivary gland) / sialoadenitis mandibularis (inflammation of the mandibular salivary gland) / sialoadenitis sublingualis (inflammation of the sublingual salivary gland)</td>
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<td>1.07.10.05</td>
<td>Alcalosis ingestorum ruminis (ruminal alkalosis)</td>
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<td>1.07.10.05.01</td>
<td>Putrefactio ingestorum ruminis (ruminal putrefaction)</td>
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<td>1.07.10.06</td>
<td>Acidosis ingestorum ruminis (ruminal acidosis)</td>
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<td>Lactacidosis ingestorum ruminis acuta (acute ruminal acidosis)</td>
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<td>Acidosis ingestorum ruminis subacuta (subacute ruminal acidosis)</td>
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<td>Free-gas bloat; secondary bloat; fast overdistention of rumen and reticulum due to abnormal accumulation of free fermentation gas above the ingesta</td>
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<td>1.07.10.07.03</td>
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<td>Excessive keratinization (keratin production) of the inner layer of the rumen</td>
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<td>Dislocatio abomasi sinistra, Dilatatio et dislocation abomasi sinistra (left-side abomasal displacement)</td>
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<td>Enteritis catarrhalis (catarrhal enteritis)</td>
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<td>Enteritis haemorrhagica (hemorrhagic enteritis)</td>
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<td>Diarrhea syndrome of calves (calf diarrhoea)</td>
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<td>1.07.13.02.01</td>
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<td>Necrosis of adipose tissue in the abdominal cavity</td>
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2. Reproduction disorders in females

2.01. Diseases of the female reproductive system

2.01.01. Inherited diseases of the female reproductive system

2.01.02. Malformations of the female reproductive system

2.01.02.01. Freemartinism

2.01.02.02. Genital malformations in females

2.01.02.03. Infantilism in females

2.01.02.04. Tissue junctions in the vagina
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### Appendix Section 7 - Functional traits

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<tr>
<td>2.05.02.01.01.</td>
<td>Acydia</td>
<td>Absence of heat with inactive ovaries</td>
</tr>
<tr>
<td>2.05.02.01.02.</td>
<td>Anaphrodisia / Anoestria</td>
<td>Silent heat; absence of heat with active ovaries</td>
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<tr>
<td>2.05.02.01.03.</td>
<td>Irregular interoestrus intervals</td>
<td></td>
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<tr>
<td>2.05.02.01.03.01.</td>
<td>Shortened interoestrus intervals</td>
<td>Interoestrus intervals &lt; 19 days</td>
</tr>
<tr>
<td>2.05.02.01.03.02.</td>
<td>Prolonged interoestrus intervals</td>
<td>Interoestrus intervals &gt; 23 days</td>
</tr>
<tr>
<td>2.05.02.01.03.03.</td>
<td>Irregular interoestrus intervals</td>
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<tr>
<td>2.05.02.01.03.04.</td>
<td>Abnormal ovulations</td>
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<td>2.05.02.01.04.</td>
<td>Delay of ovulation</td>
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<td>2.05.02.01.04.01.</td>
<td>Anovulatory oestrus cycle</td>
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<td>2.05.02.01.05.</td>
<td>Other disturbances of the oestrus cycle</td>
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<tr>
<td>2.05.02.06.</td>
<td>Nymphomania</td>
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<tr>
<td>2.05.02.03</td>
<td>Virilism</td>
<td>Masculinization of cows</td>
</tr>
<tr>
<td>2.05.02.04</td>
<td>Ovarial cysts</td>
<td>Cystic ovary disease</td>
</tr>
<tr>
<td>2.05.02.04.01</td>
<td>Follicular cystic ovary disease</td>
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<td>2.05.02.04.02</td>
<td>Luteal cystic ovary disease</td>
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<td>2.05.02.04.03</td>
<td>Cystic ovarian degeneration</td>
<td></td>
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<tr>
<td>2.05.02.05.01</td>
<td>Corpus luteum persistens (persisting corpus luteum)</td>
<td>Delayed regression of corpus luteum</td>
</tr>
<tr>
<td>2.05.02.06</td>
<td>Atrophy of the ovaries</td>
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<td>2.05.02.07</td>
<td>Dystrophy of the ovaries</td>
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<tr>
<td>2.05.03</td>
<td>Examination due to infertility</td>
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<td>2.05.04</td>
<td>Treatment due to infertility</td>
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<tr>
<td>2.99</td>
<td>Other disturbances of female fertility</td>
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<td>3</td>
<td>Reproduction disorders in males</td>
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<tr>
<td>3.01</td>
<td>Inherited diseases of the male reproductive system</td>
<td></td>
</tr>
<tr>
<td>3.01.01</td>
<td>Cryptorchidism</td>
<td>Incomplete descent of testicles into the scrotum</td>
</tr>
<tr>
<td>3.01.02</td>
<td>Testicular hypoplasia (hypoplasia of testes)</td>
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<tr>
<td>3.01.03</td>
<td>Anomalies of spermatozoa</td>
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<tr>
<td>3.01.04</td>
<td>Wolffian duct aplasia</td>
<td>Failure of development of male reproductive ducts</td>
</tr>
<tr>
<td>3.02</td>
<td>Malformations of the male reproductive system</td>
<td></td>
</tr>
<tr>
<td>3.02.01</td>
<td>Frenulum praeputii persistens (persistent preputial frenulum)</td>
<td>Permanent tissue connection between glans penis and preputium</td>
</tr>
<tr>
<td>3.03</td>
<td>Tumors of the male reproductive system</td>
<td></td>
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<tr>
<td>3.04</td>
<td>Injuries of the male reproductive system</td>
<td></td>
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<tr>
<td>3.05</td>
<td>Diseases of the preputium</td>
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<tr>
<td>3.05.01</td>
<td>Phimosis</td>
<td>Preputial constriction</td>
</tr>
<tr>
<td>3.05.02</td>
<td>Preputial inflammation</td>
<td></td>
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<tr>
<td>3.06</td>
<td>Diseases of the penis</td>
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<tr>
<td>3.06.01</td>
<td>Penis hypoplasia</td>
<td>Underdevelopment of the penis</td>
</tr>
<tr>
<td>3.06.02</td>
<td>Penis inflammation</td>
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<td>3.06.03</td>
<td>Penis prolaps</td>
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<td>3.06.04</td>
<td>Penis paralysis</td>
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<td>3.07</td>
<td>Testicular diseases</td>
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<td>3.07.01</td>
<td>Orchitis</td>
<td>Inflammation of the testes</td>
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<tr>
<td>3.07.02</td>
<td>Degeneration of the testes</td>
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<tr>
<td>3.07.03</td>
<td>Fibrosis of the testes</td>
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<td>3.08</td>
<td>Epididymal diseases</td>
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</tr>
<tr>
<td>3.08.01</td>
<td>Epididymitis</td>
<td>Inflammation of the epididymes</td>
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<td>3.09.</td>
<td>Scrotal diseases</td>
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<tr>
<td>3.09.01.</td>
<td>Inflammation of the scrotum</td>
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<td>3.10.</td>
<td>Impotentia (male infertility)</td>
<td></td>
</tr>
<tr>
<td>3.10.01.</td>
<td>Impotentia generandi</td>
<td>Lack of fertile semen</td>
</tr>
<tr>
<td>3.10.02.</td>
<td>Impotentia coeundi</td>
<td>Erection disturbance</td>
</tr>
<tr>
<td>3.99.</td>
<td>Other male reproductive disorders</td>
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<td>4.</td>
<td>Infectious disease and other microbe-related diseases (except local infections of udder and claws)</td>
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<tr>
<td>4.01.</td>
<td>Prion diseases</td>
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<tr>
<td>4.01.01.</td>
<td>BSE = Bovine Spongiform Encephalopathy</td>
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<tr>
<td>4.01.02.</td>
<td>Other prion diseases</td>
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<tr>
<td>4.02.</td>
<td>Viral infections (except local infections of udder and claws)</td>
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<tr>
<td>4.02.01.</td>
<td>Rotavirus infection</td>
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<tr>
<td>4.02.02.</td>
<td>Coronavirus infection</td>
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<tr>
<td>4.02.03.</td>
<td>Parvovirus infection</td>
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</tr>
<tr>
<td>4.02.04.</td>
<td>PI = Parainfluenza (infection with Parainfluenza 3 virus)</td>
<td></td>
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<tr>
<td>4.02.05.</td>
<td>BVD / MD = Bovine Virusdiarrhea / Mucosal Disease</td>
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<tr>
<td>4.02.05.01.</td>
<td>BVD = Bovine Virusdiarrhea</td>
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</tr>
<tr>
<td>4.02.05.02.</td>
<td>MD = Mucosal disease</td>
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<tr>
<td>4.02.06.</td>
<td>BMCF = Bovine malignant catarrhal fever</td>
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<tr>
<td>4.02.07.</td>
<td>Adenovirus infection</td>
<td></td>
</tr>
<tr>
<td>4.02.08.</td>
<td>Infection with BRSV = Bovine respiratory syncytialvirus</td>
<td></td>
</tr>
<tr>
<td>4.02.09.</td>
<td>Infection with BHV1 = Bovine herpes virus 1</td>
<td></td>
</tr>
<tr>
<td>4.02.09.01.</td>
<td>IBR = Infectious bovine rhinotracheitis</td>
<td></td>
</tr>
<tr>
<td>4.02.09.02.</td>
<td>IPV = Infectious pustular vulvovaginitis</td>
<td></td>
</tr>
<tr>
<td>4.02.09.03.</td>
<td>IBP = Infectious balanoposthitis</td>
<td>Infectious penoposthitis</td>
</tr>
<tr>
<td>4.02.10.</td>
<td>Papillomatosis</td>
<td>Cutaneous and mucosal warts due to papilloma virus infection</td>
</tr>
<tr>
<td>4.02.11.</td>
<td>Cowpox</td>
<td>Cowpox and vaccinia; diseases caused by orthopox virus infections</td>
</tr>
<tr>
<td>4.02.12.</td>
<td>FMS = Foot-and-mouth disease</td>
<td></td>
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<tr>
<td>4.02.13.</td>
<td>Stomatitis vesicularis (vesicular stomatitis)</td>
<td></td>
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<tr>
<td>4.02.14.</td>
<td>Stomatitis papulosa</td>
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<tr>
<td>4.02.15.</td>
<td>Aujeszky's disease (Pseudorabies)</td>
<td></td>
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<tr>
<td>4.02.16.</td>
<td>EBL = Enzootic bovine leukemia / leukemia</td>
<td>Bovine lymphadenosis, lymphosarcomatosis; diseases after infection with blv = bovine leukemia virus</td>
</tr>
<tr>
<td>4.02.17.</td>
<td>Rabies</td>
<td></td>
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<tr>
<td>4.02.18.</td>
<td>BT = Bluetongue</td>
<td></td>
</tr>
<tr>
<td>4.02.19.</td>
<td>Rinderpest</td>
<td></td>
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<tr>
<td>4.02.99.</td>
<td>Other virus infections</td>
<td></td>
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<tr>
<td>4.03.</td>
<td>Bacterial infections (except local bacterial infections of udder and claws)</td>
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<tr>
<td>4.03.01.</td>
<td>Escherichia coli infection</td>
<td></td>
</tr>
<tr>
<td>4.03.01.01.</td>
<td>Coli septicaemia</td>
<td>General disease due to infection with escherichia coli</td>
</tr>
<tr>
<td>4.03.01.02.</td>
<td>Coli diarrhoea</td>
<td>Diarrhoea due to infection with escherichia coli</td>
</tr>
<tr>
<td>4.03.02.</td>
<td>Yersinia enterocolitica infection</td>
<td></td>
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<tr>
<td>4.03.03.</td>
<td>Salmonellosis</td>
<td>Disease caused by infection with salmonella spp.</td>
</tr>
<tr>
<td>4.03.03.01.</td>
<td>Salmonella dublin infection</td>
<td></td>
</tr>
<tr>
<td>4.03.03.02.</td>
<td>Salmonella typhimurium infection</td>
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<tr>
<td>4.03.03.03.</td>
<td>Salmonella enteridis infection</td>
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<tr>
<td>4.03.03.04.</td>
<td>Other Salmonella infections</td>
<td></td>
</tr>
<tr>
<td>4.03.04.</td>
<td>Paratuberkulosis (Johne disease)</td>
<td>Intestinal disease after infection with mycobacterium paratuberculosis</td>
</tr>
<tr>
<td>4.03.05.</td>
<td>Pasteurellosis</td>
<td>Shipping fever; transit fever; infection with pasteurella spp.</td>
</tr>
<tr>
<td>4.03.05.01.</td>
<td>Acute pasteurellosis</td>
<td>Haemorrhagic septicaemia; severe general disease caused by infection with pasteurella multocida</td>
</tr>
<tr>
<td>4.03.05.02.</td>
<td>Chronic pasteurellosis</td>
<td>Chronic inflammatory changes of pleura and lungs due to infection with pasteurella spp.</td>
</tr>
<tr>
<td>4.03.06.</td>
<td>Infection with streptococcus pneumoniae</td>
<td></td>
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<tr>
<td>4.03.07.</td>
<td>Mycoplasma infection</td>
<td></td>
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<tr>
<td>4.03.08.</td>
<td>Infection with arcanobacterium pyogenes</td>
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</tr>
<tr>
<td>4.03.08.01.</td>
<td>Pyobacillosis</td>
<td>Abscess formation after infection with arcanobacterium pyogenes</td>
</tr>
<tr>
<td>4.03.08.02.</td>
<td>Uterine infection with Arcanobacterium pyogenes</td>
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<tr>
<td>4.03.09.</td>
<td>Infection with Staphylococci</td>
<td></td>
</tr>
<tr>
<td>4.03.09.01.</td>
<td>Acne due to infection with Staphylococci</td>
<td>Purulent inflammation of hair follicles and sebaceous glands due to staphylococcus infection</td>
</tr>
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<tr>
<td>4.03.09.02.</td>
<td>Furunculosis due to infection with staphylococcus spp.</td>
<td>Disseminated deep purulent inflammation of hair follicles and sebaceous glands due to staphylococcus infection</td>
</tr>
<tr>
<td>4.03.10.</td>
<td>Actinobacillosis</td>
<td>Wooden tongue; granulomatous inflammation due to infection with actinobacillus lignieresi, mainly affecting soft tissue like tongue</td>
</tr>
<tr>
<td>4.03.11.</td>
<td>Actinomycosis</td>
<td>Lumpy jaw; granulomatous inflammation due to infection with actinomyces bovis, mainly affecting mandible and maxilla bones</td>
</tr>
<tr>
<td>4.03.12.</td>
<td>Infection with fusobacterium necrophorum / bacteroides nodosus</td>
<td></td>
</tr>
<tr>
<td>4.03.12.01.</td>
<td>Necrobacillosis</td>
<td>Purulent and necrotizing inflammation of organs due to infection with fusobacterium necrophorum</td>
</tr>
<tr>
<td>4.03.12.02.</td>
<td>Calf diphtheria</td>
<td>Purulent and necrotizing inflammation of oral and/or laryngeal mucus membranes due to infection with fusobacterium necrophorum in calves</td>
</tr>
<tr>
<td>4.03.12.03.</td>
<td>Calf diphtheria</td>
<td></td>
</tr>
<tr>
<td>4.03.13.</td>
<td>Diseases caused by Clostridia</td>
<td>Clostridium infections and intoxications</td>
</tr>
<tr>
<td>4.03.13.01.</td>
<td>Blackleg</td>
<td>Blackquarter; fluid and gas accumulation in muscles after infection with clostridium chauvoei</td>
</tr>
<tr>
<td>4.03.13.02.</td>
<td>Braxy</td>
<td>Fluid and gas accumulation in muscles and connective tissue after infection with clostridium septicum</td>
</tr>
<tr>
<td>4.03.13.03.</td>
<td>Malignant edema</td>
<td>Fluid and gas accumulation in muscles and connective tissue after infection with clostridium novyi and clostridium perfringens</td>
</tr>
<tr>
<td>4.03.13.04.</td>
<td>Gas edema disease</td>
<td>Fluid and gas accumulation in tissue after mixed infections with gas-producing bacteria</td>
</tr>
<tr>
<td>4.03.13.05.</td>
<td>Infectious necrotic hepatitis (black disease)</td>
<td>Liver necroses and severe general signs of disease after infection with clostridium novyi</td>
</tr>
<tr>
<td>4.03.13.06.</td>
<td>Clostridium perfringens enterotoxaemia</td>
<td>Intestinal inflammations caused by toxins of clostridium perfringens</td>
</tr>
<tr>
<td>4.03.13.07.</td>
<td>Tetanus</td>
<td>Convulsive disease after wound infection with clostridium tetani</td>
</tr>
<tr>
<td>4.03.13.08.</td>
<td>Botulism</td>
<td>Paralytic disease caused by toxins of clostridium botulinum</td>
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<tr>
<td>4.03.14.</td>
<td>Moraxella bovis infection</td>
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<tr>
<td>4.03.14.01</td>
<td>IBK = Infectious bovine keratoconjunctivitis</td>
<td>Pink eye; contagious inflammation of cornea and conjunctiva of the eye after infection with moraxella bovis and/or other microbes</td>
</tr>
<tr>
<td>4.03.15</td>
<td>Corynebacterium renale infection</td>
<td></td>
</tr>
<tr>
<td>4.03.16</td>
<td>TEME = Thromboembolic meningoencephalitis</td>
<td>Thromboembolic disease with neurological signs after infection with haemophilus somnus</td>
</tr>
<tr>
<td>4.03.17</td>
<td>Campylobacter infection</td>
<td></td>
</tr>
<tr>
<td>4.03.17.01</td>
<td>Enzootic Campylobacter abortion</td>
<td>Venereal campylobacteriosis, bovine genital campylobacteriosis, vibriosis genitalis; abortion after mucosal infection of female reproductive tract with campylobacter fetus ssp. Venerealis</td>
</tr>
<tr>
<td>4.03.17.02</td>
<td>Campylobacter enteritis (winter dysentery)</td>
<td>Winter scours, vibrionic enteritis; dysentery after infection with campylobacter spp.</td>
</tr>
<tr>
<td>4.03.18</td>
<td>Chlamydia infection</td>
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<tr>
<td>4.03.18.01</td>
<td>Epizootic bovine abortion</td>
<td>Abortion after infection with chlamyphila psittaci</td>
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<tr>
<td>4.03.18.02</td>
<td>Chlamydia bronchopneumonia</td>
<td>Inflammation of bronchial tubes and lungs after infection with chlamydia</td>
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<tr>
<td>4.03.18.03</td>
<td>Chlamydia polyarthritis</td>
<td>Inflammation of multiple joints after infection with chlamydia</td>
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<tr>
<td>4.03.18.04</td>
<td>Sporadic encephalomyelitis</td>
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<tr>
<td>4.03.19</td>
<td>Infection with Erysipelothrix ruspithiae</td>
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<tr>
<td>4.03.20</td>
<td>Nocardiosis</td>
<td>Purulent inflammations with granuloma formation after infection with nocardia spp.</td>
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<tr>
<td>4.03.21</td>
<td>Listeriosis</td>
<td>Diseases after infection with listeria monocytogenes</td>
</tr>
<tr>
<td>4.03.22</td>
<td>Leptospirosis</td>
<td>Diseases after infection with leptospira spp.</td>
</tr>
<tr>
<td>4.03.23</td>
<td>Coxiellosis (Query fever)</td>
<td>Queensland fever, q-fever; diseases after infections with coxiella burnetii</td>
</tr>
<tr>
<td>4.03.24</td>
<td>Anthrax</td>
<td>Severe hemorrhagic disease after infection with bacillus anthracis</td>
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<tr>
<td>4.03.25</td>
<td>Tuberculosis</td>
<td>Diseases after infections with mycobacterium bovis and mycobacterium tuberculosis</td>
</tr>
<tr>
<td>4.03.26</td>
<td>Brucellosis</td>
<td>Diseases and abortion after infection with brucella abortus</td>
</tr>
<tr>
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<tr>
<td>4.03.27.</td>
<td>Pleuropneumonia contagiosa (contagious bovine pleuropneumonia)</td>
<td>Severe inflammation of pleura and lungs after infection with mycoplasma mycoides ssp. Mycoides</td>
</tr>
<tr>
<td>4.03.99.</td>
<td>Other bacterial infections</td>
<td></td>
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<tr>
<td>4.04.</td>
<td>Mycoses (fungal infections except local infections of udder and claws)</td>
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<tr>
<td>4.04.01.</td>
<td>Trichophytia (dermatophytosis)</td>
<td>Ringworm; mycotic skin disease after infection with trichophyton verrucosum</td>
</tr>
<tr>
<td>4.04.02.</td>
<td>Aspergillosis</td>
<td>Diseases after infection with aspergillus spp.</td>
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<tr>
<td>4.04.03.</td>
<td>Candidosis, Candidiasis</td>
<td>Diseases after infection with candida albicans</td>
</tr>
<tr>
<td>4.04.99.</td>
<td>Other mycoses</td>
<td></td>
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<tr>
<td>4.05.</td>
<td>Mycotoxicoses</td>
<td>Diseases caused by mycotoxins</td>
</tr>
<tr>
<td>4.05.01.</td>
<td>Ergotism (ergot poisoning)</td>
<td>Diseases caused by ingestion of mycotoxins of claviceps purpurea</td>
</tr>
<tr>
<td>4.05.02.</td>
<td>Aflatoxicosis (aflatoxin poisoning)</td>
<td>Diseases caused by mycotoxin aflatoxin produced by aspergillus spp. And penicillium spp.</td>
</tr>
<tr>
<td>4.05.03.</td>
<td>Aspergilotoxicosis (aspergillus poisoning)</td>
<td>Diseases caused by mycotoxins of aspergillus</td>
</tr>
<tr>
<td>4.05.04.</td>
<td>Stachybotryotoxicosis</td>
<td>Diseases caused by mycotoxins of stachybotrys alternans</td>
</tr>
<tr>
<td>4.05.05.</td>
<td>Fusariotoxicosis</td>
<td>Diseases caused by mycotoxins of fusarium spp.</td>
</tr>
<tr>
<td>4.05.06.</td>
<td>Rust poisoning</td>
<td>Diseases caused by rust mycotoxins, mainly of puccinia spp.</td>
</tr>
<tr>
<td>4.05.07.</td>
<td>Smut poisoning</td>
<td>Diseases caused by smut mycotoxins of tilletia spp. And ustilago spp.</td>
</tr>
<tr>
<td>4.05.99.</td>
<td>Other mycotoxicoses</td>
<td></td>
</tr>
<tr>
<td>4.99.</td>
<td>Other infectious diseases and microbe-related diseases (except local infections of udder and claws)</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Parasitoses (parasite infestations)</td>
<td></td>
</tr>
<tr>
<td>5.01.</td>
<td>Protozoal infections (infestation with parasitical protozoae)</td>
<td></td>
</tr>
<tr>
<td>5.01.01.</td>
<td>Trichomoniasis bovis (trichomonadosis bovis)</td>
<td>Infection with trichomonas foetus</td>
</tr>
<tr>
<td>5.01.02.</td>
<td>Coccidiosis</td>
<td>Dysenteria coccidia, coccidial gastroenteritis; infection with eimeria species from order coccidia</td>
</tr>
<tr>
<td>5.01.03.</td>
<td>Cryptosporidiosis</td>
<td>Infection with cryptosporidium spp.</td>
</tr>
<tr>
<td>5.01.04.</td>
<td>Toxoplasmosis</td>
<td>Infection with toxoplasma gondii</td>
</tr>
<tr>
<td>5.01.05.</td>
<td>Sarcosporidiosis (sarcocystosis)</td>
<td>Muscle cysts of sarcocystis species</td>
</tr>
<tr>
<td>Code</td>
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<td>Synonyms; explanations</td>
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<tr>
<td>5.01.06.</td>
<td>Piroplasmosis, i.e. babesiosis (redwater) and thelieriosis</td>
<td>Diseases caused by piroplasma infection, i.e. Infections with babesia spp. And theileria spp.</td>
</tr>
<tr>
<td>5.01.99.</td>
<td>Other protozoal infections</td>
<td></td>
</tr>
<tr>
<td>5.02.</td>
<td>Helminth infestations</td>
<td></td>
</tr>
<tr>
<td>5.02.01.</td>
<td>Trematode infestations</td>
<td></td>
</tr>
<tr>
<td>5.02.01.01.</td>
<td>Fasciolosis (fascioliasis)</td>
<td>Infections with fasciola hepatica (and other trematodes of genus fasciola)</td>
</tr>
<tr>
<td>5.02.01.02.</td>
<td>Dicrocoeliosis</td>
<td>Infections with dicrocoelium dendriticum</td>
</tr>
<tr>
<td>5.02.02.</td>
<td>Paramphistomatosis</td>
<td>Stomach fluke disease, intestinal amphistomosis; infections with paramphistomum species</td>
</tr>
<tr>
<td>5.02.03.</td>
<td>Anoplocephalosis and Monieziosis</td>
<td>Infections with tapeworms species anaplocephala and moniezia</td>
</tr>
<tr>
<td>5.02.04.</td>
<td>Cysticercosis, i.e. echinococcosis and coenurosis</td>
<td>Diseases caused by cysticercus of tapeworms species echinococcus und taenia</td>
</tr>
<tr>
<td>5.02.05.</td>
<td>Dictyocaulosis / Bronchopneumonia verminosa (parasitic bronchitis)</td>
<td>Husk, hoose; inflammation of bronchi and lungs due to infection with dictyocaulus viviparus</td>
</tr>
<tr>
<td>5.02.06.</td>
<td>Strongyloidosis</td>
<td>Infection with strongyloides species</td>
</tr>
<tr>
<td>5.02.07.</td>
<td>Trichostrongylidosis</td>
<td>Gastroenteral strongyloidosis; infections with gastroenteral nematodes</td>
</tr>
<tr>
<td>5.02.07.01.</td>
<td>Nematodirosis</td>
<td>Infection with nematodirus species</td>
</tr>
<tr>
<td>5.02.07.02.</td>
<td>Haemonchosis</td>
<td>Infection with haemonchus species</td>
</tr>
<tr>
<td>5.02.07.03.</td>
<td>Ostertagiosis</td>
<td>Infection with ostertagia species</td>
</tr>
<tr>
<td>5.02.07.04.</td>
<td>Trichostrongylosis</td>
<td>Infection with trichostrongylus species</td>
</tr>
<tr>
<td>5.02.07.05.</td>
<td>Cooperiosis</td>
<td>Infection with cooperia species</td>
</tr>
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<td>5.02.08.</td>
<td>Oesophagostomosis</td>
<td>Infection with oesophagostomum species</td>
</tr>
<tr>
<td>5.02.09.</td>
<td>Bunostomosis (hookworm infection)</td>
<td>Infection with bunostomum species</td>
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<tr>
<td>5.02.99.</td>
<td>Other helminth infestations</td>
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<td>5.03.</td>
<td>Arthropode infestations</td>
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<td>5.03.01.</td>
<td>Tick infestations</td>
<td>Infestation with ixodic ticks (ixodidae) and argasid ticks (argasidae)</td>
</tr>
<tr>
<td>5.03.02.</td>
<td>Demodicosis</td>
<td>Demodectic mite infestation; infestation with demodex bovis</td>
</tr>
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<td>5.03.03.</td>
<td>Trombidiosis (trombidiasis)</td>
<td>Infestation with neotrombicula autumnalis</td>
</tr>
<tr>
<td>5.03.04.</td>
<td>Scabies</td>
<td>Mange; infections with scabies mites</td>
</tr>
<tr>
<td>5.03.04.01.</td>
<td>Sarcotic scabies</td>
<td>Sarcotic mange, head scabies; infection with burrowing mites</td>
</tr>
<tr>
<td>Code</td>
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<td>Synonyms; explanations</td>
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<tr>
<td>5.03.04.02</td>
<td>Psoroptic scabies</td>
<td>Psoroptic mange, body scabies; infection with sucking mites</td>
</tr>
<tr>
<td>5.03.04.03</td>
<td>Chorioptic scabies</td>
<td>Chorioptic mange, tail and feet scabies; infection with surface mites</td>
</tr>
<tr>
<td>5.03.05</td>
<td>Pediculosis</td>
<td>Sucking lice infestation; infestation with haematopinus eurysternus = short-nosed sucking lice and linognathus vituli = long-nosed sucking lice</td>
</tr>
<tr>
<td>5.03.06</td>
<td>Trichodektosis</td>
<td>Infestations with bovicola bovis</td>
</tr>
<tr>
<td>5.03.07</td>
<td>Simuliosis</td>
<td>Infestations with simulium spp.</td>
</tr>
<tr>
<td>5.03.08</td>
<td>Infestation with tabanidae and muscida</td>
<td>Diseases caused by larvae of flies</td>
</tr>
<tr>
<td>5.03.09</td>
<td>Myiasis</td>
<td>Diseases caused by larvae of flies</td>
</tr>
<tr>
<td>5.03.10</td>
<td>Hypodermatosis</td>
<td>Warble disease; diseases caused by infections with larvae of hypoderminae flies</td>
</tr>
<tr>
<td>5.03.99</td>
<td>Other arthropod infestations</td>
<td></td>
</tr>
<tr>
<td>5.99</td>
<td>Other parasitoses</td>
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<td>6.</td>
<td>Metabolic diseases and deficiencies</td>
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<tr>
<td>6.01</td>
<td>Disturbances of energy, carbohydrate and fat metabolism</td>
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</tr>
<tr>
<td>6.01.01</td>
<td>Hyperketonemia / acetonemia</td>
<td>Increased content of keton bodies in the blood</td>
</tr>
<tr>
<td>6.01.02</td>
<td>Ketosis</td>
<td>Slow fever; disturbance of carbohydrate metabolism with increased content of ketone bodies in the blood</td>
</tr>
<tr>
<td>6.01.02.01</td>
<td>Primary ketosis</td>
<td>Primary disturbance of carbohydrate metabolism with increased content of ketone bodies and reduced content of glucose in the blood</td>
</tr>
<tr>
<td>6.01.02.01.01</td>
<td>Subclinical primary ketosis</td>
<td>Primary disturbance of carbohydrate metabolism with increased content of ketone bodies and reduced content of glucose in the blood without accompanying signs of disease</td>
</tr>
<tr>
<td>6.01.02.01.02</td>
<td>Manifest primary ketosis</td>
<td>Primary disturbance of carbohydrate metabolism with increased content of ketone bodies and reduced content of glucose in the blood with accompanying signs of disease</td>
</tr>
<tr>
<td>Code</td>
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<td>Synonyms; explanations</td>
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</tr>
<tr>
<td>6.01.02.02.</td>
<td>Secondary ketosis</td>
<td>Secondary, i.e. In connection with other disease occurring, disturbance of carbohydrate metabolism with increased content of ketone bodies and reduced content of glucose in the blood</td>
</tr>
<tr>
<td>6.01.02.02.01.</td>
<td>Subclinical secondary ketosis</td>
<td>Secondary, i.e. In connection with other disease occurring, disturbance of carbohydrate metabolism with increased content of ketone bodies and reduced content of glucose in the blood without accompanying signs of disease</td>
</tr>
<tr>
<td>6.01.02.02.02.</td>
<td>Manifest secondary ketosis</td>
<td>Secondary, i.e. In connection with other disease occurring, disturbance of carbohydrate metabolism with increased content of ketone bodies and reduced content of glucose in the blood with accompanying signs of disease</td>
</tr>
<tr>
<td>6.01.03.</td>
<td>Lipidosis hepatis / Steatosis hepatis</td>
<td>Fatty infiltration and degeneration of the liver</td>
</tr>
<tr>
<td>6.01.03.01.</td>
<td>Hepatic coma</td>
<td>Severe disturbance of energy metabolism with hepatic failure</td>
</tr>
<tr>
<td>6.01.04.</td>
<td>Adipositas</td>
<td>Lipomobilization syndrome; disturbance of energy metabolism with excessive fat utilization in energetically undernourished, fat cows</td>
</tr>
<tr>
<td>6.01.05.</td>
<td>Excessive loss of weight</td>
<td></td>
</tr>
<tr>
<td>6.01.05.01.</td>
<td>Thin pregnant cow syndrome</td>
<td>Excessive loss of weight in late gestation</td>
</tr>
<tr>
<td>6.01.06.</td>
<td>Paralytic myoglobinuria</td>
<td>Disturbance of carbohydrate metabolism with signs of paralysis and urinary excretion of myoglobin</td>
</tr>
<tr>
<td>6.01.99.</td>
<td>Other disturbances of energy, carbohydrate and fat metabolism</td>
<td></td>
</tr>
<tr>
<td>6.02.</td>
<td>Disturbances of protein metabolism</td>
<td></td>
</tr>
<tr>
<td>6.02.99.</td>
<td>Other disturbances of protein metabolism</td>
<td></td>
</tr>
<tr>
<td>6.03.</td>
<td>Disturbances of mineral balance</td>
<td></td>
</tr>
<tr>
<td>6.03.01.</td>
<td>Disturbances of calcium and phosphorus balance</td>
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</tr>
<tr>
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<td>Technical term</td>
<td>Synonyms; explanations</td>
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</tr>
<tr>
<td>6.03.01.01.</td>
<td>Parturient paresis (milk fever)</td>
<td>Permanent recumbency of the dairy cow with reduced calcium and phosphorus content of the blood</td>
</tr>
<tr>
<td>6.03.01.01.01.</td>
<td>Typical parturient paresis / Stages 1 and 2 of parturient paresis</td>
<td>Hypocalcemic parturient paresis; recumbency after calving with reduced calcium and phosphorus content of the blood and without or with reduced responsiveness</td>
</tr>
<tr>
<td>6.03.01.01.02.</td>
<td>Parturient coma / Stage 3 of parturient paresis</td>
<td>Recumbency after calving with reduced calcium and phosphorus content of the blood and severely reduced responsiveness</td>
</tr>
<tr>
<td>6.03.01.01.03.</td>
<td>Atypical parturient paresis</td>
<td>Recumbency after calving of unknown cause without reduced responsiveness</td>
</tr>
<tr>
<td>6.03.01.01.04.</td>
<td>Downer cow syndrome</td>
<td>Recumbency after calving without response to therapeutic calcium infusion</td>
</tr>
<tr>
<td>6.03.01.01.05.</td>
<td>Lactation paresis</td>
<td>Recumbency of the lactating cow unrelated to calving with reduced calcium content of the blood</td>
</tr>
<tr>
<td>6.03.01.02.</td>
<td>Osteopathies (bone diseases) due to disturbances of calcium and phosphorus balance</td>
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</tr>
<tr>
<td>6.03.01.02.01.</td>
<td>Rickets of calves</td>
<td></td>
</tr>
<tr>
<td>6.03.01.02.02.</td>
<td>Osteomalacia of the dairy cow</td>
<td></td>
</tr>
<tr>
<td>6.03.01.02.03.</td>
<td>Osteoporosis of the fattening bull</td>
<td></td>
</tr>
<tr>
<td>6.03.01.02.04.</td>
<td>Epiphysiolysis distalis ossium metacarpalium seu metatarsalium (metacarpal or metatarsal epiphysiolysis)</td>
<td>Loosing of the distal ends of bones in the metacarpus or metatarsus</td>
</tr>
<tr>
<td>6.03.01.02.05.</td>
<td>Rupture of the gastrocnemius muscle or tendon (Achilles tendon rupture) due to disturbances of calcium and phosphorus balance</td>
<td></td>
</tr>
<tr>
<td>6.03.01.05.06.</td>
<td>Osteochondrosis et Osteoarthritis</td>
<td>Degenerative changes in joint cartilage due to disturbances of calcium and phosphorus balance</td>
</tr>
<tr>
<td>6.03.02.</td>
<td>Disturbances of magnesium balance</td>
<td></td>
</tr>
<tr>
<td>6.03.02.01.</td>
<td>Hypomagnesemic tetany</td>
<td>Signs of paralysis with reduced magnesium content of the blood</td>
</tr>
<tr>
<td>6.03.02.01.01.</td>
<td>Hypomagnesemic tetany of calves</td>
<td>Hypomagnesaemia with hyperexcitability, muscle spasm and convulsion in suckling calves</td>
</tr>
<tr>
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<tr>
<td>6.03.02.01.02.</td>
<td>Grass tetany</td>
<td>Grass staggars; hyperexcitability, muscle spasm and convulsion with reduced magnesium content of the blood after grazing on lush pastures</td>
</tr>
<tr>
<td>6.03.02.01.03.</td>
<td>Stable tetany</td>
<td>Hyperexcitability, muscle spasm and convulsion with reduced magnesium content of the blood in stabled animals with insufficient nutritional magnesium supply</td>
</tr>
<tr>
<td>6.03.02.01.04.</td>
<td>Transport tetany</td>
<td>Muscle spasm and convulsion with reduced magnesium content of the blood after exhausting transport</td>
</tr>
<tr>
<td>6.03.03.</td>
<td>Disturbances of sodium balance</td>
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</tr>
<tr>
<td>6.03.03.01.</td>
<td>Sodium deficiency</td>
<td></td>
</tr>
<tr>
<td>6.03.04.</td>
<td>Disturbances of chloride balance</td>
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</tr>
<tr>
<td>6.03.04.01.</td>
<td>Chloride deficiency</td>
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<tr>
<td>6.03.05.</td>
<td>Disturbances of sulfur balance</td>
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<td>6.03.05.01.</td>
<td>Sulfur deficiency</td>
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<tr>
<td>6.03.06.</td>
<td>Disturbances of potassium balance</td>
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<tr>
<td>6.03.99.</td>
<td>Other disturbances of mineral balance</td>
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<td>6.04.</td>
<td>Disturbances of trace element balance</td>
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<td>6.04.01.</td>
<td>Iron deficiency</td>
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</tr>
<tr>
<td>6.04.01.01.</td>
<td>Iron deficiency anemia in calves</td>
<td>Anemia in suckling calves due to lack of iron</td>
</tr>
<tr>
<td>6.04.02.</td>
<td>Copper deficiency</td>
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</tr>
<tr>
<td>6.04.02.01.</td>
<td>Copper deficiency anemia</td>
<td>Anemia due to lack of copper</td>
</tr>
<tr>
<td>6.04.03.</td>
<td>Zinc deficiency</td>
<td></td>
</tr>
<tr>
<td>6.04.03.01.</td>
<td>Parakeratosis due to zinc deficiency</td>
<td>Disturbance of keratinization due to lack of zinc</td>
</tr>
<tr>
<td>6.04.04.</td>
<td>Selenium deficiency</td>
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<tr>
<td>6.04.05.</td>
<td>Manganese deficiency</td>
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<td>6.04.06.</td>
<td>Iodine deficiency</td>
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<td>6.04.07.</td>
<td>Cobalt deficiency</td>
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<td>6.04.99.</td>
<td>Other disturbances of trace element balance</td>
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<tr>
<td>6.05.</td>
<td>Disturbances of vitamin balance</td>
<td></td>
</tr>
<tr>
<td>6.05.01.</td>
<td>Beta carotene deficiency</td>
<td>Provitamin a deficiency</td>
</tr>
<tr>
<td>6.05.02.</td>
<td>Vitamin A deficiency</td>
<td>(hypovitaminosis A)</td>
</tr>
<tr>
<td>6.05.03.</td>
<td>Vitamin E deficiency</td>
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<tr>
<td>6.05.04.</td>
<td>Vitamin D deficiency</td>
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<tr>
<td>6.05.05.</td>
<td>Vitamin B1 deficiency</td>
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</tr>
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<tr>
<td>6.05.05.01</td>
<td>CCN = Cerebrocorticalnecrosis (necrosis of the cerebral cortex)</td>
<td>Polioencephalomalacia; softening and necrosis of the cerebral cortex due to lack of vitamin b1 = thiamine</td>
</tr>
<tr>
<td>6.05.06</td>
<td>Vitamin B12 deficiency</td>
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<tr>
<td>6.05.07</td>
<td>Biotin deficiency</td>
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<td>6.05.08</td>
<td>Folic acid deficiency</td>
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<td>7.</td>
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<td>7.01.</td>
<td>Poisoning with feed contents and additives</td>
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<td>7.01.01.</td>
<td>Sodium chloride poisoning</td>
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<td>7.01.02.</td>
<td>Nitrate / nitrite poisoning</td>
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<tr>
<td>7.01.03.</td>
<td>Urea poisoning</td>
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<td>7.02.</td>
<td>Poisoning with metals, semi-metals and their salts</td>
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<td>7.02.01.</td>
<td>Saturnism</td>
<td>Lead poisoning</td>
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<tr>
<td>7.02.02.</td>
<td>Cuprism</td>
<td>Copper poisoning</td>
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<tr>
<td>7.02.03.</td>
<td>Selenosis</td>
<td>Selenium poisoning</td>
</tr>
<tr>
<td>7.02.04.</td>
<td>Molybdenosis</td>
<td>Molybdenum poisoning</td>
</tr>
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<td>7.02.05.</td>
<td>Mercurialism</td>
<td>Mercury poisoning</td>
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<tr>
<td>7.02.06.</td>
<td>Iron poisoning</td>
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<tr>
<td>7.02.07.</td>
<td>Arsenic poisoning</td>
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<td>7.02.08.</td>
<td>Fluorine poisoning</td>
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<td>7.02.09.</td>
<td>Cadmium poisoning</td>
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<td>7.03.</td>
<td>Drug poisonings</td>
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<td>7.03.01.</td>
<td>Hypervitaminosis D</td>
<td>Excess of vitamin d</td>
</tr>
<tr>
<td>7.03.01.01</td>
<td>Calcinosis</td>
<td>Excess of calcium</td>
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## SECTION 8: ANNEX 1: BREED CODES ON BOVINE SEMEN STRAWS FOR INTERNATIONAL TRADE ASSIGNED BY ICAR SUB-COMMITTEE INTERBULL

Status: 19 June 2012

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\(^1\) Interbull breed codes 2009.  
\(^2\) Breed codes on bovine semen straws for international trade.
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\(^{(1)}\) Interbull breed codes 2009.  
\(^{(2)}\) Breed codes on bovine semen straws for international trade.
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<sup>(1)</sup> Interbull breed codes 2009.

<sup>(2)</sup> Breed codes on bovine semen straws for international trade.
### SECTION 8: ANNEX 2: BREED NAMES IN DIFFERENT COUNTRIES

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</tr>
<tr>
<td></td>
<td>Brune</td>
</tr>
<tr>
<td></td>
<td>Spanish:</td>
</tr>
<tr>
<td></td>
<td>Bruna, Parda Alpina</td>
</tr>
<tr>
<td></td>
<td>Serbo-Croatian:</td>
</tr>
<tr>
<td></td>
<td>Slovenacko belo</td>
</tr>
<tr>
<td></td>
<td>Czech:</td>
</tr>
<tr>
<td></td>
<td>Hnedy Karpatsky</td>
</tr>
<tr>
<td></td>
<td>Romanian:</td>
</tr>
<tr>
<td></td>
<td>Shivitskaja</td>
</tr>
<tr>
<td></td>
<td>Russian:</td>
</tr>
<tr>
<td></td>
<td>Bruna</td>
</tr>
<tr>
<td></td>
<td>Bulgarian:</td>
</tr>
<tr>
<td></td>
<td>Biljarska kafyava</td>
</tr>
<tr>
<td></td>
<td>The Netherlands:</td>
</tr>
<tr>
<td>National Breed Names</td>
<td>National names</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>Galloway:</strong></td>
<td><strong>Black and Dun</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Galloway</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Belted Galloway</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Red Galloway</strong></td>
</tr>
<tr>
<td></td>
<td><strong>White Galloway</strong></td>
</tr>
<tr>
<td><strong>Holstein, Black and White:</strong></td>
<td><strong>Dutch:</strong> Holstein Swartbont</td>
</tr>
<tr>
<td></td>
<td><strong>German:</strong> Deutsche Holstein, schwarzbunt</td>
</tr>
<tr>
<td></td>
<td><strong>Danish:</strong> Sortbroget Dansk Malkekvaeg</td>
</tr>
<tr>
<td></td>
<td><strong>British:</strong> Holstein Friesian</td>
</tr>
<tr>
<td></td>
<td><strong>Swedish:</strong> Svensk Låglands Boskap</td>
</tr>
<tr>
<td></td>
<td><strong>French:</strong> Prim Holstein</td>
</tr>
<tr>
<td></td>
<td><strong>Italian:</strong> Holstein Frisona</td>
</tr>
<tr>
<td></td>
<td><strong>Spanish:</strong> Holstein Frisona</td>
</tr>
<tr>
<td><strong>Holstein, Red and White</strong></td>
<td><strong>Dutch:</strong> Holstein roodbunt</td>
</tr>
<tr>
<td></td>
<td><strong>German:</strong> Holstein, rotbunt</td>
</tr>
<tr>
<td></td>
<td><strong>Danish:</strong> Roedbroget Dansk Malkekvaeg</td>
</tr>
<tr>
<td><strong>Piedmont</strong></td>
<td><strong>Italian:</strong> Piemontese</td>
</tr>
<tr>
<td></td>
<td><strong>French:</strong> Maine Anjou</td>
</tr>
<tr>
<td><strong>Rouge des Pres</strong></td>
<td><strong>Including dual purpose and beef use</strong></td>
</tr>
<tr>
<td></td>
<td><strong>French:</strong> Simmental Française</td>
</tr>
<tr>
<td></td>
<td><strong>Italian:</strong> Razza Pezzata Rossa</td>
</tr>
<tr>
<td></td>
<td><strong>Czech:</strong> Cesky strakaty</td>
</tr>
<tr>
<td></td>
<td><strong>Slovakian:</strong> Slovensky strakaty</td>
</tr>
<tr>
<td></td>
<td><strong>Romanian:</strong> Baltata româneasca</td>
</tr>
<tr>
<td></td>
<td><strong>Russian:</strong> Simmentalskaja</td>
</tr>
<tr>
<td><strong>Simmental / Fleckvieh</strong></td>
<td><strong>German:</strong> Tiroler Grauvieh</td>
</tr>
<tr>
<td></td>
<td><strong>Oberinntaler Grauvieh</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Rätisches Grauvieh</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Italian:</strong> Razza Grigia Alpina</td>
</tr>
</tbody>
</table>
Appendix Section 10 - Testing and approval of devices used in animal identification
This section contains the Annexes for application of testing and certification of devices used in animal identification.

To be valid each application has to have:

- An authorized signature and the date of signature.
- The completed application emailed in PDF format to the Service-ICAR secretariat.
- The email address of the Service-ICAR secretariat is: manufacturers@icar.org
Section 10.2 - Conformance evaluation of RFID devices. Part 1: ISO 11784/11785. Conformance of transponders including granting and use of a manufacturer code

Annex A1. Application for a test of ISO RFID conformance of transponders

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Company Address</th>
</tr>
</thead>
</table>

**VAT or tax registration number of the company:**

<table>
<thead>
<tr>
<th>Test:</th>
<th>ISO Conformance</th>
<th>Full</th>
<th>Limited</th>
<th>Listing update</th>
</tr>
</thead>
</table>

**Device Type:**

- Injectable transponder
- Electronic ear tag
- Tag attachment
- Ruminal bolus
- Other

**Device name:**

**Technology:**

- HDX
- FDX-B

**Physical characteristics:**

- Length: Diameter: Weight: Colour:

**Packaging Material:**

- Primary transponder packaging:
- Secondary transponder packaging:

**Photograph of the Device:**

The undersigned agrees to abide to all conditions set forth within ISO document “Conformance evaluation of RFID devices, Part 1: ISO 11784/11785-conformance of transponders including granting and use of a manufacturer code”.

**Date** ............................................. **Name (please PRINT):** ........................................................

**Position:** ................................... **Signature:**
Annex A2. Application for a manufacturer code allocation

(To be submitted only when a manufacturer applies the first ISO conformance test)

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Company Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**VAT or tax registration number of the company:**

- [ ] Step 1: Shared manufacturer code
  - [ ] First application, primary set of identification codes
  - [ ] Second application, additional set of identification codes

- [ ] Step 2: Unshared manufacturer code (only applicable if step 1 has been passed)

The undersigned agrees to abide to all conditions set forth within ISO document “Conformance evaluation of RFID devices, Part 1: ISO 11784/11785-conformance of transponders including granting and use of a manufacturer code”.

**Date:** ..............................  **Name (please PRINT):** ........................................................

**Position:** ...........................  **Signature:**   


Annex A3. Code of conduct

To be submitted only when a manufacturer applies the first ISO conformance test.

To maintain and enhance user confidence in the usability and functioning of ISO 11784 and ISO 11785 compliant RFID technology, the manufacturer/supplier ensures that their products offered to the market for use in animal identification (i.e. animal bit = ‘1’) and claimed to be compliant to the ISO standards 11784/11785:

- Are in full conformance to both ISO standards noted above. Test certificates issued by approved certification bodies and the signed letter from ICAR for use of the granted manufacturer code can prove conformance.
- That the conditions set forth by ICAR for the right to use such granted codes as described in this document are respected.
- The use of the Country code “999” is restricted to test applications only, and such coded devices will not be sold commercially.
- The initial purchaser of the ISO compliant ID device, including the origin of the silicon chip in the device, can be traced.
- For transponders applied to animals, in countries where there is no national authority regulating transponders, the manufacturer shall recommend to its distributor and purchaser network to maintain traceability up to and including the applier of the transponder.

The manufacturers/suppliers of RFID technology agree to the responsibility to communicate accurate information concerning ISO 11784/11785 based RFID technology, products and performances. They also agree to the responsibility to support and promote the standards in a positive way. This includes provable performance information verified by approved certification bodies.

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Company Address</th>
</tr>
</thead>
</table>

The undersigned declares to have taken notice of and agrees to abide by and submit to all the conditions set forth within ISO document “Conformance evaluation of RFID devices, Part 1” and is aware of the possibility and accepts and acknowledges the capacity of ICAR to withdraw any product certification or manufacturer code if one or more of the conditions are breached.

Date: ..................................  Name (please PRINT): .........................................................

Position: ..........................  Signature:                                         

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Company Address</th>
</tr>
</thead>
</table>

**VAT or tax registration number of the company**

Test: 
- On transponder that has been previously conformance tested
- Combined with a transponder conformance test

**Device type:**
- Injectable transponder
- Electronic ear tag
- Tag attachment
- Ruminal bolus
- Other

**Device name:**

**RA product code:**

**Technology:**
- HDX
- FDX-B

**Physical characteristics:**
- Length:
- Diameter:
- Weight:
- Colour:

**Packaging material:**
- Primary transponder packaging:
- Secondary transponder packaging:

**Photograph of the device:**


**Date** .....................................    **Name (please PRINT):** .........................................................

**Position:**...............................    **Signature:**
### Section 10.3 - ISO11784/11785 - Conformance of synchronizing or non-synchronizing transceivers

#### Annex A5. Application for a conformance test of synchronizing transceivers

<table>
<thead>
<tr>
<th><strong>Company Name</strong></th>
<th><strong>Company Address</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**VAT or tax registration number of the company:**

<table>
<thead>
<tr>
<th><strong>Transceiver type:</strong></th>
<th>ISO 11784/11785 technology:</th>
<th>Additional technologies:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>synchronized</strong></td>
<td>ISO</td>
<td>ISO + ……</td>
</tr>
<tr>
<td></td>
<td></td>
<td>…… Destron/Fecava</td>
</tr>
<tr>
<td></td>
<td></td>
<td>…… Datamars</td>
</tr>
<tr>
<td></td>
<td></td>
<td>…… Trovan</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Other configurations:</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Portable transceiver:</strong></th>
<th></th>
<th><strong>Stationary transceiver:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Physical characteristics:**

- **Dimensions (L x W x H):**
- **Weight:**

<table>
<thead>
<tr>
<th><strong>Separate Antenna:</strong></th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Serial comm.:</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

(If “Yes” please attach specifications with application)

**Device serial number:**

**Photograph of the device:**

The undersigned agrees to abide to all conditions set forth within ISO document “Conformance evaluation of RFID devices, Part 2: ISO11784/11785 – conformance of synchronised transceivers for reading ISO 11784/11785 transponders”.

**Date........................................**    **Name (please PRINT): ..........................................................**

**Position: .................................**    **Signature:**

---
Annex A6. Application form for conformance test for non-synchronising transceivers

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Company Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**VAT or tax registration number of the company**

<table>
<thead>
<tr>
<th>Transceiver type:</th>
<th>ISO 11784/11785 technology:</th>
<th>Additional technologies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-synchronised</td>
<td>ISO</td>
<td>ISO + ..........</td>
</tr>
<tr>
<td></td>
<td></td>
<td>...... Destron/Fecava</td>
</tr>
<tr>
<td></td>
<td></td>
<td>...... Datamars</td>
</tr>
<tr>
<td></td>
<td></td>
<td>...... Trovan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other configurations:</td>
</tr>
</tbody>
</table>

**Portable transceiver:**

**Stationary transceiver:**

**Physical characteristics:**

- Dimensions (L x W x H):
- Weight:

- Separate antenna: No [ ] Yes [ ]
- Serial comm. No [ ] Yes [ ]

(if “Yes” please attach specifications with application)

**Device serial number:**

**Photograph of the device:**

The undersigned agrees to abide to all conditions set forth within ISO document: “Conformance evaluation of RFID devices, Part 3: conformance test for non-synchronising RFID transceivers for reading ISO 11784/11785 transponders”.

**Date** .....................................  **Name (please PRINT):** ..........................................................

**Position:**  ..................................  **Signature:**  ..................................

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Company Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**VAT or tax registration number of the company**

**Device Type:**
- Portable reader with integrated antenna
- Portable reader with external antenna
- Portable reader with integrated and optional external antenna
- Other:

**The conformance ETSI EN 300 330 document of a notified body is enclosed**

**Device name:**

**Device serial number:**

**ICAR approval reference number:**

**Physical characteristics:**
- Dimensions (L x W x H):
- Weight:

**Separate antenna:**
- No
- Yes

(If “Yes”, please attach specifications with application)

**Photograph of the device:**

The undersigned agrees to abide to all conditions set forth within ISO document “Performance evaluation of RFID devices, Part 2: ISO 11784/11785-performance of handheld transceivers”.

*Date* ........................................    *Name (please PRINT)*: .........................................................

*Position:*..................................    *Signature*:
## Section 10.7 - Testing and certification of permanent identification devices

### Annex B1. Application form for ICAR test on official permanent identification devices: conventional plastic ear tags with or without machine readable printing

<table>
<thead>
<tr>
<th>Applicant’s name</th>
<th>...........................................................................................................................................</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicant’s address</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>VAT or tax registration number of the applicant’s company:</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>Owner of eartag design</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>Address of owner:</td>
<td>...........................................................................................................................................</td>
</tr>
</tbody>
</table>

### Device name and model number

<table>
<thead>
<tr>
<th>Device Type</th>
<th>...........................................................................................................................................</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine readable printing:</td>
<td>YES [ ] NO [ ]</td>
</tr>
<tr>
<td>Printing to be assessed:</td>
<td>YES [ ] NO [ ]</td>
</tr>
<tr>
<td>Description of machine readable language symbol:</td>
<td>(QR model 2, DM ECC200, Aztec, Code 128, Code 39 or Interleaved 2 of 5)</td>
</tr>
<tr>
<td>Description of pliers that must be used to apply tag:</td>
<td>...........................................................................................................................................</td>
</tr>
</tbody>
</table>

### Physical characteristics

<table>
<thead>
<tr>
<th>Shape</th>
<th>...........................................................................................................................................</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight:</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>Locking system:</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>Colour:</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>Material: MSDS/SDS (not mandatory)</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>Specification of raw material:</td>
<td>...........................................................................................................................................</td>
</tr>
<tr>
<td>Metallic Parts:</td>
<td>NO [ ] YES [ ]</td>
</tr>
</tbody>
</table>

... to be continued in the following page...
Annex B1. Application form for ICAR test on official permanent identification devices: conventional plastic ear tags with or without machine readable printing

<table>
<thead>
<tr>
<th>Device is useable for:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle/bovines Y / N</td>
<td>Horses/equines Y / N</td>
<td></td>
</tr>
<tr>
<td>Laboratory animals Y / N</td>
<td>Sheep/ovines Y / N</td>
<td></td>
</tr>
<tr>
<td>Pigs/porcines Y / N</td>
<td>Other: ..............................................</td>
<td></td>
</tr>
<tr>
<td>Goats/caprines Y / N</td>
<td>Companion animals Y / N</td>
<td></td>
</tr>
</tbody>
</table>

Manufacturer requirements for sample delivery are:

- Preliminary Assessment – Paragraph 10.7.5.2.1 of ICAR Guideline
- Laboratory Test – Paragraph 10.7.5.3.3 of ICAR Guideline

Please include or attach photograph of the device:

The undersigned agrees to abide by all conditions set forth within ICAR’s Guideline Section 10.7 document “ICAR Testing and Certification of Permanent Identification Devices” and specifically agrees to the following:

- Only using the raw material specified in this application, to manufacture the tags
- Submitting the ear tags to all tests and paying the fees determined by ICAR
- Complying with any additional ICAR conditions regarding production and sale, including payment of any fees to maintain the ICAR certification status; and
- Complying with the official rules of each Country where the ICAR certified tags are sold.

Date........................................     Name (please PRINT): .........................................................

Position: .................................     Signature:
Section 10.7 - Testing and certification of permanent Identification devices

Annex B2. Sets of figures to be used as reference printing

<table>
<thead>
<tr>
<th>Set-No.</th>
<th>Digits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8080</td>
</tr>
<tr>
<td>2</td>
<td>7117</td>
</tr>
<tr>
<td>3</td>
<td>3883</td>
</tr>
<tr>
<td>4</td>
<td>5656</td>
</tr>
<tr>
<td>5</td>
<td>8808</td>
</tr>
<tr>
<td>6</td>
<td>3383</td>
</tr>
<tr>
<td>7</td>
<td>1717</td>
</tr>
<tr>
<td>8</td>
<td>3038</td>
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<td>9</td>
<td>9989</td>
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<td>10</td>
<td>4949</td>
</tr>
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<td>11</td>
<td>9444</td>
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<td>12</td>
<td>2727</td>
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<tr>
<td>13</td>
<td>2772</td>
</tr>
<tr>
<td>14</td>
<td>7222</td>
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<tr>
<td>15</td>
<td>1441</td>
</tr>
<tr>
<td>16</td>
<td>1114</td>
</tr>
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<td>17</td>
<td>1414</td>
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<td>18</td>
<td>5665</td>
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<td>19</td>
<td>6555</td>
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<td>20</td>
<td>1234</td>
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<td>21</td>
<td>5678</td>
</tr>
<tr>
<td>22</td>
<td>9012</td>
</tr>
<tr>
<td>23</td>
<td>0888</td>
</tr>
<tr>
<td>24</td>
<td>8998</td>
</tr>
<tr>
<td>25</td>
<td>8999</td>
</tr>
</tbody>
</table>
Section 10.8 - Testing and certification of permanent identification devices

Annex C1. Application form for ICAR test on composition and environmental performance of external RFID devices

<table>
<thead>
<tr>
<th>Applicant's name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicant's address</td>
<td></td>
</tr>
<tr>
<td>VAT or tax registration number of the applicant's company:</td>
<td>........................................................</td>
</tr>
<tr>
<td>Owner of eartag design</td>
<td></td>
</tr>
<tr>
<td>Address of owner:</td>
<td>................................................................................................................</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Device name and model number</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Type:</td>
<td>..............................................................................................................................</td>
</tr>
<tr>
<td>RFID ear tag:</td>
<td>YES ☐ NO ☐</td>
</tr>
<tr>
<td>RFID leg tag</td>
<td>YES ☐ NO ☐</td>
</tr>
</tbody>
</table>

Description of applicator that must be used to apply tag: .................................................................
................................................................................................................................................

<table>
<thead>
<tr>
<th>Physical characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape:</td>
<td>..............................................................................................................................</td>
</tr>
<tr>
<td>Weight:</td>
<td>Locking mechanism ........................................................................................................</td>
</tr>
<tr>
<td>Dimensions: Front part.............. ......Rear part ..............................................................</td>
<td></td>
</tr>
<tr>
<td>Colour:</td>
<td>..............................................................................................................................</td>
</tr>
<tr>
<td>Material: MSDS/SDS (not mandatory)</td>
<td>..............................................................................................................................</td>
</tr>
</tbody>
</table>

Page 1 (.... to be continued in the following page)
Device is useable for:  
- Cattle/bovines: Y/N  
- Horses/equines: Y/N  
- Laboratory animals: Y/N  
- Sheep/ovines: Y/N  
- Pigs/porcines: Y/N  
- Other: ..................................  
- Goats/caprines: Y/N  
- Companion animals: Y/N

Please include or attach photograph of the device:

Manufacturer requirements for sample delivery are:

- Preliminary Assessment – Paragraph 10.8.5.2.1 of ICAR Guideline
- Laboratory Test – Paragraph 10.8.5.3.3 of ICAR Guideline

The undersigned agrees to abide by all conditions set forth within ICAR’s Guideline Section 10.8 document “ICAR Testing and Certification of Permanent Identification Devices Part 2 External RFID devices” and specifically agrees to the following:

- Only using the raw material specified in this application;
- Submitting the ear tags to all tests and paying the fees determined by ICAR;
- Complying with any additional ICAR conditions regarding production and sale, including payment of any fees to maintain the ICAR certification status; and
- Complying with the official rules of each Country where the ICAR certified tags are sold.

Date........................................ Name (please PRINT): .........................................................
Position: .................................     Signature:
Appendix Section 10 - Testing and approval of devices used in animal identification
SECTION 11 APPENDIX 1 - ICAR APPROVED TEST CENTRES
MAY 2014

The following countries have Test Centres approved by ICAR:

• France: Institut de l’Elevage, BP 85225- 35652, Le Rheu
• Italy: AIA Associazione Italiana Allevatori, Via G. Tomassetti 9, 00161 Roma
• Germany: ATB Potsdam, Max-Eyth-Allee 100, 14469 Potsdam
• The Netherlands: Animal Sciences Group, Wageningen University and Research Centre, P.O.Box 65. NL 8200 AB Lelystad

The conditions for the ICAR-approval of a test centre for testing milk recording devices are:

1. A candidate laboratory sends to ICAR a letter of interest to become an ICAR Test Centre.
2. The Sub-Committee Recording Devices after a visit to and evaluation of the applicant facilities recommends to ICAR Board the approval as appropriate.
3. On behalf of the ICAR Board authorization, Service ICAR will make an initial 3-year test center agreement with the new test centre.
4. The first test carried out by a new test centre shall be a supervised test under the Sub-Committee Recording Devices after which the Sub-Committee may certify that the new test centre is able to comply with the ICAR test procedures.
5. Service-ICAR negotiates the individual test fees with the test centre.

11.1.1 - Reference meters and flow rates

Some tests of the milk recording meters have to be done by comparing results with reference meters and flow rates. A reference milking unit shall be used when testing the influence of a milk meter on teat end vacuum. Reference flow rates are used to describe the function at different levels. A reference milk meter shall be used also to test the milk meter influence on free fatty acids (FFA) in the milk.

The reference milking unit for dairy cattle, buffalo, sheep and goats should be representative of those widely used in a large number of countries.
11.1.2 Reference flow rates

11.1.2.1 Water flow rates

The reference value is 5.0 kg/min.

11.1.2.2 Air flow rates

The reference value is 12.0 l/min for cattle and buffalo and 8.0 l/min for goats and sheep. See IDF publication IDF small ruminants.

11.1.3 Reference milk meter

11.1.3.1 Cattle and buffalo

When testing the milk meter influence on free fatty acids (FFA) according to (Appendix 3), the Tru Test HI model with 13 mm inlet and outlet shall be used as reference milk meter.

11.1.3.2 Goats and sheep

No reference milk meter.
SECTION 11 APPENDIX 2 - TEST METHOD FOR EFFECT ON FFA

The effect of the milk recording device on FFA during the test (with and without sampling device if the sampling device is not a fixed part of the milk recording device) shall be measured and compared with the effect of the reference milk recording device. The test milk shall be preferably from cows in late lactation or from cows whose milk is known to be susceptible to lipolysis. The test shall be preferably carried out on a low line setup (see the ISO 6690 annex A) because electronic milk recording devices are mostly used on low line systems. The vacuum level has to be set at the level recommended for the test milk recording device, or if not specified, at 42 kPa. Care shall be taken that the tubes are arranged so that the slope and the lifting height are the same for the test milk recording device and the reference milk recording device. At least 50 liters of fresh milk must be available for each test series. The test series has to be done within one to three hours from the milking. All the milk has to be mixed thoroughly and kept at a temperature of 30°C ± 2°C. All samples are taken in duplicate and kept for one hour in cold running tap water (10-12°C) and then stored for 24 to 28 hours at 4°C before being analyzed. The analyzing methods are described in IDF bulletin nr. 265 (1991) "Determination of free fatty acids in milk & milk products". A sample of the (unused) milk has to be taken before and after the test series, to check a possible (unwanted) increase in FFA. The difference between these two samples shall be less than 0.08 meq/100 g milk fat. The testing sequence (no milk recording device, milk recording device under test with and without a sampler, reference milk recording device) shall be in a random order. Each test series shall be carried out four times at a flow rate of 3 kg/min and four times at a flow rate of 1 kg/min. The airflow shall be set to 12 l/min for cattle and buffalo and 8 l/min for goats and sheep. Between 10 and 12 kg of milk have to pass through the milk recording device in each test run.

The influence on FFA of any milk recording device shall be expressed as the difference in FFA between using only the cluster and using the cluster and the milk recording device. The statistical analysis shall not indicate a negative influence (P<0.05) of the milk recording device in test compared to reference milk recording device.
Appendix Section 11 - Testing, approval and checking of milk recording devices

SECTION 11 APPENDIX 3 - FLOW CHART STATISTICAL ANALYSIS FOR DAIRY COWS

Minimum 8 meters, 2 farms and ? 40 measurements/meter, milking 2 times/24h. Recommendations: 25% 2-10 kg and 25% 20-40 kg.

Plot
Ref<sub>kg</sub> = Meter<sub>kg</sub>

Homoscedasticity
Heteroscedasticity

Calculate by current rules (2-10 kg and 10-40 kg)

Calculate per class (2-10 kg, 10-18 kg, 18-26 kg and 26-40 kg)

Significant (P<0,05)
Not significant (P>0,05)

Use SR, standard residual

\[ SR = \frac{\sum (Y^1 - \sum Y^2 - \sum XY)}{n - 2} \]

Use SD, standard deviation

\[ SD = \sqrt{\frac{\sum (\frac{X^2}{n} - \frac{\sum X}{n} \cdot \frac{\sum Y}{n})}{n - 2}} \]

Calculate
- Max SR/SD [Ref 2-10kg]
- Max SR/SD [Ref >10kg] or [10-18 kg, 18-26 kg and 26-40 kg]
- Max Error [Ref 2-10 kg]
- Max Error [Ref >10 kg] or [10-18 kg, 18-26 kg and 26-40 kg]
- Min Bias and Max Bias

Plot observed differences

Diff<sub>kg</sub> = ?Ref<sub>kg</sub>

Limits
- Range 2-10 kg: SR/SD 0,50 kg
- Range >10 kg: SR/SD 5 %
- Bias 2-10 kg: ±0,2 kg
- Bias >10 kg: ±2 %

Pass
Fail
3.2.1 Conditions for assembling of electronic milk meters

To guarantee a good control and functioning of the electronic milk meter, and also to facilitate the periodic maintenance, it is recommended that the electronic milk meters have to be installed in accordance with the following conditions.

1. Place of the display
   - The display and the milk meter are connected as a logical unit. Moreover the display will be placed as far as possible above the milk meter.
   - The milk meter and the display are both completed with a clear numbering.

2. Installation of the meter near the pit edge
   It is recommended to install the meter near the pit edge. In this place the accessibility and the control of the functioning of the meter during milking are best guaranteed. The following principles apply:
   - installation according to drawing 1;
   - sample-taking device needs to be easily accessible;
   - sample-taking device has to be installed at minimum 20 cm height (distance R1) from the bottom to the floor.

3. Installation of the meter under the pit edge. In case it is not possible to install the meter near the pit edge, the meter can be installed under the pit edge according to the following conditions:
   - installation according to drawing 2;
   - standards for the distances R1, R2 and R3 are as follows:

<table>
<thead>
<tr>
<th>Distance</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>20 cm</td>
<td>-</td>
</tr>
<tr>
<td>R2</td>
<td>-</td>
<td>10 cm</td>
</tr>
<tr>
<td>R3</td>
<td>5 cm</td>
<td>20 cm</td>
</tr>
<tr>
<td>R4</td>
<td>40 cm</td>
<td>-</td>
</tr>
</tbody>
</table>
   - sample-taking device needs to be easily accessible;
   - no other equipment or pipes should be installed in front of the milk meter or the sample-taking device

4. In all situations a good illumination of the milking parlor is recommended.
SECTION 11 APPENDIX 4 - PERFORMANCE CHECKING OF A BEAM BALANCE WITH TWO SCALE BEAMS

- Required visual checks: Legibility of scales, position of supports.
- Check function of fixing screw at the top scale beam and stops of weights.
- The beam balance with two scale beams is to be suspended at eye-level, using a stable fixing device.
- Both scale beams are to be set to "0". If both pointers are in vertical position, the zero setting is correct.
- Attach a weight of 10.0 kg.
- The top scale beam shall be brought into an appropriate lateral position, ensuring a stable horizontal position and a co-ordinated position of both vertical pointing devices. The indicated weight shall be 10.0 kg ± 0.2 kg.
- At the top scale beam the indicated weight shall be modified at a level of + 0.1 kg and - 0.1 kg. It is to be checked whether the scale is reacting on this actions.
- The top scale beam is to be fixed at the zero-position.
- The lower scale beam shall be brought into an appropriate lateral position, ensuring a stable horizontal position and co-ordinated positions of both vertical pointing devices. The indicated weight shall be 10.0 kg ± 0.2 kg.
- At the lower scale beam the indicated weight shall be modified at a level of + 0.1 kg and - 0.1 kg. It is to be checked whether the scale is reacting on this actions.
- The required demands are fulfilled, if the zero-level is maintained, the indicated weight is corresponding to the test weight of 10 kg ± 0.2 kg and if the beam balance is reacting on modifications of 0.1 kg.
4.1.2 Application form for approval tests of milk recording devices

Manufacturer: ............................................................................................................................................
Address: ..................................................................................................................................................
VAT number: ...........................................................................................................................................
Product manager: ......................................................................................................................................
Signing authority: ......................................................................................................................................

Intro:
An application request concerns usually a combination of devices. For example: milk meter, sampler and control unit or an automatic sampler on an automatic milk system. This should be specified on the line below.

Below that, you can specify where the product is used for, for which animals and what type of parlor it was intended.
A complete test is a laboratory and field test, a modification test is a partial test based on the level of change, a website update means no changes to the device, but in (brand) name or documentation. ICAR SC Recording devices in association with the ICAR test centers will prepare a project plan based on this request.

Name(s) and if available product number of the device(s):
..................................................................................................................................................................
..................................................................................................................................................................

Used for:
- Milk metering and sampling
- Milk sampling
- Data analysis (periodic of initial adjustment)
- ………………………………….…………………

Species:
- Dairy cattle
- Buffalo
- Sheep
- Goat

Used in (application):
- Conventional parlors
  - Low line
  - Mid/High line
- Automatic systems
- Stanchion barns
Appendix Section 11 - Testing, approval and checking of milk recording devices

Test requested:
  - Full test
  - Modification test
  - ICAR website update

Technical characteristics and photo of the device:
The technical specifications of the device should be stated below. This applies to the milk meter, sampler, control unit and software (if applicable management and controller software). Also pictures of milk meter, sampler, control unit as of the combination of a sampler with an automatic milking system should be included

Alternatively and preferable this information will be added to this request as attachments mentioned with document names in this request.

Requested starting date of the test (MMYY) .................................................................

The undersigned agrees to abide to the conditions set forth within ICAR’s Guideline document in its Section 11 PART 4 “Tests for approval of milk recording devices”

Date: ........................................................................................................................................

Name: .......................................................................................................................................

Company/position: ....................................................................................................................

Signature: .................................................................................................................................
SECTION 11 APPENDIX 5 - SPRING BALANCE

- The weight of the test vessel (tare weight) shall be measured before the first milk of a recording session enters the bucket. The tare weight shall be applied for the whole recording session. The net weight of the pointing device (adjustable) shall be set at zero and fixed in this position in an appropriate way. If no mechanical setting and/or fixing is possible, the amount of the tare weight shall be written into the relevant list of milk recording data and shall be used for calculation of the real milk yield of each cow.

- The same test vessel must be used for weighing the milk from each animal over the whole recording session.

- The same person shall read the weights during the whole recording session.

- Final milk weight is read from the stable pointing device.

- The accuracy resolution of a spring balance has to be no less than 0.1 kg.
SECTION 11 APPENDIX 6.1 - APPLICATION EXAMPLE OF THE EXPECTED MILK YIELD METHOD

Table 11.8 Concordance correlations between measured milk yield and expected milk yield for different calculations (Rouzaut & Allain, 2011).

<table>
<thead>
<tr>
<th>Expected milk yield calculation</th>
<th>Concordance correlation ( X = 5 )</th>
<th>Concordance correlation ( X = 7 )</th>
<th>Concordance correlation ( X = 10 )</th>
<th>Data amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.946</td>
<td>0.947</td>
<td>0.948</td>
<td>52191</td>
</tr>
<tr>
<td>2</td>
<td>0.954</td>
<td>0.956</td>
<td>0.957</td>
<td>52191</td>
</tr>
<tr>
<td>3</td>
<td>0.935</td>
<td>0.936</td>
<td>0.935</td>
<td>53276</td>
</tr>
<tr>
<td>4</td>
<td>0.957</td>
<td>0.958</td>
<td>0.958</td>
<td>53276</td>
</tr>
</tbody>
</table>

Step 1: Calculation of expected milk yield

Example for calculation of expected milk yield using 5 last milkings at M1 for cow n°4044

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Measured milk yield (kg)</th>
<th>Herd yields average (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-06-04</td>
<td>( M_b )</td>
<td>( y_1 = 20.2 )</td>
<td>( h_1 = 14.7 )</td>
</tr>
<tr>
<td></td>
<td>( M_b )</td>
<td>( y_2 = 12.2 )</td>
<td>( h_2 = 9.5 )</td>
</tr>
<tr>
<td>2011-06-05</td>
<td>( M_b )</td>
<td>( y_1 = 18.8 )</td>
<td>( h_1 = 14.4 )</td>
</tr>
<tr>
<td></td>
<td>( M_b )</td>
<td>( y_2 = 10.2 )</td>
<td>( h_2 = 8.6 )</td>
</tr>
<tr>
<td>2011-06-06</td>
<td>( M_b )</td>
<td>( y_1 = 19.2 )</td>
<td>( h_1 = 14.4 )</td>
</tr>
<tr>
<td></td>
<td>( M_b )</td>
<td>( y_2 = 10.8 )</td>
<td>( h_2 = 9.1 )</td>
</tr>
<tr>
<td>2011-06-07</td>
<td>( M_b )</td>
<td>( y_1 = 16.3 )</td>
<td>( h_1 = 14.2 )</td>
</tr>
<tr>
<td></td>
<td>( M_b )</td>
<td>( y_2 = 10.3 )</td>
<td>( h_2 = 9.1 )</td>
</tr>
<tr>
<td>2011-06-08</td>
<td>( M_b )</td>
<td>( y_1 = 17.2 )</td>
<td>( h_1 = 14.4 )</td>
</tr>
<tr>
<td></td>
<td>( M_b )</td>
<td>( y_2 = 10.2 )</td>
<td>( h_2 = 8.6 )</td>
</tr>
<tr>
<td>2011-06-09</td>
<td>( M_b )</td>
<td>( y_1 = 18.4 )</td>
<td>( h_1 = 14.4 )</td>
</tr>
<tr>
<td></td>
<td>( M_b )</td>
<td>( y_2 = 10 )</td>
<td>( h_2 = 8.4 )</td>
</tr>
</tbody>
</table>

Therefore, expected milk yield estimation for current milking:

\[
\text{Expected Milk Yield} = \frac{\sum_{i=1}^{5} y_i}{5} \times \frac{h_1(\text{current milking})}{\sum_{i=1}^{5} h_i} = \frac{20.4 + 18.8 + 19.2 + 16.3 + 17.2}{5} \times \frac{14.4}{5} = 18.3 \text{ kg}
\]
Step 2: Calculation of cow deviation

Cow Deviation (kg) = Measured yield (kg) - Expected yield (kg)
= 18.4 - 18.3 = 0.1 kg

Step 3: Calculation of the milk meter deviation for one milking

Example: On the 2011-06-09, milking M1, milk meter n°5 (from a 28 stands rotary milking parlour)

<table>
<thead>
<tr>
<th>Cow</th>
<th>Expected yield (kg)</th>
<th>Cow deviation (kg)</th>
<th>Relative cow deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4044</td>
<td>18.3</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>7072</td>
<td>14.5</td>
<td>0.3</td>
<td>2.0</td>
</tr>
<tr>
<td>7138</td>
<td>14.7</td>
<td>-0.9</td>
<td>-6.5</td>
</tr>
<tr>
<td>7122</td>
<td>13.5</td>
<td>4.3</td>
<td>31.9</td>
</tr>
<tr>
<td>8541</td>
<td>13.0</td>
<td>2.1</td>
<td>13.9</td>
</tr>
</tbody>
</table>

Devi at ion (%) = $\frac{\text{Sum of cow deviations (kg) for this milk meter}}{\text{Sum of Expected yields (kg) of these cows for this milk meter}} \times 100 = \frac{0.1 + 0.3 + 0.9 + 2.1}{18.3 + 14.5 + 14.7 + 13.0} \times 100 = 2.6\%$

Table 11.9. Deviation calculation of milk meter n°5 in June 2011.

<table>
<thead>
<tr>
<th>Date</th>
<th>milking</th>
<th>Deviation (%)</th>
<th>Smoothing on 10 milkings (%)</th>
<th>Smoothing on 20 milkings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/06/2011</td>
<td>M1</td>
<td>0.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01/06/2011</td>
<td>M2</td>
<td>-2.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/06/2011</td>
<td>M1</td>
<td>-2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>02/06/2011</td>
<td>M2</td>
<td>-2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/06/2011</td>
<td>M1</td>
<td>-0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03/06/2011</td>
<td>M2</td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/06/2011</td>
<td>M1</td>
<td>-0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>04/06/2011</td>
<td>M2</td>
<td>2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05/06/2011</td>
<td>M1</td>
<td>-3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>05/06/2011</td>
<td>M2</td>
<td>-0.6</td>
<td>-0.8</td>
<td></td>
</tr>
<tr>
<td>06/06/2011</td>
<td>M1</td>
<td>-0.5</td>
<td>-0.9</td>
<td></td>
</tr>
<tr>
<td>06/06/2011</td>
<td>M2</td>
<td>-0.6</td>
<td>-0.8</td>
<td></td>
</tr>
<tr>
<td>07/06/2011</td>
<td>M1</td>
<td>2.3</td>
<td>-0.3</td>
<td></td>
</tr>
</tbody>
</table>
## Testing, approval and checking of milk recording devices

### Appendix Section 11

<table>
<thead>
<tr>
<th>Date</th>
<th>Milking</th>
<th>Deviation (%)</th>
<th>Smoothing on 10 milkings (%)</th>
<th>Smoothing on 20 milkings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/06/2011</td>
<td>M2</td>
<td>-4.3</td>
<td>-0.5</td>
<td></td>
</tr>
<tr>
<td>08/06/2011</td>
<td>M1</td>
<td>-0.3</td>
<td>-0.5</td>
<td></td>
</tr>
<tr>
<td>08/06/2011</td>
<td>M2</td>
<td>0.9</td>
<td>-0.4</td>
<td></td>
</tr>
<tr>
<td>09/06/2011</td>
<td>M1</td>
<td>2.6</td>
<td>-0.2</td>
<td></td>
</tr>
<tr>
<td>09/06/2011</td>
<td>M2</td>
<td>-2.2</td>
<td>-0.6</td>
<td></td>
</tr>
<tr>
<td>10/06/2011</td>
<td>M1</td>
<td>-0.3</td>
<td>-0.3</td>
<td></td>
</tr>
<tr>
<td>10/06/2011</td>
<td>M2</td>
<td>-1.6</td>
<td>-0.4</td>
<td>-0.6</td>
</tr>
<tr>
<td>11/06/2011</td>
<td>M1</td>
<td>5.9</td>
<td>0.2</td>
<td>-0.3</td>
</tr>
<tr>
<td>11/06/2011</td>
<td>M2</td>
<td>6.3</td>
<td>0.9</td>
<td>0.1</td>
</tr>
<tr>
<td>12/06/2011</td>
<td>M1</td>
<td>1.1</td>
<td>0.8</td>
<td>0.2</td>
</tr>
<tr>
<td>12/06/2011</td>
<td>M2</td>
<td>4.5</td>
<td>1.7</td>
<td>0.6</td>
</tr>
<tr>
<td>13/06/2011</td>
<td>M1</td>
<td>4.9</td>
<td>2.2</td>
<td>0.9</td>
</tr>
<tr>
<td>13/06/2011</td>
<td>M2</td>
<td>4.3</td>
<td>2.6</td>
<td>1.1</td>
</tr>
<tr>
<td>14/06/2011</td>
<td>M1</td>
<td>0.3</td>
<td>2.3</td>
<td>1.1</td>
</tr>
<tr>
<td>14/06/2011</td>
<td>M2</td>
<td>-2.9</td>
<td>2.3</td>
<td>0.8</td>
</tr>
<tr>
<td>15/06/2011</td>
<td>M1</td>
<td>-1.5</td>
<td>2.1</td>
<td>0.9</td>
</tr>
<tr>
<td>15/06/2011</td>
<td>M2</td>
<td>-4.3</td>
<td>1.9</td>
<td>0.7</td>
</tr>
<tr>
<td>16/06/2011</td>
<td>M1</td>
<td>-3.7</td>
<td>0.9</td>
<td>0.6</td>
</tr>
<tr>
<td>16/06/2011</td>
<td>M2</td>
<td>3.6</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>17/06/2011</td>
<td>M1</td>
<td>2.4</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>17/06/2011</td>
<td>M2</td>
<td>-1.9</td>
<td>0.1</td>
<td>0.9</td>
</tr>
<tr>
<td>18/06/2011</td>
<td>M1</td>
<td>0.3</td>
<td>-0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>18/06/2011</td>
<td>M2</td>
<td>-2.5</td>
<td>-1</td>
<td>0.8</td>
</tr>
<tr>
<td>19/06/2011</td>
<td>M1</td>
<td>-0.1</td>
<td>-1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>19/06/2011</td>
<td>M2</td>
<td>-3.5</td>
<td>-1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>20/06/2011</td>
<td>M1</td>
<td>1.4</td>
<td>-0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>20/06/2011</td>
<td>M2</td>
<td>-0.5</td>
<td>-0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>21/06/2011</td>
<td>M1</td>
<td>0.3</td>
<td>-0.1</td>
<td>0.4</td>
</tr>
<tr>
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<td>-0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>22/06/2011</td>
<td>M2</td>
<td>-2.1</td>
<td>-0.6</td>
<td>-0.3</td>
</tr>
<tr>
<td>23/06/2011</td>
<td>M1</td>
<td>-0.1</td>
<td>-0.7</td>
<td>-0.5</td>
</tr>
<tr>
<td>23/06/2011</td>
<td>M2</td>
<td>-1.5</td>
<td>-0.6</td>
<td>-0.8</td>
</tr>
<tr>
<td>24/06/2011</td>
<td>M1</td>
<td>-1.4</td>
<td>-0.7</td>
<td>-0.9</td>
</tr>
<tr>
<td>24/06/2011</td>
<td>M2</td>
<td>-4.6</td>
<td>-0.8</td>
<td>-1</td>
</tr>
<tr>
<td>25/06/2011</td>
<td>M1</td>
<td>-1.7</td>
<td>-1.1</td>
<td>-1</td>
</tr>
<tr>
<td>25/06/2011</td>
<td>M2</td>
<td>-2.9</td>
<td>-1.4</td>
<td>-0.9</td>
</tr>
<tr>
<td>26/06/2011</td>
<td>M1</td>
<td>2.5</td>
<td>-1.1</td>
<td>-0.6</td>
</tr>
<tr>
<td>26/06/2011</td>
<td>M2</td>
<td>-4.8</td>
<td>-1.5</td>
<td>-1</td>
</tr>
<tr>
<td>27/06/2011</td>
<td>M1</td>
<td>3.3</td>
<td>-1.3</td>
<td>-1</td>
</tr>
<tr>
<td>27/06/2011</td>
<td>M2</td>
<td>1.6</td>
<td>-1</td>
<td>-0.8</td>
</tr>
<tr>
<td>28/06/2011</td>
<td>M1</td>
<td>-1.9</td>
<td>-1.1</td>
<td>-0.9</td>
</tr>
<tr>
<td>28/06/2011</td>
<td>M2</td>
<td>3.3</td>
<td>-0.7</td>
<td>-0.6</td>
</tr>
<tr>
<td>29/06/2011</td>
<td>M1</td>
<td>-2.2</td>
<td>-0.7</td>
<td>-0.7</td>
</tr>
<tr>
<td>29/06/2011</td>
<td>M2</td>
<td>0.9</td>
<td>-0.2</td>
<td>-0.5</td>
</tr>
<tr>
<td>30/06/2011</td>
<td>M1</td>
<td>1.5</td>
<td>0.1</td>
<td>-0.5</td>
</tr>
<tr>
<td>30/06/2011</td>
<td>M2</td>
<td>2.8</td>
<td>0.7</td>
<td>-0.3</td>
</tr>
</tbody>
</table>
Step 4: Milk meter average deviation calculation

Example for the last 10 milkings (26th to 30th of June from table 11.9):
Average deviation (%) = Average deviation from the last 10 milkings =
\[
\frac{2.8 + 1.5 + 0.9 - 2.2 + 3.3 - 1.9 + 1.6 + 3.3 - 4.8 + 2.5}{10} = 0.7\% \rightarrow \text{Correct milk meter}
\]

Example for the last 20 milkings (21th to 30th of June from table 11.9):
Average deviation (%) = average deviation from the last 20 milkings =
\[
\frac{(2.8 + 1.5 + 0.9 - 2.2 + 3.3 - 1.9 + 1.6 + 3.3 - 4.8 + 2.5 - 2.9 - 1.7 - 4.6 - 1.4 - 1.5 - 0.1 - 2.1 + 1.8 - 1.3 + 0.3)}{20} = 0.3\% \rightarrow \text{Correct milk meter}
\]

A graphic representation of the results on a longer period can also be done. That allows visualizing the deviation evolution and the occasional events occurring on the last weeks.

An example of a graphic representation for one milk meter (n°5) on the month of June is shown below. Three curves are represented: no smoothing, smoothing on 10 milkings and on 20 milkings.
### SECTION 11 APPENDIX 6.2 - APPLICATION EXAMPLE OF THE COMPARISON BETWEEN AMS AND TANK

**Step 1: Calculation of the milk meter deviation for one collection**

Example of data recorded by an AMS between 2 milk collections (from the 16 to 18 April):

<table>
<thead>
<tr>
<th>Milking start</th>
<th>Milking end</th>
<th>Cow id</th>
<th>Milk yield (kg)</th>
<th>Milk Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>16/04/2011 12:08</td>
<td>16/04/2010 12:15</td>
<td>51</td>
<td>9.7</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 12:16</td>
<td>16/04/2010 12:23</td>
<td>58</td>
<td>14</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 12:23</td>
<td>16/04/2010 12:31</td>
<td>45</td>
<td>7.5</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 12:31</td>
<td>16/04/2010 12:40</td>
<td>4</td>
<td>13.8</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 12:40</td>
<td>16/04/2010 12:53</td>
<td>19</td>
<td>11.8</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 13:29</td>
<td>16/04/2010 13:44</td>
<td>33</td>
<td>19.5</td>
<td>Tank</td>
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<tr>
<td>16/04/2011 13:51</td>
<td>16/04/2010 14:08</td>
<td>60</td>
<td>10.9</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 14:08</td>
<td>16/04/2010 14:19</td>
<td>53</td>
<td>9.9</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 14:19</td>
<td>16/04/2010 14:30</td>
<td>37</td>
<td>8.1</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 14:31</td>
<td>16/04/2010 14:37</td>
<td>11</td>
<td>6.2</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 18:14</td>
<td>16/04/2010 18:27</td>
<td>26</td>
<td>10.2</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 18:28</td>
<td>16/04/2010 18:38</td>
<td>24</td>
<td>11.3</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 18:38</td>
<td>16/04/2010 18:47</td>
<td>16</td>
<td>17.2</td>
<td>Tank</td>
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<tr>
<td>16/04/2011 18:48</td>
<td>16/04/2010 18:57</td>
<td>42</td>
<td>11.6</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 18:58</td>
<td>16/04/2010 19:06</td>
<td>15</td>
<td>10.2</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 19:07</td>
<td>16/04/2010 19:15</td>
<td>38</td>
<td>7.1</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 19:26</td>
<td>16/04/2010 19:36</td>
<td>32</td>
<td>12.5</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 19:37</td>
<td>16/04/2010 19:44</td>
<td>56</td>
<td>16.2</td>
<td>Tank</td>
</tr>
<tr>
<td>16/04/2011 19:44</td>
<td>16/04/2010 19:50</td>
<td>5</td>
<td>15.5</td>
<td>Tank</td>
</tr>
<tr>
<td>18/04/2011 11:40</td>
<td>17/04/2010 11:46</td>
<td>59</td>
<td>16.7</td>
<td>Tank</td>
</tr>
<tr>
<td>18/04/2011 11:46</td>
<td>17/04/2010 11:53</td>
<td>48</td>
<td>14.5</td>
<td>Tank</td>
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<tr>
<td>18/04/2011 11:53</td>
<td>17/04/2010 12:00</td>
<td>9</td>
<td>11.1</td>
<td>Drain</td>
</tr>
<tr>
<td>18/04/2011 14:15</td>
<td>17/04/2010 14:26</td>
<td>41</td>
<td>19.2</td>
<td>Tank</td>
</tr>
</tbody>
</table>

Sum of milk weights recorded by AMS and sent to the tank between the 2 collections

= 0.3%
Table 11.10. Deviation calculation of the milk meter on several milk collections

<table>
<thead>
<tr>
<th>Collection date</th>
<th>Collection time</th>
<th>Tank volume (l)</th>
<th>Milk weight in the tank (kg)</th>
<th>Sum of milk yields measured by the milk meter (kg)</th>
<th>Deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16/04/2011</td>
<td>13:05</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>18/04/2011</td>
<td>13:05</td>
<td>2400</td>
<td>2481.6</td>
<td>2475</td>
<td>-0.3</td>
</tr>
<tr>
<td>20/04/2011</td>
<td>13:05</td>
<td>2494</td>
<td>2578.8</td>
<td>2575</td>
<td>-0.2</td>
</tr>
<tr>
<td>22/04/2011</td>
<td>13:05</td>
<td>2434</td>
<td>2516.8</td>
<td>2509.6</td>
<td>-0.3</td>
</tr>
<tr>
<td>24/04/2011</td>
<td>13:05</td>
<td>2321</td>
<td>2399.9</td>
<td>2389.1</td>
<td>-0.5</td>
</tr>
<tr>
<td>26/04/2011</td>
<td>13:05</td>
<td>2364</td>
<td>2444.4</td>
<td>2424.9</td>
<td>-0.8</td>
</tr>
</tbody>
</table>

**Step 2: Average deviation calculation**

Average deviation for the last 3 collections (22 to 26 April from table 11.10):

Average deviation (%) = \[ \frac{\sum_{i=1}^{3} (\text{Milk weights measured by AMS milk meter})i \sum_{i=1}^{3} (\text{Collected milk})i}{\sum_{i=1}^{3} (\text{Collected milk})i} * 100 \]

= \[ \frac{(2429.9 + 2389.1 + 2509.6)(2444.4 + 2399.9 + 2516.8)}{2444.4 + 2399.9 + 2516.8} * 100 \rightarrow 0.5\% \text{ correct milk meter} \]

Average deviation for the last 5 collections (18 to 26 April from table 11.10):

Average deviation (%) = \[ \frac{\sum_{i=1}^{5} (\text{milk weights measured by AMS milk meter})i \sum_{i=1}^{5} (\text{collected milk})i}{\sum_{i=1}^{5} (\text{collected milk})i} * 100 \]

= \[ \frac{(2429.9 + 2389.1 + 2509.6 + 2575 + 2475)(2444.4 + 2399.9 + 2516.8 + 2578.8 + 2481.6)}{2444.4 + 2399.9 + 2516.8 + 2578.8 + 2481.6} * 100 \rightarrow 0.4\% \text{ correct milk meter} \]
A graphic representation of the results allows visualizing the deviation evolution.
SECTION 11 APPENDIX 7 - SURVEY OF APPROVED METERS

List of approved milkmeters for cattle

The updated list of ICAR approved milkmeters for cattle is available on web at:
www.icar.org/pages/Sub_Committees/sc_recording_devices_approved_milkmeters.htm

List of provisionally approved milkmeters for cattle

The updated list of ICAR provisionally approved milkmeters for cattle is available on web at:
www.icar.org/pages/Sub_Committees/sc_recording_devices_approved_milkmeters.htm

List of the approved milk meters for sheep and goats

The updated list of ICAR approved milkmeters for sheep and goats is available on web at:
www.icar.org/pages/Sub_Committees/sc_recording_devices_approved_milkmeters_sheep-goats.htm

Provisional list of approved Jars

Milk jars

The milk jars of the different manufacturers which to fulfill the guidelines in Part 5 and had a national approval on 1 January 1992 in at least three member countries are considered as approved. New types have to be fully tested.

The updated list of Provisional approved jars for cattle by ICAR is available on web at:
www.icar.org/pages/Sub_Committees/sc_recording_devices_approved_jars.htm
SECTION 12 APPENDIX I - RECOMMENDATIONS FOR ANALYTICAL QUALITY CONTROL IN MILK TESTING LABORATORIES

It is to be expected that meeting these requirements will provide a satisfactory minimum quality level for analytical measurements, as well as comparability between laboratories and countries. If the following scheme cannot be immediately applied, it should be considered as a target.

A - Components of a quality control and recommended frequencies

<table>
<thead>
<tr>
<th>Control</th>
<th>Frequencies</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• - External control</td>
<td>Quarterly</td>
<td>IPS</td>
</tr>
<tr>
<td>• - Internal control</td>
<td>Weekly (for each check of the mean bias)</td>
<td>CRMs, SRMs, IRMs</td>
</tr>
<tr>
<td>Routine methods</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• - External control</td>
<td>Quarterly</td>
<td>IPS/IEC</td>
</tr>
<tr>
<td>• - Internal control</td>
<td>(See b)</td>
<td>IRMs</td>
</tr>
</tbody>
</table>

IPS: Interlaboratory Proficiency Study.
CRMs: Certified Reference Materials.
IEC: Individual External Control.
SRMs: Secondary Reference Materials.
IRMs: In-house Reference Materials.
B - Frequencies and limits for checking routine methods

Frequencies and limits stated hereafter are for a part defined in existing ISO | IDF standards or are derived from contained recommendations. Other values are tentative, therefore indicative and provisional, as they are not yet defined in a standard. Experience will show whether or not the latter ones are suitable for all laboratories.

Limits stated below are proposed as "action limits" for internal instrument management. They should only be considered as technical information to users and not be used for external evaluations for which other (larger) values can appear more suitable.

<table>
<thead>
<tr>
<th>Checks</th>
<th>Frequencies</th>
<th>F</th>
<th>P</th>
<th>L</th>
<th>Limits</th>
<th>SCC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instrumental fittings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Homogenization</td>
<td>Monthly</td>
<td>≤ 0.05 % units or ≤ 1.43 % relative</td>
<td>(a)</td>
<td>none</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Carry-over</td>
<td>Monthly</td>
<td>≤ 1 %</td>
<td>(a)</td>
<td>(≤ 2 %)</td>
<td>(c)</td>
<td></td>
</tr>
<tr>
<td>• Linearity (curving)</td>
<td>Quarterly</td>
<td>≤ 1 % of range</td>
<td>(a)</td>
<td>(≤ 2 % of range)</td>
<td>(c)</td>
<td></td>
</tr>
<tr>
<td>• Intercorrection</td>
<td>Quarterly</td>
<td>+/-0.02</td>
<td>(a)</td>
<td>none</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Calibration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mean bias</td>
<td>Weekly</td>
<td>+/-0.02 %</td>
<td>(b)</td>
<td>+/-5 % relative</td>
<td>(b)</td>
<td></td>
</tr>
<tr>
<td>• Slope</td>
<td>Quarterly</td>
<td>1.00 +/-0.02</td>
<td>(b)</td>
<td>1.00 +/-0.05</td>
<td>(b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.00 +/-0.03) (*)</td>
<td>(c)</td>
<td>(1.00 +/-0.07) (*)</td>
<td>(c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.00 +/-0.05) (**)</td>
<td>(c)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall daily stability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Repeatability (sr)</td>
<td>Daily/every</td>
<td>0.014 %</td>
<td>(a)</td>
<td>5 % relative</td>
<td>(a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start-up</td>
<td>0.020 %</td>
<td>(a)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>• Daily/short-term stability</td>
<td>≥ 3/hour</td>
<td>+/-0.05 % units</td>
<td>(a)</td>
<td>+/-10 % relative</td>
<td>(b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥ 4/day</td>
<td>+/-0.03 % units</td>
<td>(c)</td>
<td>(≤ 5000 μg/ml)</td>
<td>(c)</td>
<td></td>
</tr>
</tbody>
</table>

(a): Limit stated in ISO 9622 | IDF 141 or ISO 13366 | IDF 148
(b): Limit stemming from specifications of ISO 9622 | IDF 141 or ISO 13366 | IDF 148
(c): Tentative (indicative) limit as there is no value specified in corresponding international standards
(*) Limit for first generation instruments
(**) Limit for lactose
Note 1: In case calculated values are out of limits but do not differ from a statistical point of view, adjustments in instrumental settings are not justified. Therefore, representative and/or adequate sample sets should be chosen or prepared in such a way that any outside value should be significant. Relevant aspects in this are type and number of samples, number of replicates and level of concentration.

Note 2: a) Milk with high fat and protein concentrations (milk of buffaloes, ewes, and particular cow and goat species): Because of variable high fat and protein contents, reliable limits for repeatability and short-term stability can be determined by multiplying limits for cows by the ratio of buffaloes (or ewes) average level versus cows average level.

b) Goats milk: Limits can be the same as for cows milk in case of similar fat and protein content. In case of high fat and protein contents, one will operate according to a).

C - Recalls about checkings

- **Check on homogenisation**: In infra-red analysis, the natural size of fat globules strongly affects the measurement of fat, therefore a fat size reduction is applied through an homogenisation before the measurement. Inefficient homogenisation results in poor repeatability and drifts of the signal.

- **Check on carry-over**: Successive samples with strong different of component levels may be affected by the former milk either by the residual volume of milk in the flow system or by the contamination by the stirrer and the input pipe. As an effect of a constant dilution, the error is a proportion of the difference of concentration with the previous sample. The overall carry-over effect should be minimised and, in all cases, should not exceed limits stated.

- **Check on linearity**: Specific sets of samples are prepared in order to cover the whole range of concentration and check that the instrumental measurement is proportional to the concentration of the component measured. The percentage of the bending can be estimated by the ratio (range of the residuals observed) x 100 / (range of the levels).

- **Check on intercorrections**: Specific sets of samples are prepared in order to create independent modification in respective components and verify that changes in one particular component do not affect significantly the measurement of the other components. Intercorrections are set in order to compensate the natural interactions due to a incomplete specificity of methods. The larger the range of concentrations of the correcting channel, the bigger the potential error due to an inadequate intercorrection adjustment for the corrected channel.

- **Check on the mean bias**: Representative milk samples are used to check the validity of the calibration at a medium level and prevent any drift which could occur from changes in milk composition or progressive wear of instruments. Checking that the zero and the mean bias fit the stated limits provides assurance for the maintenance of the calibration on the whole range.

- **Check on the slope**: Specific sets of samples are prepared in order to cover the whole range of levels and check that the slope is within the stated limits. It is aimed at that differences between instrumental values and reference values should not be proportional to the level but constant on the whole range. The larger the range of concentrations, the bigger the error for extreme values in case of an inadequate slope adjustment.
• **Repeatability**: Repeatability check is the simplest test indicating whether or not the instrument is working properly. Repeatability is evaluated at the start-up of each instrument on the basis of 10 times replicate analysis of one (control) milk sample. During routine testing a regular test can be made by analysing a set of 20 different individual samples in two successive runs. The estimate of the standard deviation of repeatability should meet stated limits.

• **Daily and short-term stability**: Every day and regularly along a working day, the so-called control samples (or pilot samples) are used to check instruments fitting at a medium level. Differences observed against assigned values should not exceed the stated limits +/-L. It is advised to complete the control using the calculation of the cumulative mean of the n successive differences which should not exceed the limits +/-L/ n.

• **Zero-setting**: Rinsing the flow system and checking the “zero value” are periodically required to prevent milk matter deposit on the walls of the measurement cells and/or (depending on instruments) to detect any drift of the basic signal.
### Appendix 2.1 International reference methods

<table>
<thead>
<tr>
<th>Component</th>
<th>Method</th>
<th>Reference Standards</th>
</tr>
</thead>
<tbody>
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<td><strong>Casein</strong></td>
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<td><strong>Lactose</strong></td>
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<tr>
<td><strong>Urea</strong></td>
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</tr>
<tr>
<td><strong>Somatic cell count</strong></td>
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</tbody>
</table>

**Fat**

- Gravimetric method (Röse-Gottlieb) ISO 1211 | IDF 1
- Gravimetric method (modified Mojonnier) AOAC 905.02 (IDF-ISO-AOAC-Codex)
- AOAC 993.05 (IDF-ISO-AOAC)

**Protein**

- Titrimetric method (Kjeldahl) ISO 8968 | IDF 20
- AOAC 991:20 (IDF-ISO-AOAC)
- AOAC 991:21
- AOAC 991:22 (IDF-ISO-AOAC)
- AOAC 991:23 (IDF-ISO-AOAC-Codex)

**Casein**

- Titrimetric method (Kjeldahl) ISO 17997 | IDF 29
- AOAC 927.03
- AOAC 998.05
- AOAC 998.06
- AOAC 998.07

**Lactose**

HPLC method is foreseen to provide the reference to routine methods by ISO | IDF and its international standardisation is underway (ISO DIS 22662 | IDF 198). In the meantime, standardised methods as referred to in “Part II, other methods” can be used.

**Urea**

- Differential pH-method (Reference method) ISO 14637 | IDF 195

**Somatic cell count**

- Microscope method (Reference method) ISO 13366-1 | IDF 148-1
## Appendix 2.2 Other methods (secondary reference)

<table>
<thead>
<tr>
<th>Fat</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Butyrometric method (Gerber)</td>
<td>ISO 2446</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>AOAC 2000.18</td>
</tr>
<tr>
<td>Babcock</td>
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<td>AOAC 989.04</td>
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<table>
<thead>
<tr>
<th>Protein</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Dye-binding (Amido Black)</td>
<td>ISO 5542</td>
<td>IDF 98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AOAC 975.17 (IDF-ISO-AOAC)</td>
</tr>
<tr>
<td>Dye-binding (Orange 12)</td>
<td>ISO 967.12</td>
<td></td>
</tr>
<tr>
<td>Dumas method</td>
<td>ISO 14891</td>
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</table>

<table>
<thead>
<tr>
<th>Lactose</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enzymatic</td>
<td>ISO 5765</td>
<td>IDF 79</td>
</tr>
<tr>
<td>AOAC 984.15</td>
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<tr>
<td>Gravimetric</td>
<td>AOAC 930.28</td>
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<tr>
<td>Polarimetric</td>
<td>AOAC 896.01</td>
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<table>
<thead>
<tr>
<th>Under standardisation</th>
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</thead>
<tbody>
<tr>
<td>High Performance Liquid Chromatography</td>
<td>ISO DIS 22662</td>
<td>IDF 198</td>
</tr>
<tr>
<td>Differential pH-method</td>
<td>ISO WD</td>
<td>IDF (working draft)</td>
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</table>

## Appendix 2.3 Standardized routine methods

<table>
<thead>
<tr>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Automated turbidimetric I</td>
<td>AOAC 969.16</td>
<td></td>
</tr>
<tr>
<td>Automated turbidimetric II</td>
<td>AOAC 973.22</td>
<td></td>
</tr>
<tr>
<td>Automated dye-binding (Amido Black)</td>
<td>AOAC 975.17</td>
<td>(FIL-ISO-AOAC)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Protein</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated dye-binding (Amido Black)</td>
<td>AOAC 975.17</td>
<td>(FIL-ISO-AOAC)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fat-protein-lactose</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid infra red (MIR) spectrometric</td>
<td>ISO 9622</td>
<td>IDF 141</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AOAC 972.16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Urea</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(taken into account with the underway revision of ISO 9622</td>
<td>IDF 141)</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Somatic cell count</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic particle counter (Coulter Counter)</td>
<td>International standards withdrawn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AOAC 978.26</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 2.4 Instrumental routine methods used in ICAR countries

The following list was drawn up with answers to ICAR questionnaires of 1994 and 1996, since then supplemented with new validated analysers. Methods/instruments not produced or used any longer are indicated in italic characters.

<table>
<thead>
<tr>
<th>Fat</th>
<th>Turbidimetric method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• MilkoTester (Foss Electric, DK)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fat and protein</th>
<th>Turbidimetric/dye-binding:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• MTA-PMA (Foss Electric, DK)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fat, protein (and lactose)</th>
<th>Mid infra-red spectrometry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• MilkoScan (Foss Electric, DK)</td>
</tr>
<tr>
<td></td>
<td>102, 103, 104, 104 (A/B)</td>
</tr>
<tr>
<td></td>
<td>133 A, 133 B, 134 (A/B)</td>
</tr>
<tr>
<td></td>
<td>203 A, 203 B, 300</td>
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<tr>
<td></td>
<td>255 (A or B), 605 (A or B)</td>
</tr>
<tr>
<td></td>
<td>Series 4000 (A or B)</td>
</tr>
<tr>
<td></td>
<td>FT 120 (FTIR)</td>
</tr>
<tr>
<td></td>
<td>FT 6000 (FTIR)</td>
</tr>
<tr>
<td></td>
<td>• Multispec (Multispec, UK)</td>
</tr>
<tr>
<td></td>
<td>MK 1</td>
</tr>
<tr>
<td></td>
<td>MK 2</td>
</tr>
<tr>
<td></td>
<td>Micro-null</td>
</tr>
<tr>
<td></td>
<td>• Bentley (Bentley, USA)</td>
</tr>
<tr>
<td></td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>2000 (A or B)</td>
</tr>
<tr>
<td></td>
<td>• Lactoscope (Delta Instruments, NL)</td>
</tr>
<tr>
<td></td>
<td>300, 550, 750, Filter Automatic 200,</td>
</tr>
<tr>
<td></td>
<td>Filter Automatic 400, FTIR Auto 400</td>
</tr>
<tr>
<td></td>
<td>• Aegys (Anadis Instruments, F)</td>
</tr>
<tr>
<td></td>
<td>Mi 600 (FTIR)</td>
</tr>
</tbody>
</table>
# Urea

<table>
<thead>
<tr>
<th>Colorimetric methods</th>
<th>Automated enzymatic methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4 paradimethylaminobenzaldehyde method (DMAB)</td>
<td>Conductimetry Beckmann, BUN Analyser</td>
</tr>
<tr>
<td></td>
<td>UV-photometry Flow injection analysis (FIA).</td>
</tr>
<tr>
<td></td>
<td>Visible-photometry Chemspec 150 (Bentley, USA), Skalar Segmented flow analysis</td>
</tr>
</tbody>
</table>

## Mid Infra-Red Spectrometry:
- Milkoscan (Foss Electric, DK) 4000, FT 120 (FTIR), FT 6000 (FTIR)
- Lactoscope (Delta Instruments) FTIR Auto 400
### Somatic cell count

<table>
<thead>
<tr>
<th>Method</th>
<th>Manufacturer</th>
<th>Model Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particle counting</td>
<td>Coultronic (UK)</td>
<td>Coulter Counter</td>
</tr>
<tr>
<td>Fluoro-opto-electronic</td>
<td>Foss Electric (DK)</td>
<td>Fossomatic 90, 180, 215, 250, 360, 400</td>
</tr>
<tr>
<td>Disk cytometry</td>
<td>Foss Electric (DK)</td>
<td>Fossomatic 5000</td>
</tr>
<tr>
<td>Flow cytometry</td>
<td>Anadis (F)</td>
<td>Somatic Cell Counter 300, 500</td>
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<tr>
<td></td>
<td>Bentley (USA)</td>
<td>Somacount 150, 300, 500</td>
</tr>
<tr>
<td></td>
<td>Chemunex (D)</td>
<td>Partec CA 11</td>
</tr>
<tr>
<td></td>
<td>Delta Instruments (NL)</td>
<td>Somascope MKII Manual, MKII Auto 200, MKII Auto 400</td>
</tr>
<tr>
<td></td>
<td>Foss Electric (DK)</td>
<td>Fossomatic 5000</td>
</tr>
</tbody>
</table>
SECTION 13 APPENDIX A - APPROVAL PROCEDURE THROUGH INDEPENDENT NATIONAL EVALUATIONS / APPROVALS

13.1. Before the approval request to ICAR

The instrument has been submitted for evaluation in three countries according to the milk analyser evaluation protocol of ICAR and with results meeting requirements as defined in the protocol. Reports are to be collected by the manufacturer or the requesting organisation.

13.2. Request for approval

The approval request is sent to the General Secretariat by the manufacturer or the requesting organisation together with the (three) evaluation reports and the subsequent national approvals by competent bodies. The forms to be used are appended in Annexes D and E. The General Secretariat registers the request and transmits it to the examination committee with the appropriate documents (files). The examination committee is composed of at least three experts designated by and who may be members of MA SC.

13.3. Examination and decision delivery

Reports are examined by the experts and, if needed, discussed on the occasion of a meeting with MA SC. Otherwise, general position (positive or negative) and eventual comments can be made by examiners through a standard template for every point evaluated (Annex F). In case a negative decision is taken, it is fully explained and argued. The period of examination should not exceed two months from ICAR Secretariat dispatch.
The examination committee comes to its conclusion, which is then circulated for agreement to the working group. When not agreed, a further re-examination is required to reach final consensus (within two months), otherwise the chair informs the General Secretariat of the decision of the group:

a) Positive: Endorsement by ICAR Board, addition into the list of instruments approved by ICAR, publication in ICAR Newsletter and on the website of MA SC (list of instruments with date of ICAR approval delivery); three reports available on request.

b) Negative: All possible remarks and comments on elements of the instrument/method or the evaluation necessary to be improved must be fixed before a further approval request.

13.4. Cost of administrative accounting and technical examination

The requesting organisation is charged the administrative costs of the entire process (i.e. registration, examination of technical data, publication). A fixed amount in Euros (exclusive of VAT) is established by Service-ICAR SRL and reviewed every year. It is invoiced to the requester at the opening of each case.

13.5. ICAR approval delivery

On the basis of a positive conclusion from the Sub-Committee on Milk Analysis, the ICAR Board endorses the ICAR approval which is officially delivered to the manufacturer or the requesting organisation and announced via the usual ICAR communication media after all fees have been paid.
SECTION 13 APPENDIX B - DIRECT INTERNATIONAL EVALUATION / APPROVAL

13.1. Request for evaluation and approval

The manufacturer addresses a formal request to the General Secretary of ICAR for evaluation, aiming to obtain ICAR approval of a well defined analyser. Any technical description and information on the measurement principle and functioning must be included with the request.

13.2. Process

ICAR General Secretariat registers and transmits the request with the appropriate documents to the Sub-Committee on Milk Analysis which will advise ICAR on technical admissibility (principle, functionality, fit-to-purpose) within one month. The consultation committee is composed of at least three expert members of the Milk Analysis Sub-Committee (MASC).

ICAR will liaise with the manufacturer in order to agree on the organisation and costs of the evaluation. The decision will be made on the three countries and competent laboratories from a list of accredited laboratories recognised as competent in analyser evaluation by ICAR.

ICAR will liaison with the evaluating laboratories to make the agreement on the task to undertake according to the ICAR evaluation protocol for milk analysers and agree on financial compensation through ICAR.

ICAR will make a quotation of all the costs for further invoicing to the manufacturer and will make a contract on the basis defined with the manufacturer.

Involved laboratories carry out evaluations and produce reports according to the ISO-IDF protocol and requirements. They are requested to fill in the summary table of results for their respective parts that will be collated in a single table by the ICAR Secretariat.

ICAR (Service-ICAR) will pay laboratories for their services and will invoice the manufacturer for the same amounts, plus the cost of overall organisation by ICAR and technical examination within ICAR.

13.3. Examination and decision delivery

Idem Annex 13A

13.4. Cost of administrative accounting and technical examination

Idem Annex 13A

13.5. ICAR approval delivery

Idem Annex 13A
SECTION 13 APPENDIX C - ALTERNATIVE COMPARISON FOR THE EVALUATION OF A MILK ANALYSER DERIVING FROM AN ALREADY APPROVED ANALYSER

Since the modification of the new analyser from the former device version includes only minor changes such as software upgrading or changes claimed as of negligible influence on the analytical precision (e.g. performance speed increase), a simplified method can be applied to avoid, where possible, an intensive and costly comparison against reference methods.

A previously approved instrument (e.g. a former version of the instrument tested, that is similar with regard to the principle and hardware), with every technical guarantee that the analytical response is not altered, can be used to verify whether the new instrument shows similar behaviour in term of trueness (mean and standard deviation of differences) and repeatability (ranges between duplicates).

13.1. Instruments

The former approved device and the new evaluated device must be compared under repeatability conditions i.e. same location and environmental conditions, no or little delays between each device testing, with same samples and same number of replicates (minimum 2 required).

13.2. Samples

The samples should be of the best physicochemical quality. They should be carefully split in the appropriate number of sub-samples fitting to the number of replicates so as to keep the results of replication series independent of the former testing (e.g. 4 sets of vials required for duplicate series on each of both instruments).

13.3. Analyses

They must be performed in compliance with ISO 8196-3 with special respect to the sample numbers and replicate numbers stated and after both devices have been calibrated with the same calibration sample set in compliance with ISO 8196-2.

13.4. Repeatability

Same calculations as in ISO 8196-3 are performed. Both devices must show repeatability values complying with the limit of repeatability of the standard.

13.5. Trueness

The same type previously approved device is used as the reference method. The same data analysis as in ISO 8196-3 is performed, including detection of possible outliers and covering parameters such as mean of differences and standard deviation of differences. The slope must comply with limits derived from the repeatability error as follows:
### 13.6. Compliance

If compliance with the stated limits is not achieved, then it can be concluded that either one (or both) of the two compared instruments is (are) not optimised. Hence the problematic instrument(s) should be appropriately adjusted and the comparison be redone. When non-compliance persists, it is concluded that the two methods are different and the manufacturer is reverted to a classical evaluation against the reference method.

#### Note

**a)** Usual practice is to use distinct sample vial sets per device so as to prevent sample handling and re-heating from being potential sources of error and sample damage. Nevertheless, abnormal residuals, so-called outlier bias to the regression line, can stem from insufficient sample set quality (e.g. sample damage or imperfect sample splitting for distinct sample vial sets per device). Confirmation that vial contents are actually different can be made through re-testing (with other devices) the pair of vials of the outlier sample. If compliance cannot be achieved because of the presence of outliers, calculate and report results with and without outliers.

**b)** If compliance is achieved for repeatability but not for accuracy and if milk quantity allows, re-analyse the sample set of the evaluated device with the previously approved device in duplicate. Compliance with duplicate testing could indicate an effect of the sample set. Re-evaluate with another sample preparation assuring the lowest standard deviation between samples as measured by the sample homogeneity test, e.g. not exceeding 0.008 % fat.

**c)** If non compliance for accuracy is confirmed, investigate linearity and milk component interactions (re inter-corrections in MIR analysis).

**d)** If compliance cannot be reached through optimising linearity and correcting milk component interactions of either of the devices, the conclusion must be that the devices perform different.
SECTION 13 APPENDIX D - REQUEST FORM FOR MILK ANALYSER APPROVAL BY ICAR

- REQUEST FORM FOR MILK ANALYSER APPROVAL BY ICAR -

Requesting organisation (name): ................................................................. Country: ........................................

Address: ............................................................................................................ Phone: ........................................

............................................................................................................ Fax: ........................................

............................................................................................................ E-mail: ........................................

represented by (Mr, Mrs): ................................................................. Function: ........................................

hereby makes the request to ICAR to grant ICAR international approval to the milk analyser designated here below for the application in milk recording specified in the following:

Manufacturer (name)

Instrument (name)

- Type

- Configuration (*)

- Analytical principle


<table>
<thead>
<tr>
<th>Animal species</th>
<th>Cow</th>
<th>Sheep</th>
<th>Goat</th>
<th>Buffalo</th>
<th>Other</th>
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<tbody>
<tr>
<td>- milk components / criteria tested :</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td></td>
</tr>
<tr>
<td>⇒ Protein (P)</td>
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<td></td>
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<tr>
<td>⇒ Lactose (L)</td>
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<tr>
<td>⇒ Urea (U)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>⇒ Somatic cells (SCC)</td>
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<tr>
<td>⇒</td>
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</table>

- maximum testing rate (nr test/hour)

(*) e.g. alone / combined

Enclosed documents as proof of the three required national approvals:

Countries (name)

Evaluation centers/organisations (name)

Official national approval certificates (doc n°)

Technical reports (doc n°)

Date: ........................................

Signature: ........................................

Return to: ICAR Secretariat, Service ICAR, Via G. Tomassetti 3, 00161 Rome, Italy

Tel: +39/ 0644 20 26 39 – Fax: +39/ 06 44 26 67 98 – e-mail: icar@icar.org
## Appendix E - Summary Form for Assessment Results of a Milk Analyser Evaluation

<table>
<thead>
<tr>
<th>Requesting organisation</th>
<th>Instrument / Type / Manufacturer</th>
<th>Animal species</th>
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</thead>
</table>

### Evaluation Centre
- Country

### Reference Method

#### Evaluation Centre (units)

<table>
<thead>
<tr>
<th>Evaluation criteria (units)</th>
<th>FAT (g/100 g)</th>
<th>PROTEIN (g/100 g)</th>
<th>LACTOSE (g/100 g)</th>
<th>UREA (mg/100 g)</th>
<th>SOMATIC CELLS (1000 cells/ml or %relative)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eval 1</td>
<td>Eval 2</td>
<td>Eval 3</td>
<td>Eval 1</td>
<td>Eval 2</td>
</tr>
</tbody>
</table>

#### Evaluation
- Mean of reference values \( \bar{y} \)
- SD of reference values \( s_y \)

#### Carry over ratio

#### Linearity \( \Delta y/\Delta x \)

#### Repeatability
- Average SD \( s_\text{Avg} \)
- Relative SD \( s_\text{Rel} \):
  - Average \( s_\text{Avg} \%
  - Low level \( s_\text{Low} \%
  - Medium level \( s_\text{Med} \%
  - High level \( s_\text{High} \%

#### Within lab reproducibility
- Average SD \( s_\text{Avg} \)
- Relative SR \( s_\text{SR} \):
  - Average \( s_\text{Avg} \%
  - Low level \( s_\text{Low} \%
  - Medium level \( s_\text{Med} \%
  - High level \( s_\text{High} \%

#### Accuracy
- Animal samples \( s_\text{Animal} \)
- N° animal samples \( N_a \)
- N° herds \( N_h \)
- Herd samples \( s_\text{Herd} \)
- N° herd samples \( N_h \)

#### Calibration
- Mean bias \( \pm \bar{d} \)
- Slope \( b \pm s_b \)
**SECTION 13 APPENDIX F - EXAMINATION COMMITTEE OF MILK ANALYSER EVALUATION REPORTS**

- Reporting form for examiners -

<table>
<thead>
<tr>
<th><strong>Name of the examiner:</strong></th>
<th><strong>Country:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date of the examination:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Instrument / Type / Manufacturer:</strong></td>
<td>/ /</td>
</tr>
<tr>
<td><strong>Animal species:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Milk component(s):</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Specific comments:**

<table>
<thead>
<tr>
<th><strong>1- Daily precision (repeatability and short-term stability):</strong></th>
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</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th><strong>2- Carry-over effect:</strong></th>
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</thead>
<tbody>
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</table>

<table>
<thead>
<tr>
<th><strong>3- Linearity:</strong></th>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>4- Measurement limits (lower and/or upper limits):</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>5- Repeatability:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>6- Accuracy / Trueness:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>7- Ruggedness:</strong></th>
</tr>
</thead>
<tbody>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th><strong>8- Practical convenience:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Advice of the expert:**

1- **Valid for approval:** Yes / No 2- **Invalid for approval:** Yes / No

**Comments:** (i.e. justification of negative position / advice for manufacturer, …)
# Appendix Section 13 - On-line milk analysis

## SECTION 13 APPENDIX G - REQUEST FORM FOR ICAR ADVICE ON EVALUATION TYPE

- REQUEST FORM FOR ICAR ADVICE ON EVALUATION TYPE –

<table>
<thead>
<tr>
<th>Requesting organisation (name):</th>
<th>Country:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address:</td>
<td>Phone:</td>
</tr>
<tr>
<td></td>
<td>Fax:</td>
</tr>
<tr>
<td></td>
<td>E-mail:</td>
</tr>
<tr>
<td>represented by (Mr, Mrs):</td>
<td>Function:</td>
</tr>
</tbody>
</table>

**hereby**

makes the request to ICAR to advise on the suitable protocol to apply, in the frame of ICAR international approval, for the evaluation of the milk analyser designated below for the application of milk recording with the following specifications and the technical documentation included:

<table>
<thead>
<tr>
<th>Manufacturer (name)</th>
<th>Instrument (name)</th>
<th>Type</th>
<th>Configuration (*)</th>
<th>Analytical principle</th>
</tr>
</thead>
</table>

**Animal species**

<table>
<thead>
<tr>
<th>Cow</th>
<th>Sheep</th>
<th>Goat</th>
<th>Buffalo</th>
<th>Other</th>
</tr>
</thead>
</table>
| - milk components / criteria tested:
  - Fat (F)
  - Protein (P)
  - Lactose (L)
  - Urea (U)
  - Somatic cells (SCC)
  - |
| - maximum testing rate (nr test/hour) |

(**) e.g. alone / combined

**Date:** ........................................

**Signature:** ....................................

Return to: ICAR Secretariat, Via G. Tomassetti 3, I-00161 Rome, Italy
Tel: +39/06 44202639 – e-mail: icar@icar.org

ICAR recommends to apply the protocol(s) related to ticked in square(s) in the following:

- 2.1 Routine devices
- 2.2 Manual devices
- 2.3 Updated devices

**Additional comments, recommendations:**

**Date:** ........................................

**Signature:** ....................................

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Sub-Committees

**Animal Identification**

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