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Scientific Committee on Toxicity, Ecotoxicity and the Environment

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**SCIENTIFIC COMMITTEE ON TOXICITY, ECOTOXICITY AND
THE ENVIRONMENT
(CSTEE)**

Opinion on

Evaluation of sludge treatments for pathogen reduction

Expressed at the 23rd CSTEE plenary meeting

Brussels, 24 April 2001

CONTEXT

The opinion is being sought by DG Environment in the context of a revision of Directive 86/278/EEC on the protection of the environment and in particular of soil when sewage sludge is used in agriculture. The intent is to broaden the scope to cover not only domestic but also various “industrial” sludges (but not agricultural sludges, manures and slurry) and to be more precise on requirements. A dual approach is also suggested in the revised Directive: one based on new technology intended to lead to sludges that are acceptable immediately following processing; the other involving conventional techniques (as at present) relating to sludges that need to be subject to in-field constraints. Storage is not addressed by the Directive.

To this effect, DG Environment has commissioned a study to Dr Robert Davis of WRc (UK) for evaluating sludge treatments for pathogen reduction. The study aimed at:

1. Identification of the pathogens (bacteria, viruses, parasites, fungi and yeasts) likely to be present in the different types of sludge (urban sludge, septic tank sludge, sludges from vegetable processing, sludges from meat processing, paper sludge, tannery sludge etc).
2. Evaluation of the parameters (residence time, temperature, pH, moisture etc) that make a sludge treatment process effective in killing/inactivating pathogens in sludge and assessment of the need for treatment according to the different types of sludge.
3. Evaluation of the use restrictions, *e.g.* deep injection, ploughing down, crop restrictions, etc. – for sludge which is treated to a lesser degree of hygienisation.
4. Indication of what micro-organisms(s) could be routinely used as an indicator of sludge hygienisation and what micro-organisms could be used to validate any given process in its start-up phase.

Thus, the proposed new frame for sludge spreading on the soil – as far as pathogens are concerned - would be based on three principles: process validation, process controls and end-material controls. The simultaneous application of these principles should guarantee an even higher level of public health protection than that allowed by the existing “dual-barrier approach” of Directive 86/278/EEC.

TERMS OF REFERENCE

The CSTEE, on the basis of the examination of the report by Dr Robert Davis of WRc (UK) on “Evaluation of sludge treatments for pathogen reduction”, is invited to examine the following issues:

1. Is the CSTEE satisfied that the study has considered the relevant bibliography pertaining to the presence of pathogens in sludges and to the effectiveness of different treatment processes in activating/killing the pathogens infectious for human, animal and plant health? Is such bibliography sufficient and complete?
2. Can the report be judged as an acceptable basis for the Commission in order to be able to propose the appropriate combination of treatments, user restrictions and pathogen controls for a land spreading of sludges that would minimise risks?
3. If the CSTEE disagrees on any of the assumptions, reasoning and conclusions of the report, the CSTEE is invited to elaborate on the reasons for this divergence of opinion and make suggestions on how the report could be improved.

SUMMARY OF OPINION

Response to Q1:

The CSTEE considered that the bibliography compiled by the consultant was sufficient in covering major pathogens and effectiveness of treatments.

Response to Q2:

The CSTEE was of the view that the recommendations in the Report would provide an acceptable basis for the Commission to propose appropriate treatments and user restrictions for the land spreading of sludges that will minimise risk. However, the risks are restricted to farm workers and consumers with no consideration of risks to operators in transportation and storage and little consideration of broad wildlife implications. The CSTEE believes that these risks should be given more attention.

Response to point 3:

Where the CSTEE has diverged from the views expressed by the Consultant full explanation and alternatives are given in the text. Important specific concerns included advice on: **i)** drying rates to effect destruction of pathogens (chapter 3, Consultant’s report); **ii)** residence time at 55°C to effect destruction of pathogens (chapter 4); **iii)** the use of post exposure restrictions for conventional treatments, especially where applied in situations leading to the human food chain (chapter 5); **iv)** the selection of organisms for quality assurance, and **v)** the lack of attention to metazoan pathogens (chapter 6). The CSTEE strongly recommends that these are subject to more detailed considerations before being used as a basis for legislation.

COMMENTS ON THE REPORT

General

The Report represented a substantial piece of work that will provide an acceptable basis for developing appropriate procedures for regulating land spreading of sludges in respect of sanitation. However, the CSTEE identified a number of issues that would require further consideration.

In particular, notwithstanding the comprehensive cover of the “contents”, there was no explicit consideration within the document of the specific quality criteria that might/should be targeted by the treatment processes. The CSTEE identified a number of different approaches that could, in principle, lead to different management approaches viz:

- i. On the basis of risk.
- ii. On the basis of microbial counts/limits
- iii. To limits of detection

Approach (i) implies non zero levels that are deemed acceptable because they are unlikely to cause harm to human health and wildlife. Approach (ii) specifies quality in terms of counts of groups or specific organisms (as in food quality) often requiring reduction to ambient levels or zero (see approach iii). Approach (iii) leads to levels that cannot be detected – and is clearly sensitive to developing techniques.

The Consultant implicitly uses a version of approach (ii) in which targets are set in terms of reducing microbial concentration by at least 4 orders of magnitude for advanced treatment, presumably to achieve ‘ambient’ concentrations. This follows the usual international convention – it minimises risk because it has been found to do so as a matter of past experience - but it ought to be made explicit and given some justification. Moreover, quality of the final product ought to relate to the characteristics of the receiving environment in terms of, for example, ambient load, organic content, temperature and moisture, all of which are likely to affect the risk consequences of the added sludge. There was no discussion of this in the Report.

The CSTEE also noted that little account had been given in the Report to toxins that can be released by microorganisms into the environment. It was suggested that some consideration should be given to the likelihood of this occurring in sludge and hence, on this basis, if they should be taken into account in assessing treatment processes.

Little detail is given on the distinction between advanced and conventional treatment in the Report, but possibly because the distinction is made clear in the Commission working document. Similarly, much emphasis is put on heat treatment as the important method of advanced treatment. It is argued that this is currently the most cost-effective approach, yet future developments in chemical and physical (e.g. irradiation) treatment should not be discounted.

There was no discussion of the risk that might arise for workers and the environment from transportation and storage, but this could be significant.

Finally the Report focussed on human health issues. Yet the intent is that the use of sludge should be carried out in such a way as to minimise the risk of negative effects to not only human but animal and plant health (Working document CSTEE/2000/18 – Add. 8). Notwithstanding the paucity of literature on these aspects, the CSTEE felt that this should have been given more explicit attention with respect to the issues raised by the broader approach.

Specific

[organised by chapter of the Consultant's Report].

IDENTIFICATION OF PATHOGENS (Consultant's Report, Ch. 2). The Report covered most of the relevant pathogens but there were important omissions. *E coli* O157 was not included. There should be mention of antibiotic-resistant *Salmonella*. Possibly influenza virus needs inclusion. There are also nomenclatorial issues: Calcivirus = Calicivirus; Norwalk agent is now Norwalk-like calicivirus. Some more mention should have been made of the relative importance of agents as judged by epidemiological information.

EVALUATION OF PARAMETERS AFFECTING THE KILLING AND INACTIVATION OF PATHOGENS (Consultant's Report, Ch. 3).

The Report emphasised heat treatment as currently being the most important method of advanced treatment. The CSTEE was of the view that this was covered adequately. Concern was expressed, though, on advice on thermal drying. It is not sufficient to state that, "the hygienisation of sludge will be further enhanced by the reduction in water content" (3.1.4.), because this will depend upon the speed at which drying is effected. No clear experimental results are available on this but the CSTEE was of the view that rapid reduction in water content can lead to less sensitivity of microbes to heat treatment. (See also a thesis: Kessler, U. (1993) Experimentelle Untersuchung und Modellierung der Überlebensrate von Milchsäurebakterien bei der thermischen Trocknung. Diss. TU München-Weihenstephan). This section therefore needs careful reconsideration possibly backed up by an experimental programme.

TREATMENTS (Consultant's Report Chap. 4). Again the proposed treatments focus on the use of heat. In general these follow logically from the conditions specified in the previous chapter. However, the specific conditions for "hygienisation and stabilisation by thermophilic digestion" (p. 17) are incorrect : the temperature should be raised to 55°C for at least 10 not 4 hours (cf. Fig. 3.1). This needs correcting here and in the conclusions (Consultant's Report, Ch. 7). Moreover, an important aspect of these conditions is where in the processing system temperatures are measured. There is no discussion of this in the Report, and how it will depend on the type of processing system being deployed. Table 4.1 on microbial concentrations in untreated sludge needs to specify units – are the concentrations in dry weight? – and the virus concentrations are probably underestimated.

EVALUATION OF THE USE OF RESTRICTIONS (Consultant's Report, Ch.5).

A view was expressed by the CSTEE that conventionally treated sludge should only be applied to pasture, or to crops that might be used directly by humans with great caution. More specific recommendations need developing here. For example one suggested by the CSTEE was: those sludges to be used in the production of vegetables which may be eaten raw (salads, cucumbers, etc) need to be *Salmonella* free in 25g of sludge according to current detection methods. In any event Table 5.3 was not helpful in that the time periods were not precise enough, and the advice that a 3 week no-grazing prohibition should be adequate to reduce pathogen numbers was deemed inappropriate since it cannot be applied generally.

QUALITY ASSURANCE (Consultant's Report, Ch 6). Techniques will be needed to: validate processes prior to implementation (process validation); ensure processing is optimum during use (process controls); ensure the quality of the product (end-material controls). It would be impractical to monitor all organisms so the CSTEE agreed with the consultant that indicators have to be used. The consultant advised that *E coli* and *C perfringens* should be used to assess end-quality and *Salmonella* in process validation. However, the CSTEE could see no reason why *Salmonella* should not be used in both end-product assessment and validations though it was recognised that there were concerns about adding pathogens to sludges in validation procedures. An alternative would be to use a non pathogen *Salmonella*; for examples *S. senftenberg* is neither pathogenic for humans nor naturally present in sludges and since it is very heat resistant it would seem to be an ideal candidate indicator.

The CSTEE was of the view that more standardisation would be necessary for all quality assurance techniques. There was also concern that microbes may not act as good surrogates for helminth eggs given that they are adapted to be resistant in stressful conditions. It is therefore necessary to consider using viable helminth eggs directly for validation in certain circumstances (e.g. validation of treatment of sludge with slaked lime).

SOURCES OF INFORMATION. (Consultant's Report, Chapter 7) The literature review was adequate.

CONCLUSIONS/RECOMMENDATIONS (Consultant's Report, Chapter 7)

The Conclusions given by the Consultant's Report are in general adequate. However, there will need to be some corrections in details and these are documented above. For advanced treatment, the emphasis is on the use of heat. This is sensible given requirements for cost-effectiveness, but sight should not be lost of future developments in chemical and irradiation treatments and implications for quality assurance.

For conventional treatment, more careful consideration needs to be given to specifications of post-treatment restrictions, especially with regard to situations leading to the human food chain. All risks have been considered in terms of agricultural workers and human consumers.

Yet there may be important risks, especially to operators, in the transportation and storage of sludges that should be given some consideration. Hardly any attention was given in the Report to broader wildlife effects and through them into the human food chain. More consideration should be given to these issues in the development of the Directive.