



National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

QA/QC of outside agencies in the Greenhouse Gas Emission Inventory

Update of the background information in the
Netherlands National System.

RIVM letter report 2020-0066
J. Wanders et al.



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Synopsis

Quality Assurance/Quality Control of 'outside agencies' in the greenhouse gas emission inventory

Pursuant to the United Nations Framework Convention on Climate Change, the Kyoto Protocol and EU legislation, the Netherlands is required to monitor the quantities of greenhouse gases emitted and to report on this annually. This obligation entails a series of reports, known collectively as the National Greenhouse Gas Inventory System, which comprises the annual report on actual emissions, reports on the method and descriptions of the quality monitoring and management.

The latter include the description of quality assurance and control (QA/QC) at organisations that emit greenhouse gases but do not fall under the direct influence of the quality assurance and control of the Netherlands Pollutant Emission Register. These organisations are termed *outside agencies* and this description is updated periodically.

Outside agencies are different in that they carry out their activities under the certified NEN-EN-ISO 9001 quality system. This system lays down the requirements for quality assurance and control. An independent and accredited institution is responsible for certifying these quality systems and ensures that the stipulated requirements are complied with. The agencies that did not fall under this ISO system in the past had to submit a separate process description, but this is no longer necessary.

The outside agencies for the Netherlands are: divisions of Statistics Netherlands (CBS), the Netherlands Organisation for Applied Scientific Research (TNO), Rijkswaterstaat (Directorate-General for Public Works and Water Management) Waste Management, Wageningen Environmental Research (WEnR/WOT unit) and Wageningen Livestock Research.

Keywords: QA/QC, National system, greenhouse gas emission, outside agencies

Publiekssamenvatting

QA/QC van 'outside agencies' in de broeikasgassen emissie-inventarisatie

Vanwege het Klimaatverdrag, het Kyotoprotocol en EU-regelgeving is Nederland verplicht om bij te houden hoeveel broeikasgassen worden uitgestoten en daar elk jaar verslag van te doen. Deze verplichting bestaat uit een reeks rapportages, het zogenoemde Nationaal Systeem Broeikasgassen. Dat zijn, naast de jaarlijkse rapportage over de feitelijke emissies, rapporten over de methode en beschrijvingen van de kwaliteitsbewaking en het kwaliteitsbeheer.

Hieronder valt de beschrijving van de kwaliteitscontrole en -borging (QA/QC) bij de organisaties die emissies aanleveren en niet onder de directe invloed van de kwaliteitscontrole en kwaliteitszorg van de Emissieregistratie vallen. Dit noemen we *outside agencies*. Deze beschrijving wordt periodiek geactualiseerd.

Een van de veranderingen is dat alle outside agencies hun werkzaamheden uit voeren onder het gecertificeerde NEN-EN-ISO 9001 kwaliteitssysteem. Daarin staan de eisen voor de kwaliteitscontroles en kwaliteitsborging. Een onafhankelijke en geaccrediteerde instelling voert de certificering van deze kwaliteitssystemen uit en ziet erop toe dat de eisen worden nageleefd. De agencies die eerder niet onder dit ISO-systeem vielen, moesten een aparte procesbeschrijving geven. Dat is nu niet meer nodig.

De outside agencies voor Nederland zijn: onderdelen van het Centraal Bureau Statistiek (CBS), de Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (TNO), Rijkswaterstaat Afval Management (RWS), Wageningen Environmental Research (WEnR/WOT-unit) en Wageningen Livestock Research.

Kernwoorden: QA/QC, Nationaal systeem, broeikasgasemissie, outside agencies

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Summary

As a result of the obligations under the Kyoto Protocol and EU regulation on a mechanism for monitoring and reporting greenhouse gas emissions a description of the quality assurance and quality control (QA/QC) of outside agencies must be added to the National System for the inventory of greenhouse gas emissions.

In the Netherlands almost all National System and inventory related actions are directly contracted by Ministries of Infrastructure and Water Management (IenW) and of Economic affairs and Climate Policy (EZK) to the Pollutant Release and Transfer Register (PRTR), coordinated by the National Institute for Public Health and the Environment (RIVM) and Netherlands Enterprise Agency (RVO) as acting National Inventory Entity (NIE). However, also data is prepared and processed under other arrangements. The Netherlands National System has several of these so called outside agencies. These are:

- Statistics Netherlands (CBS);
- Rijkswaterstaat Waste Management Department;
- Wageningen Environmental Research/WOT N&M Unit;
- Wageningen Livestock Research;
- Netherlands Organization for applied scientific research (TNO).

Underlying report is an update of the 2011 QA/QC descriptions of the outside agencies and serves as a background document to the National System for greenhouse gases. This report describes for each outside agency in the inventory the QA/QC on their individual contribution and calculations of greenhouse gas emissions.

All outside agencies adheres to the international standards NEN-EN-ISO 9001.

1 Quality assurance and quality control of outside agencies

The UNFCCC and IPCC guidelines provide guidance for QA/QC activities related to greenhouse gas inventories and the National System¹. The guidelines also separately distinguish potential involvement of outside agencies in emission estimates. In the Netherlands almost all National System and inventory related actions are directly contracted by the Ministries of Infrastructure and Water Management (IenW) and of Economic affairs and Climate Policy (EZK) to the Emission Registrations project, coordinated by the National Institute for Public Health and the Environment (RIVM) and Netherlands Enterprise Agency (RVO) as acting National Inventory Entity (NIE). Quality issues are part of the contract from the ministry (EZK). RIVM (PRTR) and RVO (NIE) are therefore not considered as outside agencies.

The greenhouse gas inventory is based on the national Pollutant Release and Transfer Register (PRTR) as part of the ER-project. The general process of inventory preparation has existed many years. The ER-project is organised as a project with an annual cycle.

Annex 1 lists briefly how, in accordance with the table 6.1 of Volume 1 of the IPCC 2006 Reporting Guidelines, the main QC activities (Tier 1) in the Netherlands National System are being dealt with. The mentioned organisations though not under direct contract, participate in the ER-project (through covenants) and thus are subject to these general checks for the emission estimation process. As part of the overall National System, they are also subject to the other QA/QC activities that are implemented in accordance with the QA/QC programme.

In the National System also data are supplied and processed under arrangements that are not specifically IenW- or EZK-related. The institutes that supply these data are therefore for the National System considered as outside agencies. They involve:

- Activity data on e.g. energy use, handled waste water, agriculture, road traffic and -transport, industrial production, sales, etc. from Statistics Netherlands (CBS);
- activity data and emission factors on waste through the Rijkswaterstaat Waste Management Administration;
- e.g. emission factors and activity data on LULUCF, emission factors on fertilizer use, carbon content of manure, manure management and storage, through Wageningen Environmental Research;
- emission factors on enteric methane emission in dairy cows through the Wageningen Livestock Research;
- e.g. emission factors on sea- and inland shipping and fishery, road traffic and -transport, activity data on sea- and inland shipping and fishery and airports, by Netherlands Organisation for applied scientific research (TNO).

¹ The EU regulation uses national inventory system

This report describes for each outside agency separately how the relevant QA/QC arrangements in these organisations are taken care of.

2 Quality control and quality assurance at Statistics Netherlands (CBS)

2.1 Introduction

This chapter describes the quality assurance and quality control at Statistics Netherlands (CBS; Dutch acronym for 'Centraal Bureau voor de Statistiek'). CBS is the main provider of activity data, needed for the compilation of greenhouse gas emissions, like the official statistics on energy, industry, agriculture, environment and transport. To compile greenhouse gas emissions the activity data is multiplied by emission factors, which are not provided by CBS. In general, these factors are compiled by other outside agencies in the greenhouse gas emission inventory.

To guarantee a successful involvement of CBS in the Dutch inventory system a covenant² has been set up, between CBS and RIVM. The covenant is in Dutch and it is updated every five years. The most recent version is signed on October 23, 2015. The covenant arranges all relevant aspects around data transmissions between the Dutch inventory system and CBS (inputs and outputs; also each other's expertise). Through this involvement CBS has a proper understanding of the UNFCCC reporting guidelines, including the requirements with regard to quality control and quality assurance.

2.2 The organisation

In a society where the amount of information is growing explosively, free access to reliable and integral data is crucial. As the national statistical office, CBS provides reliable statistical data to produce insight into social, economic, and environmental issues. The availability of statistical information supports the public debate, policy development and decision-making.

CBS was established in 1899 in response to the need for independent and reliable information that advances the understanding of social issues, and in later years, also economic and environmental issues. This is still the main role of CBS. Through time, CBS has grown into an innovative institution, with continuous adoption of new technologies and developments in order to safeguard the quality of its data and its independent position.

The [Statistics Netherlands Act](#) constitutes the legal basis for CBS. The EU General Data Protection Regulation (GDPR) and the GDPR Implementation Act in the Netherlands stipulate what is and what is not permissible with regard to personal data. As an autonomous administrative authority (in Dutch: ZBO), CBS performs public service

² If additional Quality Control checks by CBS are needed, they should be described in the covenant between CBS and RIVM about the involvement of CBS in the Dutch inventory system. The current version of the covenant does not contain any additional QC checks, since everything seems already covered by the CBS QA/QC-system as described in this chapter.

tasks but operates independently and not under the direct authority of a Dutch ministry.

The Minister of Economic Affairs and Climate Policy is politically responsible for relevant legislation, budget and conditions. CBS is financed from the state budget and has an Advisory Council, which provides the CBS Director General with solicited and unsolicited advice about the performance of his tasks and the exercise of his powers.

2.3 General quality policy

CBS's mission is to disseminate reliable and coherent statistical information that meets society's needs. A prerequisite of this mission is that the quality of this statistical information is guaranteed, to which end CBS has set up a quality management system, based on the highest international standards. This will allow CBS to remain one of the leading statistical institutes in this respect, without imposing complex and complicated quality systems.

The [Quality Declaration of Statistics Netherlands](#) specifies the way in which quality standards are met. Legislation also applies to CBS. At European level: Statistical Law (EU Regulation 223/2009) and the [European Statistics Code of Practice](#), which is based on 16 quality principles covering the institutional environment, statistical processes and statistical outputs.

The quality policy of CBS serves several aims:

- Complying with the mission of CBS
- Maintaining public trust in CBS and its products
- Satisfaction of users and clients

The following quality aspects of statistical outputs are taken into account:

- Relevance and completeness
- Accuracy and reliability
- Timeliness and punctuality
- Coherence, comparability and consistency
- Accessibility and clarity

CBS also aims to manage the costs of its statistics by producing them efficiently and by minimizing the administrative burden on its respondents and data suppliers.

The confidentiality policy of CBS guarantees the privacy of each data supplier, the confidential character of the information they provide, and the exclusive use of their data for statistical purposes. In the dissemination of survey results it is ensured that no figures can be traced back to individual persons, households, companies or institutions. When databases are linked very strict conditions are in place to protect individual identities.

CBS adheres to the international standards **NEN-EN-ISO 9001** (quality management systems; focusing on product quality and consumer satisfaction) and **ISO/IEC 27001** (information security), see [ISO and](#)

[privacy certification](#). CBS is certified for both standards. CBS continuously strives to improve its management systems and statistical processes, in line with these standards. To that end CBS also introduced **Lean Six Sigma** as a tool for improving the operation of all its processes, not only the statistical ones.

2.4 Quality Control (QC) and Quality Assurance (QA)

In July 2018 CBS disseminated a paper, [Statistical quality by design: certification, rules and culture](#), in which the QC/QA-system at CBS is described. The main elements of this paper are repeated here.

Quality management at CBS focuses on guiding and informing statisticians. It is based on two principles: (1) every statistical team is responsible for their own quality and (2) the CBS staff consists of conscientious professionals. It is not efficient nor would it be acceptable for staff members in a modern organization, if we were to check every action of every statistician in every statistical process. Simply put, we cannot have an auditor standing behind each statistician. We have to create, and rely on, a quality culture. To facilitate this four quality tools are used by CBS: (1) quality guidelines, (2) statistical audits, (3) self-assessments, and (4) process descriptions.

Quality Guidelines: our main tool

The general framework for quality management at CBS is set by the [Statistics Netherlands Quality Guidelines](#) (around 200 pages), which contributes to:

- achievement of CBS mission and core values;
- conformity with legislation;
- the trust of all CBS stakeholders and its products;
- stakeholder satisfaction with CBS products;
- the image and reputation of CBS;
- the transparency of CBS.

Moreover, the CBS Quality Guidelines:

- serve as input and explanatory notes for the audit framework;
- serve as input and explanatory notes in setting the self-assessment questions;
- provide a framework for statistical process redesign and adaptations;
- ensure conformity with existing lower-level frameworks.

All kinds of quality controls could be derived from the CBS Quality Guidelines.

Statistical audits

CBS statistical audits are managed by a central department according to **ISO 19011** (guidelines for auditing management systems). The auditors themselves are all internal statisticians and methodologists. The audit results are reported directly to the CBS Director General and are used by process owners to plan improvement actions. The audit framework is consistent with the CBS Quality Guidelines. The way we audit is gradually changing from 'to control' to 'in control'. The 'to control' approach is: "tell me what you are doing and I will tell you what is right and what is wrong." The 'in control' approach is: "prove to me that you are in control."

Self-assessments

All statistical processes are required to complete on a regular basis, at least once every three years, a self-assessment about its quality. The used questionnaires are consistent with the CBS Quality Guidelines. The purpose of the self-assessment is to identify points for improvement. Process owners compile action plans based on the results of the self-assessment.

Process descriptions

Quality Documents are mandatory for all 280 statistical processes at CBS. These documents contain a process description, a list of information systems, and a list of relevant Service Level Agreements (SLA) with data users and data suppliers. Each CBS Quality Document is regularly updated, at least once every three years.

3 Quality control and quality assurance at Rijkswaterstaat Waste Management Department

3.1 Introduction

This paragraph describes the quality assurance and quality control activities of Rijkswaterstaat, Waste Management Department, that are related to estimates of greenhouse gas emissions from waste related activities³ for the sector 5A, 5B and 5C/1A1a other fuels. It focuses on those aspects that have impact on the greenhouse gas inventory and describes only the main aspects.

3.2 The organisation

Rijkswaterstaat is the executive agency of the Ministry of Infrastructure and Water Management, dedicated to promote safety, mobility and the quality of life in the Netherlands.

Nationally, Rijkswaterstaat carries out programmes for the Ministry of Infrastructure and Water Management. The "waste programme" started January 1st 2005. Since then many of the tasks in the policy field of waste for the Ministry of Infrastructure and Water Management or its predecessors have been carried out within one organisation⁴. The Waste Management Department implements programmes and national and international regulations relating to waste. It also advises on the preparation and evaluation of waste policy. The Waste Management Department is the central point for authorities and companies looking for knowledge and expert advice.

One of the tasks of the Waste Management Department is the monitoring of waste and waste related aspects, such as emissions. In accordance with the Waste Management Plan⁵ of the Ministry of Infrastructure and Water Management, the Waste Management Department is the central point for the coordination of the collecting, analysing and presenting of these results and figures. This is done in cooperation with other organisations such as the CBS (Statistics Netherlands).

The required activities for the estimations of greenhouse gas emissions from the waste sector (by the Waste Management Department) are agreed upon by a cooperation covenant between the RIVM and Rijkswaterstaat. On a yearly base the emissions from composting/digesting of separated collected organic waste, incinerating in municipal solid waste incinerators and land filling are calculated. The relevant agreements from the covenant are also described in the ER implementation plan [RIVM/MNP, 2005] and the ER strategy [RIVM, 2010]. In 2020 work is in progress to update the strategy.

³ As composting/digesting, waste incineration and land filling.

⁴ Before that the different tasks were carried out by different organisations.

⁵ Landelijk afvalbeheerplan; See www.lap3.nl

3.3 General QA/QC policy

The Waste Management Department participates in all arrangements under the Emission Registration process (ER), though not as a formal subcontractor, but as stated through a covenant between RIVM and the Waste Management Department. This implies that the QA/QC, related to greenhouse gas emissions, is fully integrated in the QA/QC of the ER.

3.4 Quality control

The checks applied on the annual greenhouse gas emissions estimates are therefore part of the QC checks as elaborated in the QC Tier 1 and (where applicable) QC Tier 2 checks of the ER project. The table on QC checks in annex 2 further details this for composting, land filling and incinerating. This table should be seen as additional to the general overview, described in Annex 1 of this document.

For a proper understanding below, in addition, more general aspects of the quality control at the Waste Management Department are described.

Transparency

All monitoring activities, the collection, analysing and reporting, of the Waste Management Department are published in different documents for the public. These documents contain also the methods and detailed information on the different tasks.

Input data QC and continuity

The Waste Management Department uses input data for greenhouse gas emissions from waste related activities from different questionnaires and analyses. These questionnaires have a long term history (mostly back to 1990, some even further back), on a yearly basis. The most important questionnaires are done by the Waste Management Department themselves, according to the agreements with the Ministry of Infrastructure and Water Management.

QC checks

Quality checks are performed as part of the routine monitoring activities. These include plausibility checks, checks with data from earlier years on outliers, checks on errors and where possible comparison with other data sources. For the checks as part of the ER process, see inter alia Annex 1.

Uncertainties

Uncertainties are usually assessed through expert judgements. The uncertainty estimates for greenhouse gas emissions are fully part of the ER process and are described (Rijkswaterstaat, 2014).

3.5 Quality assurance

In addition to being fully subject to the emission estimation activities under the ER, including all the QA activities under the National System (see annual QA/QC programmes and work plans), the Waste Management Department is also responsible for the different waste reporting obligations for the Netherlands towards the European Union. These obligations have a frequency from yearly to once every three years (for all these three years). Different parties within the European

Union (e.g. Eurostat or the European Environmental Agency) collect these reports and check the information on the quality, consistency and plausibility.

3.6 Documentation and archiving

Relevant documentation and database versions are logged and archived. The period for storage of basic hard copy raw data (e.g. returned filled in forms from questionnaires) is often 5 years, sometimes longer. Electronic databases are usually stored longer. All emission related databases and tools are available going back to at least 1990.

3.7 Evaluation and improvement

As mentioned, the Waste Management Department is a full participant of the ER process and subject to the annual evaluation and improvement cycle of the National System.

4 Quality control and quality assurance at Wageningen Environmental Research

4.1 Introduction

Wageningen Environmental Research

To meet the environmental challenges of today and tomorrow, the focus of Wageningen Environmental Research on science allows us to unite our skills in cooperation between teams of subject specialists. Our 400 staff members are divided over more than 10 teams, each focused on a particular topic to develop innovative solutions that are practical, efficient and cost-effective. We execute research in the field of flora and fauna, soil, water, climate, vegetation, land cover and land use, the use of geo-information and remote sensing, environmental risk assessment, landscape and spatial planning, forestry, recreation and governance.

WOT N&M (Statutory Research Tasks Unit for Nature and the Environment)

The mission of the Statutory Research Tasks Unit for Nature and the Environment (WOT Natuur & Milieu) is to carry out statutory research tasks on issues relating to nature and the environment. These tasks are implemented in order to support the Dutch Minister of Agriculture, Nature and Food Quality (LNV), who is responsible for these issues. LNV determines aim, scope and contents of the research. For these tasks LNV concludes long term agreements with Wageningen Research (including WENR).

WOT N&M provides data on agri-environment, biodiversity and soil information to compile reports as part of national and international obligations, and works on products of the PBL Netherlands Environmental Assessment Agency, such as the Assessment of the Human Environment reports.

4.2 Quality organisation

This section describes the quality assurance and quality control activities of Wageningen Environmental Research (WENR) that are relevant to the work on estimates of greenhouse gas emissions and removals for the Agriculture and Land Use, Land Use Change and Forestry (LULUCF) sectors. This information is based on available documentation and scientific reports and on discussions of RIVM, PBL and RVO within the period 2005 – 2019.

Wageningen Environmental Research (and its predecessor Alterra) has a long-standing history of involvement in the Dutch system of emission monitoring. Its involvement includes the annual production of data that are a basis for greenhouse gas emission estimates for agricultural soils and for LULUCF. WENR fully participates in the process of emission estimates in the ER, the Netherlands Emission Monitoring system, notably in the Taskforce on Agriculture and Land Use.

The participation of WENR in emission estimates is formally arranged through two channels:

- The activities for the ER are part of the Statutory Research Tasks Unit for Nature & the Environment (in Dutch: WOT N&M) commissioned to WENR by the Ministry of Agriculture, Nature and Food Quality. WENR carries out a project with the aim to collect, process and report data on carbon stock changes in the LULUCF categories as a result of (changes in) land use and forestry, in line with the methods that are detailed in methodological background documents for LULUCF. WENR also supports the calculation of emission data on nitrous oxide emissions from agricultural soils.
- In addition, specific supporting research activities for relevant parties carried out under consultancy contracts which are used to continuously improve the monitoring and reporting (Arets et al, 2020; van Bruggen et al, 2020).

As part of its work, WENR also participates in advisory bodies for the improvement of the National System under the Kyoto Protocol, such as a special project group on LULUCF issues, that advises the Ministry of Agriculture, Nature and Food Quality on LULUCF issues. Its experts are also involved in EU Monitoring Mechanism workshops on LULUCF and agricultural soil issues and participate in the IPCC processes to develop Good Practice Guidance on relevant issues and the IPCC assessment reports. Through these activities, WENR has a thorough understanding of the UNFCCC guidelines including the requirements with regard to QA/QC.

In 2003 Wageningen Environmental Research implemented the NEN-EN-ISO 9001 certified quality management system. Since 2006 Wageningen Environmental Research has been working with the ISO 14001 certified environmental care system. By implementing the ISO 26000 guideline, Wageningen Environmental Research can manage and deliver its social responsibility. For research projects to be carried out in compliance with OECD regulations for Good Laboratory Practices, specific procedures have been described, which are an integral part of WENR's quality system.

WOT N&M maintains an ISO certified quality management system, according to the standard NEN-EN-ISO 9001:2015 that ensures that the quality aspects of all our assignments are planned for and managed in a systematic and measurable way.

4.3 Quality audits

The internal auditing system is established to check whether applied quality activities comply with the agreed quality system and contribute to the quality objectives. Audit results are reported to the Management Director and are used by the Team Leaders to improve the quality system.

For models and datasets (used within WOT N&M) activities, a dedicated audit system is established in 2004. Quality of models and datasets is

defined through a list of indicators covering scientific and technical aspects, the management and organisation and interpretation guidance and user support. These indicators are assessed in an internal audit every 4 to 5 years.

4.4 Quality assurance Certificates and Accreditations

WENR's Quality Management and Assurance System fulfils the requirements of several international standards for quality systems (see table). Audit results are reported to the Management Director and are used by the Team Leaders to improve the quality system.

Quality assurance Certificates and Accreditations

Quality certificate	Applies to	Issued by	Valid until
NEN-EN-ISO 9001:2015	WENR	DNV Business Assurance	October 25, 2021
NEN-EN-ISO 9001:2015	WOT N&M	DNV Business Assurance	October 25, 2021
ISO 14001:2015	WENR	DNV Business Assurance	October 25, 2021

WENR is committed to the continual development of the Quality Management System wherein all processes are assessed by a separate, but objective organization, for the verification of adequate process control and for objective reporting of quality to management.

4.5 Quality control in research projects

Quality measures are relevant for research projects to guarantee product quality for the customer. The measures consist of *general* and *project specific* measures.

Important *general* quality measures in research projects are:

- Use of a standard format for project description;
- Use of a standard electronic tool for calculating project costs;
- The principle that the project manager is responsible for quality control in research projects;
- The principle that the project manager is responsible for communication with customers about: project definition, applied methodology, research progress, research results, reporting and project evaluation.

The *project* manager is responsible for selection and implementation of *additional* and *project specific* quality control measures in research projects, e.g.:

- Selection of an appropriate research team (approval by the Team Leader);
- Choice of appropriate methods and models;
- Planning of an internal or external scientific reviewing panel;
- Planning of an external audit.

Besides the internal and formal quality assurance systems mentioned above, there are several external and/or informal mechanisms that contribute to the quality of our output:

- Concepts of peer-reviewed publications are subject to external screening by experts in the relevant field;
- Stimulation of co-authorships with a joint responsibility for the publication;
- Participation of WENR staff in Graduate Schools of Wageningen University, accredited by the Royal Netherlands Academy of Sciences;
- An active role in the development and application of international standards for certain fields of research.

4.6 General QA/QC issues WOT unit for Nature & the Environment (additions)

The WOT unit N&M at Wageningen Research has its own quality management system. It uses, where possible, the WENR quality management system. Forms and procedures of that system are applicable also for the WOT unit, unless other or additional procedures are mentioned in the additional quality handbook for the WOT unit itself [WOT, 2020].

4.7 Quality control WOT unit

In addition, for the WOT unit quality classes have been defined: For reports and studies, a peer expert should review the draft. Afterwards also editorial aspects are checked.

5 Quality control and quality assurance at Wageningen Livestock Research

5.1 Introduction

This annex describes the quality control and quality assurance activities of (Wageningen Livestock Research) in relation to the protocol (Bannink, 2011) for estimation of emission factor for enteric methane from dairy cows and apparent fecal N digestibility (not other cattle, not other ruminant species). The protocol includes the use of a dynamic, mechanistic model of enteric fermentation and digestion, applied as a Tier 3 approach. The methodology is described in reports and peer-reviewed papers on microbial activity and end-products of fermentation in the rumen and large intestine and digestion in the small intestine in dairy cattle (Dijkstra et al., 1992; Mills et al., 2001; Bannink et al., 2008; Bannink, 2010; Bannink et al., 2011; Bannink et al., 2018). Wageningen Livestock Research has a long standing history of mathematical modelling of fermentative and digestive processes in the digestive tract of ruminants and in predicting the extent and site of feed digestion, microbial synthesis including methanogenesis, digestion and nutrient absorption and excretion with urine and faeces. Wageningen Livestock Research works in close collaboration with the chair group of Animal Nutrition of Wageningen University & Research who initiated and delivered modelling work, in close cooperation with foreign scientists.

Involvement of Wageningen Livestock Research in the ER includes:

- the calculation of enteric methane emission in dairy cows based on statistical data delivered by CBS (QA/QC responsibility with CBS) by following a Tier 3 approach;
- the calculation of apparent fecal nitrogen digestibility in dairy cows based on the same statistical data as described for enteric methane, using the identical Tier 3 approach;
- giving advise with the amendment of protocols;
- application of the Tier 3 to evaluate nutritional measures and policy options affecting enteric methane and apparent fecal nitrogen digestibility;
- responsibility for QA/QC with use of the Tier 3, and as the developer of the Tier 3 communicate its applicability, its limitations and its operative aspects.

In addition, Wageningen Livestock Research is responsible for:

- development, evaluation and application of the Tier 3 methodology for enteric methane in dairy cows;
- the scientific quality of the Tier 3 and publication of results obtained with the Tier 3, in co-authorship with chair group Animal Nutrition of Wageningen University & Research, in peer-reviewed papers in ranked scientific journals.

5.2 The organization

The CBS is responsible for collecting, processing and publishing statistics on the composition of dairy cow rations, the chemical composition and feeding value of dietary components, and on feed intake and milk yield. These statistics are delivered strictly to scientists at Wageningen Livestock Research who have (demonstrably) the expertise to use the Tier 3 and who are familiar with construction and scientific background of the Tier 3, with its applicability and evaluations, and with its limitations.

The Wageningen Livestock Research activities that have a direct relation with the research activities on digestive processes in ruminants as well as mathematical modelling in two departments at Wageningen University & Research:

the Animal Nutrition group of Wageningen Livestock Research; this group is located in Wageningen and primarily responsible for conducting the calculations and for delivery of emission factors and related background information for the NIR;

the chair group of Animal Nutrition of Wageningen University & Research; this group is located in Wageningen and collaborates closely with the group of Wageningen Livestock Research in experimental as well as modelling research projects related to digestive and fermentative processes in the digestive tract of dairy cows.

5.3 General QA/QC issues

Wageningen Livestock Research is an institute within the legal entity 'Stichting Wageningen Research', a foundation ('stichting') incorporated under the laws of The Netherlands, with registered office at Wageningen. Wageningen Livestock has a certified ISO 9001:2015 quality system.

5.4 Quality control

All relevant processes have been described in the Quality Manual of Wageningen Livestock Research. Wageningen Livestock Research has a thorough system of audits that may lead to recommended improvements. The implementation of agreed upon resulting actions is controlled by a quality manager. Procedures are in place for continuous improvement.

5.5 Quality assurance

Wageningen Livestock Research uses various types of audits:

- annual audits by the certifier, as required under its certification process;
- internal audits, that involve both the primary processes and supporting processes. The focus of these audits is determined by the management.

5.6 Documentation and archiving

Detailed procedures are in place of document management. On each project the relevant documents are archived in the project file.

5.7 Evaluation and improvement

Evaluations or potential improvements of the Tier 3 methodology for prediction of enteric methane emission and apparent fecal nitrogen digestibility in dairy cows, or of the interpretation of the results generated, are shared with the agency responsible for the ER and archived by the latter.

Quality aspects within Wageningen Livestock Research will be addressed according to the internal Quality Manual which was described above.

5.8 Quality control

Wageningen Livestock Research participates in the ER process as an outside agency delivering estimates of enteric methane emission and apparent fecal nitrogen digestibility in dairy cows. Results are delivered and discussed with the working group on NEMA (National Emission Model of Agriculture) and integrated in this model by CBS as the agency that is primarily responsible for archiving the results delivered, and for archiving discussions related to data checks and quality control and assurance. Wageningen Livestock Research is primarily responsible for archiving the Tier 3 methodology applied, the model inputs used, the calculation results delivered and its documentation. Communication and evaluation of the Tier 3 methodology itself is preferably achieved by peer-reviewed papers in ranked scientific journals including a co-author of the chair group of Animal Nutrition of Wageningen University & Research.

All other aspects of QA/QC, related to greenhouse gas emissions, are handled by the agency responsible for the ER or with other outside agencies such as the CBS. This means that the initiative and documentation of checks on the annual enteric methane emission and apparent fecal nitrogen digestibility in dairy cows delivered by Wageningen Livestock Research is therefore subject to the QC checks elaborated in the ER. Wageningen Livestock Research only handles QC/QA aspects specifically related to application of the Tier 3 methodology for enteric methane and apparent fecal nitrogen digestibility in dairy cows. According to standard procedures, the QC/QA aspects of other Tier 1 and Tier 2 are excluded from the Wageningen Livestock Research, unless specific requests are made.

For a proper understanding, some further aspects of the QC are described below:

Transparency

The activities and methodology used by Wageningen Livestock Research in relation to the ER have been documented in a background document (Bannink, 2011). In addition the Tier 3 methodology for estimation of enteric methane emission in dairy cows has been described in peer-reviewed papers in ranked scientific journals. The Tier 3 methodology including the related ER results and an analysis of uncertainty of estimates was published in a peer-reviewed journal (Bannink et al., 2011), and recently adapted to accommodate for accurate prediction of apparent fecal nitrogen digestibility (Bannink et al., 2018). For documentation of the model formulation and the input requirements, the reader is referred to the basic modelling work published by Dijkstra et

al. (1992), Mills et al. (2001) and Bannink et al. (2008, 2011, 2018). All data delivered by CBS, the calculation routines to generate model input for the Tier 3 and the Tier 3 method itself have been documented after they have become final results and have been reported to CBS, and are stored in the project files within the project management system as implemented in Wageningen Livestock Research and remain unchanged, unless discussed and evaluated together with CBS and the agency handling the ER, as was the case with the recent adaptation to accommodate the Tier 3 for apparent fecal nitrogen digestibility.

The ER handling agency is responsible for archiving discussions, notes and decisions on options for improvement and changes in methodology in relation to the Tier 3 methodology. Since the Tier 3 methodology was introduced in 2005, there have been no changes in the formulation of the model applied in the Tier 3 methodology till 2018. In 2018 there was an update of the Tier 3 to accommodate it for prediction of apparent fecal nitrogen digestibility, which was demonstrated to have no consequence for predicted enteric methane however (Bannink et al., 2018).

Input data QC and continuity

The CBS delivers data to Wageningen Livestock Research according to a standardized protocol (evaluated by the WUM) and in a standardized format. These data are required to generate model inputs. Data are delivered yearly according to the frequency of the ER, unless there are specific requests for use of the Tier 3 methodology in addition to the Wageningen Livestock Research task for the ER.

QC checks

Quality checks of data delivered by CBS to Wageningen Livestock Research are primarily performed in the WUM. These checks include plausibility checks, checks with data from earlier years on outliers and checks on potential errors. The table in annex 1 provides more information on the QC checks performed by CBS and the specific role of Wageningen Livestock Research.

Uncertainties

Uncertainty of estimates of enteric methane and apparent fecal nitrogen digestibility in dairy cows have been established by Wageningen Livestock Research (Bannink, 2011; Bannink et al., 2011) through expert judgement of uncertainty associated with model inputs (based on data delivered by CBS) and uncertainty associated with improper model parameters or an improper model formulation.

Model protection with respect to the Tier 3 for enteric methane and apparent fecal nitrogen digestibility in dairy cows

Within Wageningen Livestock Research the control and assurance of quality with respect to the results delivered to the ER, or amendments of the methodology used in the ER, is strictly limited to scientists of Wageningen Livestock Research or of the chair group of Animal Nutrition of Wageningen University & Research who are familiar with the development, construction and application of the Tier 3 methodology. The model is protected in that sense that only these particular scientists have actual access to the Tier 3 and the modelling software required to

run the Tier 3, to evaluate it, and to improve it. The precise coding of the model (including different versions or updates) are stored in the project files within the project management system as implemented by Wageningen Livestock Research.

Data protection in relation to the Tier 3 for enteric methane and apparent fecal nitrogen digestibility in dairy cows

All data they received from CBS are treated as confidential information in principle, as far as have not appeared in publicly available reports. The latter may involve publications from CBS, Wageningen Livestock Research or the ER itself. The primary responsibility for QC/QA with respect to the data lies with CBS and data are evaluated by a Working Group on Unifying Manure and excretion data (WUM). Discussions in the WUM and decisions following from this are communicated with Wageningen Livestock Research. The CBS is initiating and documenting discussions on the national statistics of dairy cows' nutrition and performance within the WUM.

5.9 Quality assurance

Checks with other data

These checks are primarily the responsibility of the agency responsible for the data delivery for the ER.

Wageningen Livestock Research is responsible for the scientific quality of the Tier 3 methodology for enteric methane emission and apparent fecal nitrogen digestibility in dairy cows. This involves a process of model evaluation in cooperation with experts in high-ranking science groups abroad (University of Reading, Reading, UK; University of Guelph, Guelph, CA; University of California, Davis, US). This also includes evaluation of the model against independent methane and nitrogen digestion measurements in dairy cows.

Audits

The Tier 3 calculations by Wageningen Livestock Research are reviewed by the agency responsible for the ER, and are shared with colleagues within Wageningen Livestock Research or the chair group of Animal Nutrition of Wageningen University & Research, who are familiar with the Tier 3 methodology.

Since the introduction of the Tier 3 in 2005 there have been no amendments to the model which would require an additional or further audit. Because the role of Wageningen Livestock Research is rather limited to converting CBS data into model inputs, and to calculate emission factors for enteric methane in dairy cows, other types of audits (e.g. on the data received, or on the handling of the results generated by Wageningen Livestock Research) rely with the agency handling the ER or the outside-agency delivering data to Wageningen Livestock Research.

5.10 Documentation and archiving

Relevant documentation and data bases are logged and archived in separate directories for every single registration year, including all input data derived from CBS, including the results obtained, and including an analysis of trends which allows for a check on consistency and logic of

results. This information is shared with colleagues from the chair group of Animal Nutrition of Wageningen University & Research not directly involved with ER task, but informed on Tier 3 methodology and enteric methane emission and apparent fecal nitrogen digestibility in dairy cows, and who hence can be considered the most experienced independent reviewers.

The model used in the Tier 3 methodology remained unchanged since introduction in 2005 and has been archived as such, and was updated to accommodate calculations on fecal nitrogen digestibility as well in 2018.

5.11 Evaluation and improvement

Wageningen Livestock Research is continuously involved with experimental work on digestive processes and enteric methane emission in dairy cattle, as well as with the modelling of these processes by dynamic, mechanistic modelling techniques.

Observational data generated by Wageningen Livestock Research itself, or published in literature, will be used to evaluate the accuracy of methane predictions by the Tier 3 approach, and to evaluate the potential of improvement of predictions.

Work with the Tier 3 method is shared with international research groups who closely collaborate with Wageningen Livestock Research on ruminant nutrition and enteric fermentation. Preferably, such collaborative work will be published in peer-reviewed papers.

6 Quality control and quality assurance at TNO

6.1 Introduction

This paragraph describes the quality assurance and quality control activities of TNO that are related to emission estimates, reporting and the uncertainty analysis.

TNO has a long history of involvement in the Dutch Emission Registration and played an important role in the start of the Emission Registration in 1974. Currently TNO contributions to the Emission Registration are:

- Calculation of emissions of greenhouse gases and air pollutants from transport (all except road transport), industry (individual companies) and households;
- Participation in the Task forces ENINA (Energy, Industry and Waste), Transport, MEWAT (water), WESP (consumers and product use), Spatial allocation;
- Reporting of NIR/CRF, IIR/NFR and LCP;
- Uncertainty analysis of the greenhouse gas inventory in the NIR and the air pollutant inventory in the IIR;
- Contributions to the general annual QA/QC cycle.

6.2 The organisation

TNO, the Netherlands Organisation for applied scientific research TNO, was founded by law in 1932 (TNO Act - BWBR0003906) to enable business and government to apply knowledge. As an organization regulated by public law, TNO is independent: not part of any government, university or company.

The mission of TNO is to connect people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way. Innovation with purpose is what TNO stands for. TNO develops knowledge not for its own sake, but for practical application. TNO works in collaboration with partners and focus on the following domains:

- Defence, Safety & Security;
- Industry;
- Traffic & Transport;
- Healthy Living;
- Buildings, Infrastructure & Maritime;
- Circular Economy & Environment;
- Information & Communication Technology;
- Strategic Analysis & Policy;
- Energy Transition;
- Artificial Intelligence.

Experts from Circular Economy & Environment and from Traffic & Transport are involved in the Emission Registration.

6.3 General QA/QC policy

TNO's policy on quality is oriented to ensuring customer and employee satisfaction, an excellent knowledge position, healthy business operations and continuous improvement of the organization's performance. The organization is managed on the basis of multi-year strategic plans, annual plans and periodic management information. Improvement initiatives are implemented as projects.

Research and development at TNO are performed in individual projects. The project leader is responsible for dealing with and communicating the customer's questions and requirements, from the start of the project until the results have been delivered. The focus is on timely delivery of agreed project results, of high quality and within budget. Projects are executed by qualified staff using state-of-the-art knowledge, work methods and, as necessary, laboratory facilities. For laboratory facilities TNO designates employees to be responsible for the management of rooms, equipment, samples and chemicals. Peer review is an integral part of the process for delivering project results.

TNO has an NEN-EN-ISO 9001:2015 certification, as a result, external audits are performed on a regular basis by regulators and customers. Furthermore, internal quality audits are performed by trained personnel on a yearly basis. The focus of these audits is determined by the management.

The TNO management system defines the primary, managerial, support and improvement processes and is communicated to all our employees via the corporate intranet site. The TNO Company Code – the core values of which are integrity, independence, professionalism and social responsibility – is also communicated to all employees via the corporate intranet site. A PDF version of the TNO code can be found via:

<http://publications.tno.nl/publication/34634041/g81Ao7/tno-2019-code-english.pdf>

Every year, an internal audit program is performed in order to assess, on the basis of random sampling, compliance with the processes defined in the management system. The periodic assessment of TNO's knowledge position and the monitoring of customer and employee satisfaction are carried out by independent third parties. Audits are performed on a regular basis by regulators and customers.

TNO employees maintain the principles and standards as described in the Netherlands code for research integrity 2018 (NGWI). These standards can be found via the TNO website and are also underwritten by KNAW, NFU, NWO, TO2-federation, the Association of Universities of Applied Sciences and VSNU.

TNO customer satisfaction is assessed by an independent third party by means of random-sample interviews. The results of these interviews are discussed on a regular basis with all the project leaders of the applicable department. An annual overview of project results is compared with previous years and also discussed with all project leaders. These sessions are focused on learning from each other in order to further improve the customer satisfaction.

6.4 Quality control

The Emission Register contains the yearly releases of more than 350 pollutants to air, soil and water. Components are selected according to the international reporting obligations: the Kyoto Protocol, the EU Water Framework Directive, the European Pollution Release and Transfer Register (E-PRTR) and various UN and EU obligations. Additionally, components for following national environmental policies are monitored. The Emission Register project covers the whole process of collecting, processing and reporting of the emission data in the Netherlands.

Emissions are calculated using many different methodologies. Information on individual sources are provided by a few hundred facilities who have an obligation to report their annual individual emissions. These emissions are supplemented, checked and corrected (if needed) by emission specialists. Emissions from diffuse emission sources are calculated by emission experts in 5 task forces, their information is mainly based on National Statistics and various models. When the emission calculations and/or models are designed by TNO, then the new methodology is based on scientific literature, new measurements and/or international standards and the new method is internally reviewed. The results are checked with emissions reported in other countries, other sources in the Netherlands and, if possible, other relevant statistics.

After design of the emission calculation methods, these methods are used yearly to calculate emissions for the most recent years, by using the most recent statistics for this emission source. Statistics are always checked before using them in emission calculations, for example by checking the trend and comparing it to other related statistics. If these are plausible, then the data are used to calculate the emissions.

Once the emission calculations are finalised, the results are checked again:

- Checks on trend irregularities;
- Checks on plausibility of implied emission factors;
- Checks on units applied (factor 1000 mistakes);
- Checks on relations between pollutants (for example a rise in CO₂ from combustion should be accompanied by an increase in NO_x emissions).

Before the final emission data and reports are made available to the Emission Registration, the data and reports are checked by an internal (TNO) reviewer.

Before finalizing the gathered data, all data are scrutinized by all members of the Task forces (of all institutes involved) in a technical meeting ('trend analysis') in which all trends are presented, discussed and are accounted for. The results of these meetings are documented and implemented in the central database.

6.5 Quality assurance

Quality assurance comprises activities outside the actual inventory compilation. For the emission inventory works, this includes the regular review of the emission data and reports by an internal reviewer. Also,

emission data are reviewed by persons not involved in the emission inventory team. This includes at least a check of the trends (at the same time as the trend analysis, but then by a person not involved in the inventory).

Emission calculation methods are also regularly discussed within the Task Forces, resulting in a decision to check and improve a certain methodology or not. An independent audit is sometimes planned for individual Task Forces, or for the Emission Registry as a whole. This is organised by RIVM, and the results are used by all Task Force members (including TNO) for improvements.

6.6 Documentation and archiving

The methods used for calculating the emissions within the task forces are described in an annually updated methodology report. Furthermore, most emission calculation models or spreadsheets contain a sheet or document explaining the main steps and checks that need to be performed to calculate the emissions.

The emission calculations are performed either in MS Excel or MS Access and the final version of each calculation is saved on a fileshare in TNO (together with the documentation on the calculations, input data, checks, and final output data). The final version of the emission calculations in year t is used to start the emission calculations in year $t+1$. Review results are communicated by email and stored in an email archive.

Project dossiers within TNO are filed and archived after completion of the project. The duration of the storage depends on the type of contract, by default the duration is set to 7 years. In practice, emission calculations and other data for the Dutch Emission Registration are stored longer.

6.7 Evaluation and improvement

TNO has as general policy of continuous learning and improving on basis of feedback from customers and employees. Each project is evaluated at the end of the project. For the Emission Registration work, this means that project is evaluated internally on an annual basis. Identified room for improvements are fed into the internal project management and or in to the annual improvement plan for the ER.

Acknowledgement

The update process for the report "QA/QC of outside agencies in the Greenhouse Gas Emission Inventory" version 2011 started with a workshop to inform the involved outside agencies and their officials on the need for updating the QA/QC information of outside agencies in the greenhouse gas inventory. Mr Peter Zijlema and Mrs Jorieke Rienstra (both Netherlands Enterprise Agency (RVO)) contributed in organising and leading the workshop and the presentations.

The updated document was made in co-operation with RVO acting as National Inventory Entity (NIE) and the involved outside agencies.

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Annex 1 Overview of QC Tier 1 procedures by ER and NIE

Tier 1 General Inventory Level QC Procedures (Table in table 6.1 of the IPCC 2006)				
QC Activity	Procedures	Practical application in the Netherlands	Registration	Responsibility
1. Check that assumptions and criteria for the selection of activity data and emission factors are documented.	<ul style="list-style-type: none"> • Cross-check <u>descriptions of activity data and emission factors</u> with information on source categories and ensure that these are <u>properly recorded and archived</u>. 	<ul style="list-style-type: none"> • Performing in recent years extensive sectoral and other relevant reviews and studies as part of development of protocols • Any update of extensive reviews and studies arranged in QAQC programme. • Procedure described in release form for the methodology reports • Documentation and archiving arranged in procedure. 	<ul style="list-style-type: none"> • Release Form methodology reports (NIE). • Methodology reports. • Background documents on emission factors and activity data. 	<ul style="list-style-type: none"> • NIE responsible for recent improvement programme. • NIE and ER together responsible for documentation and updates. NIE checks against guidelines and procedures for documentation and archiving. Taskforce members ER responsible for annual cross-checks, registration and identification of need for updates. • NIE responsible for supervision and planning of QAQC programme.

Tier 1 General Inventory Level QC Procedures (Table in table 6.1 of the IPCC 2006)				
QC Activity	Procedures	Practical application in the Netherlands	Registration	Responsibility
2. Check for transcription errors in <u>data input and references.</u>	<ul style="list-style-type: none"> • Confirm that bibliographical data <u>references are properly cited</u> in the internal documentation. • Cross-check a sample of input data from each source category (either measurements or parameters used in calculations) for <u>transcription errors.</u> 	<ul style="list-style-type: none"> • Procedure described in the Release Form Methodology reports (NIE). The need of using this form is specified in the Work plan ER. • Planning for sample and cross checks on input data is annually described in the Work plan ER. Most cross-checks take place on the Trend Analysis Workshop. • Project manager ER responsible for instructions and documents for preparation of trend analysis workshop. 	<ul style="list-style-type: none"> • Release Form methodology reports (NIE). • Work plan ER. • E-mails by project-leader ER. • Report Trend Analysis. • QC registrations by taskforces. 	<ul style="list-style-type: none"> • Taskforce members are responsible for checking references and annual cross checks and identification of any required updates. • Project manager ER responsible for planning in the annual Work plan ER and for the instructions. • Taskforce members are responsible for cross-checks, registration and archiving. • NIE is responsible for checking that the planning and performance of these activities are according to agreements.
3. Check that emissions are <u>calculated correctly.</u>	<ul style="list-style-type: none"> • <u>Reproduce</u> a representative sample of emission <u>calculations.</u> • Selectively mimic complex model calculations with abbreviated calculations to <u>judge relative accuracy.</u> 	<ul style="list-style-type: none"> • The planning of sample and abbreviated emission calculations and judgement of relative accuracy is annually described in the Work plan ER. • Reproducing representative samples of emission calculations is part of the work in the tasks forces. 	<ul style="list-style-type: none"> • Work plan ER. • E-mail project-leader ER (request). • QC registrations and reporting by taskforce members. 	<ul style="list-style-type: none"> • Project manager ER is responsible for planning and implementation of sample and abbreviated calculations and for judgement of relative accuracy. • Taskforce members are responsible for actual implementation of sample calculations and of judgement of relative accuracy, registration and archiving. • NIE is responsible for supervising that the planning and performance of these activities are according to agreements.

Tier 1 General Inventory Level QC Procedures (Table in table 6.1 of the IPCC 2006)				
QC Activity	Procedures	Practical application in the Netherlands	Registration	Responsibility
4. Check that parameter and emission <u>units</u> are correctly recorded and that appropriate conversion factors are used.	<ul style="list-style-type: none"> • Check that units are <u>properly labelled</u> in calculation sheets. • Check that units are <u>correctly carried through</u> from beginning to end of calculations. • Check <u>that conversion factors</u> are correct. • Check that temporal and spatial <u>adjustment factors</u> are used correctly. 	<ul style="list-style-type: none"> • Checks are part of primary process. Instructions are annually described in the Work plan ER. • Checks are performed by the taskforce members ER. • Entrees in database are checked at least twice (by TNO and by taskforce members) on plausibility etc. • IEF checks provide additional check. 	<ul style="list-style-type: none"> • Work plan ER. • QC registrations by ER (e-mails + log). 	<ul style="list-style-type: none"> • Taskforce members are responsible for checks and registration. The quality coordinator of the ER responsible for archiving of QC registrations. • Project manager ER is responsible for description in the Work plan ER. • NIE is responsible for supervising the planning and checking that performance of these activities is according to agreements and requirements.
5. Check the integrity of <u>database files</u> .	<ul style="list-style-type: none"> • Confirm that the appropriate <u>data processing steps</u> are correctly represented in the database. • Confirm that <u>data relationships</u> are correctly represented in the database. • Ensure that <u>data fields</u> are properly labelled and have the correct design specifications. • Ensure that <u>adequate documentation</u> of database and model structure and operation are archived. 	<ul style="list-style-type: none"> • Database only accessible by (very limited) number of authorized staff. • TNO performs checks in database and CRF. • Documentation on databases available with database manager. 	<ul style="list-style-type: none"> • QC registrations and reporting by taskforce member (e-mail and log). • Internal documentation on ER data base. 	<ul style="list-style-type: none"> • Database manager is responsible for checks, registration and archiving. • Project manager ER is responsible for description in the Work plan ER. • NIE is responsible for annual checks that information is according to agreements and requirements.

Tier 1 General Inventory Level QC Procedures (Table in table 6.1 of the IPCC 2006)				
QC Activity	Procedures	Practical application in the Netherlands	Registration	Responsibility
6. Check for <u>consistency</u> in data <u>between source categories</u> .	<ul style="list-style-type: none"> • <u>Identify</u> parameters (e.g. activity data, constants) that are common to multiple source categories and <u>confirm</u> that there is <u>consistency</u> in the values used for these parameters in the emission calculation. 	<ul style="list-style-type: none"> • Consistency checks are part of trend analysis workshop. • Checks also enabled through separate information on activity data etc. 	<ul style="list-style-type: none"> • QC registrations and reporting by taskforce member (e-mail and log). • Report on Trend Analysis Workshop. 	<ul style="list-style-type: none"> • Database manager is responsible for checks, registration and archiving. • Project manager ER is responsible for description in the Work plan ER. • NIE is responsible for annual checks that information is according to agreements and requirements.
7. Check that the <u>movement of inventory data among processing steps</u> is correct.	<ul style="list-style-type: none"> • Check that emissions data are <u>correctly aggregated</u> from lower reporting levels to higher reporting levels when preparing summaries. • Check that emissions data are <u>correctly transcribed</u> between different intermediate products. 	<ul style="list-style-type: none"> • Process steps are described in to methodology reports. • QC checks performed on database in various steps of process. These include e.g. consistency and plausibility checks. 	<ul style="list-style-type: none"> • Methodology reports for process. • QC registrations for results. 	<ul style="list-style-type: none"> • Database manager is responsible for checks, registration and archiving. • Project manager ER is responsible for description in the Work plan ER. • NIE is responsible for annual checks that information is according to agreements and requirements.

Tier 1 General Inventory Level QC Procedures (Table in table 6.1 of the IPCC 2006)				
QC Activity	Procedures	Practical application in the Netherlands	Registration	Responsibility
8. Check that <u>uncertainties</u> in emissions and removals are estimated or calculated correctly.	<ul style="list-style-type: none"> • Check that <u>qualifications</u> of individuals providing expert judgement for uncertainty estimates are <u>appropriate</u>. • Check that qualifications, assumptions and expert judgements are <u>reported</u>. • Check that calculated uncertainties are <u>complete</u> and calculated <u>correctly</u>. • If necessary, duplicate error calculations or a small sample of the probability distributions used <u>by Monte Carlo analyses</u>. 	<ul style="list-style-type: none"> • According to Procedures on uncertainty analysis and on expert elicitation. • Tier 2 update studies at least every 5-year and in case of major methodological changes (including Monte Carlo analyses). 	<ul style="list-style-type: none"> • Procedures. • Background report on uncertainties. 	<ul style="list-style-type: none"> • NIE and ER together are responsible for uncertainties and expert elicitation. • Project manager ER is responsible for planning uncertainty estimations and calculations in the Workplan ER annual. • Taskforce members are responsible for calculations and for annual checks on complete and correct calculations of uncertainties, as well as registration and archiving. • NIE is responsible for supervising planning and checking that performance of these activities is according to the procedure. • NIE is facilitating regular Monte Carlo analyses (tier 2).

Tier 1 General Inventory Level QC Procedures (Table in table 6.1 of the IPCC 2006)				
QC Activity	Procedures	Practical application in the Netherlands	Registration	Responsibility
9. Undertake <u>review</u> of internal documentation.	<ul style="list-style-type: none"> • Check that there is <u>detailed internal documentation</u> to support estimates and enable duplication of the emission and uncertainty estimates. • Check that inventory data, supporting data and inventory records are <u>archived</u> and stored to facilitate detailed review. • Check integrity of any data archiving arrangements of <u>outside organisations</u> involved in inventory preparation. 	<ul style="list-style-type: none"> • Implemented by Methodology reports and background documents. • Checked by internal reviews and audits in accordance with QA/QC programme. • Actual annual implementation using Procedure on archiving and documentation. • Maintaining and updating description of QA/QC outside agencies (and including appropriate improvement actions in QA/QC plan if needed and possible). 	<ul style="list-style-type: none"> • Methodology reports. • Reports on internal reviews and audits. • List of key documents. • Annual archives. • Report and background info on QA/QC of outside agencies. 	<ul style="list-style-type: none"> • NIE is responsible for regular review of internal documentation. • NIE and ER together are responsible for description QA/QC activities outside agencies. • Database manager is responsible for a description of the data base structure.
10. Check methodological and data changes resulting in <u>re-calculations</u> .	<ul style="list-style-type: none"> • Check for <u>temporal consistency</u> in time series input data for each source category. • Check for <u>consistency in the algorithm/method</u> used for calculations throughout time series. 	<ul style="list-style-type: none"> • Checks are part of primary process. Instructions and planning of checks are annually described in the Work plan ER. • Checks are performed by the taskforce members ER. • Consistency in methods and time series arranged in methodology reports. • Methodological and time series change requires special permission in accordance with procedure for modifications. 	<ul style="list-style-type: none"> • Work plan ER. • QC registrations and reporting by taskforce members (e-mail+log). • Methodology reports. • Procedure for modifications of methods and/or time series. 	<ul style="list-style-type: none"> • ER Taskforce members are responsible for checks and registration, quality coordinator ER for archiving of QC registrations. • Project manager ER is responsible for description in the Work plan ER. • NIE is responsible for methodology reports and procedures. • NIE responsible for supervising the planning and checking that performance of these activities is according to the procedure.

Tier 1 General Inventory Level QC Procedures (Table in table 6.1 of the IPCC 2006)				
QC Activity	Procedures	Practical application in the Netherlands	Registration	Responsibility
11. <u>Undertake completeness checks.</u>	<ul style="list-style-type: none"> • Confirm that estimates are reported for all source categories and for all years from the base year to the period of the current inventory. • Check that known data gaps that result in incomplete source category emissions estimates are documented. 	<ul style="list-style-type: none"> • Annual checks are part of primary process. Instructions and planning of checks are annually described in the Work plan ER. • Checks are performed by the taskforce members ER. • General checks performed on completeness of sources in development of protocols and a supporting study on small and unknown sources. 	<ul style="list-style-type: none"> • Work plan ER. • QC registrations and reporting by taskforce members (e-mail+log). • Methodology reports. • Reports. 	<ul style="list-style-type: none"> • ER Taskforce members are responsible for checks and registration, quality coordinator ER for archiving of QC registrations • Project manager ER is responsible for description in the Work plan ER. • NIE responsible for supervising the planning and checking that performance of these activities is according to the procedure.
12. <u>Compare estimates to previous estimates.</u>	<ul style="list-style-type: none"> • For each source category, current inventory estimates should be compared to previous estimates. If there are significant changes or departures from expected trends, recheck estimates and explain any difference. 	<ul style="list-style-type: none"> • Annually procedure for comparing estimates to previous estimates is described in the Work plan ER, including the options for partially automated checks. • Comparison (also) part of Trend Analysis Workshop. 	<ul style="list-style-type: none"> • Report Trend Analysis Day. • Documentation-sheet ER. 	<ul style="list-style-type: none"> • Project manager ER is responsible for planning the comparison in the Workplan ER annual. • The database manager and/or taskforce members are responsible for checks, registration and archiving. • NIE responsible for supervising the planning and checking that performance of these activities is according to the agreements and requirements.

Annex 2 Additional checks by Rijkswaterstaat Waste Management Department

The Waste Management Department takes part in the Emission Registration (ER) project of the MNP, and therefore the QA and QC activities related to greenhouse gas emissions are integrated in those of the ER. These general activities are described in the Description of the National System, the QA/QC programme and the Annual Work plan ER. Annex 1 also provides a brief general overview of Tier 1 QC checks within the National System. Above that the Waste Management Department undertakes additional QC checks. By the combination of the general 'ER-checks' and the additional QC checks all of the needed QC checks listed in table 6.1 of the IPCC 2006, are fulfilled.

Additional QC checks for composting and digesting of separated collected organic waste					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
Determine the amount of organic waste composted or digested in the Netherlands	Working Group on Waste Registration	Sending questionnaires to all facilities for composting and digesting organic waste	Check if all operating facilities receive a questionnaire. Are there any new ones?	Every year	
		Collecting questionnaires	Check if all questions are answered.	Every year	
		Process and analyze questionnaires	Check if the given answers are in line with information at the legal authorities.	Every year	
			Check if the given answers are processed correctly.	Every year	
			Check if the given answers (per facility) are in line with previous years. And explain any differences.	Every year	

Additional QC checks for composting and digesting of separated collected organic waste					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
Determine the amount of organic waste composted or digested in the Netherlands.	RWS	Collect all data on organic waste composted or digested in the Netherlands not collected by the Working Group on Waste Registration at Landelijk Meldpunt Afvalstoffen (LMA).	Check if the data is not already collected by the Working Group on Waste Registration to avoid duplicates.	Every year	
			Check if the facilities that report the data are actually composting and or digesting organic waste instead of just collecting, transporting or storing it.	Every year	
			Check if the total amount of organic waste composted is in line with other sources/questionnaires (Statistics Netherlands)	Every year	
		Report the results	Check if the reported results are adopted correctly.	Every year	
Determine the emissions from composting and digesting in the Netherlands	RWS	Determine the emissions in the Excel-tool	Check if the amount of organic waste per facility is correctly taken from the report of the Working Group on Waste Registration and the additional data from LMA.	Every year	
			Check if the formulae are copied correctly.	Every year	

Additional QC checks for composting and digesting of separated collected organic waste					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
			Check if the total emission is in line with former years. And explain any differences.	Every year	
			Check if new information exists on emission factors.	Regularly	
			Check if the total emission is in line with the expectation of experts from the field.	Regularly	
		Deliver the emissions in the proper format to ER	Make sure the information is received and used.	Every year	
Emission check up	Task Force ER (ENINA)	Compare the total with former years	Check if the total amount is in line with former years. And explain differences.	Every year	
Production validated emissions	RIVM	Import the validated emissions in the databases	Check the total emission with the delivered total by RVO	Every year	

Additional QC checks for incinerating in municipal solid waste incinerators					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
Collect data on the amount of waste incinerated	Working Group on Waste Registration	Sending questionnaires to all waste incineration plants	Check if all operating facilities receive a questionnaire. Are there any new ones?	Every year	
		Collecting questionnaires	Check if all questions are answered.	Every year	
		Process and analyze questionnaires	Check if the given answers are in line with information at the legal authorities.	Every year	
			Check if the given answers are processed correctly.	Every year	
			Check if the given answers (per facility) are in line with previous years. And explain differences.	Every year	
		Report the results.	Check if the reported results are adopted correctly.	Every year	
Determine the composition of household waste	RWS	Perform sorting of waste of selected municipalities.	Check whether a representative group of municipalities is chosen.	Every year	
			Make sure the waste is sorted out in the same way as earlier years.	Every year	
		Calculate the composition of household waste.	Compare results with known trends	Every year	
		Report the results	Check if the reported results are adopted correctly.	Every year	

Additional QC checks for incinerating in municipal solid waste incinerators					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
Calculation of the fossil and not-fossil emissions	RWS	Determine the emissions in the Excel-tool.	Check if the amount of waste per facility is correctly withdrawn from the report of the Working Group on Waste Registration.	Every year	
			Check if the formulae are copied correctly.	Every year	
			Check if the total emission is in line with former years. And explain any differences.	Every year	
			Check if new information exists on emission factors.	Regularly	
			Check if the total emission is in line with the expectation of experts from the field.	Regularly	
		Deliver the emissions in the proper format to ER	Make sure the information is received and used.	Every year	
Emission check up	Task Force (ENINA)	Compare the total with former years	Check if the total amount is in line with former years. And explain differences.	Every year	
Production validated emissions	RIVM	Import the validated emissions in the databases	Check the total emission with the delivered total by Rijkswaterstaat	Every year	

Additional QC checks for land filling					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
Collect data on the amount of waste land filled	Working Group on Waste Registration	Sending questionnaires to all the land fills	Check if all operating facilities receive a questionnaire. Are there any new ones?	Every year	
		Collecting questionnaires	Check if all questions are answered.	Every year	
		Process and analyze questionnaires	Check if the given answers are in line with information at the legal authorities.	Every year	
			Check if the given answers are processed correctly.	Every year	
			Check if the given answers (per facility) are in line with previous years. And explain differences.	Every year	
		Report the results	Check if the reported results are adopted correctly.	Every year	
Determine amount of landfill gas collected and its amount of methane	Working Group on Waste Registration	Sending questionnaires to all the facilities	Check if all the operating facilities receive a questionnaire. Are there any new ones?	Every year	
		Collecting questionnaires	Check if all the questions are answered.	Every year	

Additional QC checks for land filling					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
		Process and analyse questionnaires	Check if the given answers are processed correctly.	Every year	
			Check if the given answers (per facility) are in line with previous years. And explain any differences.	Every year	
Calculate amount of DOC	RWS	Combine amount of waste land filled with carbon content for each of its fractions	Check whether the resulting value is in line with earlier years and explain the trend found	Every year	
Calculate emission of methane from landfills	RWS	Calculate amount of methane formed	Check whether the model is filled with the actual data.	Every year	
			Check if the formulae are copied correctly.	Every year	
			Check whether the resulting value is in line with earlier years and explain the trend found	Every year	
		Correct production for amount of gas calculated	Check whether the resulting value is in line with earlier years and explain the trend found	Every year	
			Check if new information exists on emission factors.	Regularly	
			Check if the total emission is in line with the expectation of experts from the field.	Regularly	

Additional QC checks for land filling					
Process step	Performer	Activity	Check	When	Remark (including the date of the check and the name of the person who checked it)
		Deliver the emissions in the proper format to TNO (ER)	Make sure the information is received and used.	Every year	
Emission check up	Task Force (ENINA)	Compare the total with former years	Check if the total amount is in line with former years. And explain differences.	Every year	
Production validated emissions	RIVM	Import the validated emissions in the databases	Check the total emission with the delivered total by Rijkswaterstaat	Every year	

