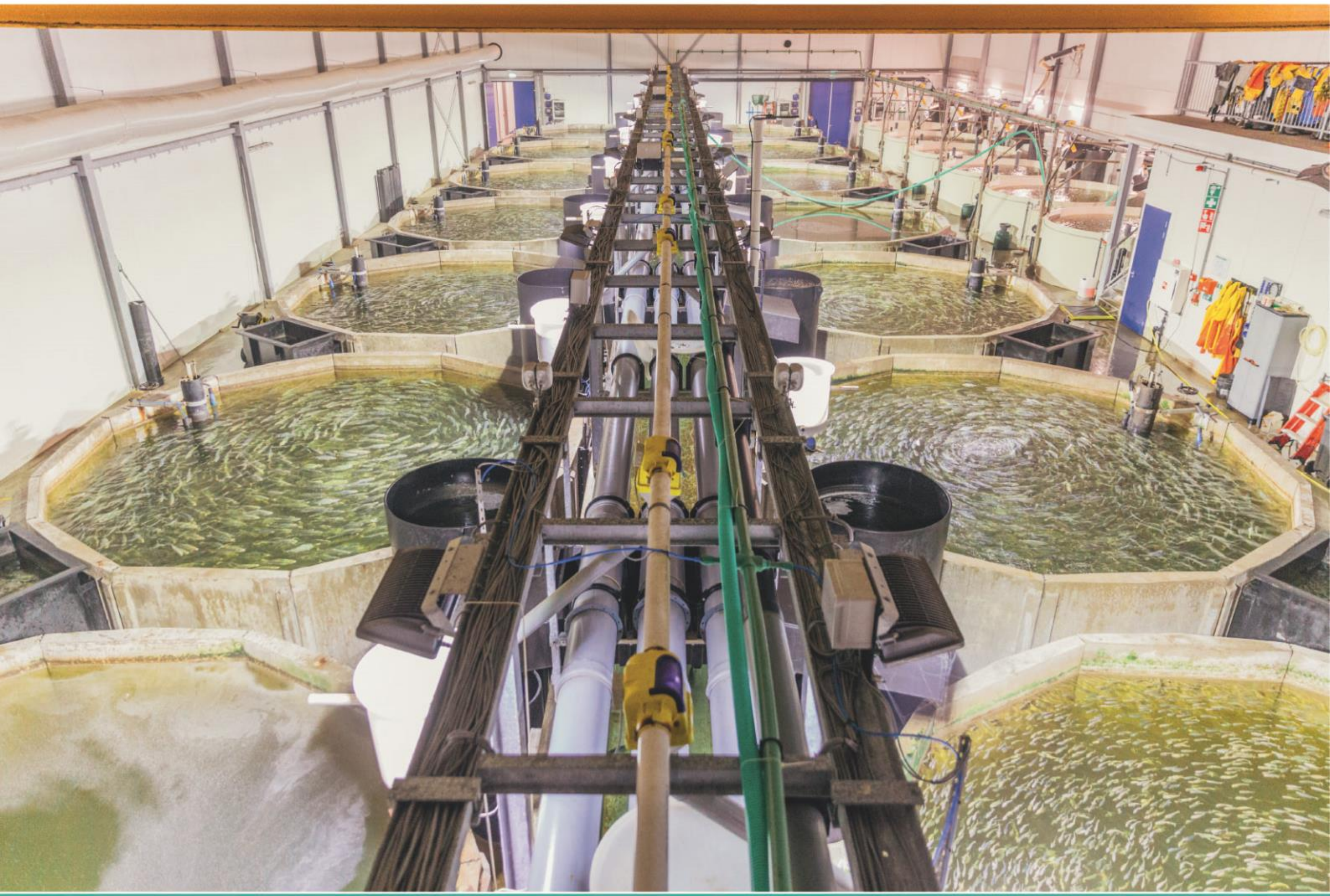
Recirculating Aquaculture Systems (RAS) Module



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Version control

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It is the responsibility of the user of the document to use the latest version as published on the ASC website.

To ensure the continued effectiveness of the ASC standards, as outlined in the ASC's Theory of Change, the revision must occur every three to five years. The next scheduled review of the ASC RAS Module is 2025. However, the content of the ASC RAS Module will be embedded within the ASC Farm Standard. Once the ASC Farm Standard becomes effective the RAS Module will be withdrawn.

Available language(s)

The official version of this document is English. The ASC may translate the RAS Module into additional languages as necessary. In case of any inconsistencies and/or discrepancies between available translation(s) and the English version, the online English version (pdf-format) will prevail.

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PURPOSE AND SCOPE

The aim of this document is to summarise the key environmental and social impacts associated with Recirculating Aquaculture Systems (RAS). RAS farms seeking certification will be certified against the appropriate ASC species standard as well as the ASC RAS module in order to ensure compliance with the ASC vision. The ASC Alignment Project will focus specifically on the impacts of different farming systems. This is thus considered an **interim solution**. The data collected within this interim solution will be fed back into the Alignment Project once available.

Background Information on Recirculating Aquaculture Systems (RAS)

Aquatic organisms can be farmed in open, closed and semi-closed systems. Certification of aquatic products from open and semi-closed systems like sea-cages, ponds or flow-through systems have been the main focus of the ASC standard at the beginning. In recent years the number of recirculating aquaculture systems (RAS) has significantly increased and thus facilitated the need to adapt the ASC standard to incorporate these highly technical systems.

RAS have been under development for the last forty years with significant improvements especially in terms of water re-use and hence reduced environmental impacts (Timmons and Ebeling, 2007). RAS operate by filtering water in order to reuse it within the same system. It is thus defined as a technology for farming aquatic organisms by reusing the water in the production (Bregnballe, 2015). RAS can be used to farm any aquatic species (fish, crustaceans, bivalves, seaweed) at different levels of intensity. The main resource inputs into RAS are the aquatic species itself, feed, water and electricity/energy. The last two are often used to define different levels of RAS.

One of the main reasons for the development of RAS are the increasing environmental regulations in countries and regions with limited access to both land and water. As water is treated and reused, the overall amount of water needed is significantly lower than for other aquaculture systems. Furthermore, the controlled environment allows for higher stocking densities resulting in lower land use. Different types of recirculation systems are usually defined by their level of recirculation.

Within the ASC RAS Module all intensive tank and raceway systems with high rates of recirculation, biological filtration, and other treatment systems will be considered RAS and have to comply with the additional indicators in this document as well as all applicable indicators in the subsequent ASC Standard.

RAS Module – Additional Indicators

The following section lists the additional indicators a RAS farm (as defined above) needs to comply to in addition to the species-specific standard, in order to obtain ASC certification.

RAS PRINCIPLE 1: MINIMISE NEGATIVE EFFECT ON WATER RESOURCES

RAS Criterion 1.1: Water Use/ Abstraction Levels

	Indicator	Requirement
RAS 1.1.1	Maximum amount of water that a farm can divert from a natural flowing water body (such as river or stream)	50% of the natural water body's flow immediately above the farm[1]
RAS 1.1.2	Amount of diverted water returned to the natural water body	> 90%
RAS 1.1.3	All use of underground pumped water has been permitted by the regulatory authorities	Yes
RAS 1.1.4	Well depths are tested at least annually and results made publicly available[2]	Yes

Rationale – Aquaculture facilities utilising flowing water require a constant supply of fresh water. Farms removing or diverting freshwater resources require appropriate and effective management to oversee water allocations and ensure efficient utilisation.

Farms that divert water from a river or stream cause a reduction in the water body's flow for the distance between the farm's inlet and outlet. It is difficult to set a global requirement that ensures that the remaining flow is sufficient to support the natural flora and fauna. Some jurisdictions are currently setting minimum flow requirements for a river or stream that farms need to respect. This is an appropriate local approach. In the absence of such regulation, or

[1] Farms will be exempted from this standard if they can demonstrate that they are in a jurisdiction that regulates the farm's water abstraction based on a minimum vital water flow for the natural water body, and the farm's water use respects that minimum vital flow. Farms would also be exempt if they can demonstrate abstraction amounts respect limits determined by a scientific study that estimates minimum vital flow.

[2] Well depths must be tested at similar times of the year, with results submitted to ASC. Wells that are by law not allowed to be opened are exempt from this indicator.

an equivalent scientific study, the RAS Module requires farms to always leave at least half of the natural flow in the water body.

Groundwater requires attention because it represents the abstraction and displacement of typically higher-quality water. Well or aquifer recharge is the process of water being replenished in the ground. When abstraction increases beyond the rate of recharge, the result is a net reduction in the water table.

Groundwater levels vary naturally from year to year, making a rigid global requirement impractical. These requirements instead require a farm to keep track of water tables over time and to make that information public. In addition, all use of underground water must be explicitly permitted to avoid situations in which water use by a farm would be undisclosed to regulators. It should be noted that a plentiful and sustainable water supply is of critical importance for aquaculture producers; thus, protection of these resources is paramount to the farm's viability.

RAS Criterion 1.2: Water Quality of Effluent and Receiving Water Body

	Indicator	Requirement
RAS 1.2.1	Maximum total amount of phosphorus released into the aquatic environment[3] per tonne (t) of fish produced over the previous 12-month period	< 4 kg/t of fish produced *unless specified differently by the species standard*
RAS 1.2.2	Minimum oxygen saturation in the outflow, measured continuously (minimum daily)[3]	60%
RAS 1.2.3	Total organic carbon (TOC) levels, sulphide levels or redox potential in sediment immediately outside the outfall[4] attributable to the farm operations as evidenced by control	No significant change in TOC levels, sulphide levels or redox potential in sediment in comparison to the control site
RAS 1.2.4	Allowance for discharging saline water to natural freshwater bodies[5]	None

[3] Farms discharging directly in the sewage system must comply with requirements set by the local authorities and/or treatment plant

[4] If there is an impact of the farm beyond the outfall/discharge point of the farm, it is up to the farm to make an argument for a reasonable AZE (allowable zone of effect) based on scientific modeling. In that case, this indicator would be applicable immediately at the edge of the AZE

[5] Surface freshwater bodies adjacent to farm property or receiving waters discharged from the farm. Freshwater is characterized by a specific conductance of less than 1,500 µmhos per centimeter and a chloride concentration of less than 300 milligrams per liter. These values correspond to salinity inferior to 1 ppt. Farms that can demonstrate that surrounding waters and soils have a salinity of 2 and above using a hand-held refractometer will not be required to provide measurements of conductance or chloride concentration. Water bodies displaying freshwater conditions only during the peak rainy season are considered as brackish water bodies under these standards.

Rationale: Effluent from aquaculture farms can have an environmental effect on rivers, streams and other bodies of water that receive the discharge. Phosphorus is one of the key nutrients to control the risk of eutrophication of receiving water bodies and organic enrichment of the sediment. It is a stable nutrient in that it does not volatilize like nitrogen compounds. It is also added to feeds in proportions that can allow estimations of other waste constituents (organic matter and nitrogen).

The ASC developed the phosphorus load requirement based on a unit of production, making it an indicator of how well a farm is minimising nutrient discharges per of fish produced. From an environmental standpoint, farms should aim for as low an annual load of phosphorus per tonne of fish as possible. Farms can lower their phosphorus load on the environment by using a better feeding strategy (ratio and feed distribution), improving feed conversion efficiency through the improvement of the environmental conditions in the farm, utilising feed that is more digestible and has lower phosphorus content, and by applying cleaning technologies such as settling ponds and filters. Production facilities are encouraged to develop methodologies to reduce their phosphorus burdens over time, while ensuring farmed fish are getting the appropriate nutrients to protect the nutritional content and health of the animals.

In an attempt to limit the oxygen burden on natural water bodies from the release of nutrients, these requirements include a minimum saturation level of dissolved oxygen at discharge.

Total organic carbon (TOC) levels, sulphide levels and redox potential are considered the best available chemical indicators for benthic health and thus aquatic ecosystem health. By comparing surveys downstream and upstream from the farm’s effluent discharge, or at the outfall and a defined reference point, the requirement aims to isolate the impact of the production facility, and ensure that no significant impact is occurring.

The release of effluents can cause salinization in surface freshwater bodies and non-saline soils near the discharge. It was thus determined that saline water must not be release in natural freshwater bodies.

RAS Criterion 1.3: Waste Disposal

	Indicator	Requirement
RAS 1.3.1	Evidence of implementation of biosolids (sludge) best management practices (BMP) (see Appendix I)	Yes
RAS 1.3.2	Specific conductance or chloride concentration of sediment prior to disposal outside the farm	The specific conductance or chloride concentration values must not exceed those of the soil in the disposal area[6]

Rationale: Biosolids are a mixture of organic waste and sediment produced or accumulated through the farming activity. Biosolids discharged into natural water bodies are of concern because solids can restrict light penetration in water bodies, accumulate downstream, cover plants and habitat and cause general shallowing of water bodies. Additionally, the organic component of biosolids will exert an oxygen demand as the organic matter decays. The simplest and best way to minimise these impacts is to remove sediments from the water column and allow organic matter to decay prior to discharge. Functionally, this infers the use of a settling basin to let solids settle out of the water column, and for bacterial decomposition and oxygen depletion to occur at the same time prior to disposal of biosolids. Many RAS farms use filtration systems to reduce the amount of suspended solids in the water. To provide assurance of appropriate disposal of biosolids, these requirements include a small number of BMPs.

[6] If a farmer has a contract outside the farm to discharge soil in a specified location, they are permitted to do as long as no disposal occurs in a natural habitat or public property without written permission of the community.

RAS PRINCIPLE 2: USE OF RESOURCES IN AN ENVIRONMENTALLY EFFICIENT AND RESPONSIBLE MANNER

RAS Criterion 2.1: Energy Consumption and Greenhouse Gas Emissions on Farms

	Indicator	Requirement
RAS 2.1.1	Presence of records and evidence of all energy consumption on the farm and representing the whole life cycle (as outlined in Appendix II)	Yes, measured in kilojoule/t fish produced/ production cycle
RAS 2.1.2	Records of greenhouse gas (GHG[7]) emissions[8] on farm and evidence of an annual GHG assessment (as outlined in Appendix II-A)	Yes
RAS 2.1.3	Documentation of GHG emissions of the feed[9] used during the previous production cycle (as outlined in Appendix II-B)	Yes
RAS 2.1.4	Evidence of a documented strategy to reduce GHG per unit of production (measured in kilojoule/t fish produced)	Yes, within three years of the initial audit

Rationale: Climate change represents perhaps the biggest environmental challenge facing current and future generations. Because of this, energy consumption used in food production has become a source of major public concern. The ASC recognizes the importance of efficient and sustainable energy use. Therefore, these indicators will require that energy consumption in the production of fish should be monitored on a continual basis and that growers should develop means to improve efficiency and reduce consumption of energy sources, particularly those that are limited or carbon- based. The data collected in this process will help the ASC set a meaningful numerical requirement for energy use in the future. Energy assessments are a new area for producers. Requiring that farms do these assessments will likely raise

[7] For the purposes of this standard, GHGs are defined as the six gases listed in the Kyoto Protocol: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride (SF_6).
[8] GHG emissions must be recorded using recognized methods, standards and records as outlined in Appendix II
[9] GHG emissions from feed can be given based on the average raw material composition used to produce the fish/crustacean (by weight) and not as documentation linked to each single product used during the production cycle. Feed manufacturer is responsible for calculating GHG emissions per unit feed. Farm site then shall use that information to calculate GHG emissions for the volume of feed they used in the prior production cycle.

awareness of the issues related to energy and build support for adding a requirement in the future related to the maximum energy of GHG emissions allowed.

RAS Criterion 2.2: Species-Specific Requirements for Recording

	Indicator	**Requirement**
RAS 2.2.1	Minimum stocking density	Records are available
RAS 2.2.2	Maximum stocking density	Records are available
RAS 2.2.3	Feed Conversion Ratio	Records are available
RAS 2.2.4	Protein Retention Efficiency	Records are available
RAS 2.2.5	Annual average farm survival rate	Records are available
RAS 2.2.6	Handling frequency and methods	Records are available

Rationale: Species-specific requirements -- especially those linked to the important 'welfare' issue -- are critical especially when it comes to closed, highly technical systems. Since the welfare topic is not yet sufficiently addressed by the ASC standards (See the ongoing *'Fish Welfare'* project), the gathering and recording of data linked to the indicators below will also potentially enable ASC in the future to set requirements in those areas. This data will be used in the Alignment Project and allow for better informed decisions.

References

Bregnballe, J., (2015). A Guide to Recirculation Aquaculture. *FAO and EUROFISH*. https://doi.org/92-5-105177-1

Martins, C.I.M., Eding, E.H., Verdegem, M.C.J., Heinsbroek, L.T.N., Schneider, O., Blancheton, J.P., d'Orbcastel, E.R., Verreth, J.A.J., (2010). New developments in recirculating aquaculture systems in Europe: A perspective on environmental sustainability. *Aquac. Eng*. 43, 83–93. https://doi.org/10.1016/j.aquaeng.2010.09.002

Timmons, M., Ebeling, J., (2007). *Recirculating Aquaculture*, 01–007 ed. Cayuga Aqua Ventures, Ithaca.

Appendix I: Sludge BMP

Methods to mitigate the impacts from fish metabolic wastes on water can range from the employment of simple settling ponds to the use of advanced technology filters and biological process. Dealing responsibly with the waste (sludge, liquid slurry, biosolids) from these processes is a critical element to responsible farm management. The ASC acknowledges that BMPs related to other principles such as correct feed composition and texture as well as good feed management practices—such as not storing feed for too long—can also influence the effectiveness of biosolids capture; however, this section deals with practices for cleaning, storage and disposal that will minimise the potential impacts of sludge/biosolids being released into the environment.

All land-based systems shall employ/undertake the following in relation to sludge/biosolids:

- A process flow drawing that tracks/maps the water and waste flow of a farm, including treatment of waste, transfer of wastes, waste storage and final waste utilisation options. Flow diagram should indicate the farm is dealing with biosolids responsibly. (Auditing guidance for evaluating whether the plan indicates responsible use: The system design shall allow for simple cleaning routines of pipes, sumps, channels and units.)
- Farm shall have a management plan for sludge/biosolids that details cleaning and maintenance procedures of the water treatment system. The plan must also identify and address the farm's specific risks such as—but not limited to—loss of power, fire and drought. The management can be evaluated in relation to maintenance records.
- Farm must keep detailed records/log of sludge/biosolid cleaning and maintenance including how sludge is discarded after being dug out of settlement ponds.
- Biosolids accumulated in settling basins shall not be discharged into natural water bodies.

Appendix II: Energy Records and Assessment

Subsections

A. Energy use assessment and greenhouse gas (GHG) accounting for farms
B. GHG accounting for feed

Appendix II – A Energy use assessment and GHG accounting for farms

The ASC encourages companies to integrate energy use assessments and GHG accounting into their policies and procedures across the board in the company. However, this requirement only requires that operational energy use and GHG assessments have been done for the farm sites that are applying for certification.

Assessments shall follow either the GHG Protocol Corporate Standard or ISO 14064-1 (references below). These are the commonly accepted international requirements, and they are largely consistent with one another. Both are also high level enough not to be prescriptive and they allow companies some flexibility in determining the best approach for calculating emissions for their operations.

If a company wants to go beyond the requirement and conduct this assessment for their entire company, then the full protocols are applicable. If the assessment is being done only on sites that are being certified, the farms shall follow the GHG Protocol Corporate Standard and/or ISO 14064-1 requirements pertaining to:

- Accounting principles of relevance, completeness, transparency, consistency and accuracy
- Setting operational boundaries
- Tracking emissions over time
- Reporting GHG emissions

In regard to the operational boundaries, farm sites shall include in the assessment:

- Scope 1 emissions, which are emissions that come directly from a source that is either owned or controlled by the farm/facility.
    - For example, if the farm has a diesel generator, this will generate Scope 1 emissions. So will a farm-owned/-operated truck.
- Scope 2 emissions, which are emissions resulting from the generation of purchased electricity, heating, or cooling.

Quantification of emissions is done by multiplying activity data (e.g., quantity of fuel or kwh consumed) by an emission factor (e.g., CO_2/kwh). For non-CO_2 gases, you then need to multiply by a Global Warming Potential (GWP) to convert non-CO_2 gases into the CO_2-equivalent. Neither the GHG Protocol nor the ISO require specific approaches to quantifying emissions, so the ASC provides the following additional information on the quantification of emissions:

- Farms shall clearly document the emission factors they use and the source of the emission factors. Recommended sources include the Intergovernmental Panel on Climate Change (IPCC) or factors provided by national government agencies such as the United States Environmental Protection Agency (USEPA). Companies shall survey available emission factors and select the one that is most accurate for their situation, and transparently report their selection.
- Farms shall clearly document the GWPs that they use and the source of those GWPs. Recommended sources include the IPCC 2nd Assessment Report, on which the Kyoto Protocol and related policies are based, or more recent Assessment Reports.

References (relevant at time of publication of Standard):

- www.emissionfactors.com
- GHG Protocol Corporate Standard Website: http://www.ghgprotocol.org/Standards/corporate-Standard
- GHG Protocol Corporate Standard Document: https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf
- ISO 14064-1 available for download (with fee): https://www.iso.org/standard/66453.html
- IPCC 5th Assessment Report: https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf
- All IPCC Assessment Reports: https://www.ipcc.ch/reports/

Appendix II – B: GHG accounting for feed

The requirement requires the calculation of the GHG emissions for the feed used during the prior production cycle at the grow-out site undergoing certification. This calculation requires farms to multiply the GHG emissions per unit of feed, provided to them by the feed manufacturer, by the amount of feed used on the farm during the production cycle.

The feed manufacturer is responsible for calculating GHG emissions per unit feed. GHG emissions from feed can be calculated based on the average raw material composition used to produce the fish (by weight) and not as documentation linked to each single product used during the production cycle.

The scope of the study to determine GHG emissions should include the growing, harvesting, processing and transportation of raw materials (vegetable and marine raw materials) to the feed mill and processing at feed mill. Vitamins and trace elements can be excluded from the analysis. The method of allocation of GHG emissions linked to by-products must be specified.

The study to determine GHG emissions can follow one of the following methodological approaches:

1. A cradle-to-gate assessment, taking into account upstream inputs and the feed manufacturing process, according to the GHG Product Standard
2. A Life Cycle Analysis following the ISO 14040 and 14044 requirements for life cycle assessments.

Should the feed manufacturer choose to do a cradle-to-gate assessment:

1. It shall incorporate the first three phases from the methodology, covering materials acquisition and processing, production, and product distribution and storage (everything upstream and the feed manufacturing process itself).

Should the manufacturer follow the ISO 14040 and 14044 requirements for Life Cycle Assessment:

1. Feed manufacturers may follow either an ISO-compliant life cycle assessment methodology or the GHG Protocol product Standard.

Regardless of which methodology is chosen, feed manufacturers shall include in the assessment:

- Scope 1 emissions, which are emissions that come directly from a source that is either owned or controlled by the farm/facility.
- Scope 2 emissions, which are emissions resulting from the generation of purchased electricity, heating or cooling.
- Scope 3 emissions, which are emissions resulting from upstream inputs and other indirect emissions, such as the extraction and production of purchased materials, following the Scope 3 Standard.

Quantification of emissions is done by multiplying activity data (e.g., quantity of fuel or kwh consumed) by an emission factor (e.g. CO2/kwh). For non-CO2 gases, you then need to multiply by a Global Warming Potential (GWP) to convert non-CO2 gases into CO2-

equivalent. The ASC provides the following additional information on the quantification of emissions:

- Farms shall clearly document the emission factors they use and the source of the emission factors. Recommended sources include the IPCC or factors provided by national government agencies, such as the USEPA. Companies shall survey available emission factors and select the one that is most accurate for their situation, and transparently report their selection.
- Farms shall clearly document the GWPs that they use and the source of those GWPs. Recommended sources include the IPCC 2nd Assessment Report, on which the Kyoto Protocol and related policies are based, or more recent Assessment Reports.

References (relevant at time of publication of Standard)

- www.emissionfactors.com
- GHG Product Life Cycle Accounting and Reporting Standard: https://ghgprotocol.org/sites/default/files/standards/Product-Life-Cycle-Accounting-Reporting-Standard_041613.pdf
- Scope 3 Standards: https://ghgprotocol.org/blog/first-drafts-product-and-scope-3-standards-released
- ISO 14044 available for download (with fee) at: https://www.iso.org/standard/38498.html
- IPCC 5th Assessment Report: https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf
- All IPCC Assessment Reports: https://www.ipcc.ch/reports/