Organisation Mondiale de la Santé Animale | World Organisation for Animal Health | Organización Mundial de Sanidad Animal

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May 2005

REPORT OF THE MEETING OF THE BUREAU OF THE OIE SCIENTIFIC COMMISSION FOR ANIMAL DISEASES

Paris, 30 -31 May 2005

A meeting of the Bureau of the OIE Scientific Commission for Animal Diseases (hereafter referred to as the Bureau) was held at the OIE Headquarters in Paris, France, from 30 to 31 May. Dr Dewan Sibartie, Deputy Head of the OIE Scientific and Technical Department welcomed the participants on behalf of Dr Bernard Vallat, the Director General of the OIE. He conveyed the apologies of Prof. Vincenzo Caporale, President of the Scientific Commission for Animal Diseases who was unable to attend the meeting on the first day and announced that the first day's meeting would be chaired by the Vice-President, Dr Kenichi Sakamoto. Dr Federico Stoessel acted as rapporteur.

The Agenda and List of participants are presented at Appendices I and II.

1. Review of the work plan and activities 2004-2006

The Bureau evaluated the activities of the Scientific Commission for animal diseases (Scientific Commission) in line with the work plan that was agreed for 2004 – 2006 noting that the plan was drawn in accordance with directives of the International Committee.

The Bureau expressed satisfaction that most of the tasks described in the plan had been carried out. A few tasks could not be completed because of changing priorities in an evolving disease situation. The President of the Scientific Commission attended the meeting of the Working Group on wildlife diseases.

2. Review of the reports of the Ad hoc / Expert Groups

- **Ad hoc Group on Blue Tongue, 28 February-2 March 2005**

  The Bureau discussed and endorsed the report of the Ad hoc Group on Blue Tongue (Appendix III).

- **Expert Group on "BSE Diagnostic Methods- the need for standardisation", 17 March 2005**

  The Bureau discussed and endorsed the report of the Expert Group on BSE Diagnostic Methods. (Appendix IV).

- **Ad hoc Group on Emerging Zoonosis, 29-31 March 2005**

  The Bureau discussed the report of the Ad hoc Group on Emerging Zoonosis (Appendix V).

- **Ad hoc Group on Antigen and Vaccine Banks for Foot and Mouth Disease, 13 – 15 April 2005**

  The Bureau discussed the report of the Ad hoc Group on Antigen and Vaccine Banks for Foot and Mouth Disease and noted that it contained valuable information (Appendix VI). The section on vaccine matching tests will be sent to the Biological Standards Commission for evaluation, comments and consideration for inclusion in the FMD Chapter of the OIE *Terrestrial Manual.* Regarding the proposal of the creation of an OIE/FAO network of FMD Reference Laboratories, the Bureau felt that the Scientific Commission should also have a leading role in its implementation and requested that a member of the Scientific Commission should be member of the steering committee.

- **Ad hoc Group on Epidemiology, 9-11 May, 2005**

  The report of the Ad hoc Group on Epidemiology was discussed and endorsed (Appendix VII). However, the Bureau noted some contradictions in the adopted classical swine fever (CSF) chapter and the proposed surveillance guidelines. The Bureau would like to see some further improvement in the chapter in adequately addressing the issue of compartmentalisation. A SCAD statement will be sent to the TAHSC.

  The Bureau further noted that the concept paper on compartmentalisation was included in the report of the Ad hoc Group on Epidemiology for information of Member Countries. The concept and the preparation of guidelines by SCAD will be discussed during the next meeting of the Ad hoc Group on Epidemiology with the participation of TAHSC and AAHSC.

3. Other Matters

- **Correspondence from South Africa**

  Dr Sibartie provided background information on the outbreak of foot and mouth disease (FMD) in South Africa during the year 2004 and the exchange of correspondence between the OIE Central Bureau and the South African Veterinary Authorities on this matter. The OIE had queried South Africa about reports indicating that the disease had actually occurred within the zone recognised by the OIE as free from FMD without vaccination and the decision of South Africa to re-delineate the boundaries of the zone for disease control purposes. South Africa has sent a complete dossier indicating that some mistakes had inadvertently occurred in some of the correspondence sent to the OIE and has given the assurances that no FMD outbreak occurred within the free zone. The Bureau decided that no action be taken to change the FMD status of South Africa.

- **Report from the OIE Reference Laboratories for foot and mouth disease**

  i) Foot and Mouth disease in Camelids

  The OIE had requested the various OIE Reference Laboratories to provide advice as to whether camelids should be regarded as animals susceptible to FMD for the purpose of the OIE *Terrestrial Animal Health Code*. (the *Terrestrial Code*) Two of the laboratories; namely; Pirbright and AARIAH have responded. The report from Pirbright indicates that camels are not clearly recognised as susceptible to FMD whereas the report from AARIAH describes the clinical occurrence of FMD in camels in 2000 although it stresses that all attempts to experimentally infect camels with FMD virus have failed.

  The Bureau suggested that from the responses of the OIE Reference Laboratories it cannot be concluded that camelids are not susceptible for Foot and Mouth Disease Virus and therefore recommended no change in the FMD Chapter in the *Terrestrial Code*.

ii) Safety of products derived from pigs vaccinated against foot and mouth disease

A query from Dr Osinga, from the Dutch Farmers Union (LTO Nederland) concerning the veterinary safety of products derived from pigs vaccinated against FMD had been directed to the OIE Reference Laboratory in Pirbright. The report from Pirbright does not provide a clear answer on the matter due to lack of clear science-based evidences~~argumentation~~.

The Bureau suggested that the Central Bureau inform Dr Osinga that the OIE *Terrestrial Code* does not have any provisions on this issue. In this respect the president of the Scientific Commission suggests to rediscuss paragraph 2.2.10.7.item 1b and 1c of the OIE *Terrestrial Code* at its next meeting in January 2006.

- **Recognition of country status for contagious bovine pleuropneumoniae (CBPP)**

Dr D. Sibartie explained the difficulties in the interpretation of some of the provisions of the current CBPP Appendix in the *Terrestrial Code*. This is causing some difficulty to Member Countries wishing to submit dossiers to the OIE to be recognised as free from CBPP.

The Bureau recommended that an Ad hoc Group be set up to review both the chapter and the guidelines on CBPP and to make the report of this group available for consideration at the next meeting of the Scientific Commission.

- **Disease notification: malignant catharrhal fever (MCF), maedi/visna**

The Bureau accepted the report provided by the expert on the wildebeest associated form of malignant catarrhal fever (MCF) and decided to recommend to the Terrestrial Animal Health Standards Commission (the Code Commission) that this form of the disease be included in the list of reportable diseases to the OIE.

The Bureau also reviewed the report of the expert on Maedi/Visna indicating that this disease does not satisfy the criteria for it to be included in the OIE list of reportable diseases. The Bureau will request additional information on Maedi Visna by another expert.

The Bureau noted that the International Committee has not accepted Hendra virus infection as a reportable event and suggested that the Code Commission be again requested to bring this to the attention of the International Committee as the disease has potential zoonotic implications and that there are many countries still free of the disease.

- **Comments on bovine tuberculosis *Terrestrial Animal Health Code* Chapter from the OIE Working Group in Animal production Food Safety**

The Bureau noted that a working group of the OIE has revised the work of the Scientific Commission. They also noted that the Working Group is assuming the codex codes of practice as reference as far as trade of animal products and certification standards without justifying the decisions on a scientific basis. The Bureau suggested that the Working Group be asked to explain their opinion on a scientific basis.

- **Report on CBPP from Zambia**

The Bureau reviewed the report provided by the Veterinary Authorities of Zambia following a request of the Central Bureau. It recognised the efforts that have been made to arrest the spread of the disease but noted that surveillance cannot be effectively carried out because of the inability to control animal movements due to lack of identification and traceability of animals.

The Bureau suggested that the Central Bureau write to the authorities of Zambia expressing appreciation at the work being carried out.

- **Carcass disposal**

  The report of the Ad hoc Group on Carcass Disposal (Appendix VIII) has been circulated to Member Countries for comments by the Terrestrial Animal Health Standards Commission. The European Union, Botswana, Canada and Switzerland have provided comments on the general guidelines for the disposal of carcasses. All comments were discussed and the text was amended according to following comments.

  - The wording in the definition of "mass destruction" was changed from animals to carcasses.
  - In pre-outbreak activities under "technical preparedness" Standing Operating Procedures was changed to Standard Operating Procedures.
  - Under "financial preparedness" a sentence will be added to mention other significant costs besides the farmers compensation.
  - Under "logistical preparedness" the need for equipment as arms and ammunition will be included.

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…/Appendices

Appendix I

MEETING OF THE BUREAU OF THE
OIE SCIENTIFIC COMMISSION FOR ANIMAL DISEASES

Paris, 30 - 31 May 2005

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Provisional Agenda

1. Review of work plan and activities 2004/2006

- Role and scope of the Scientific Commission for Animal Diseases

2. Review of reports of Ad hoc/Expert Groups

- Ad hoc Group on Bluetongue, 28 February – 2 March 2005
- Expert Group on "BSE Diagnostic Methods - the need for standardisation", 17 March 2005
- Ad hoc Group on Emerging Zoonoses, 29 – 31 March 2005
- Ad hoc Group on Antigen and Vaccine Banks for Foot and Mouth Disease, 13 – 15 April 2005
- Ad hoc Group on Epidemiology, 9 – 11 May 2005

3. Other matters

- Correspondence from South Africa
- Report from OIE Reference Laboratories for foot and mouth disease:
  a) Foot and mouth disease in camelids
  b) Safety of products derived from pigs vaccinated against foot and mouth disease
- Recognition of country status for contagious bovine pleuropneumonia (CBPP)
- Disease notification: malignant catarrhal fever, maedi/visna
- Comments on bovine tuberculosis *Terrestrial Animal Health Code* Chapter from the OIE Working Group on Animal Production Food Safety
- Report on CBPP from Zambia
- Carcass disposal

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MEETING OF THE BUREAU OF THE
OIE SCIENTIFIC COMMISSION FOR ANIMAL DISEASES

Paris, 30 - 31 May 2005

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List of Participants

MEMBERS

Prof. Vincenzo Caporale *(President)*
Director
Istituto Zooprofilattico Sperimentale
dell'Abruzzo e del Molise 'G. Caporale'
Via Campo Boario
64100 Teramo
ITALY
Tel: (39.0861) 33 22 33
Fax: (39.0861) 33 22 51
E-mail: caporale@izs.it

Dr Kenichi Sakamoto *(Vice-President)*
Chief of Diagnostic Laboratory
Department of Exotic Diseases Research
National Institute of Animal Health
6-20-1 Josui-honcho, Kodaira
Tokyo, 187-0022
JAPAN
Tel: (81-423) 21 14 41
Fax : (81-423) 25 51 22
E-mail: skenichi@affrc.go.jp

Dr Federico Stoessel *(Secretary General)*
Section agricole
Ambassade d'Argentine
225 avenue Louise
B.P. 8
B-1050 Brussels
BELGIUM
Tel: (32.2) 640 33 33
Fax: (32.2) 640 00 08
E-mail: fstoessel@agricola-ue.org

OIE CENTRAL BUREAU

Dr Bernard Vallat
Director General
12 rue de Prony
75017 Paris
FRANCE
Tel: 33 - (0)1 44 15 18 88
Fax: 33 - (0)1 42 67 09 87
E-mail: oie@oie.int

Dr Alejandro Schudel
Head, Scientific and Technical Department
E-mail: a.schudel@oie.int

Dr Dewan Sibartie
Deputy Head, Scientific and Technical Department
E-mail: d.sibartie@oie.int

Dr Christianne Bruschke
Project Officer, Scientific and Technical Department
E-mail: c.bruschke@oie.int

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Appendix III

Original: English
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REPORT OF THE MEETING

OF THE OIE AD HOC GROUP ON BLUETONGUE SURVEILLANCE

Paris 28 February - 2 of March 2005

1. Introduction

The OIE Ad hoc Group on Bluetongue (BT) met at the OIE Headquarters from 28 February to 2 March 2005. The agenda and list of participants are presented as Appendices I and II, respectively. The meeting was chaired by Professor Vincenzo Caporale, and Professor N. James MacLachlan acted as rapporteur.

Dr Bernard Vallat, Director General of OIE welcomed the participants. He recalled that during the joint December 2004 meeting of the Terrestrial Animal Health Standards Commission and the Scientific Commission for Animal Diseases, he, as Director General, had suggested that high priority be given to the development of BT surveillance guidelines that are consistent with the new chapter (2.2.13.) on BT in the OIE *Terrestrial Animal Health Code* (the *Terrestrial Code*), which will be proposed for adoption during the 73rd General Session. He further indicated that the proposed surveillance guidelines would be circulated to Member Countries prior to the 73rd General Session, and that the new guidelines should accurately reflect the scientific conclusions of the recent International Symposium on BT that was held in Taormina, Sicily, taking into account the following: a) that levels of surveillance should reflect the geographic position of the country and the disease status of the neighbouring countries, b) the need for surveillance of both vectors and animals, and c) the use of vaccination of animals prior to their movement within infected country or zone.

2. Development of surveillance guidelines for bluetongue

The proposed BT surveillance guidelines (Appendix III) are based on the general surveillance guidelines contained in Chapter 3.8.1. of the *Terrestrial Code*. It is intended that the guidelines not be prescriptive, but be flexible so that each country can adapt an approach consistent with its specific situation. However, equivalence requires that the outcome of surveillance be similar regardless of approach.

It was agreed at the outset that the objective of BT surveillance is to detect virus circulation in a country, zone or compartment. The global distribution of BTV is not static and is poorly defined in many areas, thus ongoing active surveillance is required to define the distribution of BT virus (BTV) infection with particular emphasis on regions that span the interface of BTV-free and endemic countries or zones.

Serological surveillance of ruminants, especially sentinel herds of cattle, is the preferred approach to BT surveillance, although clinical surveillance of susceptible livestock like sheep can also provide an important early warning system. Virological and vector surveillance is necessary to define the epidemiology of BTV infection in each country or zone, which can vary markedly between different global ecosystems. Criteria were developed by the group that will allow countries, including those that practise vaccination, to define their BT status based on appropriate surveillance that incorporates prescribed diagnostic laboratory tests.

…/Appendices

Appendix I

MEETING OF THE
OIE AD HOC GROUP ON BLUETONGUE SURVEILLANCE
Paris, 28 February – 2 March 2005

Agenda

1. Introduction
2. Development of Surveillance Guidelines for Bluetongue

Appendix II

MEETING OF THE

OIE AD HOC GROUP ON BLUETONGUE SURVEILLANCE

Paris, 28 February – 2 March 2005

List of participants

MEMBERS

Prof. Vincenzo Caporale
Director
Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale'
Via Campo Boario
64100 Teramo
ITALY
Tel: (39.0861) 33 22 33
Fax: (39.0861) 33 22 51
E-mail: direttore@izs.it

Dr Peter W. Daniels
Assistant Director, Diagnostics
CSIRO Livestock Industries
Australian Animal Health Laboratory (AAHL)
Private Bag 24
Geelong VIC 3220
AUSTRALIA
Tel: (61.3) 5227 5272/5000
Fax: (61.3) 5227.5555
E-mail: peter.daniels@csiro.au

Dr Jaques Février
DG Sanco E2
Rue Froissard 101
BX 1000 32.2
BELGIUM
Tel.: 32 2 296 58 72
Fax: 32 2 295 31 44
E-mail: jacques.fevrier@cec.eu.int

Dr James N. MacLachlan
Department of Pathology, Microbiology and Immunology
School of Veterinary Medicine
University of California
Davis, California 95616-8739
USA
Tel: (1.530) 754 8125
Fax: (1.530) 752 3349
E-mail: njmaclachlan@ucdavis.edu

Prof. Philip S. Mellor
Institute for Animal Health
Pirbright Laboratory
Ash Road
Woking, Surrey GU24 ONF
UNITED KINGDOM
Tel: (44.1483) 23 24 41
Fax: (44.1483) 23 24 48
E-mail: philip.mellor@bbsrc.ac.uk

Dr Cristóbal Zepeda Sein
Coordinator of International Activities, Centers for Epidemiology and Animal Health, OIE Collaborating Center for Animal Disease Surveillance Systems and Risk Analysis, USDA-APHIS-VS-CEAH
2150 Centre Ave, Building B
Fort Collins, CO 80526-8117
USA
Tel: (1.970) 494 7294
Fax: (1.970) 472 2668
E-mail: cristobal.zepeda@aphis.usda.gov

OTHER PARTICIPANTS

Dr Armando Giovannini
Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise "G. Caporale"
OIE Collaborating Centre
Via Campo Boario
64100 Teramo
ITALY
Tel: (39 0861) 33 21
Fax (39 0861) 33 22 51
E-mail: a.giovannini@izs.it

Dr Alejandro Thiermann
President of the OIE Terrestrial Animal Health Standards Commission
Tel: 33-(0)1 44 15 18 69
E-mail: a.thiermann@oie.int

OIE CENTRAL BUREAU

Dr Bernard Vallat
Director General
12 rue de Prony
75017 Paris
FRANCE
Tel: 33 - (0)1 44 15 18 88
Fax: 33 - (0)1 42 67 09 87
E-mail: oie@oie.int

Dr Alejandro Schudel
Head, Scientific and Technical Department
E-mail: a.schudel@oie.int

Appendix III

APPENDIX 3.X.X.

GUIDELINES FOR THE SURVEILLANCE OF BLUETONGUE

Article 3.X.X.1.

Introduction

This Appendix defines the principles and provides a guide for the surveillance of bluetongue (BT) in accordance with Appendix 3.8.1., applicable to countries seeking recognition for a declared BT status, with or without the use of vaccination. This may be for the entire country, *zone* or *compartment*. Guidance for countries seeking free status following an *outbreak* and for the maintenance of BT status is also provided. This Appendix complements Chapter 2.2.13.

BT is a vector-borne infection transmitted by different species of *Culicoides* insects in a range of ecosystems. An important component of BT epidemiology is vectorial capacity which provides a measure of disease risk that incorporates vector competence, abundance, biting rates, survival rates and extrinsic incubation period. However, methods and tools for measuring some of these vector factors remain to be developed, particularly in a field context. Therefore, surveillance for BT should focus on transmission in domestic ruminants.

Susceptible wild ruminant populations should be included in surveillance only if necessary for trade.

The impact and epidemiology of BT differ widely in different regions of the world and therefore it is impossible to provide specific guidelines for all situations. It is incumbent upon the member countries to provide scientific data that explain the epidemiology of BT in the region concerned and adapt the surveillance strategies for defining their infection status (free, endemic or area of potential spread) to the local conditions. There is considerable latitude available to Member Countries to justify their infection status at an acceptable level of confidence.

Surveillance for BT should be in the form of a continuing programme.

Case definition

For the purposes of surveillance, a *case* refers to an animal infected with BT virus (BTV).

For the purposes of *international trade*, a difference must be made between a case as defined below and an animal that is potentially infectious to vectors. The conditions for trade are defined in Chapter 2.2.13 of the *Terrestrial Code*.

The purpose of surveillance is the detection of virus circulation in a country or zone and not the status of an individual animal or herds. Surveillance deals not only with the occurrence of clinical signs caused by BTV, but also with the presence of infection with BTV in the absence of clinical signs.

The following defines the occurrence of BTV infection:

1. BTV has been isolated and identified as such from an animal or a product derived from that animal, or

2. viral antigen or viral RNA specific to one or more of the serotypes of BTV has been identified in samples from one or more animals showing clinical signs consistent with BT, or epidemiologically linked to a confirmed or suspected *case*, or giving cause for suspicion of previous association or contact with BTV, or

3. antibodies to structural or nonstructural proteins of BTV that are not a consequence of vaccination have been identified in one or more animals showing clinical signs consistent with BT, or epidemiologically linked to a confirmed or suspected *case*, or giving cause for suspicion of previous association or contact with BTV.

Standards for diagnostic tests and vaccines are described in the *Terrestrial Manual*.

Article 3.X.X.2.

General conditions and methods

1) A surveillance system in accordance with Appendix 3.8.1. should be under the responsibility of the *Veterinary Administration*. In particular:

   a) a formal and ongoing system for detecting and investigating *outbreaks of disease* should be in place;

   b) a procedure should be in place for the rapid collection and transport of samples from suspect cases of BT to a laboratory for BT diagnosis as described in the *Terrestrial Manual*;

   c) a system for recording, managing and analysing diagnostic and surveillance data should be in place.

2) The BT surveillance programme should:

   a) include an early warning system for reporting suspicious cases. Farmers and workers, who have day-to-day contact with domestic ruminants, as well as diagnosticians, should report promptly any suspicion of BT to the *Veterinary Authority*. They should be supported directly or indirectly (e.g. through private veterinarians or *veterinary para-professionals*) by government information programmes and the *Veterinary Administration*. An effective surveillance system will periodically identify suspicious cases that require follow up and investigation to confirm or exclude that the cause of the condition is BTV. The rate at which such suspicious cases are likely to occur will differ between epidemiological situations and cannot therefore be predicted reliably. All suspected cases of BT should be investigated immediately and samples should be taken and submitted to an *approved laboratory*. This requires that sampling kits and other equipment are available for those responsible for surveillance;

   b) conduct random or targeted serological and virological surveillance appropriate to the infection status of the country or zone.

With regards to BT, *compartment* refers to *establishments* where animals are kept in a confirmed vector free environment to prevent BTV infection. Generally, the conditions to prevent exposure of susceptible animals to BTV infected vectors will be difficult to apply. However, under specific situations like *artificial insemination centres* or *quarantine stations* such conditions may be met. The testing requirements for animals kept in these facilities are described in Articles 2.2.13.11 and 2.2.13.15.

Article 3.X.X.3.

Surveillance strategies

The target population for surveillance aimed at identification of *disease* and/or *infection* should cover susceptible domestic ruminants within the country, *zone* or *compartment*. Active and passive surveillance for BTV infection should be ongoing. Surveillance should be composed of random or targeted approaches using virological, serological and clinical methods appropriate for the infection status of the country or zone.

The strategy employed may be based on randomised sampling requiring surveillance consistent with demonstrating the absence of BTV infection at an acceptable level of confidence. The frequency of sampling should be dependent on the epidemiological situation. Random surveillance is conducted using serological tests described in the *Terrestrial Manual*. Positive serological results may be followed up with virological methods as appropriate.

Targeted surveillance (e.g. based on the increased likelihood of *infection* in particular localities or species) may be an appropriate strategy. Virological and serological methods may be used concurrently to define the BTV status of targeted populations.

A country should justify the surveillance strategy chosen as being adequate to detect the presence of BTV infection in accordance with Appendix 3.8.1. and the prevailing epidemiological situation. It may, for example, be appropriate to target clinical surveillance at particular species likely to exhibit clinical signs (e.g. sheep). Similarly, virological and serological testing may be targeted to species that rarely show clinical signs (e.g. cattle).

In vaccinated populations, serological and virological surveillance is necessary to detect the BTV types circulating to ensure that all circulating types are included in the vaccination programme.

If a Member Country wishes to declare freedom from BTV infection in a specific *zone*, the design of the surveillance strategy would need to be aimed at the population within the *zone*.

For random surveys, the design of the sampling strategy will need to incorporate epidemiologically appropriate design prevalence. The sample size selected for testing will need to be large enough to detect *infection* if it were to occur at a predetermined minimum rate. The sample size and expected prevalence determine the level of confidence in the results of the survey. The applicant country must justify the choice of design prevalence and confidence level based on the objectives of surveillance and the epidemiological situation, in accordance with Appendix 3.8.1. Selection of the design prevalence in particular needs to be based on the prevailing or historical epidemiological situation.

Irrespective of the survey approach selected, the sensitivity and specificity of the diagnostic tests employed are key factors in the design, sample size determination and interpretation of the results obtained. Ideally, the sensitivity and specificity of the tests used should be validated for the vaccination/infection history and the different species in the target population.

Irrespective of the testing system employed, surveillance system design should anticipate the occurrence of false positive reactions. If the characteristics of the testing system are known, the rate at which these false positives are likely to occur can be calculated in advance. There needs to be an effective procedure for following up positives to ultimately determine with a high level of confidence, whether they are indicative of infection or not. This should involve both supplementary tests and follow-up investigation to collect diagnostic material from the original sampling unit as well as those which may be epidemiologically linked to it.

The principles involved in surveillance for *disease/infection* are technically well defined. The design of surveillance programmes to prove the absence of BTV infection/circulation needs to be carefully followed to avoid producing results that are either insufficiently reliable to be accepted by the OIE or international trading partners, or excessively costly and logistically complicated. The design of any surveillance programme, therefore, requires inputs from professionals competent and experienced in this field.

1) Clinical surveillance

Clinical surveillance aims at the detection of clinical signs of BT at the flock/herd level. Whereas significant emphasis is placed on the diagnostic value of mass serological screening, surveillance based on clinical inspection should not be underrated, particularly during a newly introduced infection. In sheep and occasionally goats, clinical signs may include oedema, hyperaemia of mucosal membranes, coronitis and cyanotic tongue.

BT suspects detected by clinical surveillance should always be confirmed by laboratory testing.

2) Serological surveillance

An active programme of surveillance of host populations to detect evidence of BTV transmission is essential to establish BTV status in a country or zone. Serological testing of ruminants is one of the most effective methods of detecting the presence of BTV. The species tested depends on the epidemiology of BTV infection, and the species available, in the local area. Cattle are usually the most sensitive indicator species.

Surveillance may include serological surveys, for example abattoir surveys, the use of sentinel animals, or a combination of methods.

The objective of serological surveillance is to detect antibodies against BTV using tests prescribed in the *Terrestrial Manual*. Positive BTV antibody tests results can have four possible causes:

1. natural infection with BTV
2. vaccination against BTV
3. maternal antibodies
4. positive results due to the lack of specificity of the test

It may be possible to use sera collected for other survey purposes for BTV surveillance. However, the principles of survey design described in these guidelines and the requirements for a statistically valid survey for the presence of BTV infection should not be compromised.

The results of random or targeted serological surveys are important in providing reliable evidence that no BTV infection is present in a *country, zone or compartment*. It is, therefore, essential that the survey is thoroughly documented.

Serological surveillance in a free zone should target those areas that are at highest risk of BTV transmission, based on the results of previous surveillance and other information. This will usually be towards the boundaries of the free zone. In view of the epidemiology of BTV infection, either random or targeted sampling is suitable to select herds and/or animals for testing.

A surveillance zone within a free country or zone should separate it from a potentially infected country or zone. Serological surveillance in a free country or zone should be carried out over an appropriate distance from the border with a potentially infected country or zone, based upon geography, climate, history of infection and other relevant factors.

Serological surveillance in infected zones will identify changes in the boundary of the zone, and can also be used to identify the BTV types circulating. In view of the epidemiology of BTV infection, either random or targeted sampling is suitable.

3) Virological surveillance

Isolation and genetic analysis of samples of BTV from a proportion of infected animals is beneficial in terms of providing information on serotype and genetic characteristics of the viruses concerned.

Virological surveillance using tests described in the *Terrestrial Manual* can be conducted:

1. to identify virus circulation in at risk populations
2. to confirm clinically suspect cases
3. to follow up positive serological results
4. to better characterize the genotype of circulating virus in a country or zone.

4) Sentinel Herds

Sentinel herds are a form of targeted surveillance with a prospective study design. They are the preferred strategy for BTV surveillance. They comprise groups of unexposed animals managed at fixed locations and sampled regularly to detect new BTV infections.

The primary purpose of a sentinel herd programme is to detect BTV infections occurring at a particular place, for instance sentinel groups may be located on the usual boundaries of infected zones to detect changes in distribution of BTV. In addition, sentinel herd programmes allow incidence rates to be determined and the timing of infections to be observed.

A sentinel herd programme should use animals of known source and history of exposure, control management variables such as use of insecticides and be flexible in its design in terms of sampling frequency and choice of tests.

Care is necessary in choosing the sites for the sentinel groups. The aim is to maximise the chance of detecting BTV activity at the geographical location for which the sentinel site acts as a sampling point. The effect of secondary factors that may influence events at each location, such as climate, may also be analysed. To avoid confounding factors, sentinel groups should comprise animals selected to be of similar age and susceptibility to BTV infection. Cattle are the most appropriate sentinels but other domestic ruminant species may be used. The only feature distinguishing groups of sentinels should be their geographical location.

Sera from sentinel herd programmes should be stored methodically in a serum bank to allow retrospective studies to be conducted in the event of new serotypes being isolated.

The frequency of sampling will depend on the reason for choosing the sampling site. In endemic areas, virus isolation will allow monitoring of the serotypes and genotypes of BTV circulating during each time period. The borders between infected and non infected areas can be defined by serological detection of infection. Monthly sampling intervals are frequently used. Sentinels in declared free zones add to confidence that BTV infections are not occurring unobserved. In such cases, sampling prior to and after the possible period of transmission is sufficient.

The definitive measure of a country or zone's BTV infection status is detection and identification of the viruses. If virus isolation is required, sentinels should be sampled at sufficiently frequent intervals to ensure that samples are collected during the period of viraemia.

5) Vector surveillance

BTV is transmitted between ruminant hosts by vector species of *Culicoides* which vary across the world. It is therefore important to be able to identify potential vector species accurately although many such species are closely related and difficult to differentiate with certainty.

The main purpose of vector surveillance is to define high, medium and low-risk areas and local details of seasonality by determining the species present in an area, their seasonal incidence and profile, and their abundance. Vector surveillance has particular relevance to potential areas of spread. Long term surveillance can also be used to assess vector abatement measures.

The most effective way of gathering this information should take account of the biology and behavioural characteristics of the local vector species of *Culicoides* and may include the use of Onderstepoort-type light traps or similar, operated from dusk to dawn in locations adjacent to domestic ruminants, or the use of drop traps over ruminant animals.

The number of traps to be used in a vector surveillance system and the frequency of their use will depend on the availability of resources but is also dependent upon the size or ecological characteristics of the area to be surveyed.

The operation of vector surveillance sites at the same locations as sentinel herds is advisable.

The use of a vector surveillance system to detect the presence of circulating virus is not recommended as a routine procedure as the typically low vector infection rates mean that such detections can be rare. Other surveillance strategies (e.g. the use of sentinel herds of domestic ruminants) are preferred to detect virus circulation.

Article 3.X.X.4.

Documentation of BTV infection free status

1) Countries declaring freedom from BTV infection for the country, zone or compartment

In addition to the general conditions described in Chapter 2.2.13. of the *Terrestrial Code*, a Member Country declaring freedom from BTV infection for the entire country, or a *zone* or a *compartment* should provide evidence for the existence of an effective surveillance programme. The strategy and design of the surveillance programme will depend on the prevailing epidemiological circumstances and should be planned and implemented according to general conditions and methods described in this Appendix, to demonstrate absence of BTV infection during the preceding 24 months in susceptible domestic ruminant populations. This requires the support of a laboratory able to undertake identification of BTV infection through virus detection and antibody tests described in the *Terrestrial Manual*. This surveillance should be targeted to non-vaccinated animals. Clinical surveillance may be effective in sheep while serological surveillance is more appropriate in cattle.

2) Additional requirements for countries, zones or compartments that practise vaccination

Vaccination to prevent the transmission of BTV may be part of a disease control programme. The level of flock or herd immunity required to prevent transmission will depend on the flock or herd size, composition (e.g. species) and density of the susceptible population. It is therefore impossible to be prescriptive. The vaccine must also comply with the provisions stipulated for BTV vaccines in the *Terrestrial Manual*. Based on the epidemiology of BTV infection in the country, *zone* or *compartment*, it may be that a decision is reached to vaccinate only certain species or other subpopulations.

In countries or zones that practice vaccination there is a need to perform virological and serological tests to ensure the absence of virus circulation. These tests should be performed on non-vaccinated subpopulations or on sentinels. The tests have to be repeated at appropriate intervals according to the purpose of the surveillance programme. For example, longer intervals may be adequate to confirm endemicity, while shorter intervals may allow on-going demonstration of absence of transmission.

Article 3.X.X.7.

The use and interpretation of serological and virus detection tests

Serological testing

Ruminants infected with BTV produce antibodies to structural and non-structural viral proteins, as do animals vaccinated with current modified live virus vaccines. Antibodies to the BTV serogroup antigen are detected with high sensitivity and specificity by competitive ELISA (c-ELISA) and to a lesser extent by AGID as described in the *Terrestrial Manual*. Positive c-ELISA results can be confirmed by neutralization assay to identify the infecting serotype (s), however BTV infected ruminants can produce neutralizing antibodies to serotypes of BTV other than those to which they were exposed (false positive results), especially if they have been infected with multiple serotypes.

Virus detection

The presence of BTV in ruminant blood and tissues can be detected by virus isolation or polymerase chain reaction (PCR) as described in the *Terrestrial Manual*.

Interpretation of positive and negative results (both true and false) differs markedly between these tests because they detect different aspects of BTV infection, specifically (1) infectious BTV (virus isolation) and (2) nucleic acid (PCR). The following are especially relevant to interpretation of PCR assays:

1) The nested PCR assay detects BTV nucleic acid in ruminants long after the clearance of infectious virus. Thus positive PCR results do not necessarily coincide with active infection of ruminants. Furthermore, the nested PCR assay is especially prone to template contamination, thus there is considerable risk of false positive results.

2) PCR procedures other than real time PCR allow sequence analysis of viral amplicons from ruminant tissues, insect vectors or virus isolates. These sequence data are useful for creating data bases to facilitate important epidemiological studies, including the possible distinction of field and vaccine virus strains of BTV, genotype characterization of field strains of BTV, and potential genetic divergence of BTV relevant to vaccine and diagnostic testing strategies.

It is essential that BTV isolates are sent regularly to the OIE Reference Laboratories for genetic and antigenic characterization.

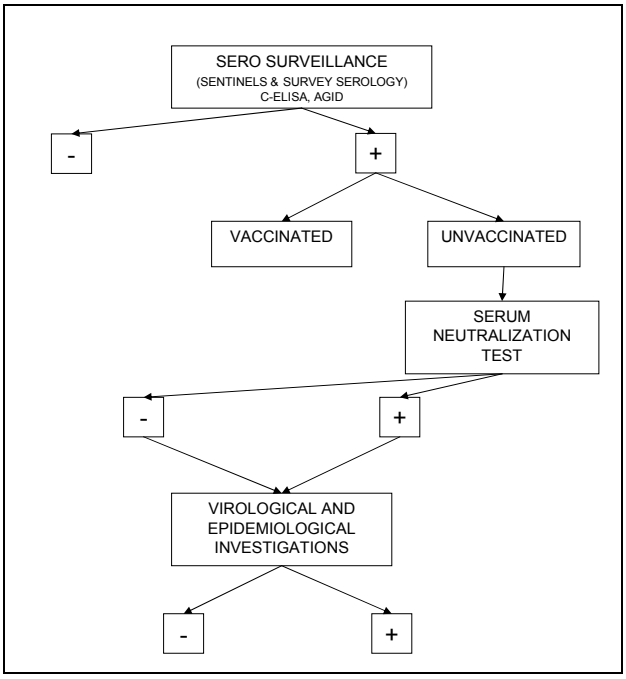

Figure 1

Application of laboratory tests in serological surveillance

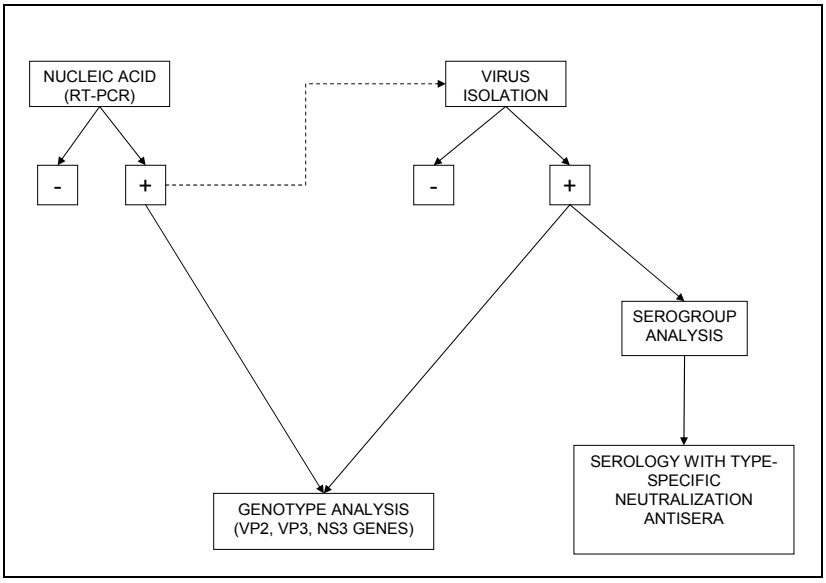

Figure 2

Application of laboratory tests in virological surveillance

Appendix IV

Original: English
March 2005

OIE EXPERT GROUP ON BSE DIAGNOSTIC METHODS - THE NEED FOR STANDARDISATION

Paris, 17 March 2005

The meeting of the Expert Group on "BSE Diagnostic Methods - the need for standardisation" was held on 17 March 2005 at OIE headquarters.

The agenda and list of participants are appended.

Dr Alejandro Schudel, Head of the OIE Scientific and Technical Department and Prof. V. Caporale, President of the OIE Scientific Commission for Animal Diseases (Scientific Commission) and chairman of the group, welcomed the experts and thanked them for their participation.

Prof. Caporale explained that the intention was to review accumulated data since the meeting of 4 December 2003, taking into account a paper submitted by the OIE Reference Laboratory of the United Kingdom, as well as the data to be presented at the meeting from Japan, Italy and France and to consider whether or not current diagnostic methods continued to be appropriate for surveillance purposes for BSE. It was essential to take into account available facts in agreeing phenotype and case definitions, if these were necessary. The meeting was intended to address the practical issues faced by Member Countries rather than to investigate hypotheses.

The terms of reference were agreed. Dr Danny Matthews was designated as rapporteur.

Criteria and terminology

Gerald Wells (VLA) presented an overview of the principles of phenotype and case definition, and the challenges faced by the findings of surveillance programmes in place around the world. Marion Simmons (VLA) presented data about sheep scrapie which highlighted the wide spectrum of recordable criteria, but where there was evidence that reliance on the measurement of single parameters was inappropriate for claiming the existence or absence of a specific, or new, strain.

Review of case data

Updates were provided through presentations on results of investigations of active surveillance case samples with atypical features found in Japan (Takashi Yokoyama), Italy (Pier Luigi Acutis) and France (Thierry Baron). While no new cases with atypical characteristics had been identified in Japan and Italy, Dr Baron indicated that 11 such cases had been identified in France (including cases detected from retrospective examinations), based upon variance in western immunoblot pattern in comparison with BSE. In seven of the cases the molecular mass of the unglycosylated band was higher (H type) than for BSE, while in four the molecular mass was lower (L type).

Transmission experiments into transgenic and wild type mice have been conducted in all three countries which initially reported such cases, and, in Italy, also into cattle and macaque, but there was still no evidence that transmission had occurred. Studies were however in progress and could not be assumed to be negative at this stage.

Additional atypical cases were reported to have occurred in Denmark, Netherlands, Belgium and Poland. The Danish and Dutch samples had been compared with Italian and French samples in collaborative studies.

The Group was therefore unable to progress their interpretation of the data beyond the conclusions about Italian and Japanese cases at the OIE Reference Laboratories meeting of 4th December 2003.

Phenotype and Case definition

While there was a gathering body of evidence that prion diseases of cattle may not present with the single phenotype historically associated with BSE, it was still not possible, because of insufficient complimentary data, particularly the absence of examples of such cases presenting as clinical disease, to agree on specific criteria that would enable classification into phenotypic sub-types. The lack of standardisation of sampling and test methodologies made this very difficult, and in most instances only biochemical characterisation had been possible in the absence of fixed tissue.

The Group agreed in principle with the draft paper provided by the Veterinary Laboratories Agency (Bovine spongiform encephalopathy (BSE): phenotypes, agent strains and case definitions"), and in particular that variations of a single measured parameter (such as western immunoblot) were insufficient to lead to claims of strain differentiation. Group members agreed to offer contributions and criticisms by the end of April, 2005 so that the paper could be submitted for publication in the OIE *Scientific and Technical Review*.

In addition, while recognising that diagnostic methods currently used for surveillance and confirmation were appropriate for the detection of most of the cases discussed, there was recognition of a need for more precise guidelines for sampling, testing, and, if appropriate, discriminatory testing. The comparison of variant isolates with standard reference material, and ideally using methods already used to detect such variants, was considered essential. It was agreed that the OIE Reference laboratories, assisted by other members of the Group, should attempt to draft a standard operating procedure (SOP) to cover such issues that could not yet be addressed in sufficient detail in the OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals.* Such an SOP could be placed on Reference Laboratory web sites, and remain as live documents to be updated as the science progresses.

In order to place the atypical cases in context the group supported the principle of conducting retrospective testing of archived material where available. Current methods of phenotype characterisation and their corresponding diagnostic techniques would not have been applied in the past, and it is possible therefore, that variant phenotypes had always existed, but remained undetected.

The adoption of an SOP approach, coupled with the acquisition of data from retrospective and prospective testing should eventually facilitate a thorough debate on phenotype definition, and a decision tree could be incorporated into the SOP to assist national reference laboratories in the characterisation of isolates. Appropriate revisions of case definition could then follow where necessary.

Members of the Group agreed to consider alternative approaches to sampling that would enable the collection of samples from a wider range of brain areas, recognising the constraints that prevent large scale removal of whole brain. In addition, members that had detected atypical samples agreed to make their methods available in the context of a ring trial when new isolates were detected, and the Veterinary Laboratories Agency agreed to produce and circulate reference material for characterisation within the test methods employed by the collaborators.

…/Appendices

Appendix I

OIE EXPERT GROUP ON BSE DIAGNOSTIC METHODS - THE NEED FOR STANDARDISATION

Paris, 17 March 2005

Agenda

1. Criteria and terminology
2. Review of case data
3. Phenotype and Case definition

Appendix II

OIE EXPERT GROUP ON BSE DIAGNOSTIC METHODS - THE NEED FOR STANDARDISATION

Paris, 17 March 2005

List of Participants

MEMBERS

Prof. Vincenzo Caporale
(*President of the OIE Scientific Commission for Animal Diseases*)
Director, Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale'
Via Campo Boario, 64100 Teramo - ITALY
Tel: (39.0861) 33 22 33
Fax: (39.0861) 33 22 51
E-mail: direttore@izs.it

Dr Pierluigi Acutis
Centro Encefalopatie Animali - CEA - Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta
Via Bologna 148, I-10154 Torino - ITALY
E-mail: pierluigi.acutis@izsto.it

Dr Thierry Baron
AFSSA Lyon, 31 avenue Tony Garnier,
BP 7033, 69364 Lyon Cedex 07 - FRANCE
Tel: 33 - (0)4 78 72 65 43
Fax: 33 - (0)4 78 61 91 45
E-mail: t.baron@lyon.afssa.fr

Prof. Steven Edwards (Absent)
(*President of the OIE OIE Biological Standards Commission*), VLA Weybridge, New Haw, Addlestone, Surrey KT15 3NB
UNITED KINGDOM
Tel.: (44-1932) 34.11.11
Fax: (44-1932) 34.70.46
E-mail: s.edwards@vla.defra.gsi.gov.uk

Dr Takashi Yokoyama
Prion Diseases Research Unit, National Institute of Animal Health, National Agricultural Research Organization
3-1-5 Kannondai
Tsukuba, Ibaraki 305-0856 - JAPAN
Tel: (81.298) 38.77.57
Fax: (81.298) 38.79.07
E-mail: tyoko@affrc.go.jp

Dr Takeshi Mikami
Food Safety Commission
6th Floor, Prudential Tower
2-13-10 Nagata-cho, Chiyoda-ku
Tokyo 100-8989 - JAPAN
Tel: +81-3-5251-9114
Fax: +81-3-3591-2235
E-mail: takeshi.mikami@cao.go.jp

Dr Torsten Seuberlich
NeuroCenter, Reference Laboratory for Spongiform Encephalopathies in Animals, University of Bern
Department of clinical veterinary medicine
Bremgartenstrasse 109a, 3012 Bern
SWITZERLAND
Tel: (41.31) 631.22.06
Fax: (41.31) 631.25.38
E-mail: torsten.seuberlich@itn.unibe.ch

Dr Danny Matthews
TSE Programme Manager,
VLA Weybridge, New Haw, Addlestone
Surrey KT15 3NB - UNITED KINGDOM
Tel: (44.1932) 35.95.12
Fax: (44.1932) 35.49.29
E-mail: d.matthews@vla.defra.gsi.gov.uk

Dr Marion M. Simmons
Head of Neuropathology
Neuropathology Section
VLA Weybridge, Addlestone
Surrey KT15 3NB - UNITED KINGDOM
Tel: 44 (0) 1932 35 75 64
Fax: 44 (0) 1932 35 78 05
E-mail: m.m.simmons@vla.defra.gsi.gov.uk

Mr Gerald A.H. Wells
Consultant Veterinary Pathologist to Veterinary Laboratories Agency – Weybridge, New Haw, Addlestone
Surrey KT15 3NB - UNITED KINGDOM
Tel: (44-1932) 357 498/1483 890 566
Fax: (44-1932) 357 805/1483 890 594
E-mail: geraldwells@btconnect.com

Dr Stefanie Czub
Head, National BSE Reference Laboratory, Head, Pathology, National Centre for Foreign Animal Disease, Canada Food Inspection Agency, 1015 Arlington Street
Winnipeg, Manitoba R3E 3M4 - CANADA
Tel: (1-204) 789-2021 -2087
Fax: (1-204) 789-2038
E-mail: czubs@inspection.gc.ca

OTHER PARTICIPANTS

Dr Stuart C. MacDiarmid
(*Secretary General of the OIE Terrestrial Animal Health Standards Commission*)
New Zealand Food Safety Authority, Principal Adviser, Zoonoses and Animal Health
P.O. Box 2835, South Tower, 68-86 Jervois Quay, Wellington, NEW ZEALAND
Tel: (64-4) 463 2648 - Fax: (64-4) 463 2530
E-mail: stuart.macdiarmid@nzfsa.govt.nz

Dr Kenichi Sakamoto
(*Vice-President of the OIE Scientific Commission for Animal Diseases*)
Chief of Diagnostic Laboratory, Department of Exotic Diseases Research, National Institute of Animal Health, 6-20-1 Josui-honcho, Kodaira, Tokyo, 187-0022, JAPAN
Tel: (81-423) 21 14 41
Fax : (81-423) 25 51 22
E-mail: skenichi@affrc.go.jp

Dr Elisabeth Vindel
CNIEL, 42, rue de Châteaudun
75314 Paris Cedex 09, FRANCE
Tel: +33 1 49 70 71 09
Fax: +33 1 42 80 63 45
E-mail: evindel@cniel.com

OIE CENTRAL BUREAU

Dr Bernard Vallat
Director General
12 rue de Prony
75017 Paris
FRANCE
Tel: 33 - (0)1 44 15 18 88
Fax: 33 - (0)1 42 67 09 87
E-mail: oie@oie.int

Dr Alejandro Schudel
Head, Scientific and Technical Department
E-mail: a.schudel@oie.int

Dr Dewan Sibartie
Deputy Head, Scientific and Technical Department
E-mail: d.sibartie@oie.int

Appendix V

Original: English
March 2005

REPORT OF THE MEETING
OF THE OIE AD HOC GROUP ON EMERGING ZOONOSES
Paris 29 - 31 March 2005

1. Introduction

The OIE Ad hoc Group on Emerging Zoonoses met at the OIE Headquarters from 29 to 31 March 2005.

The terms of reference and mission of the Group and the list of participants are presented in Appendices I and II.

Dr Alejandro Schudel, Head of the OIE Scientific and Technical Department, and Dr Alejandro Thiermann, President of the OIE Terrestrial Animal Health Standards Commission, opened the meeting and welcomed participants on behalf of Dr Bernard Vallat, Director-General of the OIE, who had passed his apologies for being unable to attend the meeting. The meeting was chaired by Dr Lonnie King and Dr Mike Nunn acted as rapporteur.

Dr King outlined the background to the formation of the Group. The meeting noted the origin of the Group in discussions at the 72nd General Session of the OIE in May 2004 that led to Resolution XXIX on challenges and opportunities of emerging and re-emerging zoonoses (see Appendix III). This resolution agreed that the OIE should actively consider, in developing its fourth strategic plan, broadening of its scope, commitment, and thinking on emerging and re-emerging zoonoses and place a high priority on developing guidelines for the prevention and control of these diseases. The Resolution specifically recommended that the OIE consider the creation of a new inter-disciplinary Ad hoc Group on Emerging and Re-Emerging Zoonoses to work in collaboration with existing OIE Working Groups on Wildlife Diseases and Animal Production Food Safety, the OIE Ad hoc Group on Epidemiology, and other relevant bodies or experts. The latter would include OIE Reference Laboratories and Collaborating Centres, FAO and the WHO. Communicable disease and zoonoses specialists of WHO as well as FAO/AGAH representative were also invited.

The Group explored the draft terms of reference and mission of the Group, and agreed to focus at this meeting on developing recommendations in five areas:

- awareness and communications between the Veterinary Services of Member Countries and their Public Health counterparts;
- training and capacity-building of Member Countries and veterinary and medical academic institutions on emerging and re-emerging zoonotic diseases;
- surveillance and reporting of emerging and re-emerging zoonotic diseases;

- prevention and control strategies for emerging and re-emerging zoonotic diseases; and

- a proposed OIE/CDC symposium on emerging and re-emerging diseases in conjunction with the 2006 International Conference on Emerging Infectious Diseases.

The Group was pleased to note a shift leading to a rise in the perceived priority of zoonoses by the Public Health authorities of many Member countries. This has been accompanied by a paradigm shift from *independence* of agencies and professions involved in this area to one that recognises their inherent *interdependence* — and thus of the need for multidisciplinary approaches to managing emerging and re-emerging zoonoses.

The Group recognised the need to identify examples of 'best practice' to illustrate approaches that Member countries and regional and international organizations might use to enhance awareness of emerging and re-emerging zoonoses, and to improve their preparedness and capacity for responding to these diseases at local, sub-national (provincial or state), national, regional and international levels. Similarly, examples of 'best practice' could be identified to illustrate approaches to other elements of managing emerging and re-emerging zoonoses.

The Group acknowledged the need to engage formally the World Conservation Union (International Union for the Conservation of Nature, IUCN) as a key international environmental organization covering the ecology of diseases in wildlife — in partnership with the OIE, FAO, and WHO — in the management of emerging and re-emerging zoonoses. *The Group recommended that the OIE invite the IUCN to nominate a representative to contribute as a 'participant' at the Group's next meeting.*

Although this Group was formed as an OIE initiative, and thus its recommendations are limited to the OIE, participants understood and strongly agreed that the actions and recommendations of the Group can be much better effectively implemented through the collaboration and support of FAO and WHO.

The Group concluded that its work and its recommendation need to be aligned to specific outcomes. The Group affirmed their belief that this special era of emerging and re-emerging zoonoses will extend well into the future and that this Group's deliberations will gain in importance and demand more and more attention. The recommendations in this report represent a set of actions that will help to achieve the following outcomes:

- create greater awareness of emerging and re-emerging zoonoses in veterinary, public health and environmental fields;

- serve as inputs for Veterinary Services of Member Countries and their Public Health and Environment counterparts to prepare and train a new cadre of professionals with the knowledge and expertise needed for successfully confronting and managing emerging and re-emerging zoonoses;

- help to change the mindset of professionals working in Veterinary Services of Member Countries and their Public Health and Environment counterparts on the complexity of emerging and re-emerging zoonoses and stimulate new ways of thinking and acting that emphasize multidisciplinary approaches, teamwork and collaboration across professions and institutions, and instil an appreciation of the dynamic interface of wildlife, domestic animals and humans from which zoonoses emerge;

- foster the creation of new partnerships between professionals working in animal health, human health, and environmental and other sciences (including social sciences) to work together to improve understanding of the determinants and risks of emerging and re-emerging zoonoses, and to join forces for the surveillance, reporting, prevention of these diseases and for responding collaboratively to these agents that flow between the wide range of host species that they affect; and

- contribute to developing strategic partnerships at sub-national, national, regional and international levels to implement best practices covering safe food production and for surveillance and disease intelligence systems spanning wildlife, domestic animals and humans.

2. Awareness and Communications

The Group examined examples of existing mechanisms for promoting awareness and communications on emerging and re-emerging zoonoses. The Group agreed that, given the increasing number of incidents due to emerging and re-emerging zoonoses throughout the world, there is a critical need to improve awareness of these diseases and to enhance communications between professions, agencies and organization involved in their management. They acknowledged that the responses of Member countries to last year's questionnaire confirmed the need to improve awareness and communications on emerging and re-emerging zoonoses. They also noted that the effectiveness of communications and awareness varied between regions, between countries, and between different levels of organization (community, local, provincial or state, and national) within countries. The Group considered that a review of case studies in the promotion of awareness and communications on emerging and re-emerging zoonoses would be a useful means of identifying lessons that could be adapted and applied to such efforts worldwide.

The Group agreed that having a designated national focal point to act as a liaison officer with other agencies and organizations would provide a useful way for CVOs to manage knowledge on emerging and re-emerging zoonoses, and noted that similar using designated national contact points are being used successfully in other areas of the OIE's work (e.g. aquatic animal health; wildlife diseases).

The Group recommended that Member Countries raise awareness and communications through having the CVO of each Member Country designate a specific senior officer, at the highest level possible, as the national contact point for liaison, both nationally and internationally, on emerging and re-emerging zoonoses. Such liaison positions for emerging and re-emerging zoonoses should provide a critical link between CVOs and Veterinary Services of Member Countries with their counterparts in both national Public Health and Environment agencies; with relevant universities and industry groups; and with relevant non-government organizations. They should also play a key role in knowledge management by providing a conduit for collecting and distributing information on emerging and re-emerging zoonoses within their respective countries. They would thus assume responsibility, under the supervision of CVOs, for collating data and information on emerging and re-emerging zoonoses for emergency and routine periodic reporting to regional and international organizations.

The Group acknowledged the need for support to be provided for the proposed national liaison officers to undertake their role and agreed that the OIE should support these officers by providing them with materials that will help them undertake their role.

> *The Group recommended that CVOs designate an officer, at the highest level possible, as the national contact point for liaison on emerging and re-emerging zoonoses, and that the OIE support these officers by providing them with materials and training that will help them undertake their role.*

3. Training and Capacity-Building

The Group discussed current training programmes that provide the knowledge and skills needed to work in areas involving the management of emerging and re-emerging zoonoses. They considered that there were deficiencies in such programmes worldwide, and noted in particular that in developed economies there was a marked trend for university veterinary undergraduate programmes to focus on training graduates for companion animal practice, with a resulting decline in focus on disciplines such as population medicine and veterinary public health that provide graduates with more of the knowledge and skills needed to manage emerging and re-emerging zoonoses. The Group acknowledged that postgraduate education (including postgraduate degrees and continuous education courses) provided an effective means of re-training young graduates with several years of experience who wished to move into careers that involved managing emerging and re-emerging zoonoses. It noted examples of such postgraduate programmes and the alternative of joint veterinary and public health programmes (e.g. the Master in Veterinary Public Health Management course offered by University of Sydney and the combined DVM/MPH programmes offered by the University of Minnesota and several other US universities). The Group agreed that understanding and managing emerging and re-emerging zoonoses require new knowledge and skills that have not been part of the traditional education and training of veterinary and animal health professionals.

The Group recommended that the OIE facilitate, in collaboration with FAO and WHO and associated collaborating centres, the development of foundation training modules for Member countries to use in educating their Veterinary Services, and their Public Health and Environment counterparts, in emerging and re-emerging zoonoses.

The meeting noted that in developing training materials, consideration needs to be given to language issues including differences in the use of some technical terms in different disciplines and the need to use simple language (augmented by glossaries of definitions of terms) in materials to be used by and communicated to individuals coming from a wide range of disciplinary backgrounds including veterinary science, human medicine and environmental and ecological sciences). It also suggested that such training materials for multidisciplinary audiences should be developed and delivered by multidisciplinary teams, and that strategic partnerships would be needed to design and deliver effective training in emerging and re-emerging zoonoses. The Group recognised the value of experiential learning, including staff exchanges (between animal health, public health and environmental agencies within each country, between countries, and from countries to regional and international organizations), and of delivery mode that allow trainees to upgrade the skills, knowledge, aptitudes and attitudes needed to manage emerging and re-emerging diseases while still engaged in their professional employment.

The Group examined the desired outcomes of training programmes for professionals working in areas involving the management of emerging and re-emerging zoonoses. Training outcomes could include improved liaison at the interface of animal health, public health, and environment and wildlife professionals and agencies; enhanced appreciation of the interdependence of these professions and agencies in managing emerging and re-emerging zoonoses; improved preparedness and response capacity for emerging and re-emerging zoonoses; improved communications and knowledge management; and changed culture in Veterinary Services to recognise their role in managing emerging and re-emerging zoonoses, including routine environmental scanning to detect potential emerging and re-emerging zoonoses in animals (including companion animals, food animals, and wildlife).

The Group recommended that CVOs actively promote and consider developing expertise in their Veterinary Services through the mutual exchange of professionals with their respective Public Health and Environment agencies, and collaborate, with research institutes and universities that undertake research and offer veterinary medicine and public health courses, to develop further training opportunities in emerging and re-emerging zoonoses.

The Group explored the possible curriculum of such training courses and concluded that they should include topics such as disease ecology; disease emergence; epidemiology (particularly surveillance and disease investigation); risk factors and risk analysis (including risk assessment, risk communications and risk management); disease emergence; role of wildlife; socioeconomic and behavioural perspectives; environmental scanning; forecasting and modelling; biosecurity and biosafety; and management leadership, and knowledge management.

The Group identified a range of target audiences for training, including Veterinary Services, Public Health practitioners; environment, ecology and wildlife professionals; industry; private veterinary and medical practitioners; university academics; media, policy-makers and politicians. It considered that training would need to be provided through a number of delivery systems, including hard copy and CD-ROM materials to support country liaison officers; workshops; short courses; online modular courses that can be undertaken while continuing employment; and research degrees (masters and PhD levels).

The Group recommended that the OIE's Regional Commissions and Representations conduct education sessions on emerging and re-emerging zoonoses in conjunction with their regular meetings, and that CVOs invite their counterparts in Public Health and Environment agencies to participate in these sessions.

4. Surveillance and Reporting

The Group noted the collaborative efforts of the OIE, FAO and WHO over the past two-and-one-half years in developing the Global Early Warning and Response System for major animal diseases, including zoonoses (GLEWS), which is designed to help combine and coordinate the different event surveillance, verification, assessment, alert and response mechanisms of these three organizations. Emphasis was laid on the three major

components of the planned platform for information-sharing through GLEWS — disease tracking and forecasting component, and a risk analysis component noting that the main focus of work to date has been on the first component. The meeting was encouraged by the collaborative efforts of the OIE, FAO and WHO in developing GLEWS, which includes critical emerging and re-emerging zoonoses.

The Group recommended that GLEWS be fully developed, adequately funded, and implemented.

Dr Karim Ben Jebara informed participants of the new OIE reporting system, emphasizing the new criteria developed by the Ad hoc Group on Terrestrial Animal Disease/Pathogenic Agents Notification. The Group noted that the OIE reporting system comprised two components that covered early warning and routine monitoring, respectively, and that the system was moving away from a focus on reporting the occurrence of particular 'listed' diseases to one of reporting significant events, including incidents due to new or previously unidentified emerging zoonoses. The Group supported the new OIE disease information system and its inclusion of critical emerging and re-emerging zoonotic events. The Group also acknowledged that its mission includes the continuous review of this system and the need for it to provide ongoing advice to the OIE on improving the system, particularly with respect to the criteria as they relate to emerging and re-emerging zoonoses, including ecological and other risk factors for disease emergence as these become better understood.

The Group discussed a range of examples of best practice in surveillance, including ProMED: the epidemiology intelligence service of the US Centers for Disease Control and Prevention (CDC); the European Program for Intervention Epidemiology Training (EPIET); and Europe's MED-VET-NET and the WHO outbreak verification list system for human disease outbreaks. It also noted the work of the OIE Working Group on Wildlife Diseases on developing approaches to disease surveillance in wildlife. The Group considered that as systems moved more to event-based surveillance, and surveillance approaches currently being developed in several pilot projects are completed, there would be increasing opportunities to use syndromic surveillance in human, domestic animal and perhaps wildlife populations to provide early warning of changes that could be investigated to determine if they might reflect the occurrence of an emerging or re-emerging zoonosis.

The Group considered that in the past too much attention has been given to disease notification and reporting of disease events that have occurred, without a concurrent emphasis on related strategies to prevent their occurrence. It supported the conclusion of the recent fourth meeting of the OIE Animal Production Food Safety Working Group that the OIE should develop methods for managing those foodborne zoonotic pathogens for which compulsory reporting might not be an appropriate risk management measure.

The Group recommended that the OIE, in permanent conjunction with FAO and WHO (including the Codex Alimentarius Commission), consider a more proactive approach to explore the development of guidelines, standards and codes of practice for animal production to help reduce the risk of occurrence of emerging and re-emerging foodborne zoonoses.

5. Prevention and Control

The Group noted that there have been a number of recent reviews of major outbreaks of emerging zoonoses, including West Nile virus, Rift Valley fever, Nipah virus and monkeypox, that include discussion on key lessons learned about the outbreaks and responses to them. It considered that there would be value in reviewing such incident reports and collating the key lessons learned from them in a concise report that could be distributed to Veterinary Services and their Public Health and Environment counterparts. The Group agreed to develop a review of key lessons learned from reports of recent outbreaks of zoonoses.

The Group recommended that OIE distribute a review of key lessons learned from recent outbreaks of zoonoses through designated country liaison officers on emerging and re-emerging zoonoses to Veterinary Services and their Public Health and Environment counterparts.

The Group considered that the outcome of this action would be enhanced links between the key individuals and agencies involved in emerging and re-emerging zoonoses in each Member country as well as progress in establishing the role and status of country liaison officers responsible for emerging and re-emerging zoonoses.

The Group noted that in many countries, disaster and emergency response services had in place sound plans for establishing multi-disciplinary and multi-agency command centres to facilitate responses to emergencies, including disease emergencies that might arise from outbreaks of emerging and re-emerging zoonoses. It acknowledged that there is value in Veterinary Services and their Public Health and Environment counterparts establishing links with such emergency services as part of national and sub-national contingency planning for disease outbreaks. It agreed that there is much to be gained from conducting desktop exercises on simulated outbreaks of zoonoses to build and maintain interagency links and to test contingency plans and outbreak preparedness. They agreed that there is value in having designated process observers to monitor, evaluate and provide constructive feedback on decision-making and what works well and what might need to be improved in such exercises (and, indeed, in real-life responses). The Group also noted that such designated process observers might also play a role in designing simulations and might be drawn from disaster and emergency response services or other organizations.

> *The Group recommended that designated country liaison officers on emerging and re-emerging zoonoses facilitate the establishment of links between Veterinary Services and their Public Health and Environment counterparts with their country's disaster and emergency response services, and that regular desktop exercises should be conducted to test contingency plans and inter-agency links for zoonotic diseases.*

The Group considered that the outcome of these actions would be significantly enhanced links between the key individuals and agencies involved in emerging and re-emerging zoonoses in each Member country as well as contributing to improved emergency response capacity for outbreaks of emerging and re-emerging zoonoses.

The Group noted that disease outbreaks and emergencies due to emerging and re-emerging zoonoses may present significant uncertainties and unknowns. To overcome this problem, the Veterinary Services and their Public Health and Environment counterparts need to adopt joint planning process to improve preparedness for and responses to such incidents. The Group acknowledged the need for this activity to go beyond routine disease reporting and tracking of incidents, to apply multidisciplinary perspectives to emerging and re-emerging zoonoses. They suggested that a multidisciplinary approach needs to be established during outbreaks and to provide ongoing advice after events on further investigations and research that might be needed to elucidate ecological and epidemiological factors that contributed to outbreaks. The Group agreed that multidisciplinary teams comprising specialists in a wide range of disciplines, from both scientific and social sciences, are needed to address the highly complex and dynamic nature of emerging and re-emerging zoonoses. They noted that efforts to understand the factors that favour the emergence and re-emergence of zoonoses emphasize the interdependence of such work and the various professions and organizations that need to be involved.

> *The Group recommended that the OIE, in collaboration with FAO and WHO, support the concept of collaborative interdisciplinary projects on emerging and re-emerging zoonoses within designated centres to provide training, education and research to help clarify risk factors and surveillance needs that should ultimately improve the understanding of and improve responses to incidents caused by emerging and re-emerging zoonoses.*

The Group examined some examples of best practice in this area — including CDC projects; the work of Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale'; the Mediterranean Zoonoses Control Programme (MZCP) in the Middle East; the multidisciplinary research programmes on diagnostics, surveillance and disease ecology of the Australian Biosecurity Cooperative Research Centre for Emerging Diseases (AB CRC); the South-East Asian Foot-and-Mouth Disease Control and Eradication Program (SEAFMD); and the recently established diagnostics and surveillance networks for avian influenza in Asia. The Group considered that establishing such projects would contribute significantly to training and education of specialists in the range of disciplines involved in managing these diseases.

6. International Conference on Emerging Infectious Diseases

The Group acknowledged the invitation to the OIE from the CDC to help design a symposium on emerging and re-emerging zoonoses in conjunction with the CDC's International Conference on Emerging Infectious Diseases (ICEID) in Atlanta, United States of America, in March 2006. ICEIDs are held every two years and attract a large number of participants from a variety of countries and disciplines. It agreed that OIE should support the proposed symposium and noted that it would also be useful to raise awareness of emerging and re-emerging zoonoses by providing similar input to a number of key international scientific conferences such as that of the International Society for Veterinary Epidemiology and Economics (ISVEE), which are held every four years, with the next scheduled to be held in Cairns, Australia, in September 2006.

The Group considered that a symposium on emerging and re-emerging zoonoses in conjunction with the CDC's ICEID in Atlanta in March 2006 could focus on a coordinating theme such as 'Emerging and Re-emerging Zoonoses: Medical and Veterinary Partnerships for the Future'. The Group suggested that the symposium could examine, in addition to the veterinary and medical aspects, several areas from a list that included: scanning for the next emerging zoonoses through improved animal health surveillance; innovative disease surveillance in wildlife; lessons learned from recent case studies worldwide; risk analysis and risk factors for the emergence of new zoonoses; the socioeconomic and psychological impact of zoonoses; forecasting and modelling; biosecurity and biosafety; and disaster medicine.

The Group recommended that the OIE take an active role with the CDC in planning, promoting and participating in a OIE/CDC symposium on emerging and re-emerging zoonoses in conjunction with the ICEID in Atlanta in March 2006, and in identifying opportunities for similar involvement in other relevant international scientific conferences.

7. Next Steps

During the meeting, participants identified a number of areas that the Group should consider at its next meeting. These included:

- wildlife issues, particularly surveillance of wildlife diseases and validation of laboratory tests for diseases in wildlife, which are both being addressed currently by the OIE Working Group on Wildlife Diseases;

- the role of serum banks in improving knowledge of the emergence and potential host range of emerging and re-emerging zoonoses, particularly in terms of considering compiling some case studies and promoting their use through country liaison officers;

- consideration of how the work of the Group might be linked to broader developments (e.g. the Millennium Development Goals) that might facilitate increased focus on issues related to the management of emerging and re-emerging zoonoses; and

- involvement of representatives of other disciplines, particularly the social sciences (e.g. specialist in risk communication and in the socioeconomic effects of zoonoses) in the work of the Group to help identify risk factors and change behaviour to reduce risks (e.g. in developing a review of cases studies in the promotion of awareness and communications on emerging and re-emerging zoonoses that would identify lessons that could be adapted and applied to such efforts worldwide).

The Group noted that its report would be considered by the Scientific Commission at its next meeting later this year and then by the International Committee in May. It agreed that it would be useful for the Group to meet again in September 2005 (with provisional dates proposed 15–16 September) and agreed with the proposal to consider holding a subsequent meeting n conjunction with the symposium on emerging and re-emerging zoonoses to be held in association with ICEID in Atlanta in March 2006.

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…/Appendices

Appendix I

Terms of Reference, Mission and Provisional Agenda

Terms of Reference

The Ad hoc Group on Emerging Zoonoses will comprise an interdisciplinary group of world-renowned experts on animal and public health, representatives from the World Health Organization, the Food and Agriculture Organization of the United Nations, the OIE Specialist Commissions (Terrestrial Animal Health Standards Commission and Scientific Commission for Animal Diseases), the OIE Working Groups on Wildlife Diseases and Animal Production Food Safety, the OIE Ad hoc Group on Epidemiology and the OIE Reference Laboratories and Collaborating Centres.

The Secretariat of the Ad hoc Group will be provided by the OIE Scientific and Technical Department, with the guidance of the Scientific Commission for Animal Diseases.

Mission

To provide advice on:

- sustainable agricultural development models that do not favour the increase in the occurrence of emerging and re-emerging zoonoses;
- capacity-building of Member Countries by providing training through international workshops and other means to the Veterinary Services of Member Countries and veterinary and medical academic institutions on emerging and re-emerging zoonotic diseases;
- the opportunities and mechanisms to promote awareness and interaction between the Veterinary Services of Member Countries and their Public Health counterparts;
- mechanisms for the timely and accurate reporting of zoonotic diseases, by sharing information on emerging and re-emerging zoonotic diseases between the Veterinary Services and their Public Health counterparts;
- surveillance systems that cover diseases of wildlife, domestic animals and humans;
- zoonotic disease control strategies at the animal production level; and
- communication with Public Health agencies on the human impact of emerging and re-emerging zoonoses.

The Ad hoc Group will prepare recommendations related to the above-listed topics. These recommendations will be submitted for endorsement by the relevant OIE Specialist Commissions and then by the International Committee. The Ad hoc Group will also be asked to provide statements, upon the request of the Director General, on any concern related to emerging zoonoses, including preparation of standards and guidelines.

REPORT OF THE MEETING
OF THE OIE AD HOC GROUP ON EMERGING ZOONOSES
Paris 29 - 31 March 2005

Provisional Agenda

1. Introduction
2. Terms of Reference of the Ad hoc Group on Emerging Zoonoses
3. Plan of work of the Ad hoc Group on Emerging Zoonoses for the next two years
   - preparation of guidelines to promote awareness and interaction between the Veterinary Services of Member Countries and their Public Health counterparts;
   - preparation of guidelines for the timely and accurate reporting of zoonotic diseases; and
   - provide guidance on communication to Public Health agencies for addressing human impact of emerging and re-emerging zoonoses
4. Input for the OIE/CDC International Conference on Emerging Zoonoses, 2006
5. Other matters

Appendix II

REPORT OF THE MEETING

AD HOC GROUP ON EMERGING ZOONOSES

29–31 March 2005

List of participants

MEMBERS

Dr Lonnie J. King
Dean, College of Veterinary Medicine
Michigan State University
G-100 Veterinary Medical Center
East Lansing
MI 48824-1314
USA
Tel: (+1) 517 355 6509
Fax: (+1) 517 432 1037
E-mail: kinglonn@cvm.msu.edu

Dr Mike Nunn
Manager (Animal Health Science)
Australian Government Department of Agriculture, Fisheries and Forestry
GPO Box 858, Canberra ACT 2601
AUSTRALIA
Tel: (+61) 2 6272 4036
Fax: (+61) 2 6272 4533
E-mail: mike.nunn@daff.gov.au

Dr Michael H. Woodford
Quinta Margarita
c/o Apartado 1084
8101-000 Loule
Algarve
PORTUGAL
Tel: (+35) 1 289 999 556
E-mail: dinton@aol.com

Dr Rossella Lelli
Head of National Reference Centre for Exotic Diseases, Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise 'G. Caporale'
Via Campo Boario
64100 Teramo
ITALY
Tel: (+39) 8 613 322 33
Fax: (+39) 8 613 322 51
E-mail: r.lelli@izs.it

Dr Jan Slingenbergh
Senior Officer, Animal Health Service
Animal Production and Health Division, Agriculture Department, FAO
Via delle Terme di Caracalla
00100 Rome
ITALY
Tel: (+39) 6 570 541 02
Fax: (+39) 6 570 557 49
E-mail: jan.slingenbergh@fao.org

Dr François-Xavier Meslin
Coordinator Monitoring and Strategy Development Zoonoses, Foodborne Diseases and Kinetoplastidae (ZFK)
WHO
20 Avenue Appia
CH-1211 Geneva 27
SWITZERLAND
Tel: (+41) 22 791 25 75
Fax: (+41) 22 791 48 93
E-mail: meslinf@who.int

Prof Hassan Aidaros
Professor of Hygiene and Preventive Medicine, and Head of the OIE Regional Scientific Committee for the Middle East, 5 Mossadak St.
12311 Dokki, Cairo
EGYPT
Tel: (+20) 2 338 6549
Fax: (20) 2 760 7055
E-mail: haidaros@netscape.net

OTHER PARTICIPANTS

Dr Alejandro Thiermann
President of the OIE Terrestrial Animal Health Standards Commission
Tel: 33-(0)1 44 15 18 69
E-mail: a.thiermann@oie.int

Dr Gunnar Nylén
Medical Officer, Monitoring and Strategy Development Zoonoses, Foodborne Diseases and Kinetoplastidae Team (ZFK), WHO
20 Avenue Appia
CH-1211 Geneva 27
SWITZERLAND
Tel: (+41) 22 791 25 75
Fax: (+41) 22 791 48 93
E-mail: nyleng@who.int

OIE CENTRAL BUREAU

Dr Alejandro Schudel
Head, Scientific and Technical Department
E-mail: a.schudel@oie.int

Dr Karim Ben Jebara
Head, Animal Health Information Department
E-mail : k.benjebara@oie.int

Dr Francesco Berlingieri
Project Officer, International Trade Department
E-mail: f.berlingieri@oie.int

Appendix III

RESOLUTION No. XXIX OF THE 72nd OIE GENERAL SESSION

Paris, May 2004

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Emerging and Re-Emerging Zoonotic Diseases: Challenges and Opportunities

CONSIDERING THAT

1. The interaction of human and animal health is producing unprecedented challenges and opportunities;

2. Zoonotic diseases are emerging and re-emerging with greater frequency, international scope, and economic importance;

3. The factors and forces driving the expansion and scale of zoonoses are still in place and are unlikely to significantly change in the near future; thus, the risks posed by emerging and re-emerging zoonotic diseases will continue unabatedly for some time;

4. Member Countries have again indicated their overwhelming support for a greater OIE role in confronting the challenges of such zoonoses;

5. Member Countries strongly believe that emerging and re-emerging zoonotic diseases will become a progressively greater factor in the demands on the activities of Veterinary Services, thus impacting on future partnerships, resources, and programmes; and

6. FAO/WHO/OIE are engaged in cooperative agreements that will continue to provide important international linkages,

THE COMMITTEE RESOLVES THAT:

1. The OIE should actively consider within the development of the fourth strategic plan the broadening of its scope, commitment, and thinking regarding emerging and re-emerging zoonoses and place a high priority on developing guidelines for the prevention and control of these diseases.

   The preparation of the fourth Strategic Plan will include proposals related to the purpose of the *Code* in matters of zoonotic aspects of listed diseases.

2. The OIE will consider the creation of a new Ad hoc Group on Emerging and Re-Emerging Zoonoses that will be inter-disciplinary in membership and help to advise on sustainable agriculture development that does not increase the occurrence of emerging and re-emerging zoonoses and on surveillance systems that cover the wildlife, domestic animal, and human continuum. The group will also assist in the education of OIE Member Countries.

   The new Ad hoc Group will work in collaboration with the existing OIE Working Groups on Wildlife Diseases and Animal Food Production Safety and the Ad hoc Group on Epidemiology and other relevant bodies or experts, in particular OIE Reference Laboratories and Collaborating Centres.

3. The OIE should provide training through workshops and other means for Member Countries and academic veterinary and medical institutions on emerging and re-emerging zoonotic diseases, especially in regional activities.

4. The OIE will undertake to explore opportunities and mechanisms to promote awareness through conferences and interactions between the Veterinary Services of Member Countries, and their public health counterparts.

Appendix III (contd)

5. The OIE will continue to support and urge Member Countries to make progress on timely and accurate reporting of zoonoses and sharing information on emerging and re-emerging zoonotic diseases, realising that many of these new diseases are not associated with animal trade or traditional listed diseases.

6. In the event of serious outbreaks of zoonotic diseases that transcend national borders, the OIE will demonstrate leadership in providing guidance on disease control strategies at the animal production levels and will support the communication efforts of public health agencies in addressing human impacts.

Appendix VI

Original: English
April 2005

REPORT OF THE MEETING OF THE OIE AD HOC GROUP ON ANTIGEN AND VACCINE BANKS FOR FOOT AND MOUTH DISEASE

Paris, 13-15 April 2005

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1. Introduction

The meeting of the OIE Ad hoc Group on Antigen and Vaccine Banks for Foot and Mouth Disease (FMD) was held at the OIE Headquarters, Paris from 13 to 15 April 2005. Dr A.Schudel, Head of the Scientific and Technical Department of the OIE, welcomed all the participants on behalf of Dr B.Vallat, Director General of the OIE. Apologies were received from Dr Tom McKenna.

Dr Schudel congratulated the Group on the outputs of the first meeting held in June 2004. He explained that as the Group functions under the auspices of the Scientific Commission for Animal Diseases (Scientific Commission) it would be chaired by Dr G. Thomson, member of that commission.

He informed that the two documents prepared by the Group at its June 2004 meeting namely; a proposed chapter on antigen and vaccine banks for inclusion in the OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* (the *Terrestrial Manual*) and a new section to the existing chapter on FMD in the *Terrestrial Manual* had already been approved by the OIE Biological Standards Commission and distributed to OIE Member Countries for comments. He pointed out that as per the request of the Scientific Commission, the Group was expected to finalise the document on the harmonisation of FMD virus characterisation for inclusion in the FMD chapter of the *Terrestrial Manual*.

Dr Keith Sumption was appointed Rapporteur.

The Agenda and the list of Participants are presented as Appendices I and II respectively.

2. Agenda

The Chairman outlined the working procedure for the meeting indicating that priorities would be given to issues mentioned in the terms of reference (TOR) during the June 2004 meeting as follows:

- to develop a new section for the FMD Chapter of the *Terrestrial Manual* on vaccine matching, under ToR 3: (Harmonisation of virus strain characterisation, and other information requirements for the identification and selection of antigens for inclusion in FMD vaccine and antigen banks).

- to reach agreement on the way forward for development of a network of FMD laboratories , as part of ToR 5: (To provide advice to the OIE on issues relating to networking of the OIE and FAO regional and international FMD Reference Laboratories).

- To agree on the next steps required to develop a network of antigen and vaccine banks (ToR 4).

In addition it was agreed that on behalf of the European Union- Foot and Mouth Disease (EU FMD) and classical swine fever (CSF) Co-ordination Action Programme (CA), Dr David Paton give a short presentation identifying synergies between the activities of the CA and the work of the Group.

3. Report of the June 2004 meeting

The Group noted that the report of the June 2004 meeting had been approved by the Scientific Commission and the two documents mentioned above had been referred to the Biological Standards commission (the Laboratories Commission) which in turn has circulated them for country comments.

4. Vaccine matching methods

The Group reviewed a paper prepared by some members of the Group namely; Drs David Paton, Ingrid Bergman, Eduardo Palma and Gavin Thomson. It was agreed that Dr David Paton and other members of the Group would use that document to develop a review of vaccine matching methods for information by end users. The review would be submitted to the OIE *Scientific and Technical Review* by September 2005 for publication in December 2005

The section proposed for inclusion in the FMD Chapter of the *Terrestrial Manual* was reviewed and approved with some amendments. It is presented as Appendix III.

5. Network of FMD Reference Laboratories

A draft document for an agreement on a network of FMD Reference Laboratories under the joint auspices of OIE and FAO was presented. Acknowledging the need for such a network, the Group discussed the document and approved it with some modification. The objectives, activities and co-ordination of the network as agreed are presented as Appendix IV. The Group strongly recommended that once approved by the OIE and FAO, the partner laboratories be invited to implement the activities of the network as soon as possible.

It was agreed that the Reference Laboratories should, as a product of the network, produce a unified annual report to the OIE for 2005. Furthermore the laboratories will work together to develop an online information system.

The Group recommended that OIE and FAO seek financial support for the network and concluded that without such support progress would be difficult to achieve.

6. Development and operation of a potential vaccine bank network

This item was held over from the previous meeting (ToR 4. To provide advice on future development and operation of a potential vaccine bank network).

The Group agreed on the following two actions:

- the CA through the use of a questionnaire survey would identify the key players and issues,
- the CA will provide a report to the Group for review and, if deemed necessary, a workshop for potential network members will be recommended to further develop the concept.

…/Appendices

Appendix I

REPORT OF THE MEETING OF THE OIE AD HOC GROUP ON ANTIGEN AND VACCINE BANKS FOR FOOT AND MOUTH DISEASE

Paris, 13-15 April 2005

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Agenda

1. Introduction
2. Agenda
3. Report of the June 2004 meeting
4. Vaccine matching methods
5. Network of FMD Reference Laboratories
6. Development and operation of a potential vaccine bank network

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Appendix II

REPORT OF THE MEETING OF THE OIE AD HOC GROUP ON ANTIGEN AND VACCINE BANKS FOR FOOT AND MOUTH DISEASE

Paris, 13-15 April 2005

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List of participants

MEMBERS

Dr Gavin R. Thomson
Consultant to GALV
International Livestock Research Institute
P O Box 30709, Nairobi
KENYA
Tel: (254 20) 422 3000x3629
Fax: (254 20) 422 3001
E-mail: g.thomson@cgiar.org

Dr Ingrid Bergmann
Centro Panamericano de Fiebre Aftosa, OPS/OMS,
Caixa Postal 589
CEP: 20001-970 Rio de Janiero
BRASIL
Tel: (55.21) 36.61.90.64
Fax: (55.21) 36.61.90.01
E-mail: ibergman@panaftosa.ops-oms.org

Dr Kris De Clercq
Department of Virology
Section Epizootic Diseases
CODA-CERVA-VAR
Groeselenberg 99
B-1180 Ukkel
BELGIUM
Tel: (32 2) 3790 512
Fax: (32 2) 3790 666
E-mail: kris.de.clercq@var.fgov.be

Dr O.G. Matlho
OIE Regional Reference Laboratory
for the Sub-Saharan continent
Broadhurst Industrial Site
Lejara Road, Private Bag 0031
Gaborone
BOTSWANA
Tel: (267) 391.27.11
Fax: (267) 395.67.98
E-mail: gmatlho@bvi.co.bw

Dr Thomas S. McKenna
(Invited but unable to attend)
Laboratory Chief
Foreign Animal Disease Diagnostic Laboratory
(FADDL), USDA/APHIS
P.O. Box 848, New York 11944
USA
Tel: (1.631) 323 3256
Fax: (1.631) 323 3366
E-mail: thomas.s.mckenna@aphis.usda.gov

Dr Eduardo L. Palma
Coordinator, FMD Research and Development
Interinstitutional Network (RIIDFA)
Santa Fé 857, 1059 Buenos Aires
ARGENTINA
Tel: (54.11) 4311 5879 / 154 540 7017
E-mail: epalma@fibertel.com.ar
or epalma@cnia.inta.gov.ar

Dr David Paton
Pirbright Laboratory
Institute for Animal Health
Ash Road, Woking, Surrey GU24 0NF
UNITED KINGDOM
Tel: (44-1483) 231012
Fax: (44-1483) 232621
E-mail: david.paton@bbsrc.ac.uk

Dr Keith Sumption
Secretary of the European Commission
for the Control of Foot and Mouth Disease
FAO
Via delle Terme di Caracalla
00100 Rome
ITALY
Tel: (39) 06 570 55528
Fax: (39) 06 570 55749
E-mail: keith.sumption@fao.org

Dr V.M. Zakharov
Federal Governmental Institute
Centre for Animal Health
FGI-ARRIAH, 600900 Vladimir, Yur'evets
RUSSIA
Tel: (7.0922) 26.06.14
Fax: (7.0922) 24.36.75
E-mail: mail@arriah.ru

OTHER PARTICIPANTS

Dr Paul Barnett
Pirbright Laboratory
Institute for Animal Health
Ash Road, Woking, Surrey GU24 0NF
UNITED KINGDOM
Tel: (44-1483) 231012
Fax: (44-1483) 232621
E-mail: paul.barnett@bbsrc.ac.uk

Dr T.W. Drew
Head of Mammalian Virology
VLA Weybridge
Woodham Lane, New Haw
Addlestone, Surrey KT15 3NB
UNITED KINGDOM
Tel: (44.1932) 35.76.37
Fax: (44.1932) 35.72.39
E-mail: t.w.drew@vla.defra.gsi.gov.uk /
tdrew.vla@gtnet.gov.uk

Dr Jean-Francois Valarcher
Institute for Animal Health
Pirbright Laboratory, Ash Road, Pirbright, Woking,
Surrey GU24 0NF
UNITED KINGDOM
Tel (44-1483) 231132
Fax (44 1483) 232621
E-mail jean-francois.valarcher@bbsrc.ac.uk

Dr Alf-Eckbert Fuessel
European Commission, D. G. VI-B.II.2
Rue Froissard 101-3/64, B-1049 Bruxelles
BELGIUM
Tel: (32-2) 295 0870
Fax: (32-2) 295 3144
E-mail: alf-eckbert.fuessel@cec.eu.int

OIE CENTRAL BUREAU

Dr Alejandro Schudel
Head, Scientific and Technical Department
12 rue de Prony, 75017 Paris
FRANCE
Tel: 33 - (0)1 44 15 18 88
Fax: 33 - (0)1 42 67 09 87
E-mail: a.schudel@oie.int

Dr Dewan Sibartie
Deputy Head, Scientific and Technical Department
E-mail: d.sibartie@oie.int

Appendix III

New Section for OIE *Diagnostic Manual* on Vaccine Matching Tests[1]

Vaccine matching tests

1. Introduction

Vaccination against one serotype of FMDV does not cross-protect against other serotypes and may also fail to protect fully or at all against other subtypes of the same serotype. The most direct and reliable method to measure cross-protection is to vaccinate relevant target species and then to challenge them by exposure to the virus isolate against which protection is required. This will take account of both potency and cross-reactivity. However, such an approach is slow and expensive, and the animal numbers needed for statistically significant results raise welfare concerns.

A variety of in vitro serological methods can be used to quantify antigenic differences between the FMDV capsid proteins and thereby estimate the likely cross-protection between a vaccine strain and a field isolate. Genetic characterisation and antigenic profiling can also reveal the emergence of new strains for which vaccine matching may be required and conversely indicate that an isolate is similar to one for which vaccine matching information is already available.

Appropriate vaccine strain selection is a critical element in the control of FMD and is necessary for the application of vaccination programmes in FMD-affected regions as well as for the establishment and maintenance of vaccine antigen reserves to be used in the event of new FMD incursions.

Vaccine potency also contributes to the range of antigenic cover provided by a vaccine. A highly potent vaccine that stimulates a strong immune response may give greater protection against a heterologous virus than an equally cross-reactive vaccine that stimulates a weaker immune response. Furthermore, booster doses of vaccine can increase potency and the subsequent breadth of antigenic cover provided by a given vaccine, although the onset of full protection may be delayed.

2. Selection of field viruses for vaccine matching studies

Serological matching of field isolates to vaccine strains requires that isolates have been serotyped and adapted to grow in cell cultures. The serotype is usually determined by ELISA or CFT using type-specific serological reagents, although methods based on monoclonal antibodies or genetic typing may also be used. BHK or IB-RS-2 cell cultures are usually used for in vitro virus replication. For vaccine matching, preferably, at least two isolates should be evaluated from any outbreak and inconsistent results should be followed up to determine whether this is due to genuine antigenic differences or is an artefact of testing.

Viruses can be selected based on epidemiological information, for instance isolation at different stages of an epidemic, from different geographic locations or from different hosts. Field evidence for a lack of vaccine induced protection is an important criterion for vaccine matching.

Antigenic profiling by CFT or by ELISA or sequence analysis of the VP1 gene are suitable approaches for selecting representative virus isolates for vaccine matching. Antigenic profiling is performed by CFT using panels of hyperimmune guinea-pig sera raised against epidemiologically relevant field isolates (Bergmann *et al*., 1988) or by ELISA using panels of well-characterised monoclonal antibodies (Alonso *et al*., 1993).

[1] To be inserted “en bloc” into the Manual as a new section between current sections B and C.

3. Selection of vaccine strains to be matched

The serotype of the virus, the region of origin and any information on the characteristics of the field isolate may give indications of the vaccines most likely to provide an antigenic match. The availability of reagents for matching to particular vaccines may limit the choice of what is possible. Vaccine matching has two purposes; firstly to chose the most effective vaccine for use in a particular circumstance and secondly to monitor, on an ongoing basis, the suitability of vaccines maintained in vaccine antigen reserves.

4. Choice of vaccine matching test

4.1. The serological relationship between a field isolate and a vaccine virus ('r' value) can be determined by CFT, ELISA or VNT (Pereira, 1977; Kitching *et al*., 1988; Rweyemamu *et al*., 1978). One way testing is recommended (r_1) with a vaccine antiserum, rather than two way testing (r_2) which also requires an antiserum against the field isolate to be matched. Due to inherent assay variability, tests need to be repeated to be confident of the results (Rweyemamu and Hingley, 1984). In vitro neutralisation may be more relevant to in vivo protection than other measures of virus-antibody interaction, although non-neutralising antibodies may also be protective (McCullough *et al*., 1992). Advantages of ELISA are that the test is rapid and utilises smaller volumes of post-vaccination sera which are often available in limited quantities. ELISA and CFT are recommended to be used as screening methods whereas VNT or the expected percentage of protection (EPP) method provide more definitive results. For either VNT or ELISA, post-vaccination sera are derived from at least five cattle 21-30 days after immunisation. The titre of antibody to the vaccine strain is established for each serum which are used individually or pooled, excluding low responders. The CFT method utilises guinea-pig sera.

4.2. A more thorough evaluation is provided by the Expected Percentage of Protection (EPP) method (Alonso *et al*., 1987) which measures the reactivity of a panel of post-vaccination antisera using either VNT or ELISA and relates the serological titres to the probability of protection, established through correlation tables associating antibody titres with protection against the relevant vaccine strain. These correlation tables derive from previously performed vaccine-specific challenge tests. However, the requirement for a panel of antisera and accompanying challenge test data for the vaccine in question currently cannot be met for a wide range of vaccine strains.

5. Vaccine matching by ELISA

5.1. This test utilises an antiserum raised against a vaccine strain. The blocking ELISA titres of this reference serum against antigens prepared from the homologous vaccine strain and a field isolate are compared to determine how antigenically 'similar' the field virus is to the vaccine virus.

5.2. The test procedure is similar to that of the liquid phase blocking ELISA (see section 2c). Additional biological reagents are: 21-30 day post-vaccination bovine vaccine sera (inactivated at 56ºC for 45-60 min); the homologous vaccine strain; the test virus, a field isolate of the same serotype as the vaccine strain

5.3. Grow the field isolate and the vaccine strain in BHK or IB-RS-2 cells. The number of cell culture passages should be kept to a minimum (normally less than four) to avoid selection of antigenic variants unrepresentative of those in the original material. A sufficient quantity of virus should be present if cell cultures are destroyed by cytopathic viral effect within 24 hours of inoculation.

5.4. Harvest and titrate the vaccine and field viruses using a panel of trapping rabbit antisera and detector guinea pig antisera raised against the same or closely related vaccine strains. If necessary, the virus antigens may be inactivated prior to use by binary ethyleneimine (BEI).

5.5. Select the optimum trapper/detector combination and the working dilution of the field virus. This should not be less than 1:6. If there is no suitable trapper/detector combination then a back-titration of the antigen stock must be performed to confirm that sufficient virus was present. Once confirmed, this indicates that none of the available vaccines are suitable.

5.6. Titrate 21-30 day post-vaccination serum of a chosen vaccine strain against the field isolate and the homologous vaccine strain. The titre against the vaccine strain should not fluctuate more than two-fold either side of a mean value.

5.7. To determine the serum titre, calculate the average optical density (OD) of 24 antigen control wells without blocking serum. This represents the maximum OD value for the test, i.e., the 100% control value. Divide this by 2 to determine the 50% inhibition value. Score wells with blocking serum positive if the OD is less than or equal to 50% and negative if the OD value is greater than this. The end-point is defined as the dilution at which half of the wells show 50% inhibition or more (i.e., identify the dilution at which one out of the two duplicate wells has an OD less than 50% of the antigen control). If the end-point falls between two dilutions, it is taken as the mid-point between these dilutions, as estimated by the Spearmann-Karber method.

5.8. Derive an 'r' value, the relationship between a field and a vaccine strain, as:

$$r_1 = \frac{\text{titre of reference serum against field virus}}{\text{titre of reference serum against vaccine virus}}$$

At least two consistent results are needed for acceptance.

5.9. Interpretation

For r_1 values derived by ELISA the following guidelines are used for interpretation: (Ferris and Donaldson, 1992)

0.4-1.0 Close relationship between field isolate and vaccine strain. A potent vaccine containing the vaccine strain is likely to confer protection.

0.2-0.39 The field isolate is antigenically related to the vaccine strain. The vaccine strain might be suitable for use if no closer match can be found provided that a potent vaccine is used and animals are preferably immunised more than once.

<0.2 The field isolate is only distantly related to the vaccine strain and the vaccine strain is unlikely to protect against challenge with the field isolate.

6. Vaccine matching by two-dimensional neutralisation test

6.1. This test also utilises an antiserum raised against a vaccine strain. The titres of this serum against 100 TCID50 of the homologous vaccine strain and the same dose of a field isolate are compared to determine how antigenically 'similar' the field virus is to the vaccine strain.

6.2. The procedure is similar to that of the microtitre plate virus neutralisation test (see Section 2a). Additional biological reagents are: 21-30 day post-vaccination bovine vaccine sera (inactivated at 56ºC for 45-60 min); the homologous vaccine strain; the test virus, a field isolate of the same serotype as the vaccine strain

6.3. Field isolates are passaged on cell cultures until adapted to give 100% CPE in 24 hours. Passages should be kept to a minimum. When adapted, determine the virus log10 titre by end-point titration.

6.4. For each test and vaccine virus a chequerboard titration is performed of virus against vaccine serum along with a back-titration of virus alone. Cells are added and incubated at 37ºC for 48-72 h after which time CPE is assessed.

6.5. Antibody titres of the vaccine serum against the vaccine strain and field isolate for each virus dose used are calculated using the Spearmann-Karber method. The titre of the vaccine serum against 100 $TCID_{50}$ of each virus can then be estimated by regression. The relationship between the field isolate and the vaccine strain is then expressed as an 'r' value as described for vaccine matching by ELISA.

6.6. Interpretation. In the case of neutralisation, r_1 values greater than 0.3 indicate that the field isolate is sufficiently similar to the vaccine strain that use of the vaccine is likely to confer protection against challenge with the field isolate (Rweyemamu, 1984). Conversely, values less than 0.3 suggest that the field isolate is so different from the vaccine strain that the vaccine is unlikely to protect. In these cases, either the field isolate should be examined against alternative vaccine strains or, rarely, it will be necessary to adapt a suitable field isolate to become a new vaccine strain.

6.7. Tests should always be repeated more than once. The confidence with which 'r' values can be taken to indicate differences between strains is related to the number of times that the examination is repeated. In practice, a minimum of at least three repetitions is advised.

7. Vaccine matching by CFT

7.1. The relationship between a field isolate and a vaccine strain can also be determined by complement fixation using a guinea-pig antiserum raised against the relevant vaccine strain.

7.2. The CFT 50% titres of this reference serum against antigens prepared from the homologous vaccine strain and a field isolate are compared to determine how antigenically 'similar' the field virus is to the homologous vaccine virus.

7.3. Field isolates are passaged on cell cultures until adapted to give 100% CPE in 24 hours. Passages should be kept to a minimum. When adapted, determine the virus titre that fixes 2.5 50% complement fixing units (CFU_{50}).

7.4. A relationship is established by titration of the guinea-pig antisera through a 2-fold dilution series against 2.5 CFU_{50} of the homologous and heterologous antigens in veronal buffer diluent (VBD) or borate saline solution (BBS) placed in separate tubes. Four haemolysis units of complement are then added to each reaction.

7.5. The test system is incubated at 37 C for 30 minutes prior to the addition of 2% of standardised sheep red blood cells (SRBC) in VBD or BSS sensitised with rabbit anti SRBC. Reagents are incubated at 37 C for a further 30 minutes and the tubes are subsequently centrifuged and read.

7.6. The CF 50 titres are calculated by the Spearmann-Karber method and an 'r' value is derived from the relationship between the reactivity of the field isolate and the vaccine strain, as:

$$r_1 = \frac{\text{Reciprocal titre of hyperimmune serum against field virus}}{\text{Reciprocal titre of hyperimmune serum against vaccine virus}}$$

7.7. Interpretation. In the case of CFT, r_1 values greater than 0.25 indicate that the field isolate is sufficiently similar to the vaccine strain that use of the vaccine is likely to confer protection against challenge with the field strain (Alonso, 1986).

8. Expected Percentage of Protection

8.1. The Expected Percentage of Protection (EPP) estimates the likelihood that cattle would be protected against a challenge of 10,000 infective doses after a single or boosted vaccination.

8.2. Individual sera are required from sixteen or thirty 18-24 month-old cattle at thirty days post vaccination and thirty days post revaccination, using a full dose of the vaccine strain to be matched.

8.3. This panel of sera is tested for antibody titres to the homologous FMD vaccine strain and the field isolate to be matched using VNT or LPB-ELISA (see Sections 2a and 2c).

8.4. If necessary, the antigens used in the ELISA may be inactivated prior to use by binary ethyleneimine (BEI).

8.5. The EPP is determined from the serological titre obtained, for each individual serum, by reference to predetermined tables of correlation between serological titres and clinical protection The mean EPP is then calculated from the EPP for each individual serum.

8.6. The clinical protection data is derived from previously performed experiments carried out on hundreds of cattle that had been immunized using the vaccine strain in question and challenged with a homologous virus (similar to the PGP potency tests described in Section 5 of the FMD Chapter in the *Terrestrial Manual*, Potency tests on final product). Each animal is scored as protected or not and tables of correlation based on logistic regression models are established between antibody titre and clinical protection.

8.7. An EPP < 75% (when sera from a group of sixteen re-vaccinated animals are used) and < 70% (when sera from a group of thirty re-vaccinated animals are used) is an indication that the vaccines will give a low protection against the field strain (Sutmöller, *et al.*, 1984).

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Appendix IV

OIE/FAO Network for Foot-and-mouth Disease Reference Laboratories

Purpose:

Safeguarding the international trade of animals or their derived products requires an efficient global surveillance for foot-and-mouth disease (FMD) including constantly updated information on antigenic and genetic characteristics of FMD virus (FMDV) involved in current outbreaks. The exchange of FMDV isolates and data relating to them is also desirable for the development and selection of vaccines and other tools for surveillance and control of FMD, as well as for harmonisation of such approaches. The purpose of this document is to provide a framework for improving the capacities and collaboration between FMD Reference Laboratories.

Objectives:

1. To gather, generate, analyse and make available laboratory information on the global occurrence and spread of FMD.

2. To provide recommendations on vaccine strain selection for implementation of control schemes and for vaccine antigen reserves.

3. To offer expertise to OIE, FAO and Member Countries to assist in the control of FMD.

4. To identify constraints to the functioning of the network and to propose solutions.

Membership:

The Network will consist of the OIE/FAO Reference Laboratories for FMD, currently:

Pirbright Laboratory, Institute for Animal Health
Ash Road, Pirbright, Woking, Surrey GU24 ONF
UNITED KINGDOM
Tel: (44) 1483 232441 Fax: (44) 1483 232448
Email: david.paton@bbsrc.ac.uk

Botswana Vaccine Institute,
Broadhurst Industrial Site, Lejara Road, Private Bag 0031, Gaborone
BOTSWANA
Tel: (267) 391.27.11 Fax: (267) 395.67.98
Telex: 2535 BD Email: gmatlho@bvi.co.bw

Centro Panamericano de Fiebre Aftosa OPS/OMS
Av. President Kennedy 7778, Sao Bento, Duque de Caxias, ZC 20054-40 Rio de Janeiro
BRAZIL
Tel: (55.21) 36.61.90.56 Fax: (55.21) 36.61.90.01
Email: ibergman@panaftosa.ops-oms.org

Federal Governmental Institute, Centre for Animal Health, FGI-ARRIAH
600900 Vladimir, Yur'evets
RUSSIA
Tel: (7.0922) 26.0.14 Fax: (7.0922) 24.38.75
Email: mail@arriah.ru

Other laboratories may be invited by OIE/FAO to join or contribute to the network according to need and progress with the development of coordination procedures.

The network will:

1. Meet at least annually to review progress and to agree plans of the network.

2. Develop processes based on best practices to achieve equivalence in FMD laboratory outputs.

3. Collect, characterise (antigenically and genetically), archive and safeguard FMD viruses representing the global diversity of strains.

4. Agree a memorandum of understanding for exchange of materials and information and if necessary a materials/information transfer agreement.

5. Develop a web-based tool for the network to share and make available laboratory information including vaccine matching results, as close to real time as possible.

6. Provide an annual network report to OIE/FAO.

7. Facilitate training and scientific exchange on FMD laboratory activities.

8. Identify research requirements and where appropriate develop joint research projects, for example on validation of diagnostic methods.

9. Maintain a database of FMD laboratory experts and their field of expertise.

Coordination:

A secretariat is needed to organise the annual meeting and reporting, to establish and maintain the web-based network tool and to facilitate the implementation of the agreed plan of work. The secretariat will be provided by one of the network laboratories and the head of this reference laboratory will act as network secretary to coordinate network activities. The Pirbright Laboratory will provide the secretariat for the first three year period.

Steering Committee:

It is proposed that a Steering Committee should be established comprising OIE, FAO and with the Network Secretariat in attendance, chaired by OIE.

The terms of reference for the steering committee

1. Review priorities, organisational relationships and progress of the Network

2. Seek funding for Network activities.

3. Provide logistical support.

Appendix VII

Original: English
May 2005

MEETING OF THE OIE AD HOC GROUP ON EPIDEMIOLOGY

Paris, 9 – 11 May 2005

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The meeting of the OIE Ad hoc Group on Epidemiology of the Scientific Commission for Animal diseases (Scientific Commission) was held at OIE Headquarters, Paris from 9 to 11 May 2005.

The Agenda and list of participants are presented as Appendices I and II, respectively.

Dr Bernard Vallat, the OIE Director General, welcomed members of the Group and explained the high expectations of the OIE International Committee on the output of the Group particularly with respect to surveillance guidelines for specific animal diseases namely; foot and mouth disease (FMD), avian influenza (AI) and classical swine fever (CSF). He pointed out that these guidelines prepared by experts, have already been reviewed by the Group and approved by both the Scientific Commission and the Terrestrial Animal Health Standards Commission (the Code Commission). They have been circulated to all OIE Member Countries and the Group was expected to review the comments received. He indicated that the Code Commission would be having a short meeting just prior to the General Session and will do the best to take on board the amendments retained by the Group. In order to facilitate the work of the Code Commission and to avoid undue confusion, he suggested that at this stage, the Group only propose minor comments for consideration by the Code Commission to enable submission of the guidelines to the International Committee for adoption during the General Session. Any major amendment to the guidelines would be considered after the General Session and submitted for adoption during the 2006 General Session. The same should apply for the *Terrestrial Code* Chapter on bovine tuberculosis.

Dr Vallat also requested the Group to review the questionnaires which need to be filled in by Member Countries when applying for country status evaluation with respect to FMD, rinderpest, contagious bovine pleuropneumonia (CBPP) and bovine spongiform encephalopathy (BSE). He pointed out that the questionnaire on FMD proposed by the Ad hoc Group of experts on FMD had already been approved by the Scientific Commission. He suggested that the questionnaires on the three other diseases be considered in parallel with the review of the relevant Chapters in the *Terrestrial Code*. He informed that an Ad hoc Group had already been set up to review the Chapter on rinderpest and a new Chapter on BSE was going to be proposed for adoption during the forthcoming General Session. He strongly recommended that the Chapter on CBPP be reviewed before developing a questionnaire for that disease.

Dr Vallat explained that many Member Countries have expressed the wish to have clear guidelines on the relatively new concept of compartmentalisation. He asked the Group to finalise a concept paper that could be distributed during the General Session for non official information of Member Countries.

Regarding the confusion resulting in the interpretation of some OIE terms, Dr Vallat requested the Group to review those definitions and to come forward with simple but clear proposals.

The meeting was chaired by Professor Vincenzo Caporale, President of the Scientific Commission and Dr J.Kellar acted as rapporteur.

1. Review of country comments on disease surveillance appendices proposed for adoption at the General Session

Comments were received from Chile, Brazil, Australia, New Zealand, the United States of America, the European Union (EU) and Canada in respect of one or more of the following disease surveillance appendices:

1. Animal Health Surveillance (Appendix 3.8.1)
2. Avian Influenza (Appendix 3.X.X.)
3. Foot and Mouth Disease (Appendix 3.8.7)
4. Classical Swine Fever (Appendix X.X.X.)

1.1. Animal Health Surveillance (Appendix 3.8.1)

The Group considered the comments received from New Zealand, United States of America (USA), the EU and Canada.

The Group modified the text of Article 3.8.1.3.2 (f) as suggested by New Zealand in order to provide greater clarity in respect of "predictive values".

The Group adopted the changes requested by the USA to Article 3.8.1.4 1 (b) regarding systematic sampling.

The Group accepted the comment from the EU in respect of Article 3.8.1.2 in that the definitions contained therein and which are also found in other Surveillance Appendices, be also incorporated in Chapter 1.1.1 on 'General definitions'. The Group further suggested that all definitions be included within Chapter 1.1.1 regardless of their frequency of occurrence elsewhere in the *Terrestrial Code*.

In respect of other comments from the EU, the Group agreed that:

- The definition of early detection system in Article 3.8.1.2 be modified to include the changes suggested.
- To reinstate the definition of "unit" in Article 3.8.1.2 because its absence created an untenable situation in respect of a number of other definitions.
- To incorporate the suggestion that the phrase "unless otherwise stated in the relevant disease chapters" be added to the wording of Article 3.8.1.6 so as preclude a contradiction of the *Terrestrial Code* Chapters on bovine brucellosis, tuberculosis, leucosis and infectious bovine rhinotracheitis.

The amended text is presented as Appendix III.

1.2. Avian Influenza (Appendix 3.X.X.)

The Group considered comments from Chile, Australia, New Zealand and the EU.

The Group adopted Chile's suggestion that the application of sentinel birds would contribute to the assessment of countries applying for recognition of free status following an outbreak

The Group deferred to the Code Commission Chile's comments regarding Avian Influenza in species other than chickens and turkeys.

The Group modified Figure 2 to accommodate the observation made by Australia in respect of the absence of an option for LPAI that is not notifiable.

The suggestion of New Zealand to modify Article 3.X.X.1 to remove reference of Notifiable Avian Influenza (NAI) to wild birds in that the Appendix is focused on domestic poultry was accepted. Wording was changed in: influenza viruses in wild birds

In respect of other comments from New Zealand, the Group agreed that:

- To defer to the Code Commission comments in respect of Article 3.X.X.1 paras 3 and 4 regarding Article titles and prescriptive versus non-prescriptive approaches.

- To change the wording "outbreaks of disease" in Article 3.X.X.2 (1) by "incidence of NAI infection or disease".

- To defer to the Code Commission comments directed at Article 3.X.X.3 para 9 and 3.X.X.4 para 1.

- To defer to the Code Commission comments directed at Article 3.X.X.5 concerning the heading employed for that Article.

- To defer to the Code Commission comments directed at Compartments pursuant to Article 3.X.X.6. The comments relating directly to the degree of additional risk associated with Compartments will be discussed at length during subsequent meetings.

- To accept the comment that Article 3.X.X.7 (2), para 2 could be improved, but not via the route suggested. Figure 2 was modified to yield the clarification sought.

The Group also agreed to give further consideration to the comments made by the EU on Surveillance Appendices at its next meeting.

The amended text is presented as Appendix IV.

1.3. Foot and Mouth Disease (Appendix 3.8.7)

The Group considered comments from New Zealand, EU and Canada.

With respect to the comments from New Zealand, the Group agreed:

- That the removal of references to design prevalence and required levels of confidence was in deference to the desire to allow greater latitude to countries in sampling strategy design.

- To defer to the Code Commission the comment that the text deleted in Article 3.8.7.2 (3) relating to annual submissions for FMD free status renewal be reinstated.

With respect to the comments provided by the EU, the Group agreed:

- To adopt the comments in respect of Articles 3.8.7.2, 3.8.7.3, 3.8.7.4 and 3.8.7.5 in respect of the inapplicability of the use of the term "compartment" until such time as the *Terrestrial Code* recognises the approach.

- That the wording agreed in the Code in respect of FMD eradication strategies replaces that currently employed in Article 3.8.7.5 1), 2), 3), and 4).

The Group accepted Canada's comments in respect of the potential impact of employing "infection/circulation" within a series of Articles in this Appendix but deferred the comments to the Code Commission for further study. The Group noted however, that Article 3.8.7.1 defines "circulation" for the purposes of this Appendix.

The amended text is presented as Appendix V.

1.4. Classical Swine Fever (Appendix X.X.X.)

The Group considered comments from USA, and the EU.

With respect to the comments received from the USA, the Group adopted the changes requested in respect of Article X.X.X.6 (1), employing the term "reestablishment" to provide greater clarity. The Group also added "military bases" and "air and sea ports" to the list of areas for targeted surveillance in Article X.X.X.6 (2).

As indicated earlier, the Group decided to give further consideration to the comments made by the EU on Surveillance Appendices at its next meeting.

The amended text is presented as Appendix VI.

2. Development of a Concept Paper on Compartmentalisation

The Group reviewed a document on compartmentalisation provided by the OIE Reference Centre for Epidemiology in Fort Collins, USA in the light of comments from the OIE Reference Centre for Epidemiology in Teramo, Italy. The Group proposed a Concept Paper on Compartmentalisation that will be distributed for non official information of OIE Member Countries during the 73rd General Session and subsequently revised by the Bureau of the Scientific Commission during its meeting in June 2005 before examination by Code Commission. The concept paper on compartmentalisation is presented as Appendix VII. It was also proposed that the two Centres collaborate in the production of a formal paper for the OIE *Revue scientifique et technique*.

3. Review of some OIE definitions related to epidemiology

The Group adopted a series of definitions, including that for 'monitoring', from *A Dictionary of Epidemiology 4th. Edition, John M. Last, Oxford University Press, 2001*.

4. Review of questionnaires needed for inclusion in country dossiers for evaluation of disease freedom

The Group noted that the questionnaire on FMD has been proposed by the Ad hoc Group of experts responsible for the evaluation of country dossiers for FMD freedom and has already been approved by the Scientific Commission. However, adopting a quasi-forensic evaluative stance, the Group felt that the existing questionnaire does not apply scrutiny sufficient to probe the robustness of all aspects of the diagnostic and reporting chain that should support the ultimate goal of disease status transparency.

The Group is scheduled to meet in September, 2005 to pursue the assessment towards the creation of a questionnaire that will respond to information needs with greater epidemiological clarity and logical flow. New questionnaires on BSE, rinderpest and CBPP are also to be considered as priorities as soon as new *Code* Chapters are adopted.

5. Next Meeting

The next meeting of the Ad hoc Group on Epidemiology is scheduled for 20-22 September 2005.

…/Appendices

Appendix I

MEETING OF THE OIE AD HOC GROUP ON EPIDEMIOLOGY

Paris, 9 – 11 May 2005

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Agenda

1. Review of country comments on disease surveillance appendices proposed for adoption at the General Session
   1.1. Animal Health Surveillance (Appendix 3.8.1)
   1.2. Avian Influenza (Appendix 3.X.X.)
   1.3. Foot and Mouth Disease (Appendix 3.8.7)
   1.4. Classical Swine Fever (Appendix X.X.X.)
2. Development of a Concept Paper on Compartmentalisation
3. Review of some OIE definitions related to epidemiology
4. Review of questionnaires needed for inclusion in country dossiers for evaluation of disease freedom
5. Next Meeting

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Appendix II

MEETING OF THE OIE AD HOC GROUP ON EPIDEMIOLOGY

Paris, 9 – 11 May 2005

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List of Participants

MEMBERS

Prof. Vincenzo Caporale
(President of the OIE Scientific Commission for Animal Diseases)
Director, Istituto Zooprofilattico Sperimentale
dell'Abruzzo e del Molise 'G. Caporale'
Via Campo Boario
64100 Teramo
ITALY
Tel: (39.0861) 33 22 33
Fax: (39.0861) 33 22 51
E-mail: caporale@izs.it

Dr Howard Batho
European Commission
Health and Consumer Protection Dir.-Gen.
Directorate E - Food Safety
E2 - Animal health and welfare, zootechnics
Rue Froissart 3rd Floor, room 76
B-1049 Bruxelles
BELGIUM
Tel: (32-2) 296 29 59
Fax: (32-2) 295 31 44
E-mail: Howard.Batho@cec.eu.int

Dr John A. Kellar
National Manager, Disease Surveillance
Science Division
Canadian Food Inspection Agency
3851 Fallowfield Road, Room C305
OTTAWA K2H 8P9
CANADA
Tel: (1.613) 228 66 98
Fax: (1.613) 228 66 75
E-mail: jkellar@inspection.gc.ca

Prof. Arnon Shimshony
P.O.B. 13327
Tel Aviv 61132
ISRAEL
Tel: (972.3) 648 15 15
Fax: (972.3) 644 5581
E-mail: ashimsh@agri.huji.ac.il

Dr Cristóbal Zepeda Sein
Coordinator of International Activities
Centers for Epidemiology and Animal Health
OIE Collaborating Center for Animal Disease
Surveillance Systems and Risk Analysis
USDA-APHIS-VS-CEAH
2150 Centre Ave, Building B
Fort Collins, CO 80526-8117
USA
Tel: (1.970) 494 7294
Fax: (1.970) 472 2668
E-mail: cristobal.zepeda@aphis.usda.gov

OTHER PARTICIPANT

Dr Alejandro Thiermann
President of the OIE Terrestrial Animal Health Standards Commission
Tel: 33-(0)1 44 15 18 69
E-mail: a.thiermann@oie.int

OIE CENTRAL BUREAU

Dr Bernard Vallat
Director General
12 rue de Prony
75017 Paris
FRANCE
Tel: 33 - (0)1 44 15 18 88
Fax: 33 - (0)1 42 67 09 87
E-mail: oie@oie.int

Dr Alejandro Schudel
Head, Scientific and Technical Department
E-mail: a.schudel@oie.int

Dr Dewan Sibartie
Deputy Head, Scientific and Technical Department
E-mail: d.sibartie@oie.int

Dre Christiane Bruschke
Project Officer, Scientific and Technical Department
E-mail: d.sibartie@oie.int

Dr David Wilson
Head, International Trade Department
E-mail: d.wilson@oie.int

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Appendix III

APPENDIX 3.8.1. ~~CHAPTER 1.3.6~~

GENERAL GUIDELINES FOR ANIMAL HEALTH SURVEILLANCE

Article 3.8.1.1.

Introduction and objectives

1) In general, surveillance is aimed at demonstrating the absence of *disease* or *infection*, determining the occurrence or distribution of *disease* or *infection*, while also detecting as early as possible exotic or *emerging diseases*. The type of surveillance applied depends on the desired outputs needed to support decision-making. The following guidelines may be applied to all diseases, their agents and susceptible species as listed in the *Terrestrial Code*, and are designed to assist with the development of surveillance methodologies. Except where a specific surveillance method for a certain *disease* or *infection* is already described in the *Terrestrial Code*, the guidelines in this Appendix may be used to further refine the general approaches described for a specific *disease* or *infection*. Where detailed *disease/infection*-specific information is not available, suitable approaches should be based on the guidelines in this Appendix.

2) Animal health surveillance is an essential component necessary to detect diseases, to monitor disease trends, to control endemic and exotic diseases, to support claims for freedom from *disease* or *infection*, to provide data to support the risk analysis process, for both animal health and/or public health purposes, and to substantiate the rationale for sanitary measures. Surveillance data underpin the quality of disease status reports and should satisfy information requirements for accurate risk analysis both for *international trade* as well as for ~~internal~~ national decision-making.

3) Essential prerequisites to enable a Member Country to provide information for the evaluation of its animal health status are:

   a) that the particular Member Country complies with the provisions of Chapter 1.3.3. of the *Terrestrial Code* on the quality and evaluation of the *Veterinary Services*;

   b) that, where possible, surveillance data be complemented by other sources of information (e.g. scientific publications, research data, documented field observations and other non-survey data);

   c) that transparency in the planning and execution of surveillance activities and the analysis and availability of data and information, be maintained at all times, in accordance with Chapter 1.1.2. of the *Terrestrial Code*.

4) The objectives of this Appendix are to:

   a) provide guidance to the type of outputs that a surveillance system should generate;

   b) provide guidelines to assess the quality of disease surveillance systems.

Article 3.8.1.2.

Definitions

The following definitions apply for the purposes of this Appendix:

Bias: A tendency of an estimate to deviate in one direction from a true value. ~~(as by reason of nonrandom sampling)~~

Case definition: A case definition is a set of criteria used to classify an animal or epidemiological unit as a case ~~or non-case~~.

Confidence: In the context of demonstrating freedom from *infection*, confidence is the probability that the type of surveillance applied would detect the presence of *infection* if the population were infected. The confidence depends on, among ~~others the design prevalence, or~~ other parameters, the assumed level of *infection* in an infected population. ~~Confidence therefore~~ The term refers to our confidence in the ability of the surveillance applied to detect *disease*, and is equivalent to the sensitivity of the surveillance system.

Early detection system: A system for the timely detection and identification of an incursion or emergence of *disease/infection* in a country, *zone* or *compartment*. An early detection system should be under the control of the *Veterinary Services* and should include the following characteristics:

a) representative coverage of target animal populations by field services;

b) ability to undertake effective disease investigation and reporting;

c) access to laboratories capable of diagnosing and differentiating relevant diseases;

d) a training programme for veterinarians, *veterinary para-professionals* and others involved in handling animals for detecting and reporting unusual animal health incidents;

e) the legal obligation of private veterinarians in relation to the *Veterinary Administration*;

f) timely reporting system of the event to the *Veterinary Services*;

g) a national chain of command.

Epidemiological unit: A group of animals with a defined epidemiological relationship that share approximately the same likelihood of exposure to a pathogen. This may be because they share a common environment (e.g. animals in a pen), or because of common management practices. Usually, this is a herd or flock; however, an epidemiological unit may also refer to groups such as the animals belonging to residents of a village, or animals sharing a communal dipping tank system.

Outbreak definition: An outbreak definition is a set of criteria used to classify the occurrence of one or more cases in a group of animals or units as an outbreak.

Probability sampling: A sampling strategy in which every unit has a known non-zero probability of inclusion in the sample.

Sample: The group of elements (sampling units) drawn from a population, on which tests are performed or parameters measured to provide surveillance information.

Sampling units: The unit that is sampled, either in a random survey or in non-random surveillance. This may be an individual animal or a group of animals (e.g. an epidemiological unit). Together, they comprise the sampling frame.

Sensitivity: The proportion of truly positive units that are correctly identified as positive by a test.

Specificity: The proportion of truly negative units that are correctly identified as negative by a test.

Study population: The population from which surveillance data are derived. This may be the same as the target population or a subset of it.

Surveillance: The systematic ongoing collection, collation, and analysis of data, and the timely dissemination of information to those who need to know so that action can be taken.

Surveillance system: A method of surveillance that may involve one or more component activities that generates information on the ~~animal~~ health, disease or zoonosis status of animal populations.

Survey: An investigation in which information is systematically collected, usually carried out on a sample of a defined population group, within a defined time period.

Target population: The population about which conclusions are to be inferred ~~drawn from a study~~.

Test: A procedure used to classify a unit as either positive, negative or suspect with respect to an *infection* or *disease*.

Test system: A combination of multiple tests and rules of interpretation which are used for the same purpose as a test.

Unit: An individually identifiable element. This is a generic concept used to describe, for example, the members of a population, or the elements selected when sampling. In these contexts, examples of units include individual animals, pens, farms, holdings, villages, districts etc.

Article 3.8.1.3.

Principles of surveillance

1) Types of surveillance

a) Surveillance may be based on many different data sources and can be classified in a number of ways, including:

i) the means by which data are collected (active versus passive surveillance);

ii) the disease focus (pathogen-specific versus general surveillance); and

iii) the way in which units for observation are selected (structured surveys versus non-random data sources).

b) In this Appendix, surveillance activities are classified as being based either on:

i) structured population-based surveys, such as:

– systematic random sampling at slaughter;
– random surveys; or

ii) structured non-random surveillance activities, such as:

– disease reporting or notifications;
– control programmes/health schemes;
– targeted testing/screening;
– ante-mortem and post-mortem inspections;
– laboratory investigation records;
– biological specimen banks;
– sentinel units;
– field observations;
– farm production records.

c) In addition, surveillance data should be supported by related information, such as:

i) data on the epidemiology of the infection, including environmental, host population distribution, and climatic information;

ii) data on animal movements and trading patterns for animals and animal products;

iii) national animal health regulations, including information on compliance with them and their effectiveness;

iv) history of imports of potentially infected material; and

v) biosecurity measures in place.

d) The sources of evidence should be fully described. In the case of a structured survey, this should include a description of the sampling strategy used for the selection of units for testing. For structured non-random data sources, a full description of the system is required including the source(s) of the data, when the data were collected, and a consideration of any biases that may be inherent in the system.

2) Critical elements

In assessing the quality of a surveillance system, the following critical elements need to be addressed over and above quality of *Veterinary Services* (Chapter 1.3.3.).

a) Populations

Ideally, surveillance should be carried out in such a way as to take into account all animal species susceptible to the infection in a country, *zone* or *compartment*. The surveillance activity may cover all individuals in the population or part of them. When surveillance is conducted only on a *subpopulation* ~~In the latter case,~~ care should be taken regarding the inferences made from the results.

Definitions of appropriate populations should be based on the specific recommendations of the disease chapters of the *Terrestrial Code*.

~~TO PROPOSE FOR INSERTION IN CHAPTER 1.1.1~~

- ~~**Carriers** – animals that harbour the agent and may spread it directly or indirectly while not demonstrating clinical signs of the disease. Depending on the disease, an animal may serve as a carrier animal for shorter or longer periods of time. The length of time that an infection can be spread by inapparent carriers is important in designing a surveillance scheme.~~
- ~~**Reservoirs** – some pathogens require either a living organism or inanimate environment for multiplication. Recognition of the location and role of a reservoir in the persistence of an infectious agent should be considered.~~
- ~~**Vectors** - a pathogen can be vector borne. Where this is the case, the biology and ecology (including seasonal effects) of vector populations should be considered.~~
- ~~**Immune status** – age of an animal, previous exposure to a specific pathogens, and use of vaccination are factors that need to be considered in determining appropriate diagnostic tests or clinical measures for evidence of infection.~~
- ~~**Genetic resistance** – some animals may not be susceptible to specific disease agents because of genetic resistance. If this is true for an infectious agent under surveillance, a method for identifying those animals that are susceptible or resistant may need to be factored into the design for surveillance.~~
- ~~**Age, sex, and other host criteria** – some pathogens can only affect animals that possess certain host related criteria. These type of criteria should be accounted for in the definition of the target population, surveillance design and interpretation of the results~~

b) Epidemiological unit

The relevant epidemiological unit for the surveillance system should be defined and documented to ensure that it is representative of the population. Therefore, it should be chosen taking into account factors such as carriers, reservoirs, vectors, immune status, genetic resistance and age, sex, and other host criteria.

c) Clustering

Infection in a country, *zone* or *compartment* usually clusters rather than being uniformly or randomly distributed through a population. Clustering may occur at a number of different levels (e.g. a cluster of infected animals within a herd, a cluster of pens in a building, or a cluster of farms in a *compartment*). Clustering should be taken into account in the design of surveillance activities and the statistical analysis of surveillance data, at least at what is judged to be the most significant level of clustering for the particular animal population and infection.

d) Case and outbreak definitions

Clear and unambiguous case and outbreak definitions should be developed and documented for each pathogen under surveillance, using, where they exist, the standards in the *Terrestrial Code*.

e) Analytical methodologies

Surveillance data should be analysed using appropriate methodologies, and at the appropriate organisational levels to facilitate effective decision making, whether it be planning interventions or demonstrating status.

Methodologies for the analysis of surveillance data should be flexible to deal with the complexity of real life situations. No single method is applicable in all cases. Different methodologies may be needed to accommodate the relevant pathogens, varying production and surveillance systems, and types and amounts of data and information available.

The methodology used should be based on the best available information that is in accord with current scientific thinking. The methodology should be in accordance with this Appendix and fully documented, and supported by reference ~~to the OIE Standards~~, to the scientific literature and other sources, including expert opinion. Sophisticated mathematical or statistical analyses should only be carried out when justified by the proper amount and quality of field data.

Consistency in the application of different methodologies should be encouraged and transparency is essential in order to ensure fairness and rationality, consistency in decision making and ease of understanding. The uncertainties, assumptions made, and the effect of these on the final conclusions should be documented.

f) Testing

Surveillance involves the detection of *disease* or *infection* by the use of appropriate case definitions based on the results of one or more tests for evidence of infection or immune status. In this context, a test may range from detailed laboratory examinations to field observations and the analysis of production records. The performance of a test at the population level (including field observations) may be described in terms of its sensitivity and specificity and predictive values. Imperfect sensitivity and/or specificity will have an impact on the conclusions from surveillance. Therefore, these parameters should be taken into account in the design of surveillance systems and analysis of surveillance data.

~~Therefore, predictive values of the test should, whenever possible, be taken into account in the design of surveillance systems and analysis of surveillance data.~~

The values of sensitivity and specificity for the tests used should be specified, and the method used to determine or estimate these values should be documented. Alternatively, where values for sensitivity and/or specificity for a particular test are specified in the *Terrestrial Manual*, these values may be used as a guide ~~without justification~~.

Samples from a number of animals or units may be pooled ~~together~~ and subjected to a testing protocol ~~test~~. The results should be interpreted using sensitivity and specificity values that have been determined or estimated for that particular pool size and testing procedure.

g) Quality assurance

Surveillance systems should incorporate the principles of quality assurance and be subjected to periodic auditing to ensure that all components of the system function and provide verifiable documentation of procedures and basic checks to detect significant deviations of procedures from those documented in the design.

h) Validation

Results from animal health surveillance systems are subject to one or more potential biases. When assessing the results, care should be taken to identify potential biases that can inadvertently lead to an over-estimate or an under-estimate of the parameters of interest.

i) Data collection and management

The success of a surveillance system is dependent on a reliable process for data collection and management. The process may be based on paper records or computerised. Even where data are collected for non-survey purposes (e.g. during disease control interventions, inspections for movement control or during disease eradication schemes), the consistency and quality of data collection and event reporting in a format that facilitates analysis, is critical. Factors influencing the quality of collected data include:

– the distribution of, and communication between, those involved in generating and transferring data from the field to a centralised location;

– the ability of the data processing system to detect missing, inconsistent or inaccurate data, and to address these problems;

– maintenance of disaggregated data rather than the compilation of summary data;

– minimisation of transcription errors during data processing and communication.

Article 3.8.1.4.

Structured population-based surveys

In addition to the principles for surveillance discussed above, the following guidelines should be used when planning, implementing and analysing surveys.

1) Types of surveys

Surveys may be conducted on the entire target population (i.e. a census) or on a sample. A sample may be selected in either of the two following ways ~~manners~~:

a) non-probability based sampling methods, such as:

i) convenience;
ii) expert choice;
iii) quota;

b) probability based sampling methods, such as:

i) simple random selection;
ii) cluster sampling;
iii) stratified sampling.
iv) systematic random sampling

Non-probability based sampling methods will not be discussed further.

~~2) Systematic selection~~

Periodic or repeated surveys conducted in order to document disease freedom should be done using probability based sampling methods so that data from the study population can be extrapolated to the target population in a statistically valid manner.

The sources of information should be fully described and should include a detailed description of the sampling strategy used for the selection of units for testing. Also, consideration should be made of any biases that may be inherent in the survey design.

2~~3~~) Survey design

The population of epidemiological units should first be clearly defined; hereafter sampling units appropriate for each stage, depending on the design of the survey, should be defined.

The design of the survey will depend on the size and structure of the population being studied, the epidemiology of the infection and the resources available.

3~~4~~) Sampling

The objective of sampling from a population is to select a subset of units from the population that is representative of the population with respect to the object of the study such as the presence or absence of infection. Sampling should be carried out in such a way as to provide the best likelihood that the sample will be representative of the population, within the practical constraints imposed by different environments and production systems. In order to detect the presence of an infection in a population of unknown disease status targeted sampling methods that optimise the detection of infection can be used. In such cases, care should be taken regarding the inferences made from the results.

4~~5~~) Sampling methods

When selecting epidemiological units from within a population, ~~a formal~~ probability sampling ~~method~~ (e.g. simple random sampling) should be used. When this is not possible, sampling should provide the best practical chance of generating a sample that is representative of the target population.

In any case, the sampling method used at all stages should be fully documented and justified.

5~~6~~) Sample size

In general, surveys are conducted either to demonstrate the presence or absence of a factor (e.g. infection) or to estimate a parameter (e.g. the prevalence of infection). The method used to calculate sample size for surveys depends on the purpose of the survey, the expected prevalence, the level of confidence desired of the survey results and the performance of the tests used.

Article 3.8.1.5.

Structured non-random surveillance

Surveillance systems routinely use structured non-random data, either alone or in combination with surveys. ~~There is a wide variety of non-random data sources that can be used.~~

1) Common non-random surveillance sources

A wide variety of non-random surveillance sources may be available. These vary in their primary purpose and the type of surveillance information they are able to provide. Some surveillance systems are primarily established as early detection systems, but may also provide valuable information to demonstrate freedom from infection. Other systems provide cross-sectional information suitable for prevalence estimation, either once or repeatedly, while yet others provide continuous information, suitable for the estimate of incidence data (e.g. disease reporting systems, sentinel sites, testing schemes). Surveillance systems routinely use structured non-random data, either alone or in combination with surveys.

a) Disease reporting or notification systems

Data derived from disease reporting systems can be used in combination with other data sources to substantiate claims of animal health status, to generate data for risk analysis, or for early detection. Effective laboratory support is an important component of any reporting system. Reporting systems relying on laboratory confirmation of suspect clinical cases should use tests that have a ~~good~~ high specificity. Reports should be released by the laboratory in a timely manner, with the amount of time from disease detection to report generation minimized (to hours in the case of introduction of a foreign animal disease).

b) Control programmes / health schemes

Animal disease control programmes or health schemes, while focusing on the control or eradication of specific diseases, should be planned and structured in such a manner as to generate data that are scientifically verifiable and contribute to structured surveillance.

c) Targeted testing / screening

This may involve testing targeted to selected sections of the population (subpopulations), in which disease is more likely to be introduced or found. Examples include testing culled and dead animals, swill fed animals, those exhibiting clinical signs, animals located in a defined geographic area and specific age or commodity group.

d) Ante-mortem and post-mortem inspections

Inspections of animals at abattoirs may provide valuable surveillance data. The sensitivity and specificity of the particular slaughterhouse inspection system for detecting the presence of infectious agents of surveillance interest under the particular inspection arrangements applying in a country should be pre-determined by the *Competent Authority* if the data is to be fully utilised. The accuracy of the inspection system will be influenced by:

i) the level of training and experience of the staff doing the inspections, and the ratio of staff of different levels of training;

ii) the involvement of the *Competent Authorities* in the supervision of ante-mortem and post-mortem inspections;

iii) the quality of construction of the abattoir, speed of the slaughter chain, lighting quality, etc; and

iv) staff morale/motivation for accurate and efficient performance.

Abattoir inspections are likely to provide good coverage only for particular age groups and geographical areas. ~~Statistical biases are likely to be more frequent for infected animals originating from larger, better managed farms rather than for animals originating from smallholder or backyard production farms, as well as for healthy rather than diseased animals~~. Abattoir surveillance data are subject to obvious biases in relation to target and study populations (e.g. only animals of a particular class and age may be slaughtered for human consumption in significant numbers). Such biases need to be recognized when analysing surveillance data.

Both for traceback in the event of detection of disease and for analysis of spatial and herd-level coverage, there should be, if possible, an effective identification system that relates each animal in the abattoir to its ~~property/~~locality of origin.

e) Laboratory investigation records

Analysis of laboratory investigation records may provide useful surveillance information. The coverage of the system will be increased if analysis is able to incorporate records from national, accredited, university and private sector laboratories. Valid analysis of data from different laboratories depends on the existence of standardised diagnostic procedures and standardised methods for interpretation and data recording. As with abattoir inspections, there needs to be a mechanism to relate specimens to the farm of origin.

f) Biological specimen banks

Specimen banks consist of stored specimens, gathered either through representative sampling or opportunistic collection or both. Specimen banks may contribute to retrospective studies, including providing support for claims of historical freedom from infection, and may allow certain studies to be conducted more quickly and at lower cost than alternative approaches.

g) Sentinel units

Sentinel units/sites involve the identification and regular testing of one or more of animals of known health/immune status in a specified geographical location to detect the occurrence of disease (usually serologically). They are particularly useful for surveillance of diseases with a strong spatial component, such as vector-borne diseases. Sentinel units provide the opportunity to target surveillance depending on the likelihood of infection (related to vector habitats and host population distribution), cost and other practical constraints. Sentinel units may provide evidence of freedom from infection, or provide data on prevalence and incidence as well as the distribution of disease.

h) Field observations

Clinical observations of animals in the field are an important source of surveillance data. The sensitivity and specificity of field observations may be relatively low, but these can be more easily determined and controlled if a clear, unambiguous and easy to apply standardised case definition is applied. Education of potential field observers in application of the case definition and reporting is an important component. Ideally, both the number of positive observations and the total number of observations should be recorded.

i) Farm production records

Systematic analysis of farm production records may be used as an indicator of the presence or absence of disease at the herd or flock level. In general, the sensitivity of this approach may be quite high (depending on the disease), but the specificity is often quite low.

2) Critical elements for structured non-random surveillance

There is a number of critical factors which should be taken into account when using structured non random surveillance data such as coverage of the population, duplication of data, and sensitivity and specificity of tests that may give rise to difficulties in the interpretation of data. Surveillance data from non-random data sources may increase the level of confidence or be able to detect a lower level of prevalence with the same level of confidence compared to structured surveys.

3) Analytical methodologies

~~Different methodologies may be used for the analysis of non-random surveillance data.~~

Different scientifically valid methodologies may be used for the analysis of non-random surveillance data. Where no data are available, estimates based on expert opinions, gathered and combined using a formal, documented and scientifically valid methodology may be used.

~~Analytical methodologies based on the use of step-wise probability estimates to describe the surveillance system may determine the probability of each step either by:~~

~~a) the analysis of available data, using a scientifically valid methodology; or where no data are available,~~

~~b) the use of estimates based on expert opinion, gathered and combined using a formal, documented and scientifically valid methodology~~.

4) Combination of multiple sources of data

The methodology used to combine the evidence from multiple data sources should be scientifically valid, and fully documented including references to published material.

Surveillance information gathered from the same country, *zone* or *compartment* at different times may provide cumulative evidence of animal health status. Such evidence gathered over time may be combined to provide an overall level of confidence. For instance, repeated annual surveys may be analysed to provide a cumulative level of confidence. However, a single larger survey, or the combination of data collected during the same time period from multiple random or non-random sources, may be able to achieve the same level of confidence in just one year.

Analysis of surveillance information gathered intermittently or continuously over time should, where possible, incorporate the time of collection of the information to take the decreased value of older information into account. The sensitivity, specificity and completeness of data from each source should also be taken into account for the final overall confidence level estimation.

Article 3.8.1.6.

~~SURVEILLANCE TO DEMONSTRATE FREEDOM FROM INFECTION~~

Surveillance to demonstrate freedom from disease/infection ~~International recognition of freedom from infection~~

1) ~~Introduction~~ Requirements to declare a country, zone or compartment free from disease/infection without pathogen specific surveillance

This Article provides general principles for declaring a country, *zone* or *compartment* free from *disease/infection* in relation to the time of last occurrence and in particular for the recognition of historical freedom.

The provisions of this Article are based on the principles described in Article 3.8.1.3. of this Appendix and the following premises:

– in the absence of disease and vaccination, the animal population would become susceptible over a period of time;

– the disease agents to which these provisions apply are likely to produce identifiable clinical signs in susceptible animals;

– competent and effective *Veterinary Services* will be able to investigate, diagnose and report disease, if present;

– the absence of *disease/infection* over a long period of time in a susceptible population can be substantiated by effective disease investigation and reporting by ~~the *Veterinary Services* of~~ a Member Country.

~~4.2. Additional requirements to declare a country or compartment free from infection without pathogen specific surveillance~~

a) Historically free

Unless otherwise specified in the relevant disease chapter, a country, *zone* or *compartment* may be recognised free from infection without formally applying a pathogen-specific surveillance programme when:

i) there has never been occurrence of disease, or

ii) eradication has been achieved or the *disease/infection* has ceased to occur for at least 25 years;

provided that for at least the past 10 years:

iii) it has been a notifiable disease;

iv) an early detection system has been in place;

v) measures to prevent *disease/infection* introduction have been in place; no vaccination against the disease has been carried out unless otherwise provided in the *Terrestrial Code*;

vi) infection is not known to be established in wildlife within the country or *zone* intended to be declared free. (A country or *zone* cannot apply for historical freedom if there is any evidence of infection in wildlife. However, specific surveillance in wildlife is not necessary.)

b) Last occurrence within the previous 25 years

Countries, *zones* or *compartment*s that have achieved eradication (or in which the *disease/infection* has ceased to occur) within the previous 25 years, should follow the pathogen-specific surveillance requirements in the *Terrestrial Code* if they exist. In the absence of specific requirements for surveillance in the *Terrestrial Code*, countries should follow the general guidelines for surveillance to demonstrate animal health status outlined in this Appendix provided that for at least the past 10 years:

i) it has been a notifiable disease;

ii) an early detection system has been in place;

iii) measures to prevent *disease/infection* introduction have been in place;

iv) no vaccination against the disease has been carried out unless otherwise provided in the *Terrestrial Code*;

v) infection is not known to be established in wildlife within the country or *zone* intended to be declared free. (A country or *zone* cannot apply for freedom if there is any evidence of infection in wildlife. However, specific surveillance in wildlife is not necessary.)

2) Guidelines for the discontinuation of pathogen-specific screening after recognition of freedom from infection

A country, *zone* or *compartment* that has been recognised as free from infection following the provisions of the *Terrestrial Code* may discontinue pathogen-specific screening while maintaining the infection-free status provided that:

a) it is a notifiable disease;

b) an early detection system is in place;

c) measures to prevent *disease/infection* introduction are in place;

d) vaccination against the disease is not applied;

e) infection is known not to be established in wildlife. (Specific surveillance in wildlife has demonstrated the absence of infection.)

3) International recognition of disease/infection free status

For diseases for which procedures exist whereby the OIE can officially recognise the existence of a *disease/infection* free country, *zone* or *compartment*, a Member Country wishing to apply for recognition of this status shall, via its Permanent Delegate, send to the OIE all the relevant documentation relating to the country, *zone* or *compartment* concerned. Such documentation should be presented according to guidelines prescribed by the OIE for the appropriate animal diseases.

4) Demonstration of freedom from infection

A surveillance system to demonstrate freedom from infection should meet the following requirements in addition to the general requirements for surveillance outlined in Article 3.8.1.3. of this Appendix.

Freedom from infection implies the absence of the pathogenic agent in the country, *zone* or *compartment*. Scientific methods cannot provide absolute certainty of the absence of infection. Demonstrating freedom from infection involves providing sufficient evidence to demonstrate (to a level of confidence acceptable to Member Countries) that infection with a specified pathogen is not present in a population.

In practice, it is not possible to prove (i.e., be 100% confident) that a population is free from infection (unless every member of the population is examined simultaneously with a perfect test with both sensitivity and specificity equal to 100%). Instead, the aim is to provide adequate evidence (to an acceptable level of confidence), that infection, if present, is present in less than a specified proportion of the population

However, finding evidence of infection at any level in the target population automatically invalidates any freedom from infection claim, unless otherwise stated in the relevant disease chapters.

Evidence from targeted, random or non-random data sources, as stated before, may increase the level of confidence or be able to detect a lower level of prevalence with the same level of confidence compared to structured surveys.

Article 3.8.1.7.

Surveillance for distribution and occurrence of infection

Surveillance to determine distribution and occurrence of infection or of other relevant health related events is widely used to assess progress in the control or eradication of selected diseases and pathogens and as an aid to decision making. It has, however, relevance for the international movement of animals and products when movement occurs among infected countries.

In contrast to surveillance to demonstrate freedom from infection, surveillance used to assess progress in control or eradication of selected diseases and pathogens is usually designed to collect data about a number of variables of animal health relevance, for example:

1) prevalence or incidence of infection;

2) morbidity and mortality rates;

3) frequency of *disease/infection* risk factors and their quantification ~~when the risk factors are expressed by continuous [real numbers] or discrete [integers] variables;~~

4) frequency distribution of herd sizes or the sizes of other epidemiological units;

5) frequency distribution of antibody titres;

6) proportion of immunised animals after a vaccination campaign;

7) frequency distribution of the number of days elapsing between suspicion of infection and laboratory confirmation of the diagnosis and/or to the adoption of control measures;

8) farm production records, etc.

~~All of the listed data may also have relevance for the risk analysis.~~

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Appendix IV

APPENDIX 3.8.7.

~~GUIDELINES FOR THE SURVEILLANCE REQUIRED TO SUPPORT THE ESTABLISHMENT OR REGAINING OF RECOGNITION FOR A FOOT AND MOUTH DISEASE FREE COUNTRY OR ZONE~~

GUIDELINES FOR THE SURVEILLANCE OF FOOT AND MOUTH DISEASE

Article 3.8.7.1.

Introduction

This Appendix defines the principles and provides a guide for the surveillance of foot and mouth disease (FMD) in accordance with Appendix 3.8.1. applicable to countries seeking recognition from the OIE for freedom from FMD, either with or without the use of vaccination. This may be for the entire country or a *zone* ~~*or compartment*~~ within the country. Guidance for countries seeking reestablishment of freedom from FMD for the whole country or a *zone* or a *compartment*, either with or without vaccination, following an *outbreak*, as well as guidelines for the maintenance of FMD status are ~~is~~ provided. These guidelines are intended to expand on and explain the requirements of Chapter 2.2.10. Applications to the OIE for ~~such~~ recognition of freedom should follow the format and answer all the questions posed by the "Questionnaire on FMD" available from the OIE Central Bureau.

~~Reference to vaccination in this guide implies vaccination as part of an official disease control programme under the supervision of the *Veterinary Administration* aimed at interrupting the transmission of FMD virus (FMDV) in the zone or country concerned. The level of herd immunity required to achieve interruption of transmission will depend on the size, composition (e.g. species) and density of the susceptible population. It is therefore impossible to be prescriptive in this matter but, in general, unless there are good reasons to employ a different target, the aim should be to vaccinate at least 80% of the susceptible population in the manner and at the frequency prescribed by the manufacturer of the vaccine concerned. The vaccine must also comply with the provisions stipulated for FMD vaccines in the *Terrestrial Manual*. It may be that a decision is reached to vaccinate only certain species or other subset of the total susceptible population. In that case the rationale should be contained within the dossier accompanying the application to the OIE for recognition of a free country or zone or recovery of such status~~.

The impact and epidemiology of FMD differ widely in different regions of the world and therefore it is impossible to provide specific guidelines for all situations. It is axiomatic that the surveillance strategies employed for demonstrating freedom from FMD at an acceptable level of confidence will need to be adapted to the local situation. For example, the approach to proving freedom from FMD following an outbreak caused by a pig-adapted strain of FMD virus (FMDV) should differ significantly from an application designed to prove freedom from FMD for a country or zone where African buffaloes (*Syncerus caffer*) provide a potential reservoir of infection. It is incumbent upon the applicant country to submit a dossier to the OIE in support of its application that not only explains the epidemiology of FMD in the region concerned but also demonstrates how all the risk factors are managed. This should include provision of–scientifically based supporting data. There is therefore considerable latitude available to Member Countries to provide a well-reasoned argument to prove that the absence of FMDV infection (in non-vaccinated populations) or circulation (in vaccinated populations) is assured at an acceptable level of confidence.

Surveillance for FMD ~~may~~ should be in the form of a continuing ~~disease surveillance~~ programme ~~or it may be a specific programme~~ designed to establish that the whole territory or part of it is free from FMDV infection/circulation.

For the purpose of this Appendix, virus circulation means transmission of FMDV as demonstrated by clinical signs, serological evidence or virus isolation.

Article 3.8.7.2.

General conditions and methods

1) A surveillance system in accordance with Appendix 3.8.1 should be under the responsibility of the *Veterinary Administration*. A procedure should be in place for the rapid collection and transport of samples from suspect cases of FMD to a laboratory for FMD diagnoses as described in the *Terrestrial Manual.*

2) The FMD surveillance programme should:

   a) include an early warning system throughout the production, marketing and processing chain for reporting suspicious cases. Farmers and workers who have day-to-day contact with livestock, as well as diagnosticians, should ~~be encouraged to~~ report promptly any suspicion of FMD ~~clinical disease resembling FMD~~. They should be supported directly or indirectly (e.g. through private veterinarians or veterinary para-professionals) by government information programmes and the *Veterinary Administration*. All suspect cases of FMD should be investigated immediately. Where suspicion cannot be resolved by epidemiological and clinical investigation, samples should be taken and submitted to an approved laboratory ~~and, if still considered suspect, samples should be taken and submitted to an approved laboratory~~. This requires that sampling kits and other equipment are available for those responsible for surveillance. Personnel responsible for surveillance should be able to call for assistance from a team with expertise in FMD diagnosis and control;

   b) implement, when relevant, regular and frequent clinical inspection and serological testing of high-risk groups of animals, such as those adjacent to an FMD infected country or zone (for example, bordering a game park in which infected wildlife are present).

   An effective surveillance system will periodically identify suspicious cases that require follow up and investigation to confirm or exclude that the cause of the condition is FMDV. The rate at which such suspicious cases are likely to occur will differ between epidemiological situations and cannot therefore be predicted reliably. Applications for freedom from FMDV infection/circulation should, in consequence, provide details of the occurrence of suspicious cases and how they were investigated and dealt with. This should include the results of laboratory testing and the control measures to which the animals concerned were subjected during the investigation (quarantine, movement stand-still orders, etc.).

   ~~During investigation into suspected *outbreaks* of FMD, it is necessary to apply measures that will contain the infection to its original locality until such time as the diagnosis is confirmed or refuted, e.g. through application of quarantine measures. The details of actions that need to be applied in such situations are not covered by this guide.~~

~~3) These general requirements apply in all Member Countries submitting their annual request for re-confirmation of FMD free status although active surveillance for FMD is not a requirement for countries that are recognised by the OIE as being free from FMD without vaccination. An active surveillance programme is required from Member Countries applying for the first time for recognition of freedom from FMD for the whole country or zone either with or without vaccination. It is also a requirement for countries seeking recognition for the recovery of their former status following an *outbreak*.~~

Article 3.8.7.2.bis

Surveillance strategies

1) Introduction

The target population for surveillance aimed at identification of *disease* and *infection* should cover all the susceptible species within the country or zone to be recognised as free from FMDV infection/circulation.

The strategy employed may be based on randomised sampling requiring surveillance consistent with demonstrating the absence of FMDV *infection*/circulation at an acceptable level of statistical confidence. The frequency of sampling should be dependent on the epidemiological situation. Targeted surveillance (e.g. based on the increased likelihood of *infection* in particular localities or species) may be an appropriate strategy. The applicant country should justify the surveillance strategy chosen as adequate to detect the presence of FMDV infection/circulation in accordance with Appendix 3.8.1. and the epidemiological situation. It may, for example, be appropriate to target clinical surveillance at particular species likely to exhibit clear clinical signs (e.g. cattle and pigs). If a Member Country wishes to apply for recognition of a specific *zone* ~~*or compartment*~~ within the country as being free from FMDV infection/circulation, the design of the survey and the basis for the sampling process would need to be aimed at the population within the *zone* ~~*or compartment*~~.

For random surveys, the design of the sampling strategy will need to incorporate an epidemiologically appropriate design prevalence. The sample size selected for testing will need to be large enough to detect infection/circulation if it were to occur at a predetermined minimum rate. The sample size and expected disease prevalence determine the level of confidence in the results of the survey. The applicant country must justify the choice of design prevalence and confidence level based on the objectives of surveillance and the epidemiological situation, in accordance with Appendix 3.8.1. Selection of the design prevalence in particular clearly needs to be based on the prevailing or historical epidemiological situation.

Irrespective of the survey design selected, the sensitivity and specificity of the diagnostic tests employed are key factors in the design, sample size determination and interpretation of the results obtained. Ideally, the sensitivity and specificity of the tests used should be validated for the vaccination/infection history and production class of animals in the target population.

Irrespective of the testing system employed, surveillance design should anticipate the occurrence of false positive reactions. If the characteristics of the testing system are known, the rate at which these false positives are likely to occur can be calculated in advance. There needs to be an effective procedure for following up positives to ultimately determine with a high level of confidence, whether they are indicative of infection/circulation or not. This should involve both supplementary tests and follow-up investigation to collect diagnostic material from the original sampling unit as well as herds which may be epidemiologically linked to it.

The principles involved in surveillance for *disease/infection* are technically well defined. The design of surveillance programmes to prove the absence of FMDV infection/circulation needs to be carefully followed to avoid producing results that are either insufficiently reliable to be accepted by the OIE or international trading partners, or excessively costly and logistically complicated. The design of any surveillance programme, therefore, requires inputs from professionals competent and experienced in this field.

2) Clinical surveillance

Clinical surveillance aims at the detection of clinical signs of FMD by close physical examination of susceptible animals. Whereas significant emphasis is placed on the diagnostic value of mass serological screening, surveillance based on clinical inspection should not be underrated. It may be able to provide a high level of confidence of detection of disease if a sufficiently large number of clinically susceptible animals is examined.

Clinical surveillance and laboratory testing should always be applied in series to clarify the status of FMD suspects detected by either of these complementary diagnostic approaches. Laboratory testing may confirm clinical suspicion, while clinical surveillance may contribute to confirmation of positive serology. Any sampling unit within which suspicious animals are detected should be classified as infected until contrary evidence is produced.

A number of issues must be considered in clinical surveillance for FMD. The often underestimated labour intensity and the logistical difficulties involved in conducting clinical examinations should not be underestimated and should be taken into account.

Identification of clinical cases is fundamental to FMD surveillance. Establishment of the molecular, antigenic and other biological characteristics of the causative virus, as well as its source, is dependent upon disclosure of such animals. It is essential that FMDV isolates are sent regularly to the regional reference laboratory for genetic and antigenic characterization.

3) Virological surveillance

Virological surveillance using tests described in the *Terrestrial Manual* should be conducted:

a) to monitor at risk populations;

b) to confirm clinically suspect cases;

c) to follow up positive serological results;

d) to test "normal" daily mortality, to ensure early detection of infection in the face of vaccination or in establishments epidemiologically linked to an outbreak.

4) Serological surveillance

Serological surveillance aims at the detection of antibodies against FMDV. Positive FMDV antibody test results can have four possible causes:

a) natural infection with FMDV;

b) vaccination against FMD;

c) maternal antibodies derived from an immune dam (maternal antibodies in cattle are usually found only up to 6 months of age but in some individuals and in some species, maternal antibodies can be detected for considerably longer periods);

d) heterophile (cross) reactions.

It is important that serological tests, where applicable, contain antigens appropriate for detecting antibodies against viral variants (types, subtypes, lineages, topotypes, etc.) that have recently occurred in the region concerned. Where the probable identity of FMDVs is unknown or where exotic viruses are suspected to be present, tests able to detect representatives of all serotypes should be employed (e.g. tests based on nonstructural viral proteins – see below).

It may be possible to use serum collected for other survey purposes for FMD surveillance. However, the principles of survey design described in this Appendix and the requirement for a statistically valid survey for the presence of FMDV should not be compromised.

The discovery of clustering of seropositive reactions should be foreseen. It may reflect any of a series of events, including but not limited to the demographics of the population sampled, vaccinal exposure or the presence of field strain infection. As clustering may signal field strain infection, the investigation of all instances must be incorporated in the survey design. If vaccination cannot be excluded as the cause of positive serological reactions, diagnostic methods should be employed that detect the presence of antibodies to nonstructural proteins (NSPs) of FMDVs as described in the *Terrestrial Manual.*

The results of random or targeted serological surveys are important in providing reliable evidence that FMDV infection is not present in a country or zone. It is therefore essential that the survey be thoroughly documented.

Article 3.8.7.3.

Documentation of FMD free status

Countries applying for freedom from FMD for the whole country or a zone~~/compartment~~ where vaccination is not practised

~~1) Introduction~~

~~A Member Country applying for recognition of freedom for the country or a zone from FMD where vaccination is not practised should provide evidence for the existence of an effective surveillance programme. The strategy and design of the surveillance programme will depend on the prevailing epidemiological circumstances. Conventionally, a statistically significant proportion of the whole population should be subjected to clinical and serological surveillance to demonstrate absence of FMDV, i.e. circulation of virus, during the preceding 12 months. This requires the support of a national or other laboratory able to undertake identification of FMDV infection through virus/antigen/genome detection and antibody tests described in the *Terrestrial Manual.*~~

~~2) Survey design~~

~~The target population for surveillance aimed at identification of *disease* and *infection* should cover all the susceptible species within the country or zone to be recognised as free from infection. This would usually require stratification of different species.~~

~~Countries wishing to show freedom from FMDV infection in which a pig adapted strain of virus had been prevalent should concentrate on sampling the national pig population. However, it would also be necessary to show that no spill over into other susceptible species has occurred. In countries or zones in which an African buffalo population is present, the buffaloes should also be sampled if included in the proposed FMDV infection free zone.~~

~~The strategy employed may be based either on randomised sampling requiring surveillance consistent with demonstrating the absence of *infection* at an acceptable level of statistical confidence. The frequency of sampling would be dependent on the epidemiological situation, but should occur at least once during the year preceding the application. Alternatively, targeted surveillance (e.g. based on the likelihood of infection in particular localities or species) may provide a more appropriate and cost-effective strategy. If the latter approach is used, it would be incumbent upon the applicant country to show that the surveillance conducted was at least as effective as randomised surveillance with stratification of different~~

~~susceptible species. It may, for example, be appropriate to target clinical surveillance at particular species likely to exhibit clear clinical signs (e.g. cattle and pigs) while directing serological surveillance at species that tend to develop less obvious signs of infection such as sheep and, in some locations, goats and wildlife species.~~

~~If a Member Country wishes to apply for recognition of a specific zone/region within the country as being free from FMDV infection, the design of the survey and the basis for the sampling process would need to be aimed at the population within the zone/region.~~

~~For randomised surveillance, the design of the sampling strategy will need to incorporate an epidemiologically appropriate design prevalence because, obviously, the sample selected for testing will need to be large enough to detect infection if it were to occur at a predetermined minimum rate. The sample size and expected disease prevalence determine the level of confidence in the result of the survey. A typical random sampling strategy would be one that provides 95% probability of detecting evidence of FMD or FMDV infection if it were present in 1% of the primary sampling units. A minimum expected level of infection within sampling units also has to be set to ensure that a sufficient number of animals within each sampling unit is tested to detect the infection if it were present in the sampling unit. Typically this value is set somewhere between 5-20% with a confidence level of 95%. In many instances it could be safely assumed that within-sampling unit prevalence would be greater than 5% bearing in mind the contagiousness of FMDV. Selection of the prevalence estimate clearly needs to be based on the prevailing or historical epidemiological situation. The reasoning used in the selection of prevalence parameters needs to be clearly spelt out in the dossier supplied to the OIE when applications are made for recognition of freedom from FMD.~~

~~The sensitivities and specificities of the testing methods employed also affect the design of sampling strategies. Clinical inspection, for example, typically has low sensitivity, especially in species that tend to suffer mild or indistinct signs of FMD (e.g. sheep). In other words, the probability of detecting FMD infection through identification of clinical cases is not particularly dependable and this therefore needs to be allowed for in the sampling design. For proving absence of infection through serology, it is usually desirable to have either a test with both high sensitivity (likely to detect a high proportion of seropositive individuals) and specificity (few false positive animals likely to be identified) or to use a combination of tests that together provide high net sensitivity and specificity. However, even if the net specificity is high, in cases where the design prevalence is low (e.g. in situations where proving absence of FMD is the objective), the positive predictive value (PV) of a test or testing system may be considerably lower than 100% (because PV is mainly a function of specificity and prevalence). This means that in such circumstances it needs to be anticipated that false positive results will occur. If the characteristics of the testing system are known, the rate at which these false positive are likely to occur can be calculated. In such circumstances detected prevalence rates significantly greater than the calculated rate would be suspicious of infection. More typically, the parameters of the testing system are imprecisely known and therefore an element of judgement in the interpretation of serological results will be necessary. Whatever the case, there needs to be an effective procedure for following up serological positives to determine ultimately, to a high level of probability, whether they are indicative of infection or not. This should involve both supplementary laboratory tests (see below) and further field follow-up to collect diagnostic material from the original sampling unit if possible as well as animals in the vicinity which may be epidemiologically linked to the suspect focus.~~

~~It is evident from the above that although the principles involved in surveillance for disease/infection are reasonably straight forward, design of large surveillance programmes to prove absence of FMD needs to be carefully done to avoid producing results that are either insufficiently reliable to be accepted by the OIE or international trading partners or excessively costly and logistically complicated. The design of any large surveillance programme therefore requires inputs from competent and experienced professionals in this field.~~

3) Clinical surveillance

Clinical surveillance aims at the detection of clinical signs of FMD by close inspection of susceptible animals. It is essential that all animals within the selected primary sampling unit are examined for signs of FMD. Any unit where suspicious animals are detected should be classified as infected until contrary evidence is produced.

There are a number of issues that need to be considered in clinical surveillance for FMD. Some of these (e.g. the general insensitivity of clinical surveillance and species differences) have been mentioned above. The practical difficulty, hard work and boredom involved in conducting repetitive clinical examinations are almost invariably underestimated (hence the low sensitivity). This therefore needs to be borne in mind in the surveillance design.

Furthermore, now that the emphasis of the chapter of this *Terrestrial Code* on FMD is on detection of infection rather than disease, it needs to be remembered that in practice detection of disease is only one of the ways in which infection can be identified. Other techniques, such as serology, may be more sensitive especially in situations where vaccination is not practised but, on the other hand, identification of clinical cases is still fundamental to FMD surveillance. Identification of such cases is also vital in providing sources of the causative virus that enable the molecular, antigenic and other biological characteristics of the virus to be established. It is essential that FMDV isolates are sent regularly to the regional reference laboratory for genetic and antigenic characterization.

4) Serological surveillance

Serological surveillance aims at the detection of antibodies against FMDV. Positive tests for FMDV antibody tests can have four possible causes:

a) natural infection with FMDV;

b) vaccination against FMD;

c) maternal antibodies derived from an immune dam (maternal antibodies in cattle are usually found only up to 6 months of age, however, in some individuals and in buffalo calves, maternal antibody can be detected for considerably longer);

d) heterophile (cross) reactions.

It is important that serological tests, where appropriate, contain antigens appropriate for detecting viral variants (types, subtypes, lineages, topotypes, etc.) that have recently occurred in the region concerned. Where the probable identity of FMDVs is unknown or where exotic viruses are suspected to be present, tests able to detect representatives of all serotypes should be employed (e.g. tests based on nonstructural viral proteins – see below).

It may be possible to use serum collected for other survey purposes for FMD surveillance but the requirement for a statistically valid survey for the presence of FMDV should not be compromised.

General considerations in the design and conduct of sero surveys have been addressed above (see Survey design). An important issue requiring planning is the procedure to be followed in the event that seropositives are detected. As already indicated, it is likely that where the design prevalence is low false positive results should be anticipated. When these occur, both laboratory and field follow-up are necessary to differentiate between true and false positives.

~~Infected animals are unlikely to be evenly dispersed within the population and a cross sectional analysis will usually detect clusters of infection. FMD is no exception to this general rule. Therefore, it is important to identify clusters of seropositive animals through simple mapping or more sophisticated cluster analysis.~~

~~If vaccination cannot be excluded as the cause of positive serological reactions, testing for the presence of antibodies to the nonstructural proteins (NSPs) of FMDVs (as described in the *Terrestrial Manual*) should be used.~~

~~The results of random sample or targeted surveys based on serology are important in providing reliable evidence that no FMDV infection is present in a country or zone. It is therefore essential that the survey be thoroughly documented.~~

In addition to the general conditions described in Chapter 2.2.10., a Member Country applying for recognition of FMD freedom for the country or a *zone~~/ compartment~~* where vaccination is not practised should provide evidence for the existence of an effective surveillance programme. The strategy and design of the surveillance programme will depend on the prevailing epidemiological circumstances and will be planned and implemented according to general conditions and methods in this Appendix, to demonstrate absence of FMDV infection, during the preceding 12 months in susceptible populations. This requires the support of a national or other laboratory able to undertake identification of FMDV infection through virus/antigen/genome detection and antibody tests described in the *Terrestrial Manual.*

Article 3.8.7.4.

Countries, zones ~~or compartment~~ ~~s~~ applying for freedom from FMD where vaccination is practised

~~In addition to the general conditions, a country or zone applying for recognition of freedom from FMD with vaccination should show evidence of an effective surveillance programme for clinical disease and demonstrate that FMD has not occurred in the country or zone for the past 2 years. Furthermore, surveillance for FMDV infection should show that FMDV has not been circulating in the vaccinated population within the past 12 months. This will require serological surveillance incorporating tests able to detect antibodies to NSPs as described in Article 3.8.6.6.~~

In addition to the general conditions described in Chapter 2.2.10., a Member Country applying for recognition of country or *zone~~/ compartment~~* freedom from FMD with vaccination should show evidence of an effective surveillance programme planned and implemented according to general conditions and methods in this Appendix. Absence of clinical disease in the country, *zone ~~or compartment~~* for the past 2 years should be demonstrated. Furthermore, surveillance should demonstrate that FMDV has not been circulating in any susceptible population during the past 12 months. This will require serological surveillance incorporating tests able to detect antibodies to NSPs as described in the *Terrestrial Manual.* Vaccination to prevent the transmission of FMDV may be part of a disease control programme. The level of herd immunity required to prevent transmission will depend on the size, composition (e.g. species) and density of the susceptible population. It is therefore impossible to be prescriptive. However, in general the aim should be to vaccinate at least 80% of the susceptible population. The vaccine must comply with the *Terrestrial Manual.* Based on the epidemiology of FMD in the country, *zone ~~or compartment~~*, it may be that a decision is reached to vaccinate only certain species or other subsets of the total susceptible population. In that case, the rationale should be contained within the dossier accompanying the application to the OIE for recognition of status.

Evidence to show the effectiveness of the vaccination programme ~~is recommended~~ should be provided.

Article 3.8.7.5.

Countries, *zones* ~~or *compartment* s~~ re-applying for freedom from FMD where vaccination is either practised or not practised, following an outbreak

In addition to the general conditions described in Chapter 2.2.10., a country re-applying for country, *zone* ~~or *compartment*~~ freedom from FMD where vaccination is practised or not practised should show evidence of an active surveillance programme for FMD as well as absence of FMDV infection/circulation. This will require serological surveillance incorporating, in the case of a country, *zone* ~~or *compartment*~~ practising vaccination, tests able to detect antibodies to NSPs as described in the *Terrestrial Manual*. ~~This is particularly important if a country intends for the whole of its territory or a zone to avail itself of the possibility of a reduced waiting period, i.e. less than 2 years after the last *outbreak*.~~

Four strategies are recognised by the OIE in a programme to eradicate FMDV infection following an *outbreak*:

1) ~~slaughter~~ *stamping-out* of all clinically affected and in-contact susceptible animals;

2) ~~slaughter~~ *stamping-out* of all clinically affected and in-contact susceptible animals and vaccination of at-risk animals, with subsequent slaughter of vaccinated animals;

3) ~~slaughter~~ *stamping-out* of all clinically affected and in-contact susceptible animals and vaccination of at-risk animals, without subsequent slaughter of vaccinated animals;

4) vaccination used without *stamping-out* ~~slaughter~~ of affected animals, without ~~or~~ subsequent slaughter of vaccinated animals.

The time periods before which an application can be made for re-instatement of freedom from FMD depends on which of these alternatives is followed. The time periods are prescribed in Article 2.2.10.7.

In all circumstances, a Member Country re-applying for country, *zone* ~~or *compartment*~~ freedom from FMD with vaccination or without vaccination ~~in a country or zone~~ should report the results of an active surveillance programme implemented according to general conditions and methods in this Appendix ~~in which the FMD susceptible population undergoes regular clinical examination or where active surveillance has targeted a statistically significant sample of the susceptible population. In addition, a statistically significant sample, based on the susceptible population at risk during the *outbreak*, would need to be tested for absence of FMDV infection. In particular circumstances, targeted surveillance could be used to accomplish the task. The procedures are outlined above.~~

Article 3.8.7.6.

The use and interpretation of serological tests (see Fig 1)

The recommended serological tests for FMD surveillance are described in the *Terrestrial Manual*.

~~ELISAs based on structural proteins are useful for screening sera for evidence of infection in animals that have not been vaccinated. However, although their sensitivity is generally high, their specificity, particularly in the case of the liquid phase blocking ELISA (LPBE), is relatively low. This presents difficulties when it comes to proving freedom from infection. These tests are also effective for monitoring serological responses to vaccination where it is certain that the animals concerned have not been infected. The net specificity of serological screening with ELISAs can be improved by retesting positive sera using the virus neutralisation test (VNT). Precise values for sensitivity and specificity of these tests are not available and, in any case, are likely to vary slightly between laboratories.~~

~~Any animal whose serum is positive by the VNT should be tested additionally for evidence of infection using either serological tests for antibodies to NSPs and/or by collection of oesophageal-pharyngeal material (probang testing) for virus detection on cell cultures or by PCR. Ideally, fresh serum should be collected from the animal(s) concerned because repeated freezing and thawing of stored sera tends to damage immunoglobulins.~~

~~Animals that have been vaccinated will have antibodies to the structural proteins of FMD virus, and some may have antibodies to the NSPs, depending on the number of times they have been vaccinated, and the amount of the NSPs present in the vaccine used. However, animals that have recovered from infection with FMD virus will have high levels of antibody to the NSPs. There are eight NSPs associated with the replication of FMD virus, namely L, 2A, 2B, 2C, 3A, 3B, 3C and 3D, and antibodies can be found to all of these in most recovered animals. Some do not persist for more than a few months, and some animals may fail to produce detectable levels to all NSPs. ELISAs have been developed to detect 2C, 3B or 3ABC antibodies, the former being detectable for up to one year after infection, and the latter for up to 2 years. A western blot technique (EITB) may also be used to detect the NSP antibodies to 2C, 3ABC, 3A, 3B and 3D; it is particularly specific and sensitive in identifying previously infected animals. All these tests have been extensively used in cattle. Similar testing in other species is on-going.~~

~~There is the option to use the NSP antibody test together with tests for detection of antibody to structural viral proteins, particularly in areas where vaccination has been used and virus activity is suspected. Titres higher than would be expected from vaccination alone may suggest FMDV infection and this can be confirmed by testing for the presence of antibodies to the NSPs.~~

~~As indicated above, the diagnostic sensitivity of tests used influences the numbers of animals that need to be sampled in a survey to provide evidence of absence of infection. The diagnostic specificity of the test influences the proportion and number of positive results to be expected in the absence or presence of infection, and therefore the selection and use of confirmatory tests. Results of surveys which indicate a significantly higher proportion of positive test results in comparison with that expected from the estimate of the false positive rate derived from the diagnostic specificity (i.e. 100 minus diagnostic specificity) may be interpreted as evidence of infection in the population. A confirmatory test of high specificity, and where appropriate other investigations, should be conducted to prove or refute the possibility of infection.~~

~~Figure 1 provides a flowchart of the test protocol that could be used to test the samples collected in a serological survey. If the population being tested has not been previously vaccinated against FMD, the serum samples can be tested using ELISAs based on structural proteins. Sera positive on the test used should be retested using the VNT, which increases the net specificity. In addition, or in place of the VNT if the laboratory is not able to manipulate live FMDV, the positive sera may be retested using an NSP antibody test, such as the 3B, 3ABC or EITB. A positive VNT or NSP test would suggest that live virus had been circulating, and would require further investigation of the herd or flock to confirm or refute the possibility. Further investigation should include serum testing of the whole herd or flock from which the positive samples were obtained. NSP tests should be used for testing sera from vaccinated herds or flocks, as such sera will be positive by VNT. 3ABC or 3B positive samples may be repeat tested using the EITB for confirmation. All animals from the unit from which positive samples are obtained should be re-tested for antibodies to NSPs.~~

~~The sensitivity and specificity of the NSP tests currently available are not fully documented, in particular for species other than cattle. Member Countries submitting to the OIE data derived from commercial or other NSP tests should provide information on the characteristics of the test being used.~~

Animals infected with FMDV produce antibodies to both the structural proteins (SP) and the nonstructural proteins (NSP) of the virus. Tests for SP antibodies to include SP-ELISAs and the virus neutralisation test (VNT). The SP tests are serotype specific and for optimal sensitivity should utilise an antigen or virus closely related to the field strain against which antibodies are being sought. Tests for NSP antibodies include NSP I-ELISA 3ABC and the electro-immunotransfer blotting technique (EITB) as recommended in the *Terrestrial Manual* or equivalent validated tests. In contrast to SP tests, NSP tests can detect antibodies to all serotypes of FMD virus. Animals vaccinated and subsequently infected with FMD virus develop antibodies to NSPs, but in some, the titre may be lower than that found in infected animals that have not been vaccinated. Both the NSP I-ELISA 3ABC and EITB tests have been extensively used in cattle. Validation in other species is ongoing. Vaccines used should comply with the standards of the *Terrestrial Manual* insofar as purity is concerned to avoid interference with NSP antibody testing.

Serological testing is a suitable tool for FMD surveillance. The choice of a serosurveillance system will depend on, amongst other things, the vaccination status of the country. A country, which is free from FMD without vaccination, may choose serosurveillance of high-risk subpopulations (e.g. based on geographical risk for exposure to FMDV). SP tests may be used in such situations for screening sera for evidence of FMDV infection/circulation if a particular virus of serious threat has been identified and is well characterised. In other cases, NSP testing is recommended in order to cover a broader range of strains and even serotypes. In both cases, serological testing can provide additional support to clinical surveillance. Regardless of whether SP or NSP tests are used in countries that do not vaccinate, a diagnostic follow-up protocol should be in place to resolve any presumptive positive serological test results.

In areas where animals have been vaccinated, SP antibody tests may be used to monitor the serological response to the vaccination. However, NSP antibody tests should be used to monitor for FMDV infection/circulation. NSP-ELISAs may be used for screening sera for evidence of infection/circulation irrespective of the vaccination status of the animal. All herds with seropositive reactors should be investigated. Epidemiological and supplementary laboratory investigation results should document the status of FMDV infection/circulation for each positive herd. Tests used for confirmation should be of high diagnostic specificity to eliminate as many false positive screening test reactors as possible. The diagnostic sensitivity of the confirmatory test should aproach that of the screening test. The EITB or another OIE-accepted test should be used for confirmation.

Information should be provided on the protocols, reagents, performance characteristics and validation of all tests used.

1) The follow up procedure in case of positive test results if no vaccination is used in order to establish or re-establish FMD free status without vaccination

Any positive test result (regardless of whether SP or NSP tests were used) should be followed up immediately using appropriate clinical, epidemiological, serological and where possible virological investigations of the reactor animal at hand, of susceptible animals of the same epidemiological unit and of susceptible animals that have been in contact or otherwise epidemiologically associated with the reactor animal. If the follow up investigations provide no evidence for FMDV infection, the reactor animal shall be classified as FMD negative. In all other cases, including the absence of such follow up investigations, the reactor animal should be classified as FMD positive.

2) The follow up procedure in case of positive test results if vaccination is used in order to establish or re-establish FMD free status with vaccination

In case of vaccinated populations one has to exclude that positive test results are indicative of virus circulation. To this end the following procedure should be followed in the investigation of positive serological test results derived from surveillance conducted on FMD vaccinated populations.

The investigation should examine all evidence that might confirm or refute the hypothesis that the positive results to the serological tests employed in the initial survey were not due to virus circulation. All the epidemiological information should be substantiated and the results should be collated in the final report.

It is suggested that in the primary sampling units where at least one animal reacts positive to the NSP test, the following strategy(ies) should be applied:

a) Following clinical examination, a second serum sample should be taken from the animals tested in the initial survey after an adequate interval of time has lapsed, on the condition that they are individually identified, accessible and have not been vaccinated during this period. Antibody titres against NSP at the time of retest should be statistically either equal to or lower than those observed in the initial test if virus is not circulating.

   The animals sampled should remain in the holding pending test results and should be clearly identifiable. If the three conditions for retesting mentioned above cannot be met, a new serological survey should be carried out in the holding after an adequate period of time, repeating the application of the primary survey design and ensuring that all animals tested are individually identified. These animals should remain in the holding and should not be vaccinated, so that they can be retested after an adequate period of time.

b) Following clinical examination, serum samples should be collected from representative numbers of cattle that were in physical contact with the primary sampling unit. The magnitude and prevalence of antibody reactivity observed should not differ in a statistically significant manner from that of the primary sample if virus is not circulating.

c) Following clinical examination, epidemiologically linked herds should be serologically tested and satisfactory results should be achieved if virus is not circulating.

d) Sentinel animals can also be used. These can be young, unvaccinated animals or animals in which maternally conferred immunity has lapsed and belonging to the same species resident within the positive initial sampling units. They should be serologically negative if virus is not circulating. If other susceptible, unvaccinated ruminants (sheep, goats) are present, they could act as sentinels to provide additional serological evidence.

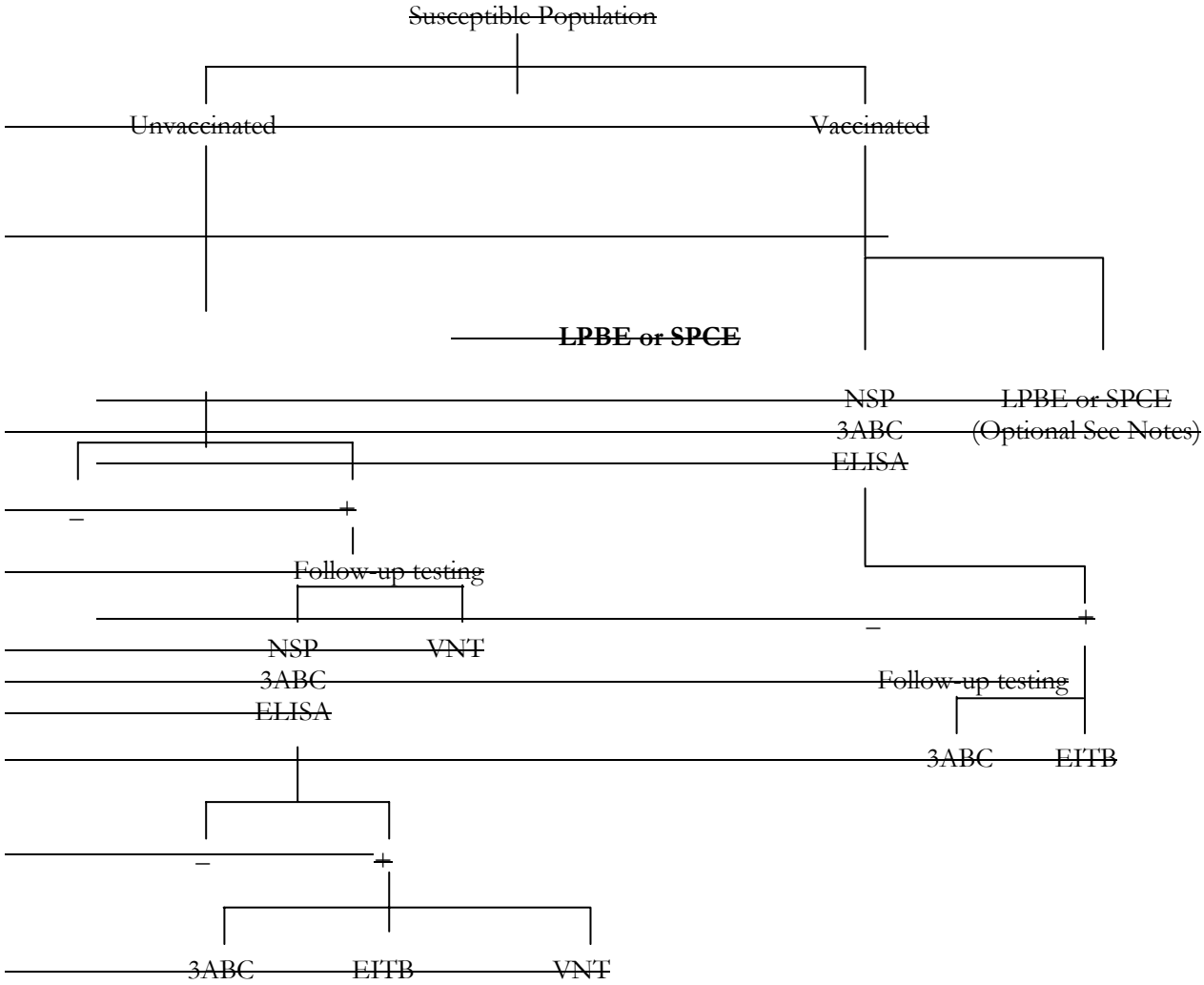
Laboratory results should be examined in the context of the epidemiological situation. Corollary information needed to complement the serological survey and assess the possibility of viral circulation includes but is not limited to:

- characterization of the existing production systems;
- results of clinical surveillance of the suspects and their cohorts;
- quantification of vaccinations performed on the affected sites;
- sanitary protocol and history of the establishments with positive reactors;
- control of animal identification and movements;
- other parameters of regional significance in historic FMDV transmission.

The entire investigative process should be documented as standard operating procedure within the surveillance programme.

Appendix IV (contd)

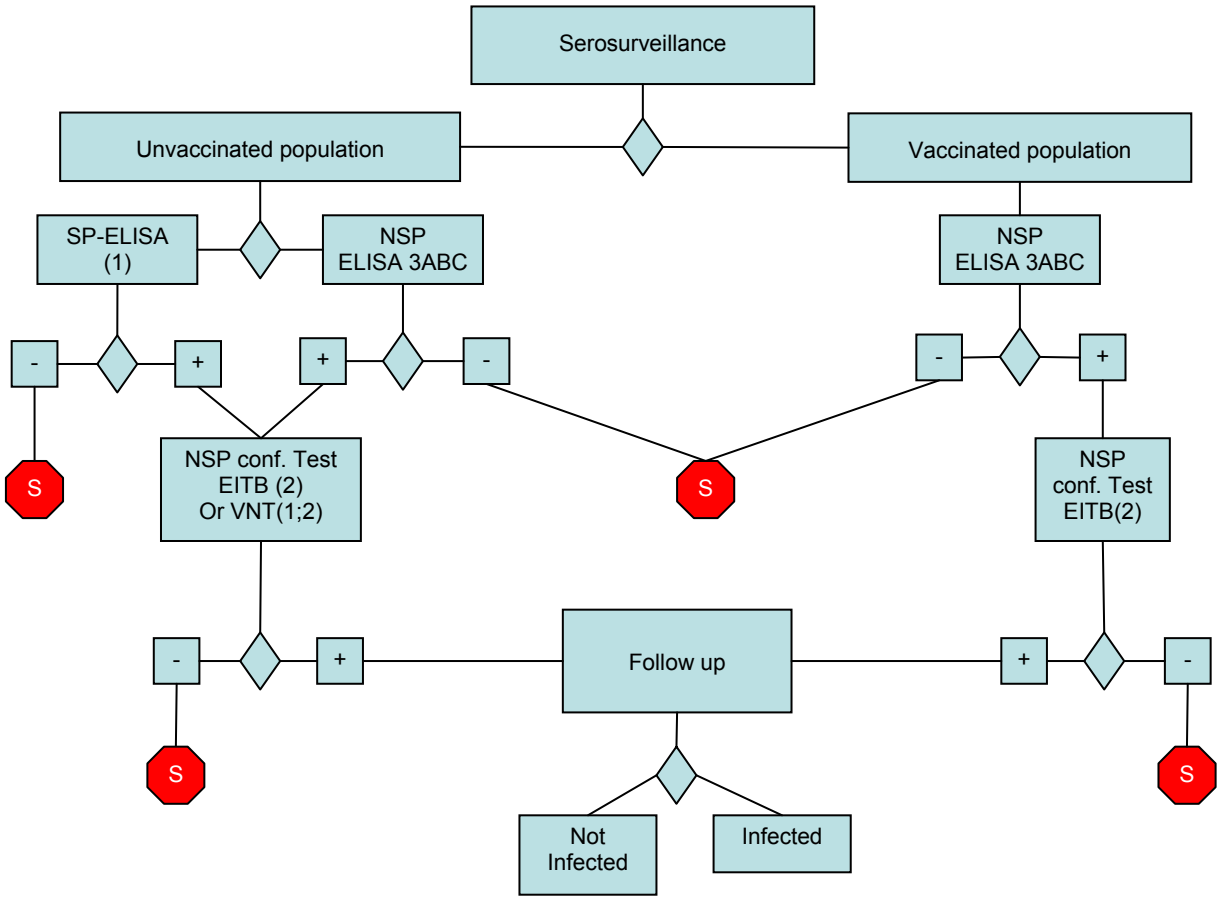
Figure 1 ***Schematic representation of laboratory tests for determining evidence of FMDV infection through or following serological surveys***



The above diagram indicates the tests which are recommended for use in the investigation of sampling units in which a positive test result has been obtained.

When feasible, detection of virus in OP fluid can also be used as complementary test on units in which positive NSP test result has been obtained.

Figure 1 ***Schematic representation of laboratory tests for determining evidence of FMDV infection through or following serological surveys***



Key:

ELISA	Enzyme-linked immunosorbent assay
VNT	Virus neutralisation test
NSP	Nonstructural protein(s) of foot and mouth disease virus (FMDV)
3ABC	NSP antibody test
EITB	Electro-immuno transfer blotting technique (Western blot for NSP antibodies of FMDV)
~~OP~~	~~Oesophageal–pharyngeal sample~~
SP	Structural protein test
S	No evidence of FMDV

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Appendix V

APPENDIX 3.X.X.

GUIDELINES FOR THE SURVEILLANCE OF AVIAN INFLUENZA

Article 3.X.X.1.

Introduction

This Appendix defines the principles and provides a guide for the surveillance of notifiable avian influenza (NAI) in accordance with Appendix 3.8.1., applicable to countries seeking recognition for a declared NAI status, with or without the use of vaccination. This may be for the entire country, *zone* or *compartment*. Guidance for countries seeking free status following an *outbreak* and for the maintenance of NAI status are provided. This Appendix complements Chapter 2.7.12.

The presence of ~~NAI~~ avian influenza viruses in wild birds creates a particular problem. In essence, no country can declare itself free from avian influenza (AI) in wild birds. However, the definition of NAI in Chapter 2.7.12. refers to the infection in poultry only and this Appendix was developed under this definition.

The impact and epidemiology of NAI differ widely in different regions of the world and therefore it is impossible to provide specific guidelines for all situations. It is axiomatic that the surveillance strategies employed for demonstrating freedom from NAI at an acceptable level of confidence will need to be adapted to the local situation. Variables such as the frequency of contacts of poultry with wild birds, different biosecurity levels and production systems and the commingling of different susceptible species including domestic waterfowl require specific surveillance strategies to address each specific situation. It is incumbent upon the country to provide scientific data that explains the epidemiology of NAI in the region concerned and also demonstrates how all the risk factors are managed. There is therefore considerable latitude available to Member Countries to provide a well-reasoned argument to prove that absence of NAI virus (NAIV) infection is assured at an acceptable level of confidence.

Surveillance for NAI should be in the form of a continuing programme designed to establish that the country, *zone* or *compartment*, for which application is made, is free from NAIV infection.

Article 3.X.X.2.

General conditions and methods

1) A surveillance system in accordance with Appendix 3.8.1. should be under the responsibility of the *Veterinary Administration*. In particular:

   a) a formal and ongoing system for detecting and investigating *outbreaks* ~~*of disease*~~NAI infection or disease should be in place;

   b) a procedure should be in place for the rapid collection and transport of samples from suspect cases of NAI to a laboratory for NAI diagnosis as described in the *Terrestrial Manual*;

c) a system for recording, managing and analysing diagnostic and surveillance data should be in place.

2) The NAI surveillance programme should:

a) include an early warning system throughout the production, marketing and processing chain for reporting suspicious cases. Farmers and workers, who have day-to-day contact with poultry, as well as diagnosticians, should report promptly any suspicion of NAI to the *Veterinary Authority*. They should be supported directly or indirectly (e.g. through private veterinarians or *veterinary para-professionals*) by government information programmes and the *Veterinary Administration*. All suspected cases of NAI should be investigated immediately. Where suspicion cannot be resolved by epidemiological and clinical investigation, as is frequently the case with LPNAI virus infections, samples should be taken and submitted to an *approved laboratory*. This requires that sampling kits and other equipment are available for those responsible for surveillance. Personnel responsible for surveillance should be able to call for assistance from a team with expertise in NAI diagnosis and control. In cases where potential public health implications are suspected, notification to the appropriate public health authorities is essential;

b) implement, when relevant, regular and frequent clinical inspection, serological and virological testing of high-risk groups of animals, such as those adjacent to an NAI infected country, *zone* or *compartment*, places where birds and poultry of different origins are mixed, such as live bird markets, poultry in close proximity to waterfowl or other sources of NAIV.

An effective surveillance system will periodically identify suspicious cases that require follow up and investigation to confirm or exclude that the cause of the condition is NAIV. The rate at which such suspicious cases are likely to occur will differ between epidemiological situations and cannot therefore be predicted reliably. Applications for freedom from NAIV infection should, in consequence, provide details of the occurrence of suspicious cases and how they were investigated and dealt with. This should include the results of laboratory testing and the control measures to which the animals concerned were subjected during the investigation (quarantine, movement stand-still orders, etc.).

Article 3.X.X.3.

Surveillance strategies

The target population for surveillance aimed at identification of *disease* and *infection* should cover all the susceptible poultry species within the country, *zone* or *compartment*. Active and passive surveillance for NAI should be ongoing. The frequency of active surveillance should be at least every 6 months. Surveillance should be composed of random and targeted approaches using virological, serological and clinical methods.

The strategy employed may be based on randomised sampling requiring surveillance consistent with demonstrating the absence of NAIV infection at an acceptable level of confidence. The frequency of sampling should be dependent on the epidemiological situation. Random surveillance is conducted using serological tests described in the *Terrestrial Manual*. Positive serological results should be followed up with virological methods.

Targeted surveillance (e.g. based on the increased likelihood of *infection* in particular localities or species) may be an appropriate strategy. Virological and serological methods should be used concurrently to define the NAI status of high risk populations.

A country should justify the surveillance strategy chosen as adequate to detect the presence of NAIV infection in accordance with Appendix 3.8.1. and the prevailing epidemiological situation. It may, for example, be appropriate to target clinical surveillance at particular species likely to exhibit clear clinical signs (e.g. chickens). Similarly, virological and serological testing could be targeted to species that may not show clinical signs (e.g. ducks).

If a Member Country wishes to declare freedom from NAIV infection in a specific *zone* or *compartment*, the design of the survey and the basis for the sampling process would need to be aimed at the population within the *zone* or *compartment*.

For random surveys, the design of the sampling strategy will need to incorporate epidemiologically appropriate design prevalence. The sample size selected for testing will need to be large enough to detect *infection* if it were to occur at a predetermined minimum rate. The sample size and expected disease prevalence determine the level of confidence in the results of the survey. The applicant country must justify the choice of design prevalence and confidence level based on the objectives of surveillance and the epidemiological situation, in accordance with Appendix 3.8.1. Selection of the design prevalence in particular, clearly needs to be based on the prevailing or historical epidemiological situation.

Irrespective of the survey approach selected, the sensitivity and specificity of the diagnostic tests employed are key factors in the design, sample size determination and interpretation of the results obtained. Ideally, the sensitivity and specificity of the tests used should be validated for the vaccination/infection history and the different species in the target population.

Irrespective of the testing system employed, surveillance system design should anticipate the occurrence of false positive reactions. If the characteristics of the testing system are known, the rate at which these false positives are likely to occur can be calculated in advance. There needs to be an effective procedure for following up positives to ultimately determine with a high level of confidence, whether they are indicative of infection or not. This should involve both supplementary tests and follow-up investigation to collect diagnostic material from the original sampling unit as well as flocks which may be epidemiologically linked to it.

The principles involved in surveillance for *disease/infection* are technically well defined. The design of surveillance programmes to prove the absence of NAIV infection/circulation needs to be carefully followed to avoid producing results that are either insufficiently reliable to be accepted by the OIE or international trading partners, or excessively costly and logistically complicated. The design of any surveillance programme, therefore, requires inputs from professionals competent and experienced in this field.

1) Clinical surveillance

Clinical surveillance aims at the detection of clinical signs of NAI at the flock level. Whereas significant emphasis is placed on the diagnostic value of mass serological screening, surveillance based on clinical inspection should not be underrated. Monitoring of production parameters, such as increased mortality, reduced feed and water consumption, presence of clinical signs of a respiratory disease or a drop in egg production, is important for the early detection of NAIV infection. In some cases, the only indication of LPNAIV infection may be a drop in feed consumption or egg production.

Clinical surveillance and laboratory testing should always be applied in series to clarify the status of NAI suspects detected by either of these complementary diagnostic approaches. Laboratory testing may confirm clinical suspicion, while clinical surveillance may contribute to confirmation of positive serology. Any sampling unit within which suspicious animals are detected should be classified as infected until evidence to the contrary is produced.

Identification of suspect flocks is vital to the identification of sources of NAIV and to enable the molecular, antigenic and other biological characteristics of the virus to be determined. It is essential that NAIV isolates are sent regularly to the regional Reference Laboratory for genetic and antigenic characterization.

2) Virological surveillance

Virological surveillance using tests described in the *Terrestrial Manual* should be conducted:

a) to monitor at risk populations;

b) to confirm clinically suspect cases;

c) to follow up positive serological results;

d) to test 'normal' daily mortality, to ensure early detection of infection in the face of vaccination or in *establishments* epidemiologically linked to an *outbreak*.

3) Serological surveillance

Serological surveillance aims at the detection of antibodies against NAIV. Positive NAIV antibody test results can have four possible causes:

a) natural infection with NAIV;

b) vaccination against NAI;

c) maternal antibodies derived from a vaccinated or infected parent flock are usually found in the yolk and can persist in progeny for up to 4 weeks;

d) positive results due to the lack of specificity of the test.

It may be possible to use serum collected for other survey purposes for NAI surveillance. However, the principles of survey design described in these guidelines and the requirement for a statistically valid survey for the presence of NAIV should not be compromised.

The discovery of clusters of seropositive flocks may reflect any of a series of events, including but not limited to the demographics of the population sampled, vaccinal exposure or infection. As clustering may signal infection, the investigation of all instances must be incorporated in the survey design. Clustering of positive flocks is always epidemiologically significant and therefore should be investigated.

If vaccination cannot be excluded as the cause of positive serological reactions, diagnostic methods to differentiate antibodies due to infection or vaccination should be employed.

The results of random or targeted serological surveys are important in providing reliable evidence that no NAIV infection is present in a country, *zone* or *compartment*. It is therefore essential that the survey be thoroughly documented.

4) Virological and serological surveillance in vaccinated populations

The surveillance strategy is dependent on the type of vaccine used. The protection against AI is haemagglutinin subtype specific. Therefore, two broad vaccination strategies exist: 1) inactivated whole AI viruses, and 2) haemagglutinin expression-based vaccines.

In the case of vaccinated populations, the surveillance strategy should be based on virological and/or serological methods and clinical surveillance. It may be appropriate to use sentinel birds for this purpose. These birds should be unvaccinated, AI virus antibody free birds and clearly and permanently identified. The interpretation of serological results in the presence of vaccination is described in 3.X.X.7.

Article 3.X.X.4.

Documentation of NAI or HPNAI free status

1) Countries declaring freedom from NAI or HPNAI for the country, zone or compartment

In addition to the general conditions described in Chapter 2.7.12. of the *Terrestrial Code*, a Member Country declaring freedom from NAI or HPNAI for the entire country, or a *zone* or a *compartment* should provide evidence for the existence of an effective surveillance programme. The strategy and design of the surveillance programme will depend on the prevailing epidemiological circumstances and should be planned and implemented according to general conditions and methods described in this Appendix, to demonstrate absence of NAIV or HPNAIV infection, during the preceding 12 months in susceptible poultry populations (vaccinated and non-vaccinated). This requires the support of a laboratory able to undertake identification of NAIV or HPNAIV infection through virus detection and antibody tests described in the *Terrestrial Manual*. This surveillance may be targeted to poultry population at specific risks linked to the types of production, possible direct or indirect contact with wild birds, multi-age flocks, local trade patterns including live bird markets, use of possibly contaminated surface water, and the presence of more than one species on the holding and poor biosecurity measures in place.

2) Additional requirements for countries, zones or compartments that practise vaccination

Vaccination to prevent the transmission of HPNAI virus may be part of a disease control programme. The level of flock immunity required to prevent transmission will depend on the flock size, composition (e.g. species) and density of the susceptible poultry population. It is therefore impossible to be prescriptive. The vaccine must also comply with the provisions stipulated for NAI vaccines in the *Terrestrial Manual*. Based on the epidemiology of NAI in the country, *zone* or *compartment*, it may be that a decision is reached to vaccinate only certain species or other poultry subpopulations.

In all vaccinated flocks there is a need to perform virological and serological tests to ensure the absence of virus circulation. The use of sentinel poultry may provide further confidence of the absence of virus circulation. The tests have to be repeated at least every 6 months or at shorter intervals according to the risk in the country, *zone* or *compartment*.

Evidence to show the effectiveness of the vaccination programme should also be provided.

Article 3.X.X.5.

Countries, zones or compartments re-declaring freedom from NAI or HPNAI following an outbreak

In addition to the general conditions described in Chapter 2.7.12., a country re-declaring for country, *zone* or *compartment* freedom from NAI or HPNAI virus infection should show evidence of an active surveillance programme depending on the epidemiological circumstances of the *outbreak* to demonstrate the absence of the *infection*. This will require surveillance incorporating virus detection and antibody tests described in the *Terrestrial Manual*. The use of sentinel birds may facilitate the interpretation of surveillance results.

A Member Country declaring freedom of country, *zone* or *compartment* after an *outbreak* of NAI or HPNAI (with or without vaccination) should report the results of an active surveillance programme in which the NAI or HPNAI susceptible poultry population undergoes regular clinical examination and active surveillance planned and implemented according to the general conditions and methods described in these guidelines. The surveillance should at least give the confidence that can be given by a randomized representative sample of the populations at risk.

Article 3.X.X.6.

NAI free establishments within HPNAI free compartments

The declaration of NAI free *establishments* requires the demonstration of absence of NAIV infection. Birds in these *establishments* should be randomly tested using virus detection or isolation tests, and serological methods, following the general conditions of these guidelines. The frequency of testing should be based on the risk of infection and at a maximum interval of 21 days.

Article 3.X.X.7.

The use and interpretation of serological and virus detection tests

Poultry infected with NAI virus produce antibodies to haemagglutinin (HA), neuraminidase (NA), nonstructural proteins (NSPs), nucleoprotein/matrix (NP/M) and the polymerase complex proteins. Detection of antibodies against the polymerase complex proteins will not be covered in this Appendix. Tests for NP/M antibodies include direct and blocking ELISA, and agar gel immunodiffusion (AGID) tests. Tests for antibodies against NA include the neuraminidase inhibition (NI), indirect fluorescent antibody and direct ELISA tests. For the HA, antibodies are detected in haemagglutination inhibition (HI) and neutralization (SN) tests. The HI test is reliable in avian species but not in mammals. The SN test can be used to detect subtype specific antibodies to the haemagglutinin and is the preferred test for mammals and some avian species. The AGID test is reliable for detection of NP/M antibodies in chickens and turkeys, but not in other avian species. As an alternative, blocking ELISA tests have been developed to detect NP/M antibodies in all avian species.

The HI and NI tests can be used to subtype AI viruses into 15 haemagglutinin and 9 neuraminidase subtypes. Such information is helpful for epidemiological investigations and in categorization of AI viruses.

Poultry can be vaccinated with a variety of AI vaccines including inactivated whole AI virus vaccines, and haemagglutinin expression-based vaccines. Antibodies to the haemagglutinin confer subtype specific protection. Various strategies can be used to differentiate vaccinated from infected birds including serosurveillance in unvaccinated sentinel birds or specific serological tests in the vaccinated birds.

AI virus infection of unvaccinated birds including sentinels is detected by antibodies to the NP/M, subtype specific HA or NA proteins, or NSP. In poultry vaccinated with haemagglutinin expression-based vaccines, antibodies are detected to the specific HA, but not any of the other AI viral proteins. Infection is evident by antibodies to the NP/M or NSP, or the specific NA protein of the field virus. Poultry vaccinated with inactivated whole AI vaccines may develop low titres of antibodies to NSP, but the titre in infected birds will be markedly higher. Alternatively, usage of a vaccine strain with a different NA subtype than the field virus can allow differentiation of vaccinated from infected birds (DIVA) by detection of subtype specific NA antibodies of the field virus. Vaccines used should comply with the standards of the *Terrestrial Manual*.

All flocks with seropositive results should be investigated. Epidemiological and supplementary laboratory investigation results should document the status of NAI infection/circulation for each positive flock.

A confirmatory test should have a higher specificity than the screening test and sensitivity at least equivalent than that of the screening test.

Information should be provided on the performance characteristics and validation of tests used.

1) The follow up procedure in case of positive test results if vaccination is used

In case of vaccinated populations, one has to exclude the likelihood that positive test results are indicative of virus circulation. To this end the following procedure should be followed in the investigation of positive serological test results derived from surveillance conducted on NAI-vaccinated poultry. The investigation should examine all evidence that might confirm or refute the hypothesis that the positive results to the serological tests employed in the initial survey were not due to virus circulation. All the epidemiological information should be substantiated and the results should be collated in the final report.

Knowledge of the type of vaccine used is crucial in developing a serological based strategy to differentiate infected from vaccinated animals.

a) Inactivated whole AI virus vaccines can use either homologous or heterologous neuraminidase subtypes between the vaccine and field strains. If poultry in the population have antibodies to NP/M and were vaccinated with inactivated whole AI virus vaccine, the following strategies should be applied:

   i) sentinel birds should remain NP/M antibody negative. If positive for NP/M antibodies, indicating AI virus infection, specific HI tests should be performed to identify H5 or H7 AI virus infection;

   ii) if vaccinated with inactivated whole AI virus vaccine containing homologous NA to field virus, the presence of antibodies to NSP could be indicative of infection. Sampling should be initiated to exclude the presence of NAIV by either virus isolation or detection of virus specific genomic material or proteins;

iii) if vaccinated with inactivated whole AI virus vaccine containing heterologous NA to field virus, presence of antibodies to the field virus NA or NSP would be indicative of infection. Sampling should be initiated to exclude the presence of NAIV by either virus isolation or detection of virus specific genomic material or proteins.

b) Hemagglutinin expression-based vaccines contain the HA protein or gene homologous to the HA of the field virus. Sentinel birds as described above can be used to detect AI infection. In vaccinated or sentinel birds, the presence of antibodies against NP/M, NSP or field virus NA is indicative of infection. Sampling should be initiated to exclude the presence of NAIV by either virus isolation or detection of virus specific genomic material or proteins.

2) The follow up procedure in case of positive test results indicative of infection for determination of infection due to HPNAI or LPNAI virus

The detection of antibodies indicative of a NAI virus infection as indicated in point a)i) above will result in the initiation of epidemiological and virological investigations to determine if the infections are due to HPNAI or LPNAI viruses.

Virological testing should be initiated in all antibody-positive and at risk populations. The samples should be evaluated for the presence of AI virus, by virus isolation and identification, and/or detection of influenza A specific proteins or nucleic acids (Figure 2). Virus isolation is the gold standard for detecting infection by AI virus and the method is described in the *Terrestrial Manual*. All AI virus isolates should be tested to determine HA and NA subtypes, and *in vivo* tested in chickens and/or sequencing of HA proteolytic cleavage site of H5 and H7 subtypes for determination of classification as HPNAI, LPNAI or LPAI (not notifiable) viruses. As an alternative, nucleic acid detection tests have been developed and validated; these tests have the sensitivity of virus isolation, but with the advantage of providing results within a few hours. Samples with detection of H5 and H7 HA subtypes by nucleic acid detection methods should either be submitted for virus isolation, identification, and *in vivo* testing in chickens, or sequencing of nucleic acids for determination of proteolytic cleavage site as HPNAI or LPNAI viruses. The antigen detection systems, because of low sensitivity, are best suited for screening clinical field cases for infection by Type A influenza virus looking for NP/M proteins. NP/M positive samples should be submitted for virus isolation, identification and pathogenicity determination.

Laboratory results should be examined in the context of the epidemiological situation. Corollary information needed to complement the serological survey and assess the possibility of viral circulation includes but is not limited to:

a) characterization of the existing production systems;

b) results of clinical surveillance of the suspects and their cohorts;

c) quantification of vaccinations performed on the affected sites;

d) sanitary protocol and history of the affected establishments;

e) control of animal identification and movements;

f) other parameters of regional significance in historic NAIV transmission.

The entire investigative process should be documented as standard operating procedure within the epidemiological surveillance programme.

Figure 1 - ***Schematic representation of laboratory tests for determining evidence of NAI infection through or following serological surveys***

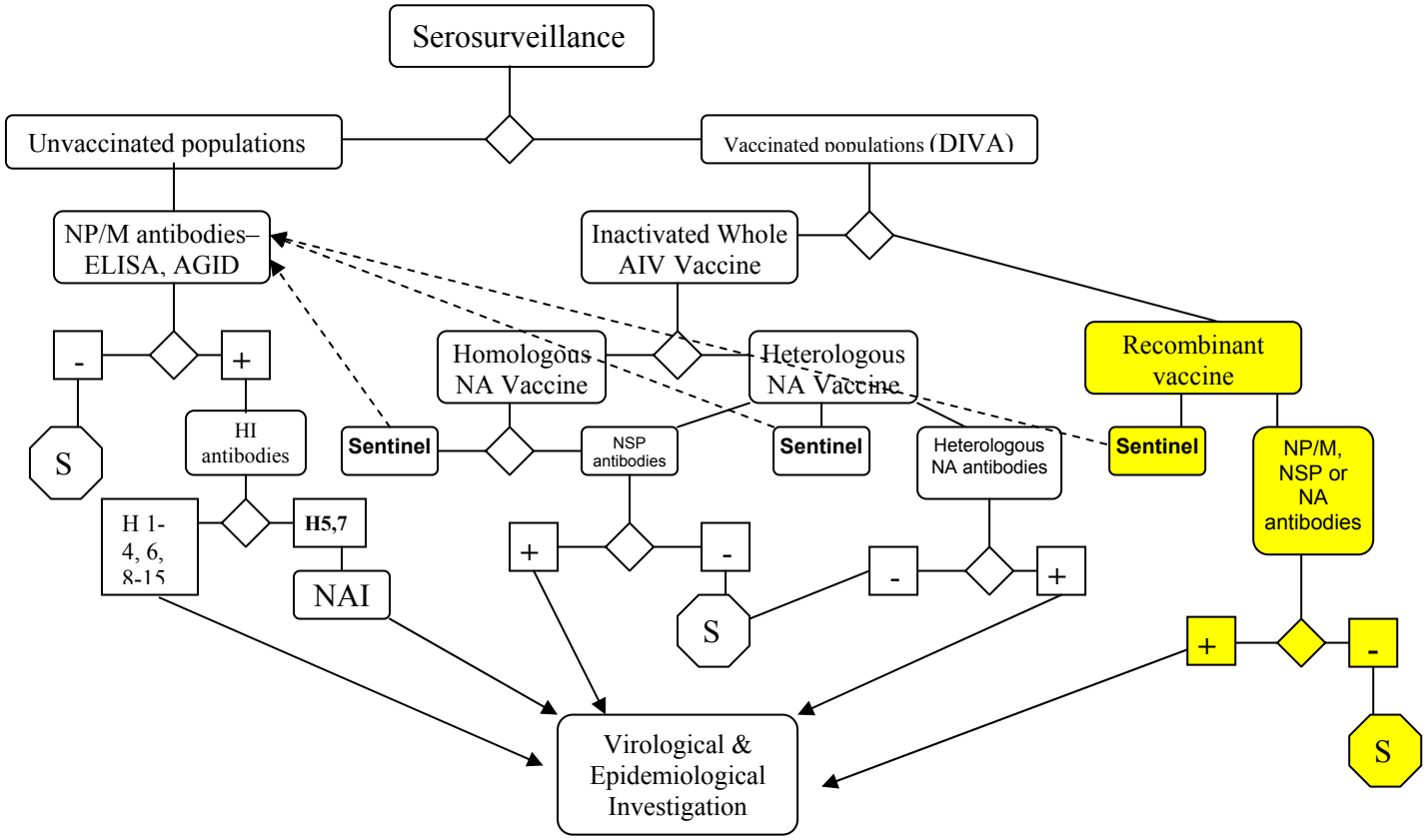
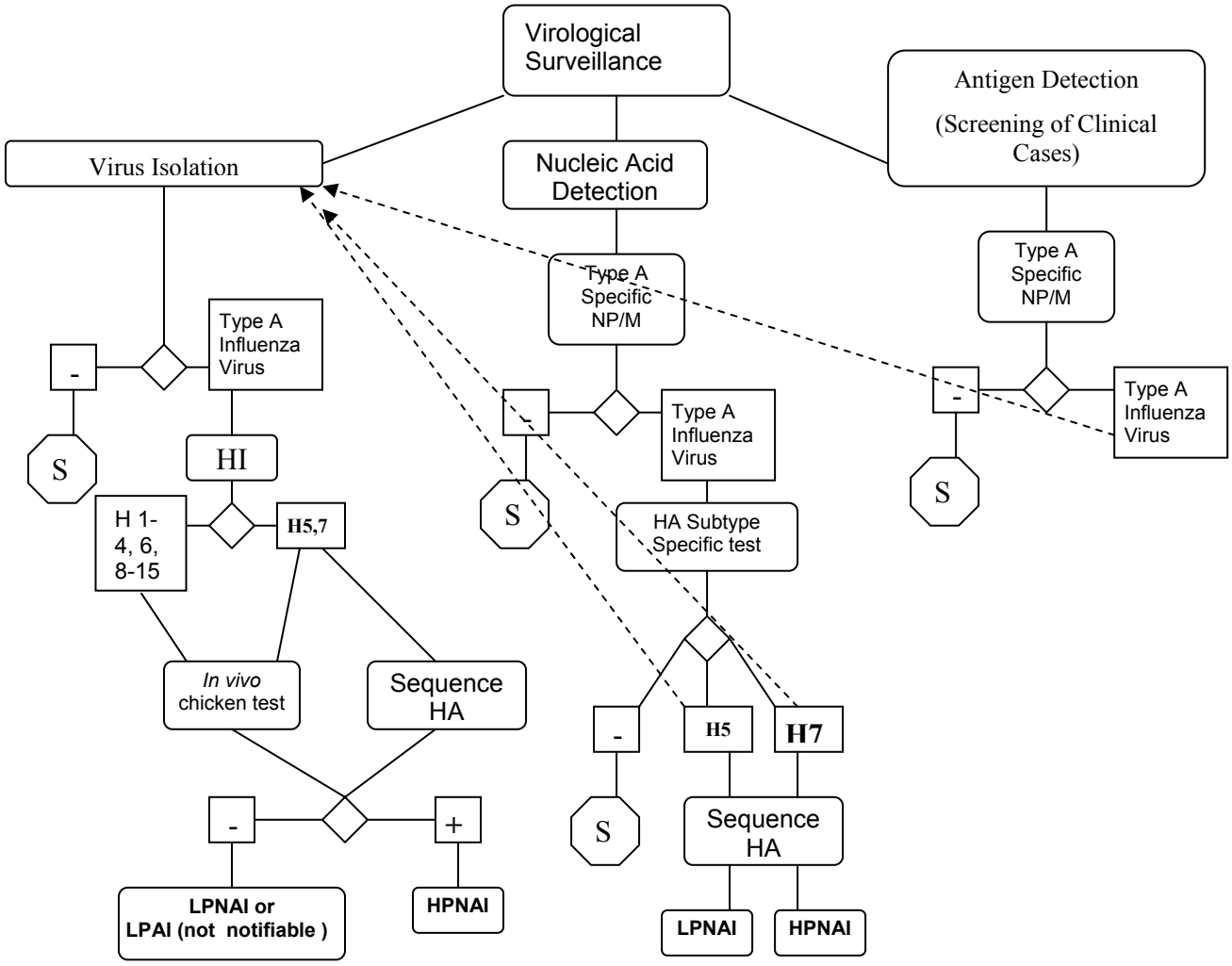


Figure 2. - ***Schematic representation of laboratory tests for determining evidence of NAI infection using virological methods***



The above diagram indicates the tests which are recommended for use in the investigation of poultry flocks.

Key:

AGID	Agar gel immunodiffusion
DIVA	Differentiating infected from vaccinated animals
ELISA	Enzyme-linked immunosorbant assay
HA	Haemagglutinin
HI	Haemagglutination inhibition
NA	Neuraminidase
~~NI~~	~~Neuraminidase inhibition~~
NP/M	Nucleoprotein and matrix protein
NSP	Nonstructural protein
~~SN~~	~~Serum neutralization~~
S	No evidence of NAIV

Apppendix VI

APPENDIX X.X.X

GUIDELINES FOR THE SURVEILLANCE OF CLASSICAL SWINE FEVER

Article X.X.X.1.

Introduction

This Appendix defines the principles and provides a guide for the surveillance of classical swine fever (CSF) in accordance with Appendix 3.8.1., applicable to countries seeking recognition of freedom from CSF. This may be for the entire country or a zone within the country. Guidance for countries seeking reestablishment of freedom from CSF for the whole country or a zone, following an *outbreak*, as well as guidelines for demonstrating the maintenance of CSF free status are also provided. This Appendix complements Chapter 2.6.7.

The impact and epidemiology of CSF differ widely in different regions of the world and therefore it is impossible to provide specific guidelines for all situations. It is axiomatic that the surveillance strategies employed for demonstrating freedom from CSF at an acceptable level of confidence will need to be adapted to the local situation. For example, the approach must be tailored in order to prove freedom from CSF for a country or zone where wild pigs provide a potential reservoir of infection, or where CSF is present in adjacent countries. The method must examine the epidemiology of CSF in the region concerned and adapt to the specific risk factors encountered. This should include provision of scientifically based supporting data. There is therefore latitude available to Member Countries to provide a well-reasoned argument to prove that absence of CSFV infection is assured at an acceptable level of confidence.

Surveillance for CSF should be in the form of a continuing programme designed to establish that the whole country or zone is free from CSFV infection. Consideration should be given to the specific characteristics of CSF epidemiology which include: the role of swill feeding and the impact of different production systems on disease spread, the role of semen in transmission of the virus, the lack of pathognomonic gross lesions and clinical signs, the frequency of clinically inapparent infections, the occurrence of persistent and chronic infections, and the genotypic, antigenic, and virulence variability exhibited by different strains of CSFV. Serological cross-reactivity with other pestiviruses has to be taken into consideration when interpreting data from serological surveys. A common route by which ruminant pestiviruses can infect pigs is the use of vaccines contaminated with bovine viral diarrhoea virus (BVDV).

For the purpose of this Appendix virus infection means presence of CSFV as demonstrated directly by virus isolation, the detection of virus antigen or virus nucleic acid, or indirectly by seroconversion which is not the result of vaccination.

Article X.X.X.2.

General conditions and methods

1) A surveillance system in accordance with Appendix 3.8.1. should be under the responsibility of the *Veterinary Administration*. A procedure should be in place for the rapid collection and transport of samples to an accredited laboratory as described in the *Terrestrial Manual*.

2) The CSF surveillance programme should:

a) include an early warning system throughout the production, marketing and processing chain for reporting suspicious cases. Farmers and workers, who have day-to-day contact with livestock, as well as diagnosticians, should report promptly any suspicion of CSF to the *Veterinary Authority*. They should be supported directly or indirectly (e.g. through private veterinarians or *veterinary para-professionals*) by government information programmes and the *Veterinary Administration*. Since many strains of CSFV do not induce pathognomonic gross lesions or clinical signs, cases in which CSF cannot be ruled out should be immediately investigated employing clinical, pathological, and laboratory diagnosis. This requires that sampling kits and other equipment are available to those responsible for surveillance. Personnel responsible for surveillance should be able to call for assistance from a team with expertise in CSF diagnosis, epidemiological evaluation, and control;

b) implement, when relevant, regular and frequent clinical inspections and serological testing of high-risk groups of animals (for example, where swill feeding is practised), or those adjacent to a CSF infected country or zone (for example, bordering areas where infected wild pigs are present).

An effective surveillance system will periodically identify suspicious cases that require follow up and investigation to confirm or exclude that the cause of the condition is CSFV. The rate at which such suspicious cases are likely to occur will differ between epidemiological situations and cannot therefore be reliably predicted. Recognitions for freedom from CSFV infection should, as a consequence, provide details of the occurrence of suspicious cases and how they were investigated and dealt with. This should include the results of laboratory testing and the control measures to which the animals concerned were subjected during the investigation (quarantine, movement stand-still orders, etc.).

Article X.X.X.3.

Surveillance strategies

1) Introduction

The target population for surveillance aimed at identification of *disease* and *infection* should include domestic and wild pig populations within the country or zone to be recognised as free from CSFV infection. Such surveillance may involve opportunistic testing of samples submitted for other purposes, but a more efficient and effective strategy is one which includes targeted surveillance.

Depending on the local epidemiological situation, targeted surveillance could be considered as more effective than a randomized surveillance strategy. Surveillance is targeted to the pig population which presents the highest risk of infection (for example, swill fed farms, pigs reared outdoors, farms in proximity to infected wild pigs). Each country will need to identify its individual risk factors. These may include: temporal and spatial distribution of past *outbreaks*, pig movements and demographics, etc.

For reasons of cost, the longevity of antibody levels, as well as the existence of clinically inapparent infections and difficulties associated with differential diagnosis of other diseases, serology is often the most effective and efficient surveillance methodology. In some circumstances, which will be discussed later, clinical and virological surveillance may also have value.

The country should justify the surveillance strategy chosen as adequate to detect the presence of CSFV infection in accordance with Appendix 3.8.1. and the epidemiological situation. Cumulative survey results in combination with the results of passive surveillance, over time, will increase the level of confidence in the surveillance strategy. If a Member Country wishes to apply for recognition by other

Member Countries of a specific zone within the country as being free from CSFV infection, the design of the surveillance strategy and the basis for any sampling process would need to be aimed at the population within the zone.

For random surveys, the design of the sampling strategy will need to incorporate epidemiologically appropriate design prevalence. The sample size selected for testing will need to be large enough to detect infection if it were to occur at a predetermined minimum rate. The sample size and expected disease prevalence determine the level of confidence in the results of the survey. The country must justify the choice of design prevalence and confidence level based on the objectives of surveillance and the epidemiological situation, in accordance with Appendix 3.8.1. Selection of the design prevalence in particular clearly needs to be based on the prevailing or historical epidemiological situation.

Irrespective of the survey design selected, the sensitivity and specificity of the diagnostic tests employed are key factors in the design, sample size determination and interpretation of the results obtained. Ideally, the sensitivity and specificity of the tests used should be validated for the vaccination/infection history and production class of animals in the target population.

Irrespective of the testing system employed, the surveillance system design should anticipate the occurrence of false positive reactions. This is especially true of the serological diagnosis of CSF because of the recognized cross-reactivity with ruminant pestiviruses. There needs to be an effective procedure for following up positives to ultimately determine with a high level of confidence, whether or not they are indicative of CSFV infection. This should involve confirmatory and differential tests for pestiviruses, as well as further investigations concerning the original sampling unit as well as animals which may be epidemiologically linked.

2) Clinical and virological surveillance

Beyond their role in targeted surveillance, clinical and virological surveillance for CSF have two aims: a) to shorten the period between introduction of CSF virus into a disease free country or zone and its detection, and b) to confirm that no unnoticed *outbreaks* have occurred.

One element of clinical surveillance involves the detection of clinical signs of CSF by close physical examination of susceptible animals. The spectrum of disease signs and gross pathology seen in CSF infections, along with the plethora of other agents that can mimic CSF, renders the value of clinical examination alone somewhat inefficient as a surveillance tool. Nevertheless, clinical presentation should not be ignored as a tool for early detection; in particular, any cases where clinical signs or lesions consistent with CSF are accompanied by high morbidity and/or mortality should be investigated without delay. In CSFV infections involving low virulence strains, high mortality may only be seen in young animals.

In the past, clinical identification of cases was the cornerstone of early detection of CSF. However, emergence of low virulence strains of CSF, as well as new diseases - in particular post-weaning multisystemic wasting syndrome and porcine dermatitis and nephropathy syndrome have made such reliance less effective, and, in countries where such diseases are common, can add significant risk of masking the presence of CSF. In zones or countries where such diseases exist, careful clinical and virological surveillance of such cases should be applied.

Clinical signs and pathology of CSF infection will also vary considerably, depending on the strain of virus as well as host factors, such as age, nutrition and health status. These factors, along with the compounding effects of concurrent infections and disease caused by ruminant pestiviruses, dictate the need for laboratory testing in order to clarify the status of CSF suspects detected by clinical monitoring. The difficulties in detecting chronic disease manifested by non-specific clinical signs and delayed seroconversion and seronegativity, in persistently infected piglets, both of which may be clinically

normal, makes virological investigation essential. As part of a herd investigation, such animals are likely to be in a minority and would not confound a diagnosis based on serology. However, individually, or as part of recently mixed batches, such animals may escape detection by this method. A holistic approach to investigation, taking note of herd history, pig, personnel and vehicle movements and disease status in neighbouring zones or countries, can also assist in targeting surveillance in order to increase efficiency and enhance the likelihood of early detection.

The labour-intensive nature of clinical, pathological, and virological investigations, along with the smaller 'window of opportunity' inherent in virus, rather than antibody detection, has, in the past, resulted in greater emphasis being placed on mass serological screening as the best method for surveillance. However, surveillance based on clinical and pathological inspection and virological testing should not be underrated. If targeted at high risk groups in particular, it provides an opportunity for early detection that can considerably reduce the subsequent spread of disease. Herds predominated by adult animals, such as nucleus herds and artificial insemination studs, are particularly useful groups to monitor, since infection by low virulence viruses in such groups may be clinically inapparent, yet the degree of spread may be high.

Clinical and virological monitoring may also provide a high level of confidence of rapid detection of disease if a sufficiently large number of clinically susceptible animals is examined. In particular, molecular detection methods are increasingly able to offer the possibility of such large-scale screening for the presence of virus, at reasonable cost.

Wild pigs and, in particular, those with a wholly free-living existence, rarely present the opportunity for clinical observation, but should form part of any surveillance scheme and should ideally be monitored for virus as well as antibody.

Vaccine design and diagnostic methodologies, and in particular, methods of virus detection, are increasingly reliant on up-to-date knowledge of the molecular, antigenic and other biological characteristics of viruses currently circulating and causing disease. Furthermore, epidemiological understanding of the pathways of spread of CSFV can be greatly enhanced by molecular analyses of viruses in endemic areas and those involved in *outbreaks* in disease free areas. It is therefore essential that CSFV isolates are sent regularly to the regional OIE Reference Laboratory for genetic and antigenic characterisation.

3) Serological surveillance

Serological surveillance aims at the detection of antibodies against CSFV. Positive CSFV antibody test results can have five possible causes:

a) natural infection with CSFV;

b) legal or illegal vaccination against CSF;

c) maternal antibodies derived from an immune sow (maternal antibodies) are usually found only up to 4.5 months of age but in some individuals, maternal antibodies can be detected for considerably longer periods;

d) cross reactions with other pestiviruses;

e) non-specific reactors.

The infection of pigs with other pestiviruses may complicate a surveillance strategy based on serology. Antibodies to bovine viral diarrhoea virus (BVDV) and Border disease virus (BDV) can give positive results in serological tests for CSF, due to common antigens. Such samples will require differential tests to confirm their identity. Although persistently infected immunotolerant pigs are themselves seronegative, they continuously shed virus, so the prevalence of antibodies at the herd level will be high. Chronically infected pigs may have undetectable or fluctuating antibody levels.

It may be possible to use sera collected for other survey purposes for CSF surveillance. However, the principles of survey design described in this Appendix and the requirement for statistical validity should not be compromised.

The discovery of clustering of seropositive reactions should be foreseen. It may reflect any of a series of events, including but not limited to the demographics of the population sampled, vaccinal exposure or the presence of infection by field strains or other pestiviruses. Because clustering may signal field strain infection, the investigation of all instances must be incorporated in the survey design. Clustering of positive animals is always epidemiologically significant and therefore should be investigated.

In countries or zones that are moving towards freedom, serosurveillance can provide valuable information on the disease status and efficacy of any control programme. Targeted serosurveillance of young stock will indicate whether newly circulating virus is present, although the presence of maternal antibody will also need to be considered. If conventional attenuated vaccine is currently being used or has been used in the recent past, serology aimed at detecting the presence of field virus will likewise need to be targeted at unvaccinated animals and after the disappearance of maternal antibody. General usage in such situations may also be used, to assess levels of vaccine coverage.

Vaccines also exist which, when used in conjunction with dedicated serological tests, may allow discrimination between vaccinal antibody and that induced by field infection. Such tools, described in the *Terrestrial Manual*, will need to be fully validated. They do not confer the same degree of protection as that provided by conventional vaccines, particularly with respect to preventing transplacental infections. Furthermore, serosurveillance using such differentiation requires cautious interpretation on a herd basis.

The results of random or targeted serological surveys are important in providing reliable evidence that no CSFV infection is present in a country or zone. It is therefore essential that the survey be thoroughly documented.

Article X.X.X.4.

Country or zone free of CSF in domestic and wild pigs

1) Historically free status

The free status should be reviewed whenever evidence emerges to indicate that changes which may alter the underlying assumption of continuing historical freedom, has occurred. Such changes include but are not limited to:

a) an emergence, or an increase in the prevalence of CSF in countries or zones from which live pigs or products are imported;

b) an increase in the volume of imports or a change in their country or zone of origin;

c) an increase in the prevalence of CSF in the domestic or wild pigs of adjacent countries or zones;

d) an increased entry from, or exposure to, wild pig populations of adjacent countries or zones.

2) Free status as a result of an eradication programme

In addition to the general conditions described in Chapter 2.6.7., a Member Country seeking recognition of CSF freedom for the country or a zone, whether or not vaccination had been practised, should provide evidence for the existence of an effective surveillance programme. The strategy and design of the surveillance programme will depend on the prevailing epidemiological circumstances and will be planned and implemented according to general conditions and methods in this Appendix, to demonstrate the absence of CSFV infection, in domestic and wild pig populations. This requires the support of a national or other laboratory able to undertake identification of CSFV infection through virus detection and serological tests described in the *Terrestrial Manual*.

Article X.X.X.5.

Country or zone free of CSF in domestic pigs but with infection in the wild pig population

1) In addition to the general conditions described in Chapter 2.6.7., a Member Country seeking recognition of CSF freedom for the country or a zone, whether or not vaccination had been practised, should provide evidence for the existence of an effective surveillance programme. The strategy and design of the surveillance programme will depend on the prevailing epidemiological circumstances and will be planned and implemented according to general conditions and methods in this Appendix, to demonstrate the absence of CSFV infection, in domestic and wild pig populations. This requires the support of a national or other laboratory able to undertake identification of CSFV infection through virus detection and serological tests described in the *Terrestrial Manual*.

2) The objective of surveillance in this instance is to demonstrate that the two subpopulations are effectively separated by measures that ensure the biosecurity of domestic pigs. To this end, a biosecurity programme which includes but is not limited to the following provisions should be implemented:

a) a programme for the management of CSF in wild pigs;

b) delineation of CSF wild pig control areas around every CSF case reported in wild pigs;

c) assessment of the presence and mitigative role of natural boundaries;

d) documentation of the ecology of the wild pig population;

e) proper containment of domestic pigs;

f) control of movement of *vehicles* with cleaning and *disinfection* as appropriate;

g) control of personnel entering into the *establishments* and awareness of risk of fomite spread;

h) prohibition of introduction to the *establishments* of hunted animals and products;

i) registry of animal movements into and out of *establishments*;

j) information and training programmes for farmers, hunters, processors, veterinarians, etc.

3) The biosecurity programme implemented would also require internal and external monitoring by the *Veterinary Authorities*. These elements should include but are not limited to:

   a) periodic clinical and serological monitoring of herds in the country or zone, and adjacent wild pig populations following these guidelines;

   b) herd registration;

   c) official accreditation of biosecurity programme;

   d) periodic monitoring and review.

4) Monitoring the CSF status of wild populations will be of value in assessing the degree of risk they pose to the CSF free domestic population. The design of a monitoring system for wild pigs is dependent on several factors such as the organization of the *Veterinary Services* and resources available. The occurrence of CSF in wild pigs may vary considerably among countries. Surveillance design should be scientifically based and the Member Country must justify its choice of design prevalence and level of confidence based on Appendix 3.8.1.

5) The geographic distribution and approximate size of wild pig populations need to be assessed as a prerequisite for designing a monitoring system. Sources of information may include wildlife conservation organizations, hunter associations and other available sources. The objective of a surveillance programme when the disease is already known to exist should be to determine the geographic distribution and the extent of the infection.

Article X.X.X.6.

Recovery of free status

1) Countries or zones ~~re-~~seeking reestablishment of freedom from CSF following an outbreak

   In addition to the general conditions described in Chapter 2.6.7., a country re-seeking country or zone freedom from CSF should show evidence of an active surveillance programme for CSF as well as absence of CSFV infection.

   Populations under this surveillance programme should include, but not be limited to:

   a) *establishments* in the area of the *outbreak*;

   b) *establishments* epidemiologically linked to the *outbreak*;

   c) animals used to re-populate affected *establishments* and any *establishments* where contiguous culling is carried out;

   d) wild pig populations in the area of the *outbreak*.

   In all circumstances, a Member Country ~~re-seeking~~seeking reestablishment of country or zone freedom from CSF with vaccination or without vaccination should report the results of an active and passive surveillance programme in which the pig population undergoes regular clinical, pathological, virological, and/or serological examination, planned and implemented according to general conditions and methods in these guidelines. The surveillance should be based on a statistically representative sample of the populations at risk.

2) Country or zone free of CSF in wild pigs

While the same principles apply, surveillance in wild pigs presents challenges beyond those encountered in domestic populations in each of the following areas:

a) determination of the distribution, size and movement patterns associated with the wild pig population;

b) assessment of the possible presence of CSF within the population;

c) determination of the practicability of establishing zones.

The design of a monitoring system for wild pigs is dependent on several factors such as the organization of the *Veterinary Services* and resources available. The geographic distribution and approximate size of wild pig populations need to be assessed as a prerequisite for designing a monitoring system. Sources of information may include wildlife conservation organisations, hunter associations and other available sources. The objective of a surveillance programme is to determine the geographic distribution and estimation of target population.

Estimates of wild pig population can be made using advanced methods (radio tracking, linear transect method, capture/recapture) or traditional methods based on the number of animals that can be hunted to allow for natural restocking (hunting bags).

For implementation of the monitoring programme, it will be necessary to define the limits of the territory over which wild pigs range in order to delineate the epidemiological units within the monitoring programme. It is often difficult to define epidemiological units for wild animals. The most practical approach is based on natural and artificial barriers.

The monitoring programme should also include animals found dead, road kills, animals showing abnormal behaviour or exhibiting gross lesions during dressing.

There may be situations where a more targeted surveillance programme can provide additional assurance. The criteria to define high risk areas for targeted surveillance can be:

– areas with past history of CSF;
– sub-regions with high wild pig density;
– border regions with CSF affected countries or zones;
– areas of contact between sub-populations;
– air and sea ports,
– military bases
– picnic and camping areas;
– around farms with free-ranging pigs;
– special risk areas determined by local *Veterinary Authorities*.
– garbage dumps.

Apppendix VII

COMPARTMENTALISATION CONCEPT PAPER

by

Aaron Scott, Cristóbal Zepeda Sein, Lindsey Garber, John Smith, David Swayne, Andrew Rhorer, J. Kellar, A. Shimshony, H. Batho, V. Caporale and A. Giovannini

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Compartmentalisation

Introduction

The objective of this document is to describe the concept of a "compartment" and to develop criteria and guidelines for the application of this concept.

Currently, trade may be established from a country with an active disease component only through the process of zoning/regionalisation. This concept is based on geographic boundaries and does not provide trade access to portions of industry in geographic areas that cannot be considered disease free even though their management and biosecurity measures substantially reduce or eliminate disease risk.

Recently, the concept of compartmentalisation was introduced to the OIE *Terrestrial Animal Health Code* (the *Terrestrial Code*) as an alternative way to manage disease and pathogens in animal populations without unnecessarily disrupting trade. Regionalisation or zoning can be thought of as recognising animal subpopulations of differing health status based on geographical boundaries, while compartmentalisation is based primarily on management practices. However, geographic considerations and good management practices play a role in the application of both concepts. Compartmentalisation is not a new concept for Veterinary Services; in fact, it has been applied for a long time in many disease control programmes that are based on the concept of disease-free herds/flocks. Examples of such programmes include tuberculosis, brucellosis and pseudorabies. The intent of this document is to provide a structured framework for the application and recognition of compartments within countries or zones.

The fundamental requirement for application of either concept is that the animal population considered for trade maintains a functional separation through management or geographic boundaries that allow a clear epidemiological differentiation from populations of higher risk. For example, a confinement operation of poultry or swine might have biosecurity measures and management practices that result in virtually zero risk from diseases or agents in the same geographic area. On the other hand, a geographically isolated population of animals or birds might have substantial risk from travellers, tourists, or other long range epidemiological links. Thus the concept of a compartment extends the application of a "risk boundary" beyond that of a geographic interface and considers all epidemiological factors contributing to a functional separation that creates an effective boundary.

The main criterion for a compartment is that the animals contained in it are clearly recognisable as part of a unique subpopulation with limited or no epidemiological links to other populations of risk. The measures taken to ensure the identification of the sub-population and the recognition and maintenance of its health status should be documented in detail.

For the purpose of international trade, compartments should be under the direct control and responsibility of the official *Veterinary Administration* in the country.

The following pages describe guidelines for the definition and evaluation of an animal disease compartment.

Definitions:

OIE definitions

Compartment

means one or more *establishments* under a common biosecurity management system containing an animal sub-population with a distinct health status with respect to a specific disease for which required surveillance, control and biosecurity measures have been applied for the purpose of international trade.

Establishment

means the premises in which animals or birds are kept.

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Seven factors for evaluation and recognition of a compartment

1. Definition of the compartment

A compartment is an animal subpopulation with a defined status in respect of the conditions of interest, a geographical identity and integrity in maintenance of its membership and status. The compartment must be clearly defined, indicating the functional relationships of all its components and their contribution to an epidemiological boundary between the animals in the compartment and populations of higher risk. The definition of compartment may revolve around common animal ownership or management, membership in associations, industry improvement plans or breed registries with prescriptive biosecurity guidelines, or similar functional demarcations.

The compartment may also be defined by disease specific factors. For example, a cattle population may be defined as a BSE free compartment dependent primarily on careful historical documentation of feed sources, animal movements and identification. Alternatively, a swine confinement operation might be defined by the ability of its biosecurity plan to exclude infectious agents on a day to day basis. In the poultry industry, a compartment may be defined on the basis of a slaughter plant and all the establishments that supply birds to it as well as those establishments that are vertically integrated with the operation.

In general, a compartment is defined by the factors common to a population that provide distinct disease risk separation from animals or birds at higher risk for the disease(s) in question.

2. Epidemiologic separation of the compartment from potential sources of infection

Epidemiological parameters comprise a major portion of the defining criteria for a compartment. These factors relate to pathways of disease transmission, mitigations to prevent exposure, disease specific factors, and environmental factors that affect exposure and propagation of the disease agent.

a) Biosecurity in respect of health related issues

The biosecurity plan should address potential pathways for introduction and spread of infection into the compartment. In addition to detailing disease introduction pathways, a biosecurity plan should provide standard operating procedures that mitigate exposure from each pathway and describe a plan for the implementation and monitoring of compliance with the procedures. Finally, the plan should include means for education and training of workers to ensure that all persons involved in biosecurity are knowledgeable and informed.

b) Physical, geographic, or location factors that affect the status of biosecurity in the compartment

While a compartment is primarily based on biosecurity measures, a review of geographic factors is needed to ensure that the functional boundary provides adequate separation of the compartment from adjacent high risk animal populations. The following considerations are taken in conjunction with biosecurity measures and, in some instances, may alter the degree of confidence achieved by general biosecurity and surveillance measures.

- Disease or pest status in areas adjacent, or with unmanageable epidemiological links to the compartment.

- Location of nearest flocks or herds. Are the facilities within the compartment immediately adjacent to flocks or herds of higher risk or is there a buffer area that would preclude direct contact or aerosol spread?

- Consideration of environmental spread of the disease agent. Are aerosols a factor in the transmission of the disease-causing agent? Is the climate such that agent survivability would be extremely brief or extremely prolonged?

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In any case, sufficient evidence should be submitted to assess the efficacy of the biosecurity plan in accordance with the level of risk for each identified pathway. The compartment should periodically assess the biosecurity risk of all operations through a formal process using a survey instrument designed to identify high risk aspects. Based on the outcome, concrete and documented mitigation steps should be taken to reduce areas of high risk for introducing the agent.

c) Identification and registration

A prerequisite to assess the integrity of the membership of the compartment is the existence of a valid traceability system. All animals within the compartment should be identified in such a way that their individual history can be audited. Depending on the system of production, identification may be done at the herd, flock, lot or individual animal level. All animal movements into and out of the compartment should be certified by the official veterinary service and documented.

3. Documentation of factors critical to the definition of compartment

Standard operating procedures should be in place to document all operations of the compartment. Documentation must provide clear evidence that the biosecurity, surveillance, traceability and management practices are adequate to meet the definition of the compartment. In addition to animal movement information, the necessary documentation should include herd or flock production records, feed sources, surveillance tests, birth and death records, visitor logbook, morbidity history, medications, vaccinations, biosecurity plans, documentation of training and any other criteria necessary for evaluation of disease exclusion.

The historical disease status of the compartment has to be documented, indicating the dates of last disease occurrence (if any), the number of outbreaks and the methods for disease control that were applied. Vaccination status for many diseases must be considered in regard to the interpretation of surveillance data. The type of vaccine and frequency of administration are needed in many cases to evaluate test results and to determine the risk of the disease in the population. Therefore, documentation of vaccine-related factors must be maintained for a period of time based on the disease, vaccine types and production cycles.

The information contained in the records may vary according to the species and disease(s) under consideration. For example, in a disease such as BSE that is strictly transmitted by feed, with a long incubation period, complete records of all feed sources for several years would be essential to recognise the compartment. On the other hand, historic feed records would be of little value for a highly contagious disease such as avian influenza.

4. Supervision and control of the compartment

The authority, organisation, and infrastructure of the veterinary services, including laboratories, must be clearly documented in accordance with the chapter on the evaluation of veterinary services of the OIE *Terrestrial Code*, to provide confidence in the integrity of the compartment

Official oversight of biosecurity and surveillance is an essential component of compartmentalisation. The supervision of the factors critical to maintenance of a compartment status should be developed through cooperation of industry and government veterinary services. The final authority for the purposes of domestic and international trade lies within the official *Veterinary Services*. All production within the compartment should be carried out according to a single standard of operation.

Industry's responsibilities in most cases will include the application of biosecurity measures, quality assurance schemes, monitoring the efficacy of the measures, documenting corrective actions, conducting surveillance sampling, rapid reporting and maintenance of records in a readily accessible form. A HACCP approach is an appropriate tool with which to design and apply these measures.

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The Official *Veterinary Services* with authoritative responsibility for international trade will provide movement certification, periodic inspections of facilities, biosecurity measures, records, surveillance, and sampling procedures. Official *Veterinary Services* should conduct surveillance and sampling and they will conduct or oversee laboratory diagnostic examinations. The extent of oversight and frequency of inspections must be adequate to provide reasonable confidence to trading partners that the measures defining the compartment are applied in a manner that meets the importing country's appropriate level of protection.

Table 1. General considerations of compartmental biosecurity: pathways of entry of disease agents and responsive mitigations

Potential pathways of entry	**Examples of responsive mitigations**
Endemic compartments	No interactions with endemic compartments. Biosecurity practices protect farm site from neighbouring herds/flocks. (also see employee policy)
Wild populations	Animals in the free compartment should be housed in a way that provides adequate separation from other wild populations (e.g. wild boars, wild birds)
Employees	Policy prohibiting employees' contact with high risk animals. e.g. in the poultry industry a policy preventing employees from owning or handling birds off farm or attending avian shows or exhibitions; shower, dedicated clothing/footwear Training
Service sectors (e.g. Catching/vaccination/cleaning crews/feed delivery/service personnel)	Require use of disposable or dedicated clothing/footwear Require that they not have been on another farm same day Require truck/equipment cleaned and disinfected before coming on farm
Congregation of sick/dead animals from multiple sources (e.g., rendering)	Compost, incinerate, or bury dead animals e.g. for poultry, covered barrel at perimeter of property – dead birds placed in bags in barrel
Vehicle traffic	Park away from animal housing, preferably outside farm perimeter Only essential vehicles enter premises (e.g., feed truck) Spray station at entrance – use on own vehicles as well as others
Visitors	Prohibit visitors in animal area Fences, signs, locked gates, or guards to discourage entry
Wild animals	No attractants such as garbage Fencing House production animals indoors
Equipment	Do not share equipment with other farm sites, including same parent company Dedicated racks and flats (e.g., colour coded) – thoroughly cleaned and disinfected between uses
Downtime	Minimum downtime between flocks or litters? Cleaning and disinfection E.G for poultry: number of flocks before change litter?

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5. Surveillance for the agent or disease

a) Surveillance should involve the collection and analysis of disease/infection data such that the official *Veterinary Services* have confidence that the flocks or herds comply with the defined status of a compartment. A surveillance system that is able to ensure early detection in the event that the agent enters a flock or herd is essential. The surveillance system should comply with the General Guidelines for Surveillance in the *Terrestrial Code* and the specific guidelines for surveillance for the disease of interest.

b) Depending on the disease of interest, many different combinations of testing and surveillance may be applied to achieve the desired confidence in disease freedom. The surveillance methodology will usually follow OIE guidelines but may utilise a demonstrably equivalent method. Based on an assessment of risk factors, a country may choose to sample with greater intensity in areas of higher risk and less so in other areas that have a documented lower risk. In general, an appropriate combination of active (ongoing laboratory-based testing) and passive (voluntary intermittent reporting or testing) is necessary to achieve the surveillance goals described above. A system for reporting the results of surveillance testing must be documented and efficacious to inform veterinary officials and trading partners of positive tests, abnormal clinical signs and production observations that are included in the surveillance strategy. Surveillance information must be reported immediately by the compartment management and field veterinary officials responsible for surveillance and monitoring of the disease.

6. Diagnostic capabilities

Officially designated laboratory facilities complying with the OIE standards for quality assurance as defined by the OIE *Manual for diagnostic Tests and Vaccines* for terrestrial and aquatic animals should be available for sample testing. The laboratory tests and their use should be audited by the national authority. In particular, laboratories and personnel performing the tests should be trained and certified by the national reference laboratory as to competency. Periodically, the laboratories and personnel should complete a proficiency test to verify continuing competence. Reporting of test results should be transparent.

7. Emergency response, control, and notification capability

Rapid diagnosis, reporting, and notification of disease are critical to minimising risk from outbreaks. The structure of the compartment must be such that producers and their employees are aware of the notifiable diseases and procedures for reporting. Likewise, each laboratory that conducts surveillance testing must have systematic procedures in place for rapid reporting of disease results to authoritative government officials. The veterinary authority must then have standard operating procedures to inform the OIE and if necessary, other pertinent international bodies.

Conclusion

OIE Member Countries have continuously striven to facilitate risk-based trade in the face of the challenges represented by disease prevalence in the livestock and poultry populations involved. In recent years, regionalisation/zoning was introduced as a means for trading from a sub-national area in an otherwise infected country. This requires that the official *Veterinary Services* exert control at the region/zone level equivalent or superior to that at the national level.

Compartmentalisation is a tool that may also be applied to facilitate trade. Fundamental to its application is the official *Veterinary Services*' control over the compartment and the free exchange of information necessary to convince importing countries that the risk of disease introduction from trade is minimised. Therefore, the procedures for establishing trade based upon the compartmentalisation concept should be similar to those practised for regionalisation or zoning.

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The preceding guidelines provide a basis for establishing, evaluating and exchanging information on compartmentalised animal populations in the interest of international trade. As in the case of similar national or zoned/regionalised applications, the related trade decisions are ultimately determined by the importing country's assessment of whether its acceptable level of risk can be met during the commercial transaction.

APPENDIX 3.6.5

GENERAL GUIDELINES FOR THE DISPOSAL OF CARCASSES

Introduction

The mass destruction and disposal of animals in the event of an animal disease outbreak are always subject to intense public and media scrutiny thereby obligating the *Veterinary Administration* of a Member Country to not only conduct carcass disposal operations within acceptable scientific principles to destroy the causative pathogen of disease but also to satisfy animal welfare, public and environmental concerns.

The guidelines in this Appendix are general and generic in nature. They are recommended for adoption after consideration of the application best suited to prevailing circumstances of a specific disease outbreak. The choice of one or more of the recommended technologies should be in compliance with the mandates provided for within relevant local and national legislation and be attainable with the resources available within the Member Country. The guidelines should also be read and applied in conjunction with the procedures described for the humane killing of animals in Appendix XXX of the *Code*.

The chapter aims to briefly describe the definitions applicable to the disposal of carcasses, outline the regulatory and jurisprudence requirements that should be considered, identify the most important risk factors associated with the disposal of carcasses, list the social factors and practical considerations relevant to carcass disposal, give guidelines on appropriate technologies that could be applied and give guidance on the decision-making process in electing the most appropriate technology for the disposal of carcasses under specific circumstances.

Where indicated within the relevant chapters of the *Code,* the vaccination of animals in combination with or without a stamping-out policy to contain a disease outbreak could be the preferred choice above mass destruction. The eventual decision to embark on the mass destruction and disposal of animals to contain a disease outbreak should be carefully evaluated against available alternatives, environmental, socio-political and socio-economical concerns, trade implications as well as prevailing ethical and ethnic beliefs and preferences.

Definitions

For the purpose of this Appendix the following definitions relevant to the disposal of carcasses shall apply:

- **Carcass -** means the body of an animal subsequent to euthanasia or death that requires safe destruction.
- **Disposal -** means the inactivation of the pathogen with reduction of the carcass and related materials to constituent components.
- **Technology -** means the process by which disposal is achieved.
- **Transport -** means the bio-secure removal of animals or carcasses or material from the site of infection to the site of disposal.
- **Bio-security -** means the absolute containment of infection.

- **Human safety -** means elimination of risks to the health and well-being of the persons involved in animal disposal procedures.

- **Animal welfare -** means reference to guidelines established for humane killing as defined in Appendix XXX.

- **Mass destruction -** means an emergency mass culling of animals ~~destruction~~ and disposal of the carcasses~~a large number of animals~~ for disease control purposes.

Regulations and jurisdiction

The laws regulating animal health, prevention and eradication of animal diseases, and the organisation of the *Veterinary Administration* should give the *Veterinary Services* the authority and the legal powers to carry out the necessary activities for an efficient and effective disposal of carcasses. For most of the disposal options, legislation of other governmental bodies at national or local level is in force and should be respected. Therefore close co-operation between the *Veterinary Service* and these authorities is indispensable to develop a coherent set of legal measures for carcass disposal in peace time in order to apply these undisturbed where and when it is necessary. In this context the following aspects should be clearly regulated:

- Right of entry on a farm and its premises for personnel of the *Veterinary Service* and of contractors working for the *Veterinary Service.*

- Total movement ban to be applied on an infected or suspected farm and the authority to make exemptions under certain bio-security conditions - for instance for transport of carcasses to another location for disposal.

- The obligation for the involved farmer, his relatives and his personnel to co-operate with and to apply all the measures ordered by the *Veterinary Service.*

As regard to infected and suspected animals and their products:

- the transfer of the ownership of these to the competent authority (for instance through confiscation or buying up with compensation of the farmer) and

- the right to kill these animals on the farm or wherever the *Veterinary Service* determines.

If burning of the carcasses is the option of choice:

- the Veterinary Service should have the authority to determine the place where the pyre is situated,

- national and local governmental organisations competent for the protection of the environment should have given their approval for this solution in advance and should have adopted the necessary legal framework to allow this and

- all involved authorities should have determined on the conditions for removal of the ashes.

If mass burial, mounding or open farm burial is the preferred option:

- the Veterinary Service should have the authority to determine the place of burial in accordance with other involved authorities,

- national and local governmental organisations competent for the protection of the environment and subsoil water reserves should have agreed with this solution and should have adopted the necessary legislation and

- all involved authorities should have determined together the regime applicable to the site after the burial.

If rendering or any other centralised processing is the preferred option:

- the Veterinary Service should have the authority to require the necessary capacity at the processing company and to determine priorities,

- national and local governmental organisations regulating these types of processing should have agreed with the increased production volumes and other related consequences beforehand and should have covered the legal aspects and

- all involved authorities should have determined on the conditions applicable to the products from these carcasses.

It might happen that the chosen option for carcass disposal has to be applied near the border of a neighbouring country. In such cases the competent authorities of this country should be consulted and common legal solutions should be found in order to prevent misunderstanding and conflict.

If there is insufficient capacity in the country for processing of carcasses and if other options for carcass disposal are also limited, a solution could be the processing in another country. However, when an outbreak of an infectious animal disease occurs in a country, governments take preventive measures against import of potentially infected animals and products from the infected region. Those measures will also prevent the importation and transport of carcasses to a processing plant. If the export option is the choice, the conditions should be well established between the two involved countries and all legal aspects cleared beforehand. It should be realised that strong opposition can be expected from the farming community in the importing country against such transports. An agreement and preparation of the necessary legal aspects in peace time will help to apply this solution rapidly when it is needed. Clear communication about the process to be followed will help to elicit public support.

Pre-outbreak activities

The decision to embark on the mass destruction and disposal of animals in the event of a major disease outbreak or the mass disposal of animals in the event of natural disasters such as floods, and the implementation of the decision, need often to be taken in a short limit of time and activities to execute the decision, must similarly proceed with the minimum delay. The success or failure however, is primarily determined by the structures, policies and infrastructure that were established and agreed upon well in advance of such an event within contingency plans and working relationships and responsibilities established in preparation with other supportive structures.

- *Technical preparedness* – implies a predetermined decision process enunciated in a document, training of staff in the technical aspects of applicable technologies and the development of instructional manuals such as standard~~standing~~ operating procedures (SOP's) for events of disposal. The sensitivity and public scrutiny on the process of carcass disposal requires that a trained and competent official must be available on site. Such an official must be familiar with procedures to conduct the chosen technologies for carcass disposal.

- *Financial preparedness* - the factors of a compensation or insurance mechanism to assist affected producers; access to emergency funding permitting rapid and effective action; and access to an expanded human resource through agreements with private veterinarians, are considered critical to the success of the program. To be effective, these factors must be considered, resolved and in place prior to a disease occurrence. Transparency on the criteria for compensation and the minimum delay in the execution of payments are critical factors to ensure cooperation from affected farmers.

- *Pre-established partnerships* - a relationship with industry is essential to obtain compliance with animal health policies. Partnerships should not only include farmer associations or commodity representatives but also animal welfare organisations, supportive structures such as security services, disaster management units within government structures, the media and consumer representative groupings. This relationship is encouraged and essential to enhance the receptivity to future risk communications. In some countries tourism is a very significant contributor to the national economy and can be adversely affected by animal disposal and emergency operations.

- *Communication plan* - the *Veterinary Administration* must accept that the information on any event of mass culling and disposal of animals cannot and should not be withheld from public scrutiny. Sharing the information based on scientific facts on an ongoing basis is essential. Information sharing with politicians and the media is especially important but information sharing with officials involved in the outbreak, affected farmers and professional organizations is equally essential but often neglected or forgotten. A well informed and knowledgeable spokesman should be available at all times to answer questions from the media and the public. Consistency in the information given is essential and should be guided by an available set of pre-empted well debated questions and answers that should be daily updated. An essential pre-requisite is to ensure ownership by politicians for the policies applied for the mass destruction and disposal of animals to contain a disease outbreak. The support by politicians should already be established in policy formulation and budgetary processes by the *Veterinary Administration* of the Member Country.

- *Equipment* – a supply of essential emergency equipment should be available immediately while contracts with rendering plants should be established as a default standing arrangement. The management of equipment should include provisions for expansion, temporary storing facilities, transport, and transport on farm, drivers, disinfection, mobile handling facilities for animals such as mobile crush-pens, protective and disposable material and logistical support. Procurement procedures should be simplified and special authorizations provided for the operation to enable the minimum delay in obtaining essential equipment and to supplement or replace existing equipment. Equipment would also include the type of burning material used for pyre burning of carcasses. In some countries sufficient wood would still be available but usage thereof is subject to environmental legislation and environmental concerns. Old vehicle tyres are a cheap and readily accessible alternative to wood but could be a source of environmental pollution and should only be used if sanctioned by applicable local or national legislation. The prior identification of sources of burning material are therefore essential so that it could be obtained with the minimum loss of time and effort when needed.

- *Transport arrangements* – The transport needed during mass disposal of animals are generally not included in the normal stock of vehicles of a *Veterinary Administration.* Heavy trucks, tractors, bulldozers, front-end loaders and the like, are all types of vehicles needed for transport of animals, collection of burning material, filling and closure of disposal sites and transport from the farm to a disposal site. It is important to ensure that the vehicles used do not pose a source for dissemination of the infection.

Risk factors

The list of risk factors has not the pretension to be complete. Other risk factors may influence the choice of a technique for carcass disposal as well.

- ***Speed*** - early detection of new infections, immediate killing of infected animals and rapid removal of the carcasses with inactivation of the pathogen are of utmost importance for the eradication of infectious diseases. Viral pathogens will not further multiply after the host is killed, but active and passive spread of the pathogen from the carcasses and their surroundings should be blocked as soon and as effectively as possible.

- ***Occupational health safety*** - carcasses in decomposition soon become a health risk for the persons who have to handle them during the process of disposal. Disposal should be organised in such a way that the workers are safeguarded against the risks of handling decomposed dead bodies. However special attention should be given to zoonotic aspects of certain pathogens as for instance avian influenza. Workers should be sufficiently protected against infection with a zoonotic pathogen (protective clothing, gloves, face masks, spectacles, vaccination, anti viral medicines, regular health checks).

- ***Pathogen inactivation*** - the chosen disposal procedure must give optimal safety as regards to the inactivation of the pathogen. If this cannot be achieved instantly, the spreading of the pathogen from the process should be blocked. Scientific information about the reduction of the pathogenic agent over time under the expected climatological conditions for any of the technologies should be the basis for the lifting of restrictions for the products or sites

- ***Environmental concerns*** - the different technologies for carcass disposal have different effects on the environment. For instance pyre burning will produce smoke and smells; burial might lead to gas production; escape of these gases and as a result smell; but also risk of contamination of air, soil, surface and sub surface water. Increased operating hours or increased throughput in a rendering plant may lead to increased smell or disturbances in the normal functioning of the waste water treatment and other protective facilities of the plant.

- ***Availability of capacity*** - practically all the technologies for carcass disposal have limitations on capacity. When the number of carcasses to be disposed of is high, the capacity of the acceptable technologies will soon be the bottle neck. An assessment of possibilities and capacities in peace time is very important to be able to take quick decisions in case of emergency. Temporary storage of carcasses in cold stores under conditions preventing cross-contamination could sometimes relieve the lack of processing capacity.

- ***Cost*** - technologies for carcass disposal and specially those using sophisticated equipment are very costly. Budgetary provisions should be made for emergencies. When the Veterinary Service during a disease outbreak seeks the cooperation of private companies offering the needed capacity, the costs might escalate tremendously. Therefore it is necessary to negotiate a contract in peace time with those suppliers about capacities and costs when preparing a strategy for eradication.

- ***Public reaction*** - carcass disposal can easily lead to adverse reactions from the public when pictures of half burned or hoisted carcasses are shown on TV or in press. Urbanised populations estranged from rural practices will react often very emotionally on these images. In poorer countries the destruction of valuable meat of not yet sick animals may provoke public misunderstanding.

- ***Acceptance by farmers*** - the owners of an infected farm will in general prefer technologies at a distance and not on their own farm. Farmers outside an infected zone will prefer disposal within the infected area. All farmers will be very sensitive with regard to the safety measures taken to prevent spread of the disease by the used technology and the transport of the carcasses to the processing plant or disposal site. Proper compensation of owners for the loss of their animals or for the disposition of burial or burning sites will improve acceptability.

- ***Transport*** - for the application of all technologies for disposal, cranes, shovels and trucks must be used to transport the carcasses. This equipment can transfer the infection to other farms. Cleaning and disinfection of the outside surfaces of these vehicles when leaving an infected premise should receive special attention. The hygiene of the driver, his cabin, his lockers and his clothing and footwear should also be part of this process. The trucks transporting carcasses should be leak proof and be completely covered in order to prevent spread of the pathogen from the truck. The Veterinary Service should supervise the departure of the vehicle from the farm, the route the transport passes and the arrival at the disposal plant or site.

- ***Wildlife*** - many infectious diseases can affect wild animals as well as domesticated animals. Sometimes farm animals become infected through contact with game, but the population of wild animals might also become infected from an outbreak of a disease on a farm. When disposing of carcasses full attention should be given to the prevention of contamination of wildlife. Predators could try to get access to dead carcasses which might cause active or passive spread of the infection to other wild or domesticated animals.

Social factors related to carcass disposal

Culling and destroying of animals for the eradication of infectious disease often produce vehement reactions from the public. Reactions can be expected from the owners of animals which have to be culled, from farmers who are scared that their animals might contract the disease, animal welfare advocates who try to protect the lives of animals, people who abhor pictures of the culling of animals and the transport, burning and burial of carcasses, organisations who fight for environmental protection, culling perceived as a waste of edible food, etc.

In general a stamping out policy is applied to defend the export interests of the animal husbandry industry and is economically motivated. However, in some countries the general public and politicians express their doubts or their opposition against economical reasons as the leading argument to apply this strategy.

Even not all farmers will support the economic necessity of stamping out. For many farmers the rapid regaining of export markets is of no interest. Animals often represent a much more important and differentiated value than pure economics. For an animal breeder his animals represent a professional achievement based on the skills of himself and his ancestors. Many hobby farmers consider their animals as personal companions. In traditional communities animals are kept not for production but for a variety of reasons like a beast of draught or burden, for ceremonial reasons or as a symbol of wealth. For some religions the killing of certain animals is not acceptable. The export related economic argument will fail to convince such owners of the need for culling especially when animals, not showing any symptoms of disease but identified as carriers or serological positive, are included in the culling operation. Loss of certain animals cannot be compensated financially.

Practical considerations

In addition to the risk factors and pre-outbreak activities identified above, several practical issues, often not considered or often accepted as obvious but not attended to, need to be noted. The list is not exhaustive but gives an indication of some of the easily forgotten but essential considerations:

- ***Selection of disposal site*** – sufficient top soil to cover the site; water drainage; prevailing wind conditions; easy access to transport; availability of meteorological data; separation from sensitive public sites.

- ***Selection of contractors for transport –*** availability; can they supply in all the needs; exclusive use of vehicles or would they also be used for other purposes (risk of disease transmission); access to available roads; suitable for the purpose to be used.

- ***Logistical preparedness for the appropriate technology*** – availability of burning material (wood, old tyres); sufficient manual labour available; sites and availability of disinfection tents for personnel; storage and disposal of protective clothing; housing for personnel to prevent them from going back to home and spread infection; facilities for entry and exit control; availability of electricity for night operations; personal facilities for personnel such as toilets, drinking water; availability of communication – mobile phone reception; protection (eg vaccination) of personnel; rendering capacity at rendering plants; arms and ammunition, additional cold storage and holding facilities at rendering plants and abattoirs; availability of freezing facilities before rendering.

- ***Procedures and policies for disposal of other products*** – manure, eggs; milk; non-animal products; animal feed.

- ***Wildlife*** – do they pose a risk in the immediate environment; expertise availability for culling of wildlife; availability of capture teams?

Recommended technologies for the disposal of carcasses

These technologies are presented as a hierarchy based on their reliability for pathogen inactivation.

- ***Rendering -*** This is a closed system for mechanical and thermal treatment of animal tissues leading to stable, sterilized products, e.g. animal fat and dried animal protein. It grinds the tissue and sterilizes it by heat under pressure. The technology exists in fixed facilities and is in normal usage. It produces an effective inactivation of all pathogens with the exception of prions where infectivity is reduced. A medium sized rendering plant could process 12 tonnes per hour of operations. The availability of the capacity should be determined in advance. Such a plant can operate within environmental standards.

- ***Incineration -*** This technology can be applied as:

    - Fixed, whole-carcass incineration,
    - Mobile air curtain whole carcass incineration,
    - Municipal incinerators,
    - Co-incineration

    Fixed whole carcass incineration occurs in an established facility in which whole carcasses or carcass portions can be completely burned and reduced to ash. Effective inactivation of pathogens is produced. Without additional technology, the exhaust emissions are not subjected to environmental control. However these emissions can be subjected to air scrubbing procedures to meet environmental standards. Fixed facility incineration has been used to dispose of BSE infected

carcasses, as well as rendered meat-and-bone meal (MBM) and tallow from cattle carcasses considered to be at risk of BSE. Fixed facility incineration is wholly contained and usually highly controlled. It is typically fuelled by diesel, natural gas, or propane. The exhausts may be fitted with afterburner chambers to completely burn hydrocarbon gases and particulate matter from the main combustion chamber. Whole carcass disposal can be problematic given the batch-feed requirements at most biological waste incineration plants. Many waste incineration facilities refuse whole animals which are 70% water, but prefer waste of 25% water. Therefore, combining rendering and incineration is a promising approach. The resultant ash is less problematic and is considered safe. Although this is a more controlled procedure, there is still a potential fire hazard.

Municipal incinerators are pre-established facilities which are normally used for the burning of household or industrial waste. They may not be currently licensed to burn carcasses.

Co-incineration is a process in which meat and bone meal, carcasses or parts of carcasses are burned in conjunction with other substances such as hazardous waste incineration, clinical waste incineration, and other industrial incinerations such as power plants, cement kilns, blast furnaces and coke ovens. In practice meat and bone meal has been used as a secondary fuel on a large scale in cement kilns and power plants.

Air curtain incineration - air curtain incineration involves a machine that fan-forces a mass of air through a manifold, thereby creating a turbulent environment in which incineration is accelerated up to six times faster than open-air burning. The equipment for this process can be made mobile which can be taken on-site but the potential fire hazard must be considered. Because it can be used on site, there is no requirement for transportation of the animal material. It also produces effective inactivation of pathogens and may actually achieve higher temperatures (1000 ^{0}C). Fuelled by diesel engines, high velocity air is blown into either a metal refractory box or burn pit. The materials required are wood (in a wood:carcass ratio of from 1:1 to 2:1), diesel fuel for both the fire and the air-curtain fan, and properly trained personnel. For incineration of 500 adult swine, the requirements are 30 cords of dry wood and 200 gallons of diesel fuel. The product is ash. Since the procedure is not wholly contained, it is subject to variable factors such as human operation, weather, and local community preferences.

Pyre burning - this is an open system of burning carcasses either on-farm or in collective sites fuelled by additional materials of high energy content. This is a well established procedure that can be conducted on site with no requirement for transportation of the input material. However, this process could be contrary to environmental standards for air, water and soil. It takes an extended period of time and has no verification of pathogen inactivation. In fact, there is a possibility of particulate transmission from incomplete combustion. Further, because the process is open to view, there is a negative reaction and lack of acceptance by the public.

Comparison of incineration methods

With all three incineration methods described above, the greater the percentage of animal fat, the more efficiently a carcass will burn. (Swine have a higher fat content than other species). For fixed facility incinerators, the capacity depends on the chamber's size and can range from 50 kg / hour up to 10 tonnes of poultry carcasses / day. Preprocessed, relatively homogeneous carcass material is more easily handled than large numbers of whole animal carcasses. Depending on the design and on-site management, air-curtain incinerators can burn 4 - 6 tons of carcasses / hour.

- ***Open-air burning*** can be relatively inexpensive, but it is not suitable for TSE infected carcasses. It is labour and fuel intensive, and dependent on favourable weather. It has environmental problems and a poor public perception. It is generally accepted that open-air burning pollutes. Although this is dependent on a number of factors. This may be more perception than established fact. Open air burning can also pose significant public perception, psychological, and economic problems

- ***Fixed facility incineration*** destroys TSE infected carcasses and is highly biosecure. However it is expensive and difficult to operate and manage from a regulatory perspective. Properly operated fixed facility incineration pose fewer pollution concerns

- ***Air-curtain incineration*** is mobile, usually environmentally sound, and suitable for combination with debris removal. However it is fuel intensive, logistically challenging, and is not validated to dispose of TSE infected carcasses. Air curtain technology in general has been shown to cause little pollution with fire boxes burning cleaner than trench burners. It has higher combustion efficiencies with less carbon monoxide and particulate matter emissions.

- ***Composting -*** carcass composting is a natural biological decomposition process that takes place in the presence of oxygen. In the first phase, the temperature of the compost pile increases, organic materials break down into relatively small compounds, soft tissue decomposes, and bones soften partially. In the second phase, the remaining materials, mainly bones, break down fully to a dark brown or black humus containing primarily non-pathogenic bacteria and plant nutrients.

  Composting systems require a variety of ingredients including carbon sources, bulking agents and biofilter layers. Carbon sources can include materials such as sawdust, straw, cured cornstalks, poultry litter, ground corn cobs, wheat straw, hay, shavings, paper, leaves, vermiculite, and matured compost. A 50:50 mixture of separated solids from manure and a carbon source can be used as a base material for carcass composting. The finished compost retains nearly 50% of the original carbon source which can be recycled in the compost process. A carbon:nitrogen (C:N) ratio in the range of 25:1 - 40:1 generates enough energy and produces little odour during the composting process. As a general rule the weight of carbon source materials to mortalities is approximately 1:1 for high C:N materials such as sawdust, 2:1 for medium C:N materials such as litter and 4:1 for low CN materials such as straw.

  Bulking agents have bigger particle sizes than carbon sources and maintain adequate air spaces (around 25-35% porosity) within that compost pile by preventing packing of materials. Bulking agents include spent horse bedding, wood chips, rotting hay bales, peanut shells, and tree trimmings. The ratio of bulking agents to carcasses should result in a bulk density of the final compost mixture that does not exceed 600 Kg/m^3. The weight of the compost mixture in a 19 litre bucket should not be more than 11.4 kg.

  A biofilter is a layer of carbon source or bulking material that enhances microbial activity with proper moisture, pH, nutrients, and temperature. It deodorizes gases released at ground level and prevents access by insects and birds thus minimizing transmission of disease agents.

  The site selection criteria include a well drained area at 90 cm above the high water table level, at least 90 metres from sensitive water resources, and an adequate slope (1-3%) to allow proper drainage and prevent pooling of water. Runoff should be collected and treated. The location should be downwind of nearby residences. The site should have full accessibility but have minimal

interference with other operations and traffic. Storage time of mortalities should be minimized. Co-composting materials should be ground to 2.5 - 5.0 cm and mixed. Compost materials should be lifted and dropped rather than be pushed into place. Compost piles should be covered by a biofilter layer during both phases of composting. The moisture content of the carcass compost pile should be 40-60% (wet basis).

A temperature probe should be inserted straight down into each quadrant of the pile and internal temperatures should be monitored daily and weekly during both phases of composting. During the first phase, the temperature at the core of the pile should rise to at least 55-60°C within 10 days and remain there for several weeks. A temperature of 65°C at the core, maintained for 1 - 2 days, will reduce pathogenic bacterial activity and weed seed germination. However spore formers such as *Bacillus anthracis* and other pathogens such as *Mycobacterium tuberculosis* will survive. Proper aeration is important in maintaining uniform temperature and moisture content throughout the pile. After the first phase of composting, the volume and weight of the pile may be reduced by 50-75%. Following the first phase, the entire compost pile should be mixed, displaced and reconstituted for the secondary phase. If necessary, moisture can be added.

The end of the second phase is marked by an internal temperature of 25-35°C, a reduction in bulk density of approximately 25%, a colour of dark brown to black and the lack of an unpleasant odour. Although heat generated during carcass composting results in some microbial destruction, it is not sufficient to completely sterilize the end product. Pathogenic bacterial activity is reduced when the temperature in the middle of the pile reaches 65°C within one to two days. An average temperature of 55-60°C for a day or two reduces pathogenic viruses, bacteria, protozoa (including cysts) and helminth ova to an acceptably low level, but endospores produced by spore-forming bacteria would not be inactivated.

- ***Trench burial and mass burial -*** this is a system to deposit whole carcasses below ground level and to be covered by soil, with no additional inactivation of pathogens. It is an established procedure which if conducted on site does not require transportation and is used to control the spread of disease. It does however require an environmental assessment because of the potential contamination of groundwater, or of aquifers if leachate is not controlled. Further, it does not inactivate all pathogenic agents.

- ***Licensed commercial landfill -*** this process involves deposition of carcasses in predetermined and environmentally licensed commercial sites. Because the site has been previously licensed, all environmental impacts such as leachate management, gas management, engineered containment, flooding and aquifers have already been considered. However, the area is open and uncovered for extended periods, there is a potential emission of aerosols, and there is resistance from the public to such an approach.

- ***Mounding -*** this process is one of mass burial above ground and it has similar considerations to those of mass burial and composting.

- ***Fermentation -*** this process is a closed system of anaerobic microbiological decompositions which requires prior mechanical and thermal treatment and which results in the production of biogas. This process does not inactivate pathogens, but typically uses non-dried rendered product as the input material.

- ***Alkaline hydrolysis -*** alkaline hydrolysis uses sodium hydroxide or potassium hydroxide to catalyse the hydrolysis of biological material into a sterile aqueous solution consisting of small peptides, amino acids, sugars, and soaps. Heat is applied (150°C) to accelerate the process. The only solid byproducts are the mineral constituents of the bones and teeth of vertebrates. This residue (2% of the original weight of the carcass) is sterile and easily crushed into a powder. The temperature and alkali conditions of the process destroy the protein coats of viruses and the peptide bonds of prions.

Both lipids and nucleic acids are degraded. Significantly large carbohydrate molecules, such as cellulose, although sterilized by the process, are not digestible by alkaline hydrolysis e.g. paper, string, undigested plant fibres, and wood shavings.

The process is carried out in an insulated steam-jacketed, stainless steel pressure vessel with a sealed lid. The vessel operates at 70psig to achieve 150°C. The process does not release any emissions into the atmosphere and only causes minor odour production. The end product solution can be released into the sanitary sewer with proper monitoring of pH and temperature according to guidelines. The total process time for alkaline hydrolysis digestion of carcass material is 3-8 hours depending on the disease agent eg bacterial and viral contaminated waste (4 hours), transmissible spongiform encephalopathy waste (6 hours). A mobile trailer unit has a capacity of digesting 4000 pounds of carcasses every 8 hours.

- ***Lactic acid fermentation*** - lactic acid fermentation is a means to preserve carcasses up to 25 weeks until they can be rendered. Fermentation is an anaerobic process. Carcasses are ground to fine particles, mixed with a fermentable carbohydrate source and a culture inoculant, and added to a fermentation container. For lactic acid fermentation, lactose, glucose, sucrose, whey, whey permeates, and molasses are suitable carbohydrate sources. The carbohydrate source is fermented to lactic acid by *Lactobacillus acidophilus*.

  Under optimum conditions with a temperature of about 35°C, the pH of fresh carcasses is reduced to less than 4.5 within two days. Some microorganisms are destroyed by the acid pH while the remainder will be destroyed by heat during rendering.

- ***Anaerobic digestion*** - this process is suited for large-scale operations. It reduces odours and reduces pollution by greenhouse gases due to the combustion of methane. It can eliminate carcasses and at the same time produce energy but may require size reduction and sterilization of carcasses on-site before applying anaerobic technology. Anaerobic digestion transforms waste into fertilizer. Although anaerobic digestion is less expensive with mesophilic organisms at 35°C, the use of thermophilic organisms at 55°C is preferred because the additional heat destroys some pathogens. It is necessary to use additional heat treatment at the end of the process to fully inactivate pathogens however, even with this, prions are not inactivated. Carcasses have a higher nitrogen content than most other wastes and therefore result in a high ammonia concentration which can inhibit anaerobic digestion. This limits the loading rate for anaerobic digesters that are treating carcass wastes.

Non-traditional and novel technologies

- ***Pre-processing*** - this involves on farm pre-processing prior to transportation of carcasses to central facilities because of the complexity and cost (e.g. rendering or incineration). Preprocessing could include the grinding of carcasses. (A large portable grinder can grind up to 15 tons of animal carcasses per hour). This could then be transported in sealed containers, or be subjected to fermentation or freezing. The primary objectives are to minimize on-site contamination risks and to maximize the number of options for disposal.

- ***Carcass disposal at sea -*** disposal in a coastal sea or on a continental plateau cannot occur without the authorization of the coastal State which must make a regulation on the dumping and which must consult with other neighbouring States. International Conventions express a fundamental principle which countries should be obliged to respect even if they are not signatories. These Conventions do not directly prohibit disposal of carcasses at sea, but do define the conditions to be met. It is possible for this disposal if it is technically and scientifically proven that the products to be disposed are not harmful, and if the State has authorised this disposal with a permit.

- ***Bio-refining*** - this is a high pressure, high temperature hydrolytic process, conducted in a sealed pressurized vessel. The waste material is treated at 180 ^{o}C at 12 bar pressure for 40 minutes, heated by indirect steam application to the biolytic reactor. The process can accommodate whole animal carcasses, MBM, food processing wastes, other compostable material, paper and comparable materials, and cereal straws either alone or in combination. In the dehydration cycle, the steam water is condensed and either used for other purposes or discarded. Each cycle lasts four hours. The capacity of each reactor is 20,000 tonnes of raw material per year. The process inactivates all microbiological agents. It is currently under evaluation for its efficiency in inactivating the prions of transmissible spongiform encephalopathies.

Special considerations for prion diseases

One of the problems in demonstrating the effectiveness of the inactivation of prions is the lack of a simple, rapid and inexpensive test for the presence of the infective agent, especially at low concentrations. The ultimate test is bioassay in a sensitive detector species by an efficient route, but usually this is only relevant in research. Typically this is done using panels of mice bred to be susceptible to particular types of transmissible spongiform encephalopathies (TSEs). However it must be recognized that the mouse to cattle species barrier has been demonstrated to be 500, therefore affecting sensitivity.

Although rendering at 133^{0}C and three bars of pressure for 20 minutes is a defined standard, reductions of infectivity by this technology are in the order of 1:200 – 1:1000. Commercial incinerators have an inactivation rate of one million fold, while burning on pyres has a reduction rate of 90 %. (It should be noted that pyres are not suitable for sheep because of the wool and fat.) Alkaline hydrolysis produces a 3-4 log reduction in infectivity over a three hour period. Landfill and deep burial are suggested to have a reduction in infectivity of 98 – 99.8 % over three years. Based on this information, rendering, incineration, and alkaline hydrolysis are the most reliable technologies at this time. The significance of small amounts of infectivity become evident when you consider that experimentally it has been shown that exposure of sensitive species to as little as 1.0, 0.1 or even 0.01 grams of infected nervous tissue can induce infection.

Given all of the above (except complete burning in closed furnaces), it must be recognized that no process has been demonstrated to be 100 % effective in removing TSE infectivity and there will be some residual levels of infectivity remaining after treatment.

Guidelines for decision-making for the disposal of carcasses

Strategies for carcass disposal require preparation well in advance of an emergency in order to maximize the efficiency of the response. Major issues related to carcass disposal can include the number of animals involved, bio-security concerns over movement of infected and exposed animals, people and equipment, environmental concerns, and the extreme psychological distress and anxiety experienced by producers and emergency workers.

The disposal of large numbers of carcasses will be expensive. As well, fixed and variable costs will vary with the choice of the disposal method. Each method used will result in indirect costs on the environment, local economies, producers, and the livestock industry. Decision makers need to understand the economic impact of various disposal technologies.

A disposal option hierarchy may be incapable of fully capturing and systematizing the relevant dimensions at stake, and decision makers may be forced to consider the least preferred means. It therefore requires a comprehensive understanding of any array of carcass disposal technologies and must reflect a balance between the scientific, economic, and social issues at stake. Timely slaughter, maintenance of security and prevention of further spread of disease, are the essential considerations in terms of disease control.

- ***Process for decision- making***:

The following is an example of a possible process for aiding decision-making by comparing the suitability of various disposal options against factors that are considered important for the specific disposal event in question.

Step 1 - Define the factors to be considered. Include all relevant factors and allow enough flexibility to permit modifications for different situations and locations. Examples of possible factors include operator safety; community concerns; international acceptance; transport availability; industry standards; cost effectiveness and speed of resolution. These factors can be modified or changed, as is shown in the following example, to best fit the situation of event involved.

Step 2 - Assess the relative importance of the factors by weighting each on their considered importance to addressing the event in question. The sum of all the weightings, regardless of the number of factors, must total 100.

Step 3 - Identify and list all disposal options under consideration. Rate each disposal option against each factor and assign a Utility Rating of between 1 to 10 to each comparison. The Utility Rating (U) is a number between 1 and 10 which is allocated according to how well the option achieves the ideal with respect to each factor, (e.g. 1 = the worst possible fit, and 10 = the best fit).

Step 4 - For each factor and each disposal option, multiply the Factor Weight (F) x Utility Rating (U) to yield a numeric Balanced Value (V), (e.g. V = F x U)

Step 5 -By adding the Balanced Values to a sum for each disposal option, it is possible to compare the suitability of disposal options by numerically ranking the sums of the Balanced Values for each disposal option. The largest sum would suggest that disposal option as the best balanced choice.

Example - An example of the use of this process follows in Table 1. In this example rendering achieved the highest sum and would be considered as the best balanced choice and the most suitable disposal option for the factors considered.

Table 1: **Decision Making Process**

Method		Rendering		Fixed Incineration		Pyre Burning		Composting		Mass Burial		On-Farm Burial		Commercial Landfill	
	Weight	Utility	Value	Utility	Value	Utility	Value	Utility	Value	Utility	Value	Utility	Value	Utility	Value
Factors															
Operator Safety	20	7	140	4	80	8	160	3	60	7	140	8			
Speed of Resolution	20	8	160	8	160	2	40	5	100	5	100	6			
Pathogen Inactivation	15	10	150	10	150	8	120	5	75	4	60	4			
Impact on Environment	10	10	100	8	80	3	30	10	100	3	30	3			
Reaction of the Public	10	10	100	7	70	1	10	9	90	3	30	4			
Transport Availability	5	1	5	1	5	8	40	5	25	3	15	8			
Acceptable to Industry	5	7	35	7	35	7	35	7	35	6	30	7			
Cost	5	4	20	1	5	6	30	9	45	8	40	9			
Risk to Wildlife	5	10	50	10	50	5	25	4	20	5	25	5			
Capacity to Meet Requirements	5	5	25	3	15	9	45	9	45	9	45	9			
Total Weight to Equal 100 Units	100	sum	785	sum	650	sum	535	sum	595	sum	515	sum		sum	