**European Commission Ref. 070201/2014/693666/FRA/ENV.C.3 Service Agreement 7:
Continued improvements of inventory methodologies**

**Task 3.2: Ammonia emissions from fertiliser use**

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**Consultation paper for discussion**

1. **Context**

Ricardo-AEA Ltd, Aether Ltd and AMEC have been commissioned to investigate and propose improvements to inventory methodologies in a number of key areas identified by the Task Force on Emission Inventories and Projections (TFEIP) and other bodies. The European Commission, as part of a collaborative initiative, has provided funding for this project, which is expected to be the focus of discussion at the TFEIP meeting and workshops in May 2015.

Task 3.2 of this project is entitled “Ammonia emissions from fertiliser use.” This paper sets out our initial views on the delivery of this task, and is intended to form the basis of discussions with TFEIP subgroup chairs, TFEIP members, and other stakeholders.

1. **The issue(s) to be addressed**

Among the following priority areas of the GB chapters for agriculture the project aims to bring up to date is the methodology needed to calculate ammonia (NH3) emissions following the application of nitrogen (N) fertilizer.

Emissions of NH3 following the application of N fertilizers to agricultural soils typically contribute *c*. 10% of European emissions of NH3 from agriculture, albeit the contribution varies widely among EU member states. The main factors controlling NH3 volatilization are the type of N-fertilizer applied, temperature and, for some types of fertilizer, soil pH. Earlier reviews have concluded that NH3 emissions from urea are the most variable, ranging from 6 to 47% of applied N, and on average greater than those following the application of other types of N fertilizer. For example, reported emissions from ammonium nitrate (AN) (and calcium AN, CAN) are much smaller, never exceeding 4% of applied N. There are fewer studies of other fertilizers such as ammonium sulphate (AS) and di-ammonium phosphate (DAP). Emissions following the application of AS and DAP increase greatly with increasing soil pH. In general, it is considered that emissions from other N fertilizers are less than those from urea, with the exception of AS and DAP on calcareous or otherwise alkaline soils. Earlier editions of the Guidebook indicated that NH3 emissions following the application of urea were *c*. 15% of applied urea-N at 12°C, compared with emissions of only c. 1% of N applied as AN at the same temperature.

The most recent review of NH3 emissions following the application of N fertilizers, carried out by Aarhus University indicated that emissions following the application of urea may have been significantly underestimated and may be closer to *c*. 25% of N applied at typical spring temperatures. However, those findings were heavily influenced by the results of a large study carried out in the UK in which emissions of NH3 were measured using wind tunnels: a technique that is known to overestimate absolute emissions of NH3. The objective of that UK study was to make a thorough comparison of urea and AN as N fertilizers and for such a comparison wind tunnels are a satisfactory means of measuring relative differences in emissions.

1. **Proposed approach**

We therefore propose that before updating the Guidebook to incorporate the findings of the reanalysis we will:

* *Carry out a multi-factorial analysis of all available measurements of NH3 emissions following the application of N fertilizers.*
* *Critically review the literature reporting measurements of NH3 emissions following the application of N fertilizers.*

***Multi-factorial analysis of all available measurements of NH3 emissions following the application of N fertilizer.***

This multi-factorial analysis will consider the following factors:

* *N fertilizer type* (Urea; AN; CAN; AS; urea/ammonium nitrate solution (UAN); urea/AS solution (UAS). Data from other types of N fertilizer will be included in the analysis but the limited number of datasets may mean that it may not be possible to make robust emission estimates.
* *Average temperature during NH3 measurement period.*
* *Total rainfall following N fertilizer application.*
* *Average wind speed over the NH3 measurement period.*
* *Soil moisture content at the time of N fertilizer application.*
* *Soil type (soil texture class).*
* *Soil clay content (%).*
* *Soil pH at the time of N fertilizer application.*
* *Soil cation exchange capacity (CEC).*
* *Ammonia emission measurement technique (micrometeorological technique or wind tunnels).*
* *Amount of N fertilizer applied (kg/ha).*
* *Duration of measurement period.*

Data from both field and laboratory experiments will be subject to analysis and 'field' and 'laboratory' will be included in the multi-factorial experiment to determine if there is a systematic difference in emissions from laboratory and field studies.

The basis for this analysis will be a dataset established by the chairs of the Agriculture and Nature Panel. Additional data, subject to verification, will also be added to the overall dataset, from a spreadsheet made available by Lex Bouwman. Data from recently published studies will be added to the overall database.

***Critically review the literature***

We will review the literature to elaborate on the findings of the multi-factorial analysis and to assess specific uncertainties highlighted by the recent review by Aarhus University carried out to update the GB. Factors of particular importance to be considered are as follows.

*Emissions from different types of N fertilizers*Meta-analysis of large amounts of data is a powerful tool with which to carry out a rigorous statistical analysis of factors leading to emissions. A disadvantage is that such analyses are unbalanced and the findings may be dependent on a few data comprising very large or very small emissions having an undue weight on the analysis. If the dataset is sufficiently large the risks of a few data exerting undue influence is diminished but may still exist. We will therefore examine studies that have carried out orthogonal comparisons of emissions from more than one type of N fertilizer within the same experiment(s) to assess the extent to which these direct comparisons confirm findings of the multi-factorial analysis

*Effect of temperature on emissions following application of urea fertilizer.*The analysis by Aarhus University found that where an individual study has measured NH3 emissions following urea application over a range of temperatures emissions are usually shown to increase with increasing temperature. However, when data from several sources were amalgamated, as was done in the update by, no such relationship was apparent. This was due to the influence of other factors, wind speed, rainfall after application and soil type (emissions being greater from sandy soils). Aarhus University therefore proposed an average EF for the EMEP area. We will determine whether a uniform EF for the entire EMEP area is the most appropriate approach.

*Soil type*Soil type is also an important factor in determining emissions following the application of urea with greater emissions being measured on sandy soils with limited buffering capacity. Again, where balanced comparisons of NH3 emissions following application of N fertilizer(s) to different soil types have been published we will compare these findings to those of the multi-factorial analysis.

Other factors to be evaluated from publications of balances studies will be:

*Soil moisture at the time of N fertilizer application and rainfall after application*

*Measurement technique*

1. **Your views**

The dataset is being complied by the contractor and the co-Chair of the Agriculture and nature Panel and the multi-factorial analysis will being carried out at the University of Aarhus under the supervision of the co-Chair of the Agriculture and nature Panel.

We will present the findings and any proposed revisions to the GB methodology to EAGER and the Agriculture and Nature Panel and agree the most appropriate method for incorporation in the Guidebook.

Your views are sought on the following key issues:

1. Are there any robust data from your country on NH3 emissions following N fertilizer application that we should add to the database?
2. Does your national inventory have an approach to calculating NH3 emissions following N fertilizer application that might be used in the Guidebook?
3. Once the results of the multi-factorial analysis are available we would like your views on the findings and the usefulness of the proposed approach.
4. **Consultation programme**

An introductory discussion has been held with the TFEIP management group at their meeting on 11 February 2015. The results of the multi-factorial analysis will be presented at the EAGER meeting on 16-17 April 2015 for discussion. Consultation with TFEIP members is planned to take place during the TFEIP meeting and workshop in May 2015. Following this, the project team will develop draft methodologies and Guidebook text. This will be circulated for consultation in late 2015, working with the TFEIP Expert Panel co-chairs.

Thank you for your co-operation with this process.

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