

Report on
the Assessment of
the Geographical BSE-Risk
(GBR) of
CANADA
July 2000

NOTE TO THE READER

Independent experts have produced this report, applying an innovative methodology by a complex process to data that were voluntarily supplied by the responsible country authorities. Both, the methodology and the process are described in detail in the final opinion of the SSC on "the Geographical Risk of Bovine Spongiform Encephalopathy (GBR)", 6 July 2000. This opinion is available at the following Internet address:

<http://europa.eu.int/comm/food/fs/sc/ssc/out113_en.pdf>

In order to understand the rationale of the report leading to its conclusions and the terminology used in the report, it is highly advisable to have read the opinion before reading the report. The opinion also provides an overview of the assessments for another 24 countries.

P A R T I

Description of the method and its
limitations, and definitions and
process used for assessing the GBR
of CANADA

1. INTRODUCTION

The Geographical BSE-Risk (GBR) is a qualitative indicator of the likelihood of the presence of one or more cattle being infected with BSE (Bovine Spongiforme Encephalopathy), pre-clinically as well as clinically, at a given point in time, in a country. Where its presence is confirmed, the GBR gives an indication of the level of infection.

This opinion describes a transparent methodology that the Scientific Steering Committee (SSC) has developed, over about two years, to assess the GBR for any country that provides the information required for the assessment. This methodology is limited to bovines and feed based transmission of BSE. It does not take into account any other initial sources of BSE than the import of infected cattle or contaminated feed. It is assumed that the disease first appeared in the UK from a still unknown initial source. An important characteristic of the methodology is that it does not depend on the confirmed incidence of clinical BSE, which is sometimes difficult to assess due to serious intrinsic limitations of surveillance¹ systems. The other advantage of this methodology is that it allows an easy identification of possible additional measures that in a given situation may improve the ability of a country to cope with BSE.

The qualitative nature of this methodology and its limitations should be understood in the context of present scientific knowledge on BSE and of the availability and quality of data. As they both evolve, and with the possible advancement of diagnostic methods, the need may arise for the methodology to be revised and/or its application to particular countries to be repeated.

In parallel with the work of the SSC, the OIE (Office International des Epizooties) has developed further the BSE-chapter in its Animal Health Code, which makes reference to risk analysis as an integrated part of the procedure to establish the BSE-status of countries or zones. The compatibility of the OIE approach and the SSC methodology for assessing the GBR is extensively discussed in this opinion.

The present opinion also describes the highly interactive procedure through which the methodology has been applied to those countries that have submitted information and data so far, and the results of this application.

The SSC wants to underline that its main task is to assess whether the presence of one or more infected cattle in a given country is « highly unlikely », « unlikely, but not excluded », « likely, but not confirmed », or « confirmed at lower or higher level » and what the future trend might be. In making this assessment, the SSC has used a reasonable worst-case approach (i.e. a conservative approach) every time data availability was insufficient.

¹ Surveillance should be understood as the process of identifying BSE-cases and animals at risk of being infected.

It should be clear that the GBR has no direct bearing on human exposure to BSE. In fact, at a given GBR, the risk that food is contaminated with the BSE agent depends on three main factors:

- the likelihood that infected bovines are processed;
- the amount and distribution of infectivity in BSE-infected cattle at slaughter; and
- the ways in which the various tissues that contain infectivity are processed.

Also the risk that animals are exposed to the BSE agent is strongly influenced by a range of other parameters.

The SSC believes that decisions aimed at managing the BSE-risk are the responsibility of the authorities in charge and might need to take into account other aspects than those covered by this risk assessment.

2. THE GEOGRAPHICAL BSE-RISK (GBR) - METHODOLOGY AND PROCEDURE

2.1 DEFINITION OF THE GEOGRAPHICAL BSE-RISK (GBR)

The Geographical BSE-Risk (GBR) is a qualitative indicator of the likelihood of the presence of one or more cattle being infected with BSE, pre-clinically as well as clinically, at a given point in time, in a country. Where presence is confirmed, the GBR gives an indication of the level of infection as specified in the table below.

GBR level	Presence of one or more cattle clinically or pre-clinically infected with the BSE agent in a geographical region/country
I	Highly unlikely
II	Unlikely but not excluded
III	Likely but not confirmed or confirmed, at a lower level
IV	Confirmed, at a higher level

Table 1 - Definition of GBR and its levels

The SSC is well aware that the borderline between GBR level III and IV has to remain arbitrary, as no clear scientific justification can be provided for this differentiation. The SSC adopts for the time being the OIE threshold, i.e. an incidence of more than 100 confirmed BSE cases per million within the cattle population over 24 months of age in the country or zone, calculated over the past 12 months.

The SSC also agrees with the OIE (see also section 2.6 of this document) that, under certain circumstances, countries with an observed domestic incidence between 1 and 100 BSE-cases per million adult cattle calculated over the past 12

months, should be put into the highest risk level if, for example, there are clear indications that the true clinical incidence is in fact higher than 100 per million adult cattle calculated over the past 12 months.

Active² surveillance exercises in Switzerland (of adult cattle not notified as BSE or CNS suspect in fallen stock, emergency slaughter, and normal slaughter) and the UK (OTMS-survey³) both detected several confirmed BSE-cases that would have remained undetected by normal, passive⁴ surveillance, even if targeted at animals with neurological symptoms. The SSC therefore assumed that passive surveillance does not give a true estimate of the existing BSE-cases. The Swiss and UK results indicate that it is likely that passive surveillance, based solely on notification of symptomatic BSE-suspects, will not detect more than half or one third of all clinical cases, or even fewer. However, as long as it is impossible to detect pre-clinical cases in the early phases of the incubation period, active surveillance of apparently healthy animals younger than 24 months cannot be expected to improve the detection level.

At this stage it should be reiterated that the applied 4 GBR-levels are only used to illustrate in qualitative terms different risk levels. Each of these levels includes a range of different potential risks. This range is not considered in the current classification.

2.2 METHODOLOGY FOR ASSESSING THE GBR

2.21 Basic assumptions

The present application of the SSC-methodology for the assessment of the GBR is based on the assumption that BSE arose in the United Kingdom (UK) and was propagated through the recycling of bovine tissues into animal feed. Later the export of infected animals and infected feed provided the means for the spread of the BSE-agent to other countries where it was again recycled and propagated via the feed chain.

For all countries other than the UK, import of contaminated feed or infected animals is the only possible initial source of BSE that is taken into account. Potential sources such as a spontaneous occurrence of BSE at very low frequency or the transformation into BSE of other (animal) TSEs (scrapie, CWD, TME, FSE⁵) being present in a country are not considered, as they are not scientifically confirmed.

² Active surveillance = testing of cattle that are not notified as BSE-suspects but belong to risk sub-populations.

³ OTMS=Over Thirty Months Scheme. This scheme excludes all cattle older than 30 months from the animal feed and human food chain. The survey involved sampling about 3000 cattle older than 60 months and which did not show any symptoms compatible with BSE and found 18 BSE-cases.

⁴ Passive surveillance = surveillance of notified BSE-suspects, i.e. cattle that are notified because of clinical signs compatible with BSE.

⁵ TSE=Transmissible Spongiform Encephalopathy; CWD=Chronic Wasting Disease; TME=Transmissible Mink Encephalopathy; FSE=Feline Spongiform Encephalopathy

The only transmission mode considered in the model is feed. Contaminated feed is taken as the only possible route of infection because epidemiological research showed clearly that the origin and maintenance of the BSE epidemic in the UK was directly linked to the consumption of infected meat and bone meal by cattle. Blood, semen and embryos are not seen to be effective transmission vectors⁶. Accordingly, blood-meal is not taken into account, neither.

During the assessment, it became obvious from different sources that cross-contamination of MMBM⁷-free cattle feed with other feeds that contain such ingredients can be a way of propagating the disease. Therefore, it is important to understand that, as long as feeding of MMBM, BM (Bone meal) or Greaves to other farmed animals is legally possible, cross-contamination of cattle feed with animal (ruminant) protein can not be eliminated. Dedicated production lines and transport channels and control of the use and possession of MMBM at farm level would be required to fully control cross-contamination. It should be clear that any cross contamination of cattle feed with MMBM, even well below 0.5%, represents a risk of transmitting the disease⁸. However, the influence of cross-contamination on the GBR has to be seen in the light of the risk that the animal protein under consideration could carry BSE-infectivity.

In the light of the qualitative nature of the exercise, its relatively lesser importance in comparison to feed, and the lack of final scientific confirmation of its existence, the possible impact of maternal transmission on the GBR has not been taken into account⁹ in this methodology.

Similarly no "third route of transmission" was taken into account. The existence of a third mode of transmission of BSE, in addition to feed and vertical transmission, such as horizontal transmission via the environment, cannot be excluded. However, to date there is no scientific evidence for such a third potential mode of transmission¹⁰. The assessment also does not take into account the possibility that sheep and goats may have become infected with BSE¹¹.

The present GBR risk assessments (see chapter 3 and annex III) are only addressing entire countries and national herds. This is because of the limited availability of detailed, regionalised data. The SSC does not discount the issue of regional differences, for example in the types of animal husbandry e.g. dairy or beef, of feeding or of slaughtering ages. If complete data sets were to be provided on a regional scale, i.e. clearly relating to a defined geographical area, these could be assessed in the same way as data referring to entire countries.

⁶ See SSC-opinion on vertical transmission, 18-19 March 1999 and on the safety of ruminant blood (13/14 April 2000)

⁷ MMBM = Mammalian MBM

⁸ In its opinion on cross-contamination (n° 12 in annex I) the SSC already expressed this position.

⁹ There are statistical indications that the disease may be vertically transmitted from dam to calf. It was statistically shown that the risk of maternal transmission occurring is higher if the calf was born within 6 months before the onset of the clinical signs in the dam. Offspring cull and assurance that the dam has survived without BSE for at least six months after calving will thus provide a certain degree of assurance that its offspring is safe (see Opinions N°s 2, 4, 23, 24 and 30 listed in Annex 1).

¹⁰ See SSC-opinions N°s 4, 23, and 30 listed in Annex 1

¹¹ See SSC opinion on the risk of infection of sheep and goats with BSE, 24/25 September 1998

2.22 Information factors and model of the BSE cattle system

The methodology is based on information on 8 factors that were originally identified by the SSC in January 1998. In table 2 the most relevant information is listed that was finally found to be important for carrying out the assessment.

<p><i>Structure and dynamics of the bovine population</i></p> <ul style="list-style-type: none"> - Number and age distribution of beef and dairy cattle, both alive and slaughtered - Husbandry systems, proportional to the total cattle population (beef/dairy, intensive/extensive, productivity of dairy cattle, co-farming of pig/poultry and cattle, geographical distribution of cattle and pig/poultry populations and of different husbandry systems)
<p><i>Surveillance of BSE</i></p> <p><u>Measures in place to ensure detection of BSE-cases:</u></p> <ul style="list-style-type: none"> - Identification system and its tracing capacity - Date since when BSE is compulsory notifiable and criteria for a BSE-suspect - Awareness training (when, how, who was trained) - Compensation (since when, how much in relation to market value, payment conditions) - Other measures taken to ensure notification of BSE suspects - Specific BSE-surveillance programs and actions - Methods and procedures (sampling and laboratory procedures) used for the confirmation of BSE-cases <p><u>Results of BSE-surveillance:</u></p> <ul style="list-style-type: none"> - Number of cattle, by origin (domestic/imported), type (beef/dairy), age, method used to confirm the diagnosis and reason why the animal was examined (CNS, BSE-suspect, BSE-related culling, other) - Incidence of reported BSE-cases by year of confirmation, by birth cohort of the confirmed cases, and – if possible – type of cattle
<p><i>BSE related culling</i></p> <ul style="list-style-type: none"> - Culling schemes, date of introduction & criteria used to identify animals that are to be culled - Information on animals already culled in the context of BSE
<p><i>Import of Cattle and MBM (Note: Semen, embryos or ova not seen as an effective transmission route. MBM is used as proxy for mammalian protein as animal feed)</i></p> <ul style="list-style-type: none"> - Imports of live cattle and/or MBM from UK and other BSE-affected countries - Information that could influence the risk of imports to carry the BSE agent (BSE-status of the herds of origin of imported cattle, precise definition of the imported animal protein, etc.) - Main imports of live cattle and/or MBM from other countries - Use made of the imported cattle or MBM
<p><i>Feeding</i></p> <ul style="list-style-type: none"> - Domestic production of MBM and use of MBM (domestic and imported) - Domestic production of composite animal feed and its use - Potential for cross-contamination of feed for cattle with MBM during feed production, during transport and on-farm, measures taken to reduce and control it, results of the controls
<p><i>MBM-bans</i></p> <ul style="list-style-type: none"> - Dates of introduction and scope (type of animal protein banned for the use in feed in different species, exceptions, etc.) - Measures taken to ensure and to control compliance - Methods and results of compliance control
<p><i>SBM-bans (SBM: Specified Risk Material, i.e. material posing the highest risk of infection)</i></p> <ul style="list-style-type: none"> - Dates of introduction and scope (definition of SRM, use made of SRM, exceptions from /target animals of the ban, etc.) - Measures taken to ensure and to control compliance - Methods and results of compliance control
<p><i>Rendering</i></p> <ul style="list-style-type: none"> - Raw material used (type: Slaughterhouse offal including SRM or not, other animal waste, fallen stock, etc.; annual amounts by type of raw material) - Process conditions applied (time, temperature, pressure; batch/continuous;) and their share of the annual total domestic production)

Table 2 – Information factors for assessing the GBR *Note: all information should be available for the period from 1980 onwards and be presented on an annual base. For the purpose of the GBR-assessment reasonable worst case assumptions have been used whenever the information was not complete.*

In order to clarify the (often-delayed) interaction between these factors, the SSC has adopted a simplified strictly qualitative model of the cattle/BSE system¹² (Figure 1) which focuses on the feed-back loop that needs to be activated to spark a BSE-epidemic. This feed-back loop consists essentially of the processing of (parts of) cattle that carry the BSE-agent into feed and the feeding of this to cattle who then get infected and multiply the BSE-agent inside their bodies leading to very different concentration of infectivity in different tissues.

This feed-back loop is influenced by a number of factors that, on the one hand, may activate the loop and, on the other hand, might prevent this activation or slow down or reverse the building up of BSE-infectivity within the system.

In the model used by the SSC the initial introduction of the BSE-agent has to come from outside – it is therefore called an external challenge of the system¹³. Two possible routes of introduction are considered: import of infected cattle or import

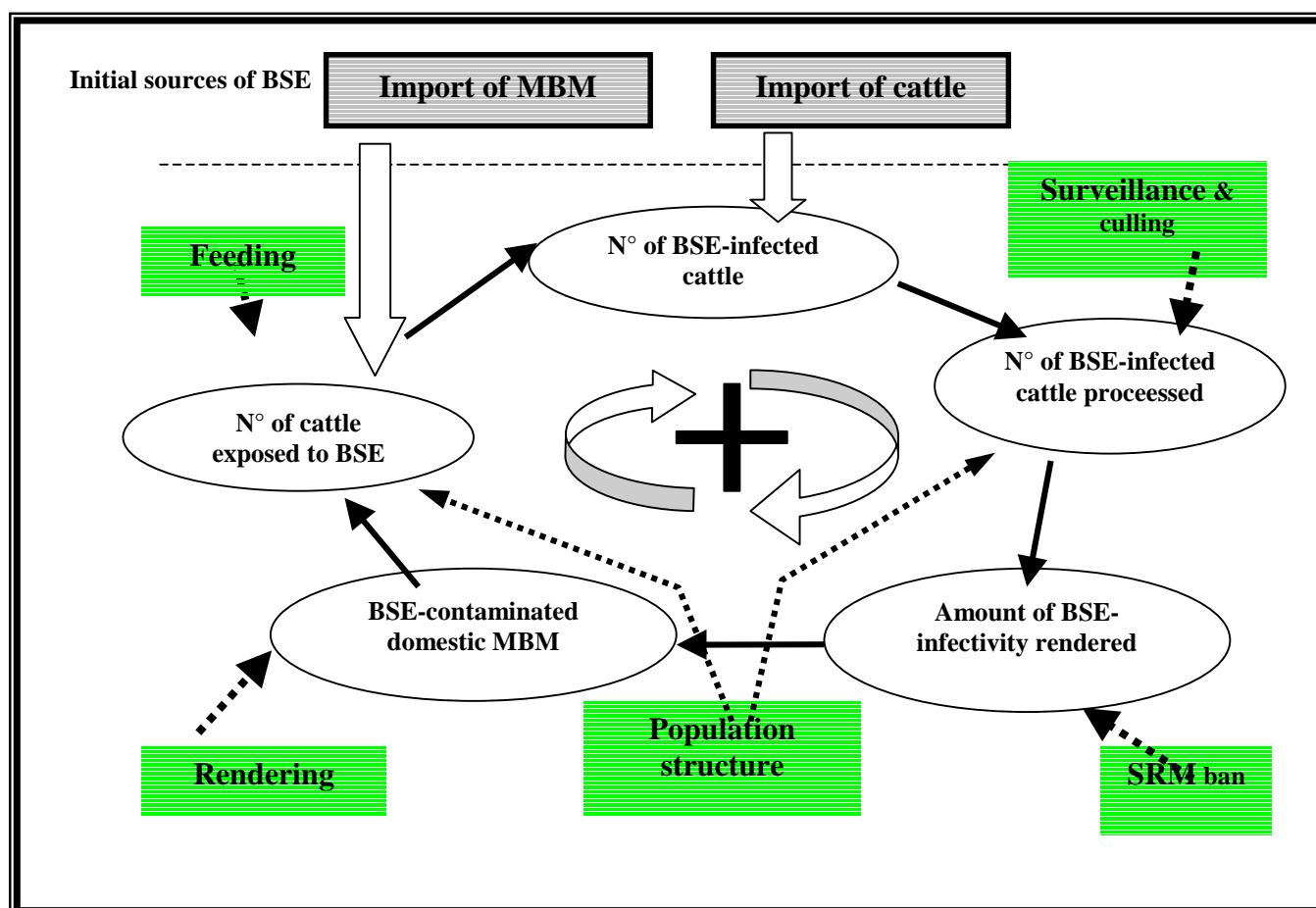


Figure 1: The model of the BSE/cattle system used by the SSC

¹² A BSE/cattle system of a country or region comprises the cattle population and all factors that are of relevance for the propagation of the BSE-agent, should it be present within its boundaries. The model used by the SSC to describe this system is presented in figure 1, it is a deliberately kept simple.

of contaminated MBM.

The factors assumed to be able to prevent the building-up of BSE-infectivity in the system are the following:

- ⇒ Surveillance and culling. By identifying BSE-cases (by passive and active surveillance including testing and laboratory confirmation) and excluding them and related cattle at risk of being infected from processing (by “culling” and destruction), the risk of introducing the BSE-agent into the feed chain is reduced.
- ⇒ SRM-removal. By excluding those tissues known to carry the bulk of the infectivity that can be harboured by a (pre-)clinical BSE-case from rendering, it reduces the infectivity that could enter the feed chain. Excluding fallen stock from the feed chain is seen to be equally effective as a “partial” SRM-ban because, according to Swiss experience, the frequency of infective (pre-) clinical cases in fallen stock seems to be higher than in normal slaughter.
- ⇒ Rendering. Appropriate rendering processes reduce BSE-infectivity that is carried by the raw material by a factor of up-to 1,000 (see footnote ¹⁴).
- ⇒ Feeding. By ensuring that no feed that could carry the BSE-agent reached cattle this effectively reduces the risk of new infections in the domestic cattle population.

In summary, the model basically can be broken down into two parts relating to challenge (chapter 2.23 and 2.25) and stability (chapter 2.24). The model assumes a mechanism for their interaction.

2.23 External challenge

The term “**external challenge**” is referring to both the likelihood and the amount of the BSE agent entering into a defined geographical area in a given time period through infected cattle or MBM.

2.231 Assessing the external challenge

During the GBR-assessment exercise it became necessary to establish guidelines for assessing the external challenge in order to ensure that comparable challenges were always assessed similarly.

To this end it was first decided to regard the external challenge independent from the size of the challenged BSE/cattle system and in particular the size and structure of the total cattle population (see also section 2.25)

Secondly, it was decided to use the assumed challenge resulting from imports from the UK during the peak of the BSE-epidemic in the UK as the point of reference and to establish the challenge resulting from imports during other periods and from other BSE-affected countries in relation to this baseline.

¹³ For the UK it is assumed that the initial introduction of the agent happened before the period taken into account in this model.

¹⁴ See SSC-opinion on the Safety of Meat and Bone Meal, 26/27 March 1998

Therefore, the figures given in table 3 below refer to imports from the country (UK) and the period of time where the risk of contamination of exports with the BSE-agent was regarded to be highest. For live cattle imports this was assumed to be the period 1988 to 1993. As a reasonable worst case assumption it was assumed¹⁵ that during this period the average BSE-prevalence of infected animals in exported cattle was around 5%¹⁶, i.e. of 20 animals one could have been infected. Therefore, a moderate external challenge would have made it likely that at least one infected animal was imported. The other levels of external challenge were established with the intention of indicating differences from this level of potentially imported infection.

The assessment of the challenge posed by MBM imports (also table 3) were similarly chosen in accordance with the following events and steps:

- The critical period, i.e. the period of highest risk that MBM imports from the UK were contaminated was set to 1986 –1990. This is the period with the highest case incidence in the birth cohorts.
- The risk peaked in 1988 when SBO¹⁷ were excluded from the human food chain but included into rendering and feed production. It was reduced with the exclusion of SBO¹¹ from rendering at the end of 1989.
- The table below indicates that the import of one ton of MBM is seen to pose the same challenge as the import of one live animal. This is justified by the fact that available import statistics do not allow the differentiation between different forms of animal proteins and that practically all MBM produced in Europe is always a mixture of ruminant and non-ruminant material. It should also be seen in the context that the probability that more than one infected cattle was processed per ton of final MBM is very low, even in the UK¹⁸.

¹⁵ The period 88-93 was chosen as highest risk period for live cattle imports because it covers the period of roughly one incubation period before the highest incidence (1992/93). Recent data on case incidence in birth cohorts show that this was already high in 1985/86 and 1986/87. However, as cattle are normally exported at an age between 6 (veal) and 24 (breeding stock) months, it was felt justified to keep this range. Nevertheless it might be possible that the risk carried by imports in 1987 was slightly underestimated by this approach.

¹⁶ The value of 5% was used because at normal survival probabilities only one in 5 calves reaches an age of 5 years. If the case incidence in a birth cohort was about 1%, about 5% of the calves in that birth cohort could have been infected.

¹⁷ Specified Bovine Offal = those bovine offal that contain the highest concentration of BSE-infectivity in a clinical BSE-case.

¹⁸ As one cattle carcass is rendered into about 65 kg MBM, 18 carcasses would be needed per ton of MBM.

<u>EXTERNAL CHALLENGE</u>	Cattle (n° of heads) imports		MBM ¹ (tons) imports			
	1988 - 93 from UK	UK-imports before 88 and 94-97: * 10; after 97: * 100	Imports from other countries with BSE: * 100	1986 - 90 from UK	UK-imports before 86 & 91-93: * 10, after 93 * 100	Imports from other BSE-countries * 10
Extremely High	≥10.000					
Very High	1.000 - < 10.000			1.000 - < 10.000		
High	100 - < 1.000			100 - < 1.000		
Moderate	20 - < 100			20 - < 100		
Low	10 - < 20			10 - < 20		
Very low	5 - < 10			5 - < 10		
Negligible	0 - < 5			0 - < 5		

¹ The abbreviation "MBM" refers to different animal meals (MBM, MMBM, BM, Greaves) that could carry the BSE-agent because it contains animal (ruminant) proteins. It does not refer to composite feed that could potentially contain MBM, MMBM, BM or Greaves.

Table 3: Definition of BSE-challenge levels

In other countries affected by BSE and, in the UK, at other periods the risk that exported cattle were carrying the BSE-agent or that MBM was contaminated with BSE was lower. Accordingly the challenge posed by the same amount of imports would be much lower or the same level of challenge would only occur at higher imports. To adapt the thresholds accordingly, the following multipliers were used:

Import from UK in other periods:

Cattle: before 1988 and from 1994 to 1997: multiply all thresholds by **10**;
1998 and after: multiply all thresholds by **100**;
MBM: before 1986 and from 1991 to 1993: multiply all thresholds by **10**;
1993 and after: multiply all thresholds by **100**.

Import from other countries than UK affected by BSE: regardless of period and whenever there is reason to assume that BSE was already present at time of export:

Cattle: multiply all thresholds by **100**,
MBM: multiply all thresholds by **10**.

It has to be underlined that the above figures in the table and the multipliers are only indicative. It is obvious that the final external challenge associated with imported cattle and their impact will largely depend of a number of factors including their age at slaughter. Excluding imported animals from the feed chain would reduce the challenge that the excluded animals represent to a negligible level. Accordingly imported animals that are slaughtered before reaching an age of 24 months would represent a lower challenge than imported animals used for breeding and then rendered at an age high enough to be approaching the end of the incubation period. If available, this and similar information are used to modulate the criteria in the table.

2.24 Stability

Stability is defined as the ability of a BSE/cattle system to prevent the introduction and to reduce the spread of the BSE agent within its borders. Stability relies on the avoidance of processing of infected cattle and the avoidance of recycling of the

BSE agent via the feed chain. A “stable” system would eliminate BSE over time; an “unstable” system would amplify it.

The most important stability factors are those which reduce the risk of recycling of BSE, in particular:

- avoiding feeding of MBM to cattle,
- a rendering system (“rendering”), able to largely inactivate BSE-infectivity (e.g. by applying “standard¹⁹” treatment at 133°/20^{min}/3^{bar}), and
- exclusion of those tissues/organs from rendering where BSE infectivity could be particularly high (“SRM-removal”). Excluding fallen-stock from the feed chain will also reduce the amount of BSE infectivity that could enter the feed chain and is necessary for a fully efficient SRM-removal. Excluding fallen stock from rendering alone, i.e. without exclusion of SRM from other cattle, would have some effect but is not as efficient as a “reasonably OK” system of SRM-removal.

A comprehensive surveillance system (including passive and active elements) and related activities that ensure detection and isolation (and destruction) of BSE-cases and cattle at risk of being infected would also enhance the stability of the system.

These stability factors were already relevant before their contribution to prevent spreading the BSE epidemic was scientifically understood. It is therefore clear that even compliance with a regulation that at that time was scientifically up-to-date may not always have guaranteed stability.

2.241 Stability levels

A BSE/cattle system can only be regarded to be “**optimally stable**” if all three main stability factors (feeding, rendering, SRM-removal including fallen stock) are in place, well controlled, implemented and audited (“OK”). Ideally such a system would also exclude fallen stock from processing into feed and integrate a highly effective capacity to identify BSE-cases and exclude them together with cattle at risk of being infected from being processed. Such a system would fully prevent propagation of BSE-infectivity and eliminate BSE-infectivity from the system very fast.

If two of the three factors are assessed to be “OK” but one of these factors is only reasonably implemented (“reasonably OK”), the system could at best be assumed to be “**very stable**”. Propagation would be largely prevented but the elimination of BSE-infectivity from the system is slower than in an “optimally stable” system.

A system can still be assumed to be “**stable**” as long as two of the three factors are “OK”, or one is “OK” and two are “reasonably OK”. BSE will be eliminated from the system over time but propagation may still take place – only at a lower rate than the elimination of BSE from the system.

If all three factors are “reasonably OK”, the system can nevertheless only be assessed as “**neutrally stable**”, i.e. it would neither amplify nor reduce circulating

¹⁹ As defined in the SSC-opinion on MBM, see n°8 in annex 1

BSE-infectivity over time. The same is true if only one factor is “OK” and two are not present or only badly implemented.

If only two factors are “reasonably OK”, the system is seen to be “**unstable**”. It will amplify BSE, should it be introduced. This means the propagation rate is higher than the elimination rate, if there is any.

With only one “reasonably OK” factor in place, the system is assumed to be “**very unstable**”, i.e. recycling a large proportion of the BSE-agent and propagating the disease rather fast.

If none of the three factors can even be considered as “reasonably OK”, the system would be “**extremely unstable**”, quickly propagating the BSE-agent, should it enter, and amplifying the BSE-load of the system.

These considerations are summarised in table 4 below that was used as guidance for ensuring comparability of approaches used for assessing the degree of stability of a given BSE/cattle system between the different country assessments.

<u>STABILITY</u>	Level	<i>Effect on BSE-infectivity</i>	Most important stability factors		
			Feeding	Rendering	SRM-removal
Stable: <i>The system will reduce BSE-infectivity</i>	Optimally* stable	<i>Very fast</i>	Feeding OK, rendering OK, SRM-removal OK		
	Very stable	<i>Fast</i>	Two of the three factors OK, one reasonably OK.		
	Stable	<i>Slow</i>	Two OK or 1 OK and two reasonably OK.		
Neutrally stable		<i>+ - constant</i>	3 reasonably OK or 1 OK		
Unstable: <i>The system will amplify BSE-infectivity</i>	Unstable	<i>Slow</i>	2 reasonably OK		
	Very Unstable	<i>Fast</i>	1 reasonably OK		
	Extremely Unstable	<i>Very Fast</i>	None even reasonably OK		

Table 4: BSE-stability levels (*“Optimally” should be understood as “as good as possible according to current knowledge”.)

Explanation concerning the three main stability-factors:

Feeding: OK = evidence provided that it is highly unlikely that any cattle received MMBM.

Reasonably OK = voluntary feeding unlikely but cross contamination cannot be excluded.

Rendering: OK = only plants that reliably operate at 133°/20^{min}/3^{bar}-standard.
Reasonably OK = all plants processing high-risk material (SRM, fallen stock, material not fit for human consumption) operating at 133°/20^{min}/3^{bar} – standard, low-risk material is processed at more gentle conditions.

SRM-removal: OK=SRM-removal from imported and domestic cattle in place, well implemented and evidence provided. Fallen stock is excluded from the feed chain.

Reasonably OK = SRM- removal from imported and domestic cattle in place but not well implemented or documented. If in addition to a “reasonable OK” SRM-removal fallen-stock is excluded from rendering, the “SRM-removal” might be considered “OK”. Exclusion of fallen stock from rendering alone is regarded to be useful but not as effective as a “reasonably OK” SRM-removal.

Note:

Surveillance and culling are essential for the ability of a system to identify clinical BSE-cases and to avoid that they, and related at-risk animals, enter processing. A good surveillance system can therefore, in combination with appropriate culling, improve the stability by supporting the exclusion of BSE-infectivity from the system. It would, however, not be sufficient to make a system more stable (move it into the next higher stability level) than it would be due to the three main stability factors.

2.25 Internal challenge

The term “internal challenge” is referring to the likelihood and the amount of the BSE-agent being present and circulating in a specific geographical area in a given time period.

If present, the agent could be there in infected domestic animals, where it would be replicated, in particular in SRMs, and in domestic MBM made from the infected domestic cattle. The internal challenge in a given period is a consequence of the interaction of the stability of the system and the combined external and internal challenge to which it was exposed in a previous period.

- If a fully stable BSE/cattle system is exposed to an external challenge, processing and recycling of the BSE-load entering the system will be prevented and the infectivity load will be neutralised over time. No internal challenge will result from this external challenge because the system is able to cope with it.
- If an unstable BSE/cattle system is exposed to an external challenge, processing and recycling of the BSE-load entering the system will take place and the agent will start circulating in the system. It will first be present in contaminated domestic MBM and, if this is fed to domestic cattle, these are likely to become infected. After approximately another 5 years (average incubation period) a certain number of them, which have survived until that age, could become clinical-BSE cases. Others might be processed before developing clinical symptoms and the infectivity harboured by them will again be recycled. By this way the internal BSE-load of the system is going to be amplified and a BSE-epidemic could develop (see fig.2).

The number of domestic cattle that are pre-clinically or clinically infected with the BSE-agent while being alive in the system at a given point in time could be taken as an indicator of the size of the internal challenge. However, it is currently impossible to detect pre-clinical BSE-cases and early clinical phases of BSE are

easily misdiagnosed. Therefore the time frame required for an internal challenge to be detected in an unstable country challenged by BSE will normally be at least one incubation period after the initial challenge (approximately 5 years). It may be much longer, depending on a number of factors including the following ones:

- ⇒ the extent of the BSE challenge (a larger challenge would lead to more new infections with a higher number of cases reaching the clinical phase);
- ⇒ the extent of the instability of the country (a very unstable system would amplify the infectivity faster and lead more rapidly to a higher number of cases);
- ⇒ the size of the national cattle population (within a smaller population the same number of cases might be more easily discovered than in a large population, i.e. given a similar initial challenge and similar rates of propagation it would take longer to reach the same incidence level), animal demographics and agricultural and marketing practices of the challenged countries (e.g. if cattle are hardly reaching an age of 5 or more years, the probability that incubating animals turn into clinical cases is reduced); and
- ⇒ the quality and validity of the BSE surveillance in the challenged country (the better the surveillance the earlier the detection as the risk of missing a case is smaller).

Depending on the many specifications of each case, detection of an internal challenge may take from a minimum of an average of 5 years from the initial challenge (average incubation period) up to several incubation periods. The longer periods might be valid because several cycles of about one incubation-period each are needed to reach numbers of clinical BSE-cases that are detectable by existing surveillance systems.

In principle, it cannot be excluded that, under certain circumstances, even an infectious load entering an unstable BSE/cattle-system may have no impact. This may happen if it is unintentionally eliminated, e.g. if contaminated imported MBM is all fed to pigs or poultry and does not reach cattle, even if during that period feeding MBM to cattle was legally possible and generally done. However, the SSC has assumed, as a reasonable worst case scenario, that exposure of an unstable system to the BSE agent would always result sooner or later in an internal challenge. The speed of this development depends on the degree of stability of the system.

2.26 Interaction of overall challenge and stability over time

The overall challenge is the combination of the external and internal challenges being present in a BSE/cattle system at a given point of time.

Four different basic combinations of stability and challenge can be seen.

- A “**stable**” system that is not or only slightly “**challenged**”: this is obviously the best situation.
- A “**stable**” system that is highly “**challenged**”: this is still rather good because the system will be able remove the BSE, even if this might need some time.

- An “unstable” system is not or only slightly “challenged”: as long as BSE is not entering the system, the situation is good. However, if BSE would enter the system it could be amplified.
- An “unstable” system is “challenged”: obviously this is an unfortunate situation. BSE-infectivity entering the system will be amplified and an epidemic will develop.

These “stability” and “challenge” situations are illustrated by the two-dimensional diagram given in Figure 2, where both axes spread between the respective lowest and highest feasible level.

		Overall Challenge						
		Negligible	Very low	Low	Moderate	High	Very high	Extremely high
Stability Reduction Amplification	Optimally stable							
	Very stable	Best					Good	
	Stable							
	Neutral							
	Unstable				→			
	Very Unstable		X→	→				
	Extremely Unstable	Good					Worst	

Figure 2: Stability/challenge combination, four principal situations and a hypothetical development over time

Since the above-mentioned 8 factors, on which challenge (external and internal) and stability depend, change over time, it is necessary to assess the challenge and stability at different periods. These periods might, for example, be determined in function of changes of stability (e.g. by an MBM-ban) and/or challenge (e.g. preventing BSE from entering the system).

The arrows in figure 2 indicate an example for a hypothetical development over time. A very unstable system is exposed to a very low initial (external) challenge. Because of the low stability and as it is assumed that no special measures are taken to prevent the “dangerous” imports from entering the feed cycle, e.g. by putting the imported animals under strict monitoring and prohibiting them to be rendered, the BSE-infectivity is recycled and, over time, amplified. After some time (several years) the challenge (external plus internal) is reaching a moderate level but in the hypothetical example the stability is improving, too, for example by excluding ruminant MBM from cattle feed. The system, however, remains unstable and

therefore the BSE-infectivity that is present in the system continues to be recycled and amplified. A high challenge develops. Fortunately the stability of the system is increasing. As soon as it is stable the system eliminates BSE-infectivity and the challenge decreases (as long as no new external challenges occur). With a further improvement of the stability the decrease of the challenge will be quicker.

From the above explanations it becomes clear that the past stability and overall challenge of the system are the reason for the current internal challenge and hence the current GBR. The impact of most risk management measures on the number of clinical BSE-cases is delayed by at least one incubation period of BSE, in bovines on average 5 years. Therefore measures taken in the last five years may have had an immediate effect on the recycling and amplification of the BSE-agent and hence the internal challenge and the current GBR but will only be reflected in the number of clinical BSE-cases around one incubation period after their effective implementation.

It is also clear that the future development of the GBR is influenced by the occurrence of additional external challenges and the continued ability of the system to reduce any incoming or already existing BSE infectivity. Assuming that new challenges can be avoided, the current stability determines the slope of the GBR-trend. An optimally stable system will very quickly reduce the GBR-level and an extremely unstable system will very quickly amplify any BSE-infectivity that is already in the system and increase the GBR-level.

2.3 PROCEDURE FOR ASSESSING THE GBR

2.31 Development of the methodology

In January 1998, the SSC established a list of factors on which it would require information for assessing the Geographical BSE-Risk (GBR)²⁰.

In July 1998, the Commission recommended to Member States and interested Third Countries to provide information on these factors²¹.

In December 1998, the SSC issued a draft opinion on a method for assessing the Geographical BSE-Risk of a country or region. This was adopted in February 1999²², taking into account comments received and the method was first applied in March 1999 to 11 Member States of the European Union (MS) that had supplied dossiers at that time. The methodology and process were repeatedly updated. The basis for these updates was the experience gained with its application to 26²³ countries who had voluntarily submitted information and the comments received from several of these countries on

- the drafts of their reports (April/May and June 1999 and 2000),

²⁰Opinion of the SSC on defining the BSE-risk for specified geographical areas. 22/23 January 1998

²¹Commission recommendation of 22 July 1998 concerning information necessary to support applications or the evaluation of the epidemiological status of countries with respect to TSEs. (C(1998) 2268); 98/ 447/EC)

²²Opinion of the SSC on a method to assess the Geographical BSE-Risk of countries or regions. 18-19/02/99

²³The reports for the Czech Republic, India and the Slovak Republic are still pending finalisation.

- a working document of the SSC on the GBR (April 2000), and
- the preliminary opinion of the SSC on the Geographical risk of BSE and the preliminary country reports on the BSE-risk assessment (May 2000).

2.32 The process

The application of the SSC methodology was carried out with the help of about 50 independent experts, coming from most of the Member States and Third Countries.

More than three independent experts assessed each country and discussed their analyses with the country's experts in order to clarify the available information. These discussions proved to be very valuable. To date, July 2000, twenty-three countries have been assessed.

The assessed countries have openly co-operated in the assessment by sending their country experts and by reacting to the draft reports forwarded to them for comments. During the process many countries provided additional information that improved the basis for the risk assessment.

The process by which the independent experts²⁴ assessed the GBR of a given country is outlined in table 5. The report on the assessment of the GBR of each country followed the same scheme. The interaction of the countries was essentially contributing to the tasks in step 1 (data appreciation) and the appraisal of the appropriateness of the conclusions drawn and presented under the points 2-5.

Notwithstanding the efforts made to harmonise the approaches taken by the different experts, a certain degree of difference in appraisal of comparable data could not have been avoided. With a view to harmonise the different country reports and to ensure consistency a final review of all assessments was carried out from January 2000.

Having taken account of the draft country reports available in January 2000, the SSC charged 20 independent experts to review them. In order to do so they were asked to establish criteria for determining the respective degrees of stability and challenge of each country, and to apply these consistently to all assessments. The experts were also requested to apply a consistent approach to estimating the current and future GBR derived from the past and current interaction of stability and challenge.

²⁴ In order to identify these independent experts the ad-hoc TSE/BSE group discussed the importance of the quality of the experts and developed a set of criteria that was subsequently adopted by the SSC (October 1998). Members of the ad-hoc group and of the SSC were invited to submit names and a list of possible candidates was established, also including experts known to the secretariat from previous work. This list was discussed at the TSE/BSE ad-hoc group and also given to the SSC. There were no objections to the list and it was left to the secretariat to invite the experts taking account of the selection criteria agreed on and the availability of the experts.

1. Appraisal of the quality of the available data
2. Assessment of the Stability of the BSE/cattle system (over time). 2.1 Ability to identify BSE-cases & to exclude cattle at-risk of being infected from processing 2.2 Ability to avoid recycling BSE-infectivity, should it enter processing 2.3 Overall assessment of the stability (over time)
3. Assessment of the challenges to the system (over time) 3.1 External challenge resulting from importing BSE 3.2 Internal challenge resulting from the interaction of external challenge and stability. 3.3 Overall challenge (over time)
4. Conclusion on the resulting risks (over time) 4.1 Interaction of stability and overall challenge (over time) 4.2 Risk that BSE-infectivity enters processing (over time) 4.3 Risk that BSE-infectivity is recycled and the disease propagated (over time)
5. Conclusion on the Geographical BSE-Risk 5.1 The current GBR as function of the past stability and challenge 5.2 The expected development of the GBR as function of past and present stability & challenge. 5.3 Recommendations to influence the expected development of the GBR.

Table 5: - Outline for the assessment procedure established by the SSC and applied by the independent experts. This outline was also used to structure the Country reports.

In order to do so, the 20 independent experts:

- agreed on practical criteria of assessing challenge and stability to be used as "orientation" to avoid inconsistencies between countries and
- established guidelines for revising and harmonising the reports & their presentation and
- agreed on the current GBR-level and the expected trend for each of the countries assessed on the basis of the information available to them early in February 2000.

The reports that had been prepared by the 20 independent experts were then examined by the TSE/BSE ad-hoc-group and the SSC.

On 2/3 March 2000 the SSC indicated a general agreement with the assessments while still pinpointing to room for improvement in terms of consistency within and between reports and terminology-standardisation. The SSC also recognised the need to up-date them in the light of additional information that became available between May 1999 and early March 2000. It charged a small group of its members and some assessors to carry out this task, taking due account of comments received by the members of the TSE/BSE ad-hoc group, the SSC and the Commission services, which were also invited to comment on the factual correctness of the reports. Subsequently the reports were sent to the respective countries together with a copy of a draft of this opinion. Comments on both documents were requested from the countries by early May 2000. The comments received were taken into account for revising the methodology of the SSC for assessing the Geographical Risk of Bovine Spongiform Encephalopathy (GBR) and preparing

preliminary versions of the country reports. It was assumed that countries, which did not submit comments, agreed to the provided documents.

On 25/26 May 2000 the SSC adopted the preliminary opinion and the preliminary GBR-country reports and requested their immediate publication on the Internet, inviting comments on both, the opinion and the reports, until 19 June 2000. Being aware of the sensitivity of the topic, the SSC made it clear that it would only consider comments related to the Risk-Assessment dimension of the issue, not those on the Risk-Management aspects.

The current final opinion and the related final GBR-country-reports take due account of the comments received. These documents now set out the SSC's final views on both the methodology issues and the GBR in each country that has been considered.

In reviewing this opinion and the related country reports it should be understood that in the view of the SSC it is expected that the framework of analysis will need to be revised if novel findings emerge, i.e. this opinion is dynamic in process as more scientific evidence will be available. These may relate to the source of BSE, to the diagnosis and transmissibility of BSE or to the infective dose for man. It can also be expected that novel developments in surveillance and management techniques or new tests to assess the prevalence of sub-clinical BSE conducted in a country may also precipitate the need for a selective re-assessment of a particular GBR.

The SSC's experience in assessing changes in the challenges and stability of countries, however, suggests that trends in incidence figures may allow different conclusions to be drawn only after 3 –5 years. In any case, the current assessments have to be up-dated from time to time.

2.4 AVAILABILITY AND QUALITY OF DATA

The SSC is well aware of the critical importance of the availability and quality of data for any risk assessment. It is, therefore, necessary to appreciate that the current GBR assessments are mainly based on information provided by the assessed countries and that it is essential to assume that the information provided is correct. In essence the provision of an appropriate basis for the GBR-assessment was the responsibility of the competent national authorities.

In general the available data were seen to be adequate to carry out the assessment of the GBR. Despite all efforts, however, considerable differences in the availability and quality of data remain of concern.

Additional sources of information, such as reports from the missions of the EC-Veterinary Inspection Services (the Food and Veterinary Office, FVO) and UK trade statistics were also used as available.

To complement insufficient information, and in line with the recommendation of the Commission of July 1998, "reasonable worst case assumptions" were used whenever extrapolation, interpolation or similar approaches were not possible.

A shortcoming in many dossiers, which had to be overcome by reasonable worst case assumptions, was insufficient information on compliance with the preventive measures put in place by the competent national authorities. For most countries additional information on this issue could therefore improve the basis for the risk assessment further.

While for E.U. Member States reports from the missions of the FVO were generally available, this is not the case for Third Countries, with the exception of Switzerland. This is important because in case of conflicting information the FVO-mission reports were generally taken as the authoritative source. Mission reports have also been demonstrated to be very useful sources to fill gaps in the available information.

In addition the information base for third countries could also be improved by extensive exploitation of additional publicly available sources. Given these considerations it might be argued that the foundation on which the assessments for third countries are based is not in all cases fully equivalent to the one for the Member States.

Another problem with data availability was recognised, as some countries did not provide data before 1988. In view of the importance of this period for possible initial challenges and recycling of BSE, and in order to treat all countries equally the independent experts stated the following:

“Whenever the available information does not cover the period 1980 to 1988, an open question remains as to the challenge and stability of the system during that period. To this end the following was generally applied:

Challenge: *Given the fact that the UK-epidemic was building up during that period, the implication is that any country that traded live cattle or MBM with the UK in this period could have imported some BSE-infectivity. If the system was unstable during that period (what was frequently the case) the potentially incoming BSE-infectivity could have been amplified.*

In order to have a first approximation of the possible external challenge, UK-export data to the country in question were used. The Commission is also invited to provide the appropriate EUROSTAT data for the same purpose. An analysis of the different import/export figures from different sources would be most useful to improve the information basis for the period in question for all countries.

Stability: *The stability of the system prior to 1988 is estimated on the basis of the available information, if necessary through extrapolation from the last known data.*

If it is not possible to base an assessment of imports on the UK export data or to extrapolate the stability, it will be assumed that the country was subject to a low challenge while its BSE/cattle system was not fully stable. This unfavourable situation is assumed to have lasted until the available data allow assessing the situation differently”.

The impact of incoming cattle on the GBR of the receiving country is assessed on appraisal of the BSE situation in the exporting countries at time of export. Should it become apparent that this appraisal was wrong, the assessment of the geographical BSE-risk of the receiving country would have to be reviewed. Imports from not-assessed Countries could not be taken into account. It was also in principle impossible to take account of triangular trade as a route for external challenges to develop.

2.5 MONITORING THE EVOLUTION OF THE GEOGRAPHICAL BSE-RISK

In order to monitor the evolution of the GBR, it is very important to improve the ability to identify clinically and sub-clinically BSE-infected animals and potentially infected MBM.

According to field observations in Switzerland, the incidence of BSE is higher in fallen stock and in cows offered for emergency slaughter than in healthy looking animals presented at routine slaughter.

Since the GBR-assessment exercise started, three rapid post-mortem tests for BSE became available. These make appropriate intensive surveillance programmes possible, targeting at-risk sub-populations such as adult cattle in fallen stock or in emergency slaughter, cohorts of confirmed BSE cases. Results from such programmes, applied to statistically justified samples, could improve the basis for future assessments of the GBR, or help to verify the current risk assessment.

Three rapid tests in bovines have been shown by the European Commission (European Commission, 1999, *The Evaluation of Tests for the Diagnosis of Transmissible Spongiform Encephalopathies in Bovines* – see DG-SANCO internet site at http://europa.eu.int/comm/dgs/health_consumer/index_en.htm) to have excellent potential (high sensitivity and specificity) for detecting or confirming clinical BSE for diagnostic purposes or for screening dead or slaughtered animals, particularly casualty animals or carcasses to be used for rendering.

The above tests are:

- *Prionics* : an immuno-blotting test based on a western blotting procedure for the detection of the protease-resistant fragment PrP^{Res} using a monoclonal antibody
- *Enfer* : a chemiluminiscent ELISA, using a polyclonal anti-PrP antibody for detection
- *CEA* : a sandwich immunoassay for PrP^{Res} carried out following denaturation and concentration steps. Two monoclonal antibodies are used.

The currently available rapid post-mortem tests are able to prove the presence of PRP^{res} in the CNS of cattle that are close to the end of the incubation period or already clinically ill. However, these tests cannot be considered to be able to identify pre-clinical cases at earlier stages of the incubation. The SSC, therefore, regards these tests to be useful for complementing existing surveillance efforts based on notification of BSE-suspects and detection of infected cattle with heavy loads of infectivity.

They should not, however, be used to guarantee the absence of the BSE-agent from an individual animal tested and found to be negative. The SSC wants to underline its support for the development of improved rapid BSE-diagnostic tests ultimately aimed at having reliable ante-mortem tests able to detect pre-clinical BSE.

Moreover, for an accurate assessment of the future trends in GBR, compliance data (from farming/slaughtering/rendering¹² industries) will be especially important. This information will be needed to determine the effectiveness of the various preventive measures, including bans, adopted and hence their impact on the GBR.

2.6 RELATION OF THE GBR TO THE OIE CODE ON BSE

2.61 The role of Risk Assessment

The OIE International Animal Health Code, Chapter 3.2.13 related to BSE, adopted May 2000, states that the status of a country or zone can only be determined from the outcome of a risk analysis. The OIE – International Animal Health Code, Section on Risk Analysis (section 1.4) outlines methods for this process as they are related to issues for the importation of animals or animal products. The OIE identifies the components of the risk analysis process as: hazard identification, risk assessment, risk management and risk communication. The risk assessment is the component of a risk analysis that estimates the risk associated with a hazard. Risk assessment methods should be chosen in relation to the specific situation. They may be qualitative or quantitative. The SSC method for the assessment of the Geographical BSE-Risk is one of the possible qualitative methods that can be used for the risk assessment component of this process. It is, however, an innovative approach using terminology different to those applied in the risk assessment literature and the OIE-section on risk analysis.

The SSC method for the assessment of the geographical BSE-risk is comparable to the OIE-guidance on risk analysis and in particular the chapter on risk assessment. The following points should be taken into consideration when determining the comparability of the SSC-method to other potentially proposed methods:

- The hazard identification is not included in the SSC-method for the assessment of the GBR as it was taken for granted that the BSE-agent is the hazard (see also the SSC-opinion on Human Exposure Risk).
- The release assessment required according to the OIE-guidance could be compared with the assessment of the “external challenge” and the “internal challenge” and their interaction as described in this opinion. The SSC assessment is not completed if the risk of an external challenge has been identified as negligible. This is contrary to the OIE-guidance. This SSC

¹²As a follow-up to its earlier validation studies on appropriate heat treatments of animals meals, the Joint Research Centre has conducted a study on the Prevention of Epidemic Diseases by appropriate Sterilisation of Animal Waste. According to SSC Opinion (20-21 January 2000), the test may become, after further validation, a useful additional part of verification and control protocols for verifying the appropriateness of processing equipment in rendering plants (effective wet sterilisation carried out at least at 133°C/20’/3 bars), provided a sample of appropriate test material is available to be processed.

approach is justified by the high degree of uncertainty with the epidemiology and biology of the BSE-agent as well as with its monitoring and surveillance. The SSC method attempts to address the stability of the assessed BSE/cattle systems as a means to establish its capacity to resist future challenges that are currently unknown.

- One might, however, compare the thrust of the SSC-method with an exposure assessment. The assessment of the inherent stability of a given BSE/cattle system with regard to BSE might be compared, to a certain degree with an analysis of the pathways needed to allow the exposure of animals to BSE. In an unstable system the pathways are open and would lead to exposure whereas in a stable system the risk of exposure occurring is much lower because the pathways are closed. Typically, a pathway assessment would depend on the specific situation and could, according to the OIE, vary from country to country. The SSC-method applies systematically one model of the BSE/cattle system that describes the pathways in a fully transparent and standardised manner. This provides a basis for obtaining comparable results in different countries.

The SSC-method derives a similar end-point as an exposure assessment described in the OIE-guidelines for risk assessment: it provides a qualitative estimation of the likelihood of the exposure to an identified hazard (the BSE-agent), at a given point in time. However, the SSC-method requires assessing the consequences of past exposures, in the SSC-terminology the internal challenges, which together with the external challenges again interact with the stability and create a new exposure situation. Because of the importance of the time dimension in this delayed process the SSC-terminology seems to be more adequate to describe the positive feed-back loop that is responsible for the BSE risk than the more static terms used in conventional Risk Analysis and Risk Assessment.

The SSC-risk assessment is well in keeping with the recommendation in the BSE-chapter of the OIE code. There it is requested to include all factors that could have lead to a risk of introducing or propagating the BSE agent in the country/region under consideration. This list is in fact very similar to the list of risk factors used by the SSC.

According to the BSE-chapter of the animal health code of the OIE, a BSE-risk analysis has to evaluate whether potentially infected material was imported, and, in such a case, whether the conditions in the country were/are sufficient to cope with potentially infected material, i.e. to prevent the disease being propagated. This is, indeed, exactly the objective of the SSC-method.

The OIE's list of factors that should be taken into account when analysing the BSE-risk includes:

- importation of meat-and-bone meal (MBM) or greaves potentially contaminated with a transmissible spongiform encephalopathy (TSE) or feedstuffs containing either; (note: MBM-imports are a very important part of the external challenge which is assumed by the SSC to be the only initial source (except in the UK). Due to lack of data the SSC currently did not take account of greaves or feedstuff-imports);

- importation of animals, embryos or ova potentially infected with a TSE; (note: while animal imports are an essential element of the external challenge assessment, the SSC does not take account of embryos or ova as the risk of transmitting the disease via these routes is regarded to be insignificant in comparison to the import of MBM and infected live cattle);
- consumption by cattle of MBM or greaves of ruminant origin; (note: the use of MBM is a central point of the SSC-assessment and greaves, and bone meal have been addressed whenever data were differentiated enough to allow for this);
- origin of animal waste, the parameters of the rendering processes and the methods of animal feed production; (note: this is one of the central points of the SSC-method, determining the stability of the system It is covered under the headings SRM-ban, rendering, and cross-contamination in the reports);
- epidemiological situation concerning all animal TSE in the country or zone; (note: the SSC does not take account of other animal TSEs because (a) the available data were very poor and (b) the link with BSE is not scientifically established, even for scrapie); and
- extent of knowledge of the population structure of cattle, sheep and goats in the country or zone. (note: while the information on the population structure – and dynamics- of the cattle population is taken account of, the information on small ruminants is, for the time being, not considered by the SSC).

The OIE also requests that the following measures, and their date of effective implementation (“relevant period of time”), be considered when determining the BSE- status. The SSC-method, however, considers them together with the other risk factors:

- compulsory notification and investigation of all cattle showing clinical signs compatible with BSE; *(note: this factor is taken into account in the SSC-methodology when assessing the capacity of the system to identify clinical BSE-cases and to eliminate animals at risk of being infected before processing)*;
- a BSE surveillance and monitoring system with emphasis on risks identified; *(note: also taken into account by the SSC when assessing the BSE-surveillance and when assessing the compliance with the feed and SRM bans)*;
- an on-going education programme for veterinarians, farmers, and workers involved in transportation, marketing and slaughter of cattle, so as to encourage reporting of all cases of neurological disease in adult cattle; *(note: this is an integral part of the SSC-assessment of the surveillance system)*;
- examination in an approved laboratory of brain or other tissues collected within the framework of the aforementioned surveillance system; *(note: again taken into account by the SSC in the context of the surveillance assessment)*;
- treatment of at-risk animals linked to confirmed cases (culling) *(note: covered by the SSC as a separate point contributing to the ability of the system to identify clinical cases and to eliminate at risk animals)*.

From the above it is clear that there is a close similarity between the relevant factors identified by OIE and those being used by the SSC to assess the GBR.

The SSC provides a detailed methodology for assessing the geographical BSE-risk, taking account of all relevant factors, including those listed in the BSE-chapter of

the International Animal Health Code of the OIE. The SSC method also involves an external review of the GBR on the basis of information provided by countries and, in view of the long incubation period of the disease and its initially probably slow progress, it tries to cover the last twenty years. As it is based on a prescribed model of the dynamics of the BSE-disease, this methodology can be applied consistently and transparently to available information. The application of the principle of reasonable worst case assumptions and special care to ensure consistency of these assumptions allows a reasonable estimation of the GBR even in cases where the available information is not fully satisfactory.

3. IMPLICATION OF THE GBR ON FOOD AND FEED SAFETY

From the definition of the GBR (see section 2.1) it is clear that it refers to the risk situation at the live-animal level.

At a given GBR the risk that food or feed is contaminated with the BSE-agent, depends on three main factors:

1. the likelihood that bovines infected with BSE are processed;
2. the amount and distribution of infectivity in BSE-infected cattle at slaughter;
3. the ways in which the various tissues that contain infectivity are used.

In addition the trading of potentially contaminated foods and feeds also influences this risk.

3.1 LIKELIHOOD THAT BOVINES INFECTED WITH BSE ARE PROCESSED

The likelihood that processed bovines are infected with BSE (processing risk) depends obviously on the GBR. However, the processing risk may differ for different cattle sub-populations, defined on the basis of criteria such as herd history, feeding history, date of birth in relation to identified challenges.²⁵

If the difference in processing risk of different sub-populations is known, excluding those that carry a higher specific processing risk would reduce the overall processing risk below the level that is indicated by the overall GBR.

This is for example possible by excluding birth cohorts born before an effective MBM-ban from slaughter²⁶. The exclusion of fallen-stock (in particular adult cattle) from rendering also reduces the processing risk. Ensuring that as many as possible of the infected (clinically and pre-clinically) cattle are excluded from processing also reduces the processing risk. The quality of the BSE-surveillance and the related measures (culling) are essential in this context.

²⁵ See, for example the SSC opinion on “closed herds”, or on the “Date based export scheme” for criteria that are used to define sub-populations with a much lower BSE-risk.

²⁶ The Date based export scheme, excluding animals born in the UK before the ultimate MBM ban of 01/8/1996 from export, is an example for the application of this principle.

3.2 AMOUNT AND DISTRIBUTION OF INFECTIVITY IN BSE ANIMALS

3.21 Amount

The amount of infectivity carried by an infected animal strongly depends on the incubation stage it is in. Assuming that most infection happen close to birth, the age of an animal is a good approximation of the potentially possible incubation stage and hence its infective load.

For instance, the infective load of animals below 24 months of age is in general very much lower than it would be possible for an animal of 60 months, assuming that both were infected shortly after birth.

Reducing the age at slaughter can hence reduce the infective load that potentially could enter the human food chain. Excluding older animals from rendering would have a similar effect on the feed chain.

The OTMS (Over Thirty Months Scheme) that excludes in the UK all animals older than 30 months from the human food and animal feed chain makes use of this effect. As, in the meantime, all animals that are allowed to be processed are also born after the latest MBM-ban (01/08/1996), it can be assumed that the combined effect of the OTMS and the feed-ban very effectively reduces the processing risk below the level expected from the current GBR (level IV).

3.22 Distribution

It is known that in an infected cattle that is approaching the end of the incubation period, the BSE infectivity is very unequally distributed. Certain tissues (the so-called SRM – Specified Risk Material) represent a particularly high risk. Their exclusion from further use (food or feed) reduces the infective load that could enter the respective chains. (See also the opinion of the SSC on SRM of Dec. 1997).

3.3 USE OF THE VARIOUS ORGANS AND TISSUES FROM BSE-ANIMALS

Each tissue/organ of a bovine can be used for a range of uses. Some of them require processing that is known to be capable to reduce BSE-infectivity.

The SSC has expressed its opinion on the production of gelatine, tallow, MBM, and a range of other bovine based products that may be used for food, feed or non-food/feed purposes. It has defined the conditions that have to be met to achieve maximal BSE-infectivity reduction and/or the BSE-infectivity reduction that can be expected from the normally applied/applicable processes. It has also included into these conditions considerations of the BSE-risk carried by the raw material with regard to tissues and the geographical origin of the animals.

With regard to process conditions it has been shown that some reduce BSE-infectivity²⁷, others (e.g. normal cooking, sub-standard rendering) have no measurable impact on it.

4. CONCLUSION

The assessment clearly shows that the current GBRs reflect, more than anything else, differences among the commercial and agricultural practices existing between the early 80s and the early 90s, a time when knowledge on BSE, and its public health impact, was very limited. Since then, however, the awareness has tremendously increased and effective measures have been put in place to minimise the impact of BSE on public health.

In fact, at a given GBR, the risk of humans or animals to be exposed to the BSE-agent can be influenced by measures

- before slaughter, that exclude at-risk animals (such as fallen-stock²⁸) and/or reduce their age at processing;
- during slaughter by excluding SRM from further processing,
- after slaughter by applying appropriate processes, able to reduce BSE-infectivity.

These measures might also be modulated in view of the intended end use of the meat or other bovine derived products. If control can be ensured, products that are only used for non-food/non-feed uses (also called industrial uses) could carry a higher risk than food or feed products. The SSC has the intention to address this issue in more detail in a specific opinion.

²⁷ See the various SSC-opinions on the safety of Gelatine, Tallow, MBM, Hydrolysed proteins, Fertilisers, etc.

²⁸ See the opinion of the SSC on “fallen-stock”

PART II

REPORT ON THE ASSESSMENT OF THE
GEOGRAPHICAL BSE RISK OF
CANADA

EXECUTIVE SUMMARY

OVERALL ASSESSMENT

The current geographical BSE-risk (GBR) level is II, i.e. it is unlikely but cannot be excluded that domestic cattle are (clinically or pre-clinically) infected with the BSE-agent.

Stability: Before 1992 the Canadian system was extremely unstable as MBM was fed to cattle, SRM was rendered for feed with processes not able to optimally reduce BSE-infectivity, and BSE-surveillance was inappropriate. After 1993, as a result of the improved passive surveillance of BSE, the traceback and removal of cattle imported from the UK, and the culling practices employed after the detection of the single imported BSE case, the stability increased but the system remained unstable. The introduction of the RMBM ban in 1997 and its subsequent implementation increased the stability of the system to neutral in 1998.

External challenges: Between 1985 and 1987 a very low external challenge resulted from importing cattle from the UK; from 1988 to 1990 these imports represented a low external challenge. Thereafter they were stopped. As a result of the importation and subsequent (time-delayed) processing of some UK-cattle, BSE-infectivity could have entered the Canadian system. Imports of MBM could have added to this challenge and remained a certain (low level) external challenge after 1993.

Interaction of external challenges and stability: While extremely unstable the Canadian system was exposed to a very low or low challenge by cattle imports from UK. It cannot be excluded that BSE-infectivity entered the country by this route and was recycled, reaching domestic cattle. A low-level domestic prevalence cannot therefore be fully excluded to exist since the early 90s. However, the level must be below the detection level of the rather good passive surveillance in place.

As long as there are no changes in stability or challenge the probability of cattle to be (pre-clinically or clinically) infected with the BSE-agent will remain at the current very low level.

Justification

1. DATA

The available information was suitable to carry out the GBR risk assessment.

2. ASSESSMENT OF THE STABILITY OF THE BSE/CATTLE SYSTEM

2.1 Ability to identify BSE-cases and to eliminate animals at risk of being infected before they are processed

- The passive surveillance system is assessed to be good, within the limits of passive surveillance, since 1993, thanks to the high number of suitable brains annually examined it is assumed that relatively small numbers of clinical BSE-cases would be picked up.
- The present cattle ID system, however, is not sufficient to easily and reliably trace back and eliminate risk-populations in the national herd should domestic BSE cases be identified.

2.2 Ability to avoid recycling of the BSE-infectivity, should it enter processing

- Between 1980 and 1997 the Canadian system would not have been able to avoid recycling of the BSE-agent to any measurable extent. If the BSE-agent was introduced into the feed chain, it could have reached cattle.
- In 1997 the ability to avoid recycling of BSE-infectivity gradually improved with the introduction of the ruminant MBM-ban and its implementation. Since 1998 it is assumed to be rather good.
- Since cross-contamination cannot be excluded, and as SRM is still rendered by processes unable to significantly reduce BSE-infectivity, the system is still regarded to be unable to fully avoid recycling of BSE-infectivity already present in the system or incoming.

2.3 Overall assessment of the stability (over time)

- Before 1992 the Canadian system was extremely unstable. Cattle received MBM that was produced by processes below the 133/20/3-standard from ruminant and non-ruminant material which included SRM and fallen stock. In addition BSE-surveillance was insufficient.
- After 1992 the improved but still passive BSE surveillance and the culling practices employed after the detection of the single imported BSE case improved the stability from “extremely unstable” to “very unstable”. RMBM was still allowed to be fed to cattle and rendering as inappropriate with regard to BSE-deactivation as before.
- After 1993, as a result of traceback and removal of cattle imported from the UK, the stability increased but the system remained “unstable”, i.e. incoming or circulating BSE would still have been recycled and amplified.
- The introduction of the RMBM-ban in 1997 and its subsequent implementation increased the stability of the system to “neutrally stable” in 1998.

3. CHALLENGES

- Before 1987 a “very low” and from 1988 to 1990 a “low” external challenge is assumed. It resulted from a very small number of UK-imported cattle (11 that carried a risk of being infected) that entered processing. Other external challenges, due to import of live cattle or MBM from other countries affected by BSE, were regarded as insignificant but still not non-negligible.

- It is unlikely, but cannot be excluded, that some BSE entered the Canadian feed chain and resulted in a (small) internal challenge.
- The overall challenge was therefore first determined by the very low and low external challenges. As a reasonable worst case scenario it is assumed that the (unlikely) internal challenge, which could have resulted from the interaction of the insufficient stability and the external challenges, was just enough to maintain a low level of the overall challenge, even after the external challenges practically ceased in 1993.

4. CONCLUSION ON THE RESULTING RISKS

4.1 Interaction of stability and challenges

- From 1980 to 1992 the extremely unstable system was exposed to “very low” (prior to 1988) and to “low” external challenges (1988-1992).
- The development of an internal challenge is unlikely but cannot be excluded because the extremely unstable system would most probably have recycled and amplified incoming BSE-infectivity.
- If at all an internal challenge would have started to develop around 1990 and, in that case, could have at least partly compensated the declining external challenges that were significantly reduced/stopped with the exclusion of all imported cattle from processing in 1993. As a reasonable worst case scenario it is assumed that this kept the overall challenge at a constant, low level, after 1993.
- After 1992 the stability of the system increased through implementation of a good passive surveillance system and the traceback and removal of imported cattle. The system became “unstable” in 1994 and “neutrally stable” after 1997. It could hence cope better with the low overall challenge that is assumed to have been present.
- Given the fact that the system is still not seen to be able to reduce circulating BSE-infectivity, it is unlikely but cannot be excluded that a low (internal) challenge is maintained.

4.2 Risk that BSE-infectivity enters processing

- Before stopping the use of cattle imported from BSE affected countries (1993), the processing risk was low, but not negligible. It resulted from 11 imported animals that were found carrying a risk of being infected and that entered the Canadian food and/or feed chains.
- If, indeed, one or some of the imported animals that were processed was infected, BSE-contaminated RMBM would have been produced that could have reached and infected some domestic cattle. These animals, if existing, would have posed a secondary processing risk, probably about one incubation-period later, i.e. around 1993 to 1998.

4.3 Risk that BSE-infectivity is recycled and propagated

- The risk that propagation did take place was highest, but still low, when the processing-risk peaked, i.e. from the end 80s to 1993 (due to imported animals being processed) and then again between 1993-1998 (if domestic cases would have been processed).

- In 1997 the risk to recycle the agent and to propagate the disease was reduced due to the RMBM-ban. It is not fully mastered because cross-contamination of cattle feed with inappropriately produced RMBM cannot be excluded.

5. CONCLUSION ON THE GEOGRAPHICAL BSE-RISK

5.1 The current GBR

The current geographical BSE-risk (GBR) level is II, i.e. it is unlikely but cannot be excluded that domestic cattle are (clinically or pre-clinically) infected with the BSE-agent.

5.2 The expected development of the GBR

- Assuming that the current measures will be continued to be well implemented and controlled and that there will be no changes in stability or (external) challenge, the GBR will remain as low as it currently is.

5.3 Recommendations for influencing the future GBR

- As long as the stability of the Canadian system is not significantly enhanced it remains critically important to avoid any new (external) challenges.
- All measures that would improve the stability of the system, in particular with regard to its ability to avoid recycling of the BSE-agent should it be present in the cattle population, would reduce further, over time, the probability that cattle could be infected with the BSE-agent. Possible actions include
 - removal of SRMs and/or fallen stock from rendering,
 - rendering processes with a higher potential to deactivate the BSE-agent,
 - improved compliance with the RMBM-ban including better control and reduction of cross-contamination.
- Results from an improved intensive surveillance programme, targeting at risk sub-populations such as adult cattle in fallen stock or in emergency slaughter, could help to verify the current assessment.

FULL REPORT

1. AVAILABLE DATA

1.1 Consistency, completeness and treatment of gaps in the available data

The dossier was comprehensive and largely complete. Extrapolation, interpolation and realistic worst case assumptions were used to bridge gaps that could not be closed otherwise.

1.2 Sources of information used

- Information provided by the country authorities and the country experts.
- UK export-figures for live animals and MBM.

1.3 Recommendations for improving the basis for assessing the GBR

- Structuring the report as requested in the Recommendation of the Commission of July 1998 would improve the clarity of the data presentation.
- Detail on the imports of cattle and MBM by year of import and country of origin for the periods 1980 to 1998.
- Results from a further improved passive surveillance and of an active targeted surveillance (screening of asymptomatic cattle in risk sub-populations such as fallen stock or emergency slaughter for BSE) could (a) verify the current assessment and (b) provide a better basis for future assessments.

1.4 Overall assessment of the suitability of the available information for the assessment

- The available information was considered as suitable to assess the GBR.

2. STABILITY

2.1 Ability to identify BSE-cases and to eliminate animals at risk of being infected before they are processed

2.11 Factor 1: Population structure

2.111 Population data

- Cattle population: 12.15 Million in 1988 increasing to 14.37 Million in 1998;
- Cattle population above 24 months of age: approx. 6.0 Million.

2.112 Age distribution of cattle, alive and at slaughter

- Share of cattle population slaughtered on a yearly basis: 25 %
 - The number of animals slaughtered being older than 2 years of age decreased from 20 % in 1988 to 15 % in 1998.

2.113 Husbandry systems

- Ratio dairy to beef cattle in 1996 = 1:4
- Of the approximately 3 Million dairy cattle 2 Million are located in the two eastern provinces Ontario and Quebec.
- Mixed farming (cattle and monogastric species) is usually not practiced; the country expert estimated the proportion of mixed farming to be less than 1%.

2.114 Cattle identification and monitoring system:

- Individual regions traditionally have ID systems under provincial authorities. Brand inspectors are present when cattle are assembled.

- It is estimated by the Canadians that the level of a national, uniform ID for cattle is less than 10 %; most of those individual pedigree animals
- Mandatory ID for the milk-fed veal sector was implemented in Quebec in 1996, but does not contain information on the herd of origin.
- An agreement of the relevant industries to develop a national cattle ID and trace back strategy was reached on 1 May 1998 (starting in 2001). The federal government's role in this issue has been a supportive rather than a regulatory one.

2.12 Factor 6: Surveillance

2.121 Description of the surveillance system and its development over time

- BSE was made notifiable in 1990.
- Every cow over one year of age exhibiting central nervous system signs suggestive of BSE submitted to a laboratory or presented at an abattoir is subjected to a BSE laboratory diagnostic test (histology and over the past years also PrP^{Sc}-based laboratory tests.
- In addition, cattle submitted for rabies examination and found rabies negative are examined for BSE. Samples are prepared immediately upon arrival to the federal laboratory responsible for the rabies diagnostic for possible later BSE examination, i.e. formaline fixation.
- Since 1940's a rabies control program has been running, where farmers, veterinarians and the general public are well educated about this neurological disease. In 1990, when BSE was made notifiable, this awareness was extended to suspicions of BSE.
- Since 1993 the number of brains examined per year did exceed the number recommended by OIE (300 - 336 for countries with a cattle population over 24 months of age of 5.0 to 7.0 Million) in all years, except in 1995:

year	1992	1993	1994	1995	1996	1997	1998	1999	To
samples	225	645	426	269	454	754	844	895	4,512

Table 1: Number of bovine brains annually examined for CNS diseases, including BSE

- According to the country experts approx. 98% of the examined cattle were older than 24 months and approx. 90% exhibited neurological symptoms.
- The list of neurological differential diagnoses for the 754 brains examined in 1997 included encephalitis (70 cases), encephalomalacia (19), hemophilus (7), hemorrhage (2), listeriosis (38), meningoencephalitis (36), rabies (22), tumors (2), other conditions (135) and no significant findings (423).
- Compensation is paid for suspect BSE cases as well as for animals ordered to be destroyed (90-95 % of market value with a maximum of 2,500 Can\$ per cow).
- Diagnostic criteria developed in the United Kingdom are followed at ADRI, Nepean. According to the very detailed protocol for the collection, fixation and submission of Bovine Spongiform Encephalopathy (BSE) specimens at abattoirs under inspection by the Canadian Food Inspection Agency, the specimen shall be shipped to National Center for Foreign Animal Disease, Winnipeg, Manitoba.

2.122 *Quality of the surveillance system with regard to BSE*

- Given the high awareness of the different actors in the field with regard of rabies and, since 1990, of BSE, and the significant number of brains annually examined since 1993, relatively small numbers of clinical BSE-cases would be picked-up by the Canadian surveillance system, within the limits of a passive surveillance system. A very small number of cases might have gone unnoticed, though.
- The lack of an individual, nation-wide ID system for about 90% of the cattle population is a drawback that could pose problems if cases occur in the domestic cattle population.
- However, the back tracing of the imported cases showed a certain potential to overcome this drawback. The targeted surveillance of the imported cattle from UK was able to identify most of the cattle. Those still alive in 1993 were excluded from processing.

2.13 Factor 8: Culling

- Following the BSE index import case, all other UK imports of bovines were destroyed and incinerated or shipped back to the UK.
- The current eradication policy does include:
 1. depopulation of the herd in which the infected animal is diagnosed,
 2. depopulation of the herd in which the positive animal was born,
 3. destruction of birth cohorts to the positive animal,
 4. destruction of bloodline relatives (dam and progeny),
 5. destruction of embryos collected from index and source herds.
- The carcasses of the culled animals are destroyed by incineration or burial.

2.14 Overall appreciation of the ability to identify BSE-cases and to eliminate animals at risk of being infected before they are processed

- The passive surveillance system is assessed to be good, within the limits of passive surveillance, since 1993, thanks to the high number of suitable brains annually examined it is assumed that relatively small numbers of clinical BSE-cases would be picked up.
- The present cattle ID system, however, is not sufficient to easily and reliably trace back and eliminate risk-populations in the national herd should domestic BSE cases be identified.

2.2 Ability to avoid recycling of the BSE-infectivity, should it enter processing

2.21 Factors 3 and 4: Domestic MBM production and use

2.211 *Domestic production of MBM*

- The annual Canadian production of MBM is approximately 575.000 tons of which approx. 40.000 tons are exported each year, mainly to US.

2.212 *Description and history of feed ban(s) and their compliance*

- Before 1997, there was no legal restriction to include MBM into cattle feed.
- An MBM-ban was introduced in August 1997; it is forbidden since to feed mammalian MBM to ruminants except if of pure porcine and equine origin, i.e. in practice a ruminant-to-ruminant ban (RMBM-ban).

2.213 Use of MBM (before and after feed ban)

- Typically dairy cattle will receive significant amounts of supplementary feed during their productive life (200-400g supplement protein per day). Beef cattle in the western part do usually not receive complementary feed. Beef cattle in the eastern part receive normally no supplement protein but the calves could have had access to creep feeds containing MBM, after weaning the ratios may have contained supplemental protein containing MBM (100-400g per day).
- According to the country experts MBM is mainly fed to pigs and poultry and included in petfood. Exact figures could not be produced. It therefore has to be assumed that dairy cattle were likely to be exposed to ruminant MBM until 1997.

2.22 Factor 5: SRM-ban and treatment of SRM**2.221 Description and history of SRM bans**

- There is no SRM ban in place.

2.222 Fate of SRMs

- SRMs are rendered together with other slaughter offal and fallen stock.

2.23 Factor 7: Rendering and feed production**2.231 Raw material used for rendering**

- Slaughterhouse offal, including SRM and fallen stock are rendered.
- The country expert estimated that 20% of the rendering plants, processing 20% of the total amount of raw material, are connected to slaughterhouses. Their raw material is more than 98 % offal from these slaughterhouses while less than 2 % is fallen stock. No estimation was given for the remaining 80% of the rendering capacity.

2.232 Rendering processes and their ability to reduce BSE-infectivity

- There are 32 rendering plants of which 6 are processing blood exclusively.
- The rendering systems (parameters) were specified for 13 plants producing mixed MBM, none of these fulfilled the 133/20/3 standard.
- The remaining plants process porcine or poultry material exclusively.

2.233 Capacity of the rendering system to reduce any potential BSE-infectivity in the raw material

- Overall the Canadian rendering industry is apparently not able to ensure a significant reduction of incoming BSE-infectivity.

2.24 Cross-contamination**2.241 Possible types of cross contamination**

- Cross-contamination of non-ruminant MBM with ruminant MBM during rendering might occur in the 13 plants producing mixed MBM but not in the plants processing porcine or poultry material exclusively. 11 of the 13 plants have separated lines for “prohibited” and “non prohibited” materials.
- Cross-contamination in the about 600 feed mills is assumed to be possible as long as cattle and pig feed is produced in the same production lines, and premises.
- Cross-contamination during transport is possible, particularly if the same trucks are used for transporting RMBM and PMBM (porcine or poultry MBM which still might be included into cattle feed) or for transporting pig/poultry feed and cattle feed.

- On-farm cross-contamination is unlikely because of the small number of mixed farms.

2.242 Measures undertaken to control cross-contamination

- With the introduction of the RMBM ban (1997) the feed mills (approximately 600) were checked for compliance with the ban, including good manufacturing practices and record keeping, i.e. the separation in production of MBM containing ruminant material (RMBM) from non-ruminant MBM.
- The feed mills had previously – since 1983 – been regularly checked in relation to production of medicated feed.
- No examinations are performed to assess cross-contamination with RMBM of the protein (e.g. PMBM) that enters cattle feed. Differentiation would anyway be difficult.

2.243 Assessment of the potential level of cross-contamination

- Cross-contamination of cattle feed with RMBM can not be excluded. Hence, as reasonable worst case scenario, it has to be assumed that cattle, in particular dairy cattle, can still be exposed to RMBM and hence to BSE-infectivity, should it enter the feed chain.

2.25 Overall appreciation of the ability to avoid recycling BSE-infectivity, should it enter processing

Between 1980 and 1997 the Canadian system would not have been able to avoid recycling of the BSE-agent to any measurable extent. If the BSE-agent was introduced into the feed chain, it could have reached cattle.

- In 1997 this ability gradually improved with the introduction of the ruminant MBM ban and its implementation.
- Since cross-contamination cannot be excluded, and as SRM is still rendered by processes unable to significantly reduce BSE-infectivity, the system is still unable to fully avoid recycling of BSE-infectivity already present in the system or incoming.

2.3 Overall assessment of the stability

- Before 1992 the Canadian system was extremely unstable. Cattle received MBM that was produced by processes below the 133/20/3-standard from ruminant and non-ruminant material which included SRM and fallen stock. In addition BSE-surveillance was insufficient.
- After 1992 the improved but still passive BSE surveillance and the culling practices employed after the detection of the single imported BSE case improved the stability from “extremely unstable” to “very unstable”. RMBM was still allowed to be fed to cattle and rendering as inappropriate with regard to BSE-deactivation as before.
- After 1993, as a result of traceback and removal of cattle imported from the UK, the stability increased but the system remained “unstable”, i.e. incoming or circulating BSE would still have been recycled and amplified.
- The introduction of the RMBM-ban in 1997 and its subsequent implementation increased the stability of the system to “neutrally stable” in 1998.

3. CHALLENGES

3.1 External challenge resulting from importing BSE-infectivity

3.11 Factor 2: Import of live cattle

- According to the country expert about 40,000 bovines are imported from US per year for slaughter, almost 100% steers and heifers. A very low number of bovines for breeding have been imported from New Zealand and Austria. These imports were not considered to be challenges.
- About 160 beef cattle were imported from UK during the years 1982 to 1990, at least 45 of it in the critical period 1988/89.
- These imports posed a low external challenge before 1988 and a moderate external challenge in 1988/89.
- Following the occurrence of the BSE index case in 1993 (imported from UK in 1987 at the age of 6 months) an attempt was made to trace all other cattle imported from UK between 1982 and 1990 (when import of cattle from UK to Canada was banned).
- 53 animals imported from the UK before 1990 had been slaughtered and 16 animals imported from the UK had died. Eleven of the UK cattle were sold to farms in the USA in 1993. All but one of the remaining 80 imported animals were successfully traced in Canada and taken out of production (culled and incinerated or buried, or shipped back to UK) in 1993 and 1994. In relation to the 12 cattle imported from the UK in 1988, four were sent to incineration, two exported and six rendered; whereas out of the 33 imported in 1989, twenty-one were incinerated, one buried, six exported and five rendered.
- The 69 imported animals that were slaughtered or died before 1993 carried a certain risk of being infected with the BSE-agent, in particular those that were imported in 1988 and 1989 (11). Thanks to the measures taken in total 11 cattle imported from the UK in the critical period, i.e. in the late eighties, entered the system. Therefore, the final challenge that the UK-imports posed to the system's ability to avoid recycling was very low before 1988 and low in 1988/89.
- Further research on the UK-imported BSE case showed that it had been fed compound feed of Canadian origin in the quarantine upon arrival to Canada, where it stayed for 2 months before being transferred to the Canadian herd of destination being a beef herd on pasture. According to the country expert, any risk of BSE contamination of the feed used in the quarantine was excluded by the thorough investigations. It was concluded that the animal must have been infected before. In 1987 no other cases of BSE had occurred in the herd of origin in UK; but later, i.e. after shipment of the said calf, two cases occurred in that herd.
- No cattle imports were recorded after 1990. The last importation of cattle from other countries with BSE in native cattle came from France in 1985. They did not represent a non-negligible challenge.

3.12 Factor 3: Import of MBM or feed containing MBM

- Imports of MBM have taken place from Australia, New Zealand and minor amounts from Belgium, Denmark, Germany, Spain and US. A further specification about the imports prior to August 1997 could not be produced. A realistic worst case assumption is that the imports from BE, DE, DK, and SP

caused a low or very low external challenge. It cannot be fully excluded that BSE-infectivity entered the country by this route but it is regarded unlikely.

- Imports of MBM have not taken place from UK since 1978 (initially because of FMD regulations).

3.2 Internal challenge resulting from domestic infected animals

3.21 Interaction of external challenges and stability

- The extremely unstable (1980 – 1992) or very unstable (1993) Canadian system was exposed to a very low (1985-1987) and low (1988-1990) external challenge, mainly due to UK-imported cattle that were processed but also because of some MBM-imports from other EU-countries.
- If BSE-infectivity was indeed imported it could have been recycled and domestic cattle could have been exposed to BSE-infectivity. The potential exposure due to imported animals ended in 1993, when the remaining animals were traced and excluded from the system. An exposure to MBM that was imported from European Countries could have taken place also later but the probability that this happened is regarded to be low.

3.22 Assumed development of the domestic prevalence

- There is no evidence that a domestic prevalence has developed.
- However, since the external challenges did occur during a period of very low stability, it cannot be excluded that some domestic animals were infected with BSE in the late 80s early 90s, resulting in a certain domestic prevalence. If these animals were rendered while approaching the end of the incubation period, e.g. 93-98, a second wave of domestic infections would have resulted. These animals could show clinical symptoms at the late 90s or beyond.
- Given that it is neither likely that BSE-infected cattle were imported and entered the Canadian system nor that the MBM imports from Europe were contaminated, it is unlikely but cannot be excluded that a domestic prevalence developed.
- However, the surveillance system is considered to be able to identify BSE affected cattle, especially since BSE became notifiable (1990) and the number of samples increased in 1992. The fact that no domestic cases have been seen is reassuring – it indicates that BSE is probably not present in the country, at least not at levels above the detection limits of the country's good but passive surveillance system.

3.3 Overall assessment of the combined challenges

- Before 1987 a “very low” and from 1988 to 1990 a “low” external challenge is assumed. It resulted from a very small number of UK-imported cattle (11 that carried a risk of being infected) that entered processing. Other external challenges, due to import of live cattle or MBM from other countries affected by BSE, were regarded as insignificant but still not non-negligible.
- It is unlikely, but cannot be excluded, that some BSE entered the Canadian feed chain and resulted in a (small) internal challenge.
- The overall challenge was therefore first determined by the very low and low external challenges. As a reasonable worst case scenario it is assumed that the (unlikely) internal challenge, which could have resulted from the interaction of the insufficient stability and the external challenges, was just enough to

maintain a low level of the overall challenge, even after the external challenges practically ceased in 1993.

4. CONCLUSION ON THE RESULTING RISKS

4.1 Interaction of stability and challenges

- From 1980 to 1992 the extremely unstable system was exposed to “very low” (prior to 1988) and to “low” external challenges (1988-1992).
- The development of an internal challenge is unlikely but cannot be excluded because the extremely unstable system would most probably have recycled and amplified incoming BSE-infectivity.
- If at all an internal challenge would have started to develop around 1990 and, in that case, could have at least partly compensated the declining external challenges that were significantly reduced/stopped with the exclusion of all imported cattle from processing in 1993. As a reasonable worst case scenario it is assumed that this kept the overall challenge at a constant, low level, after 1993.
- After 1992 the stability of the system increased through implementation of a good passive surveillance system and the traceback and removal of imported cattle. The system became “unstable” in 1994 and “neutrally stable” after 1997. It could hence cope better with the low overall challenge that is assumed to have been present.

		Overall Challenge						
Stability		Negligible	Very low	Low	Moderate	High	Very high	Extremely high
Optimally stable								
Very stable								
Stable								
Neutral			98					
Unstable			94-98					
Very Unstable			93-94					
Extremely Unstable		80-87	88-92					

Figure 1: Development of Stability and Challenge over time

- Given the fact that the system is still not seen to be able to reduce circulating BSE-infectivity, it is unlikely but cannot be excluded that a low (internal) challenge is maintained.

4.2 Risk that BSE-infectivity enters processing

- Before stopping the use of cattle imported from BSE affected countries (1993), the processing risk was low, but not negligible. It resulted from 11 imported animals that were found carrying a risk of being infected and that entered the Canadian food and/or feed chains.

- If, indeed, one or some of the imported animals that were processed was infected, BSE-contaminated RMBM would have been produced that could have reached and infected some domestic cattle. These animals, if existing, would have posed a secondary processing risk, probably about one incubation-period later, i.e. around 1993 to 1998.

4.3 Risk that BSE-infectivity is recycled and propagated

- The risk that propagation did take place was highest, but still low, when the processing-risk peaked, i.e. from the end 80s to 1993 (due to imported animals being processed) and then again between 1993-1998 (if domestic cases would have been processed).
- In 1997 the risk to recycle the agent and to propagate the disease was reduced due to the RMBM-ban. It is not fully mastered because cross-contamination of cattle feed with inappropriately produced RMBM cannot be excluded.

5. CONCLUSION ON THE GEOGRAPHICAL BSE-RISK

5.1 The current GBR

The current geographical BSE-risk (GBR) level is II, i.e. it is unlikely but cannot be excluded that domestic cattle are (clinically or pre-clinically) infected with the BSE-agent.

5.2 The expected development of the GBR

- Assuming that the current measures will be continued to be well implemented and controlled and that there will be no changes in stability or (external) challenge, the GBR will remain as low as it currently is.

5.3 Recommendations for influencing the future GBR

- As long as the stability of the Canadian system is not significantly enhanced it remains critically important to avoid any new (external) challenges.
- All measures that would improve the stability of the system, in particular with regard to its ability to avoid recycling of the BSE-agent should it be present in the cattle population, would reduce further, over time, the probability that cattle could be infected with the BSE-agent. Possible actions include
 - removal of SRMs and/or fallen stock from rendering,
 - rendering processes with a higher potential to deactivate the BSE-agent,
 - improved compliance with the RMBM-ban including better control and reduction of cross-contamination.

Results from an improved intensive surveillance programme, targeting at risk sub-populations such as adult cattle in fallen stock or in emergency slaughter, could help to verify the current assessment.