# Guidance for Auditors to understand a Mass Balance exercise and Verification Test

## Introduction

The marine ingredients production and trade is very important for the development and grow of the food and feed industry, aquaculture and other related livestock production.

We have to assure the sustainability across all this value chain as a crucial aspect to manage and communicate to all the stakeholders. Final customers' requirements are forcing many industries to show improvements and commitment through third party Sustainability certifications.

MarinTrust is one of these Standards that is evolving and improving to guarantee the marine ingredients supply in an ethical and sustainable way.

The following Mass Balance exercise is a tool that will contribute to avoid fraud or bad practices along the CoC.

## Scope

The marine ingredients are basically 2 products: Fishmeal and Fish Oil. Both are normally elaborated in the same facility and share the process line. The yields that can be expected in the production are based in the composition of the raw material used.

Whole fish (different species)

Trimmings, offal, discards (canning, frozen fish)

This is important to consider because the marine ingredient will have different quality characteristics depending of the raw material and it´s freshness. The main quality parameters to consider are:

| Fishmeal | Fish Oil |
|---|---|
| Protein | FFA (Free Fatty Acids) |
| Ash | Moisture and impurities |
| Fat | Peroxide |
| Moisture | Anisidine |
| Salt | TOTOX |
| FFA | Fatty Acid profile (EPA and DHA) |
| TVN | Gardner Color |
| Histamine | Soap content |

# Fishmeal Criteria

It is also important to know that yields for fishmeal normally are better when whole fish is processed, comparing with trimmings or offal. This is explained because whole fish has more "flesh", therefore more protein in the fishmeal. While fishmeal from trimmings are higher in ash and lower in protein, unless there will be a process to remove part of the fish bones that will decrease ash content but increase protein. But this will affect more the final yield. Only for reference, the yield from whole fish (Peruvian anchovy) to fishmeal is 4 – 4.5 tons of fish for 1 ton of fishmeal. That means 25 – 22%.

For Fishmeal, the first 4 parameters (Protein, Ash, Fat and Moisture) are call proximate analysis and usually their sum is around 100%. Additional parameters constitute the proximate when other compounds containing crude fibre and Nitrogen-Free Extract (NFE, more or less representing sugar and starches) are added, e.g. when feed is elaborated including vegetable origin ingredients.

This is important to know, because this proximate and the other parameters like salt, FFA, TVN and Histamine, can be followed through all the CoC and is expected to be relative constant. The parameter that can vary significantly during storage, specially where very humid environment occurs, is moisture. In this case, moisture can increase and the other 3 parameters of the proximate will decrease proportionally.

These quality criteria have to be considered when fishmeal is mixed, blended and repacked. In this case, losses can be considered due to transport and process, especially when is done in bulk. Gains are also possible if some additives are included in this process, e.g., organic acids or antioxidants.

# Fish Oil criteria

Crude Fish oil, depending on the raw material and process, can be destined for feed or for human consumption. Crude Fish oil for Human consumption has to start with fishing vessels additionally registered for this purpose, raw material fit for crude fish oil for HC and dedicated process and storage. Additional process like Fish oil for feed is incorporated normally in the crude form. The yield will depend on the fat content of the raw material.

The quality parameters to follow in the same way as fishmeal are FFA, moisture, peroxide and Anisidine (if you have both, you can calculate TOTOX = 2Peroxide+1Anisidine). Special attention is needed with Fatty Acid profile (EPA and DHA) for the importance in the nutritional properties for aquaculture, foods, nutraceutical supplements and pharmaceutical applications. When blending processes occur, a correct traceability and mass balance related to the quality parameters is a must.

Sometimes, when crude fish oil with very high FFA is produced, semi-refined process (degumming/neutralization) can be applied to reduce this content. But the losses are relevant and are in function of the FFA and other parameters. As general reference, approximately the

losses will be 2 fold the sum of FFA, moisture and impurities. If a bleaching process is included to reduce the dark color, additional losses will be considered with the oil retained in the bleaching earth incorporated and then filtered.

If we have an acid fish oil with 8% FFA, 1% moisture and 1% impurities, the loss will be around 20%. This is important to take into account for the mass balance because in case of traders / processors these losses need to be reflected in the quantities at the beginning and at the end. That means it´s not acceptable to have 100 tons of 8% FFA and finally 100 tons of 3% FFA, because the losses when the FFA is reduced is at least 2 fold the difference in FFA, that means the final quantity should be 90 tons of 3% FFA.

The other possible case is a crude fish oil that is mixed with a neutralized one. The way this can be detected is comparing the original quality parameters and the final ones. The FFA and the color will be lower and there will be an additional parameter to consider: soap content.

The same concept is applicable to fish oil refining and concentration, where additional processes are in course: Refining (neutralization), Bleaching, Winterization, Deodorization or Purification, esterification / trans esterification. In each step specific criteria are applied and will depend on the technology, individual basis, and characteristics of the fish oil processed.

Along all the CoC, fish oil is normally stored and transported in bulk. These operations could become additional threat to fish oil integrity due to the possibilities of intended or unintended mixtures with non-certified fish oils. Also changes during transport, extracting fish oil and substituting with water or another kind of substances could happen. In this context, quantities will match. So is a good practice monitoring the stock and quality of the product stored and transported to contrast the product dispatched and received.

The losses during fish oil bulk transport is considered less than 0.2% due to the oil that will stay attached to the walls and will depend on how fluid is the product. The stearin (solid part of the oil at room temperature) is a natural part of the fish oil but it can be more difficult to removed due to the higher density compared with the fluid part (olein).

In the case of storage tanks, when they are being dispatched, is not feasible to take out all the fish oil. Normally some tank bottoms with high stearin content will remain and have to be removed manually. This is a common situation especially when the fish oil has been stored without movements for a long period of time. In this case, a natural separation occurs, the stearin tends to stay in the bottom of the tank, while the olein remains on the top.

The following table can summarize the relation between quantities and quality to perform a Mass balance as a useful tool that will allow to show good practices, transparency and real commitment to the fish ingredients sustainability.

| Product | Fishmeal | | Crude Fish Oil for Feed | | Crude Fish Oil for HC | |
|---|---|---|---|---|---|---|
| **Process stage** | **Raw Material** | | **Raw Material** | | **Raw Material (vessels registered for HC)** | |
| Production | Fat and solids Content (%) | Yield (MT)<br>Production (MT) | Fat Content (%) | Yield (MT)<br>Production / Secondary recovery | Fat Content (%) | Yield (MT)<br>Only main production |
| Storage, Blending and transport | MT in | MT out | MT in | MT out | MT in | MT out |
| | % Gains - Additives | | % Gains - Additives | | % Gains - Additives | |
| | % Losses (process, storage, transport) | | % Losses (process, storage, transport) | | % Losses (process, storage, transport) | |
| | Proximate (protein, ash, fat, moisture) | | FFA, moisture, impurities | | FFA, moisture, impurities, peroxide, anisidine, TOTOX | |
| | TVN, Histamine, FFA, salt | | Color, soap, Fatty Acids Profile (EPA and DHA) | | Color, soap, Fatty Acids Profile (EPA and DHA) | |
| Refining and / or Concentration | | | MT in | MT out | MT in | MT out |
| | | | Refining | % Losses / Gains | Refining | % Losses / Gains |
| | | | Bleaching | % Losses / Gains | Bleaching | % Losses / Gains |
| | | | | | Winterization | % Losses |
| | | | | | Deodorization / Purification | % Losses |
| | | | | | Esterification / trans esterification | % Losses |
| Feed producer | MT in | MT out | MT in | MT out | | |
| | % Ingredients / Additives | | % Ingredients / Additives | | | |
| | % Losses (process) | | % Losses (process) | | | |

The first part refers to the production yield obtained from raw material to fishmeal and fish oil. As mentioned before, the yields will depend on the fat and solids (protein and ash) content in the raw material and is in function of the nature of the fish used and if it´s is whole or parts like trimmings.

The second part consists in the operations of storage, blending and transport of the finished products. This could be done by the same producer and/or traders, subcontractors. In this movements, gains are related to inclusion of additives and losses come from material that could not be completely removed from storage tanks, cisterns and conveyors. The quality parameters of the products have to be relative stable because there aren't processes that change the characteristics mentioned in the table. Even if blending operations occurs, the final product will be the mixture of known products and the result is the weighted average of the quality parameters.

The third part includes only crude fish oil processing, considering feed and food uses. In the fish oil refining and concentration processes, losses are closely related to quality parameters, specially FFA, moisture and impurities. EPA and DHA content is determinant in outcome yields when concentration of their ethyl esters are in place.

Finally, the fourth part is regarding the use of fishmeal and fish oil for feed production. In this case, more gains have to be considered due to the addition of diverse ingredients, greater in proportion than the marine ingredients.

# Mass Balance

With these criteria, the mass balance can be performed by asking the applicant for a specific lot or a period of time of production.

Due to the different kind of applicants and their diverse management systems, the compilation of the data needed can spend considerable time because part of the information will be managed by the quality area, while the quantities / yields normally are in the production area.

The template asks for raw materials bought and in stock, product during process and final product sold an in stock during the evaluated period.

Losses and gains have to be considered and checked with the general criteria described and the balance has to match not only quantities but quality criteria.

If some issue doesn't match, e.g. significantly difference in tons or quality parameters, more information or explanations are necessary to ask. Care must be taken in the way this questions are done. The idea is to give insights on how this can be an opportunity to improve the traceability.

# Definitions

- Mass Balance: Generally, a term used in comparisons of the inputs and outputs of processes.
- Total oxidation value (ToTox) = 2 x Peroxide value + 1 x Anisidine value
- Explanatory note: Oxidation of fish oils is a sequential process: following an initial raise of peroxide value, the anisidine value rises. The peroxide value is therefore a parameter for primary oxidation products, the anisidine value for secondary oxidation products. The parameter ToTox, which means "total oxidation of oil", was established to avoid that both of these oxidation products are present at maximum levels. The maximum allowed ToTox value is set separately and lower than the sum of the individual possible maximum limits set for peroxide and anisidine values.
- Secondary recovery: fish oil recovered from the pumping sea water used to unload the fish from the vessels to the plants. The process includes physical flotation with or without microbubbles, superficial foams collecting and further heating and separation of the fish oil. It´s also called PAMA oil in Peru, and is considered only for feed purposes. It could be 20% of the fish oil yield.

**Marin Trust Mass Balance/Volume Reconsilation Exercise**

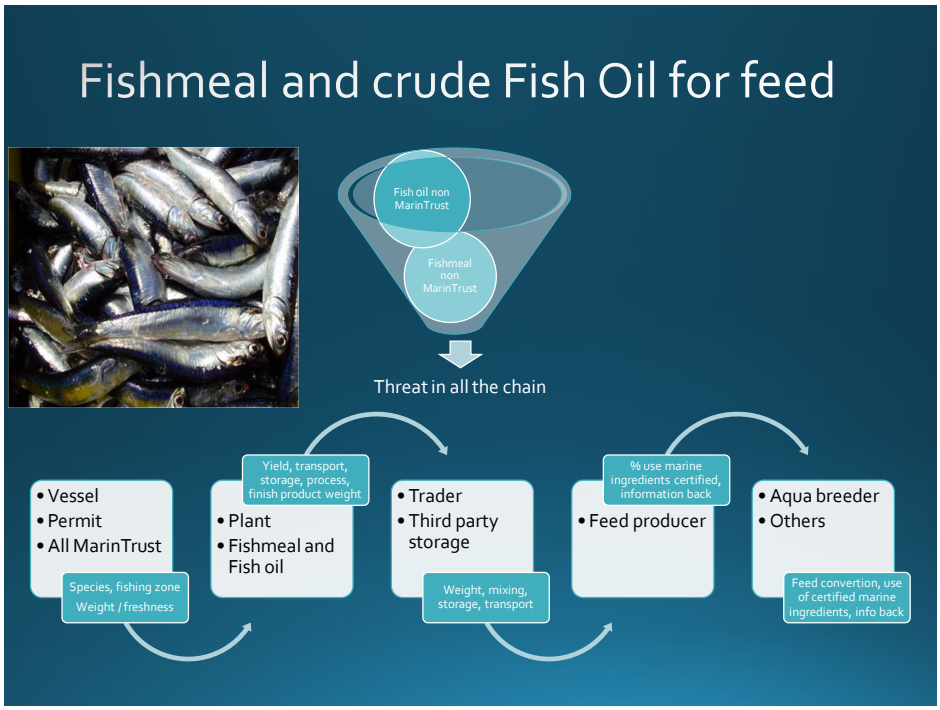
Period of time / defined production batch or lot

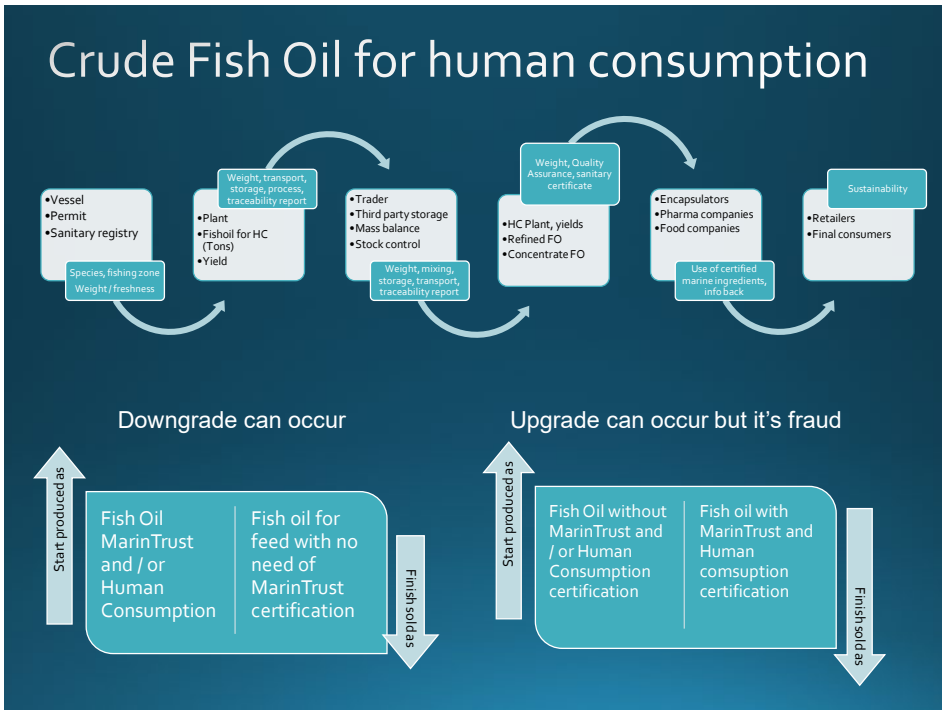
| Material/Product | Details | Input - output | Input - output | Input - output |
|---|---|---|---|---|
| Compliant Fish Meal or Fish Oil | 1 | | | |
| Start Date / Time for Exercise to commence | 2 | | | |
| End Date / Time for Exercise to be completed | 3 | | | |
| Unit weight/volume ( Tonnes, KGs, Lt etc) | 4 | | | |
| Traceability Codes (if relevant) | 5 | | | |
| Total Product Weight' | 6 | | | |
| Raw material - Stock at start date (if not processing record all product stocks) | A | | | |
| Raw material - Stock purchased or received in period (or if not processing record all product purchases) | B | | | |
| | N/A | | | |
| Raw material - Stock used for processing | D | | | |
| Raw material - Stock at end date (or if not processing, all product stocks) | E | | | |
| Processing - Stock of processed product at start date | F | | | |
| Processing - Processed product produced during period (i.e. weight of output from processing) | G | | | |
| Processing - Processed product sold or dispatched during period | H | | | |
| Processing - Stock of processed product at end date | I | | | |
| Processing - Stock of partially processed product at end date | J | | | |
| Raw material: Total In = (A + B) | K | | | |
| Raw material: Total out = ( D + E) | L | | | |
| Raw material: Difference = (K - L) | M | | | |
| Processing: Processed product inputs from start date = (F + G + J) | N | | | |
| Processing: Processed product sold and stored at end date = (H + I) | O | | | |
| Processing: Difference = (N - O) | P | | | |
| Conversion Rate (Yield). Calculated as a percentage of G/D. | Q | | | |
| Approximate % weight gains (e.g. added ingredients / additives) | R | | | |
| Approximate % weight losses (e.g. due to drying / seperation) | S | | | |
| Approximate % increase in yield due to added weight gains and losses: = (R-S) | T | | | |
| Volume of raw material converted to a non-approved status | U | | | |
| Volume into processing then converted to a non-approved status | V | | | |
| Volume of processed product then converted to a non-approved status | W | | | |

| Explanation of processing weight gains - with details of percentage of added ingredients |
|---|
| |

| Explanation of processing weight losses |
|---|
| |

# Traceability flow through the CoC



# Traceability verification test

When an applicant performs a Traceability verification test, the minimum information to consider to assure a proper and complete traceability forward and back, is the follows:

- Species
- Fishing vessels
- Catch area
- Raw Material weight / Dates of landing
- Marine Ingredients Producer factory
- Marine ingredients producer factory Dates of processing
- Marine Ingredient Product (Batch/Lot number – volume produced)
- Product identification (documentation related: delivery notes, invoices, Bill of lading, certificates of analysis, official certificates, etc.)
- Product received (Batch/Lot number – volume produced)
- Feed / Food processing factory
- Dates of finished product processing
- Finished product (Batch/Lot number – volume produced)
- Product dispatched

If a trader or third party storage is involved in this verification test, where mixtures or blending processes occurs, information about these operations should be included.

The objective is to check the last test done by the applicant and the auditor can ask for a random set of records or specific information stated in the test. For example, records linking a vessel with a specific landing / weight, or some production records or stock reports.

# Mass Balance / Volume reconciliation

If a Mass Balance is performed considering a specific batch/lot or volume produced, in complement with a traceability verification test, raw material and finished product should match regarding inputs and outputs.

Due to different management and processing control systems, the result of this Mass Balance will not be as exact as expected because factories normally use production orders or production reports for periods of time between one day and one month instead of calculating yields per lot or batch.

Similar to the traceability verification test, the auditor should make a sampling procedure for information stated in the Mass Balance, in order to crosscheck data for consistency.