

# Concept Best Available Technologies & Techniques: Bulk Fertilizer Handling

March 2019



*Covered conveyor loading system at Hamina Kotka. Photo Courtesy of Hamina Kotka.*



*Underground water treatment plant,  
by EcoSense Intl.*



*Floating treatment wetlands by KCI*



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## Background

This document is intended to further the necessary discussion for port improvements for handling fertilizers in Baltic Sea ports. To that intention, CCB encourages industry development of best practices in an open innovation setting, with learning shared among peer organizations.

HELCOM has identified several earlier unknown major point sources of nutrient pollution in the Baltic Sea Region countries related to the production of phosphate and nitrogen fertilizers. All of those sites required pollution mitigation measures to be taken urgently. Based on these findings, organizations within the Coalition Clean Baltic (CCB) network have raised attention to the need of evaluating the whole fertilizer production/logistics chain.

One of the areas where CCB is assessing potential losses of this kind is fertilizer handling in port terminals. According to our knowledge and recent cases e.g. in Sweden, nutrient losses from ports facilities for handling fertilizer and fertilizer-related materials can constitute considerable point sources of nutrient pollution, measuring cumulatively in tons of directly bioavailable nitrogen and phosphorus per year. Such losses may occur mainly during ship loading/unloading operations as well as from temporary open storage and improper stormwater management at port facilities. Hold washing is another source, which may be best mitigated while a ship is in port. Conservative estimates of losses in dry cargo handling and shipping are 0.05%, which may also be an industry standard for contractually allowed losses. This suggests that the Baltic could receive a minimum of 16,700 tons of fertilizer lost each year from shipping and handling. Indications of such losses in various harbours around the Baltic, including rather modern facilities, are included in [CCB's May 2017 report](#).

Currently, none of the EU legislative acts (e.g. EU IED) covers environmental aspects of port handling facilities for fertilizers. Globally, this issue is mostly covered in national regulations, port by-laws and codes of conduct (e.g. in [Canada](#), [USA](#) and [Australia](#)).

HELCOM agreed that this emerging issue must be investigated in order to mitigate potential nutrient inputs to the Baltic Sea at the [17<sup>th</sup> meeting](#) of the HELCOM Maritime Working Group. In cooperation with CCB, HELCOM and Sweden developed and circulated an online questionnaire early in 2018. The initial survey yielded few responses related to 2017 fertilizer-shipping volumes. In light of the [questionnaire outcome](#), the [18<sup>th</sup> meeting](#) of the HELCOM Maritime Working Group encouraged further investigation by interested parties.

## Introduction

Dry bulk, packed and liquid fertilizer cargoes carried on vessels can enter the marine environment at different phases during storage and transport: loading and unloading, transshipment, and washing of cargo holds.

According to this 2016 [study](#), experts assume that about 0.05% of bulk cargo can be lost regularly during storage and transport. Based on the total bulk quantities shipped worldwide, an estimated 4.3 billion tons, it is likely that at least 2.15 million tons per year are discharged into the oceans, primarily in coastal regions. Or, from oral reports based solely on ship hold washing, 60–100 tons of mixed solids in washing water are discharged after washing per hold. An average bulker has 5 cargo holds (4 to 7 holds per vessel are common). In 2013, 10,800 bulk cargo vessels were operating worldwide. Assuming that the discharged washing water contains 5% solids and 20 washing operations per year and per vessel are likely to be carried out, it was estimated that 3.2 million tons of solid bulks are discharged per year. Either estimate, while crude in precision, still indicate a magnitude of this type of input.

Even with a conservative estimate of 0.05% loss of bulk cargo due to unloading operations and cleaning of ship holds, a potential loss from 33 million tons of fertilizer handled in the Baltic Sea in 2013 (see estimates in CCB 2017 Report) could be 16,700 tons per year. See Annex 1 of this report.

However, industry recognizes and allows contractual losses of **0.5%**, an **order of magnitude greater** than that used in the conservative estimate above. There is at least one report of occasional losses above this contractually allowed amount, to no greater than **3%** as well. This implies the losses in the Baltic, and the associated impacts on eutrophication, could be astonishingly greater.

Despite the Baltic Sea listing as a Special Area under MARPOL Annex V, and the [well documented impacts](#) of fertilizers on eutrophication, such washing water discharge may still legally occur due to the lack of reception facilities for washing water and other kinds of sewage in Baltic ports. See Annex 3 of this report.

Most dry bulk commodities are prone to spillage and dust pollution, posing environmental problems even for ports which handle comparatively low tonnages. Ports which handle bulk materials – either incoming, outgoing or both – are confronted with critical ship-to shore transfer problems, which are far more complex than those involving ship loading or unloading of general cargo or containers. The dry bulk cargo also needs to be stored, if only temporarily, within the port zone. It also needs to be conveyed between the quayside and the storage location. A major environmental problem, common to these operations and unique to dry bulk cargo handling, is that of material spillage and dust pollution. Storage, if uncovered, adds to complications in the event of stormwater runoff.

Developing an Environmental Management System, if not already in place in a given port, would aid in the implementation and monitoring of these solutions in addition to other environmental issues present in port operations.

In recent years considerable advances have been made in environmentally acceptable methods of bulk handling in ports which are summarized below. Given the breadth of technologies available and specific layout of the seventy-five Baltic ports handling fertilizer, this document only introduces and summarizes some of the solutions for key areas in pollution mitigation and loss reduction. These solutions focus on three key areas, including:

- Loading and Unloading
- Stormwater Management
- Ship Hold Washing

The technologies and techniques introduced here are a mix of common sense and technical solutions. We encourage further investigation of these solutions as relevant for the specific needs of each Baltic port,

including opportunities for synergies such as combining stormwater management with hold washing, whenever possible.

Implementing a uniform code of practice, plan, or Environmental Management System (EMS) to encompass these areas noted above would greatly serve the objectives of the Baltic Sea Action Plan. Baltic ports may already have developed their own EMS, conforming to ISO 14001:2015, into which consideration of nutrients could more easily integrate into port operations. In the event ports do not have an EMS, creating one would assist in addressing concerns for nutrient pollution among other environmental issues present in port operations. For further discussion and a collection of detailed examples, see the [Manual of Best Management Practices for Port Operations](#).

## Loading and Unloading

Loading and unloading dry bulk, even in small quantities, introduces issues from accidental spillage and dust pollution. Wind and normal handling can both release appreciable amounts of dust, anywhere the cargo is exposed to open air. Given the sensitivity of the Baltic to eutrophication, mitigating even the relatively small % of spills and dusting is warranted. Much of the following section is adapted from the technical review in Annex 3 of CCB 2017 report and a technical summary from [GreenPort](#).

General techniques applicable to reducing dust during loading and unloading.

- Enclose conveyors, chutes and telescoping arm loaders;
- Reduce the distance from equipment to ship holds, particularly reducing freefall of material;
- Suspend unloading and handling operations during unfavorable weather conditions (rain, wind) that could otherwise increase run-off or blowing dust;
- Spray a light mist of water for dust control during handling operations;
- Introduce dust suppression with bag house filters, screw conveyors and vacuum collecting equipment wherever practical;
- Regular sweeping of the bulk storage and access/egress areas, and handling swept material to prevent its introduction into the Baltic.

## Storage

With all loading and unloading operations, protection from weather, wind, and rain is crucial to minimize loss. This includes covered storage. Several ports reported using open-roof storage for fertilizers, including terminals in Liepaja and Gdansk, though from the questionnaire it is unclear if the Liepaja storage is for packed or loose fertilizers. In Gdansk this open storage is only for packed fertilizers.

Covering the entire loading and unloading process, such as that implemented at Hamina Kotka in Finland, Polish terminals in Gdansk and Gdynia, at least one terminal in Tallinn, and the Yara fertilizer terminal at Norrköping, Sweden, have already modified their handling procedures to keep covered the entire loading and unloading process. Baltic Bulk Terminal in Gdynia has further implemented procedures to halt loading and unloading operations in periods of rain and snow to further prevent weather-related losses.



## Ship Loading

A ship loader itself is normally a fairly straightforward machine consisting of a belt conveyor supported by a boom structure which is capable of traversing, slewing, luffing and telescoping to allow bulk cargo to be transferred from the quayside and dropped into the hold of the vessel. Spills are an inherent problem of belt conveyors where large amounts of spillage occurs at conveyor transfers and hoppers, and along the length of conveyor belts. Spilled materials on the ground, if not removed, are flushed into storm or wastewater sewers during rain storms. Dripping and spills from conveyors that are above open water and shiploaders may be significant sources of contaminants in the receiving water and/or the sediment.



*Modified conveyor loader in Gdansk.*

In order to minimise dust pollution shiploaders can employ a fully contained telescoping loading chute attached to the end of the ship loading boom, extending down into the vessel's hold so that it rests on top of the cargo. These enclosed chutes are often combined with internal speed-dampening mechanisms to slow the freefall of material. As the loading operation proceeds and the level of cargo rises in the hold, the outer bellows of the chute will compress thus ensuring that the base of the chute is constantly resting on the cargo where a skirt arrangement provides a dust-proof seal.

The [Vigan loader](#), pictured above, was installed in Gdansk in 1999 for handling fertilizers. Its operating capacity is 1000 tons per hour and includes some specialized modifications, including air filters.

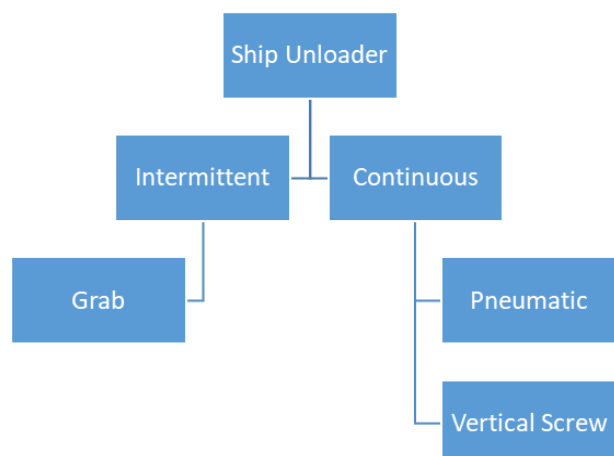
Other methods can include using big bags directly in shipment, or loading directly from specialized container systems such as those developed by Ultramar in Riga, Latvia.

Reported through the HELCOM questionnaire, Baltic terminals in Hamina Kotka, Gdansk, and Tallinn have each reported their use of closed conveyors and loading chutes, and may serve as examples for installations in other Baltic ports. The covered loading conveyor at Hamina Kotka is pictured on the cover of this report.



*Example of a contained loading chute.*

## Ship Unloading



Discharging bulk cargo from vessels is a more complex task and raises a variety of environmental concerns which can include dust pollution, cargo spillage, high energy consumption and unacceptably high levels of noise. Normally the port or terminal operator needs to select a system which can achieve the required discharge capacity while at the same time incurring minimal environmental impact. Often in circumstances where various different cargoes need to be handled, a compromise decision is reached. See Annex 2 for detailed comparison tables.



*Example of a continuous mechanical unloader.*

There are two main basic categories of ship unloaders: continuous and intermittent. Within Continuous unloaders there is another critical distinction between pneumatic and mechanical methods. These are the primary types used for fertilizer handling, though other styles of unloading equipment exist.

Pneumatic unloaders operate like giant vacuum cleaners, extracting material from the ship's hold by means of negative air pressure. They are only suitable for use with powdery cargoes or those of small-particle size. They

offer the major environmental advantage of not causing dust pollution, but traditionally suffer from the drawback of high energy consumption and high noise output. According to information via equipment company [Vigan](#), Russia's Port of Luga operates one pneumatic unloader for fertilizer operating at 1500 tons per hour, installed in 2014.

Continuous mechanical unloaders are probably the most environmentally acceptable of the three available options. They normally cause only minimal levels of dust pollution and are more energy efficient than alternative systems. However, the capital investment cost for this type of equipment is high.

Discontinuous mechanical unloading, or grab handling, is the most popular method of ship discharge and also the most prone to spillage and dust pollution. Its popularity resides in the fact that it is extremely versatile, allowing cargoes from heavy ores and rock through to fine powders to be handled by just one machine. Traditional drawbacks are spillage, dust pollution and noise.



*Example of a grab loader. Note the dust rising from normal operation.*

The following table summarizes some of the key considerations for choosing between these different technologies.<sup>1</sup> The power consumption of the Grab unloader includes the assumption that the engine is used for dynamic braking when lowering the grab into the ship hold. Tons per hour = tph.

Features	Unit	Grab	Pneumatic	Vertical Screw
Unloading capacity rate	tph	600-3000	300-1200	600-2500
Maximum vessel size	DWT	250,000	45,000	180,000
Power consumption (per rate unloaded tph)	Kwh/t	0.2-0.4	0.85-0.9	0.3-0.6
Operational efficiency	%	50-55%	65%	70%
Operating Expense (per ton unloaded)	US\$/t	5.20	4.30	4.60

<sup>1</sup> Source: <https://www.linkedin.com/pulse/how-choose-right-ship-unloading-system-carlos-equi-1>



## Stormwater Management/SUDS

Pollution sources from fertilizer handling are distributed across the port facility, including areas under handling equipment, storage buildings, and areas open to airborne dust from handling. Where focused spills can be managed as they occur, manual cleanup from airborne dusting is nearly impossible. This dusting enters the Baltic in stormwater runoff. Thus consolidating and capturing stormwater in some form to recycle nutrients is a key area for nutrient load reduction, and possible recovery, in Baltic ports.

Traditional drainage options include routing stormwater through pipes to remove it as quickly as possible from an area, without recapturing any pollutants or nutrients contained within. Sustainable drainage systems (SUDS) can provide a framework to manage stormwater and recover pollutants. Using a SUDS framework, solutions to filter, capture, and possibly recycle nutrients are either mechanical filtration, biofiltration, or some combination of both. As with other solutions, options for managing stormwater are site specific. Some of the details a solution must account for are slope, elevation, flood risk, total drained area, maintenance, and knowledge of any specific pollutants that may be more abundant in the drainage area. For example, Polish fertilizer producers import Moroccan phosphorous, which can be contaminated with [high levels of cadmium](#). Thus, SUDS in Poland may also need to consider cadmium in addition to nutrient reduction.

In addition to routing water as in traditional drainage, a SUDS approach can:

- Reduce runoff volumes and flow rates in existing surface water systems to help prevent flooding (or provide capacity to accommodate new development without increasing flood risk).
- Improve water quality where the water passes through green planted systems, or through hard or proprietary SUDS components that are designed to reduce the silt and pollution in runoff.
- Enable groundwater to be recharged using infiltration systems, where appropriate.
- Provide attractive amenity spaces or landscape features as an integral part of existing urban spaces or new development.
- Improve biodiversity by contributing to green networks and corridors, and creating a range of habitats for wildlife.

\*From [Guidance on the Construction of SUDS - C768](#)

There are a number of specific technologies and techniques used in SUDS with far greater technical complexity than can be explained in this document. Below are a few summary examples and descriptions to show the breadth of options available.

The following table, adapted from guidance tables at Stockholm Vatten och Avfall, shows estimated pollutant reduction efficiency from different types of water treatment mechanisms and systems. Given uncertainties in the data, these estimates are best interpreted as orders of magnitude for relative effect rather than 'true' figures. Determining the correct combination of methods for any specific port requires expert consultation.

'Total P' represents phosphorus both in solvent and particle-bound. 'Loose P' represents only phosphorus in solvent. 'Total N' represents nitrogen in both solvent and particle-bound. There was not enough data to represent 'Loose N' in the table.

Estimated reduction efficiency in various types of water treatment	Total P	Loose P	Total N
	[%]	[%]	[%]
<b>Delay in ground / surface profile</b>			
Green area with surface distribution	65	25	40
Swale (shallow ditch)	30	0	40
Macadam Ditch	60	15	35
Reduced plant bed (biofilter)	65	25	40
<b>Underground</b>			
Retention basin	55	0	15
Infiltration/percolation system*	100	100	100
<b>Mechanical filtration</b>			
Drainage filter	25	0	0
Water treatment plant	45	0	15
<b>Open settling and purification</b>			
Settling Pond	50	30	35
Wetland	50	40	35

\* The data for this percolation system assumes zero overflow back to surface water, that all water fully infiltrates the earth and watertable.

### Delay In Ground/Surface Treatments

Delay in ground/surface treatments may be the most simple type of filtration, using open planted land and the soil underneath, with stormwater filtering through. The areas tend to be smaller, and capture runoff directly without dedicated piping systems to deliver water. Storm drains may be incorporated underneath to capture water already filtered through these methods. Green areas, swales, macadam ditches, and biofilter areas are only a few examples.



*Example of a ditch-type green area*

Green areas are the simplest of all, resembling a lawn or other natural land to capture runoff from buildings and paved areas. Swales are shallow ditches that help capture water as green areas do, with some effect of infiltration that can vary depending on construction and soil underneath. Macadam is a kind of uniform stone used to filter and delay water drainage, used in various capacities in stormwater management including surface ditches along roadsides and green areas. A reduced plant bed combines lower elevation and certain types of vegetation to also delay and filter water, the plants themselves consuming otherwise excessive nutrient loads. This is a type of biofilter area, though others can also be called the same.

### Underground Treatments

Underground treatments are ideal when space is limited for biofiltration. An underground retention basin is closed on the bottom, receiving water from a drainage system. Various filters and chemicals may be used to increase water purification and capture dissolved pollutants before water is drained into another treatment or filtration method. An underground percolation or infiltration system is open on the bottom, providing several steps of separation, filtration, and settling as stormwater moves through this system. The table assumption of 100% capture of all nitrogen and phosphorus assumes the remainder of a designed system using this technique does not reintroduce water to the Baltic.

## Mechanical Filtration

Mechanical filtration is just this, a screen or other filtering medium placed in-line of a stormwater flow. In the case of drainage filters, these can be installed in pre-existing drains where there is no room for other solutions. For fertilizer types of pollution these appear to be poor options. Another more complex type of mechanical filtration is a small water treatment plant, which is an underground series of filters and screens. These are ideal where space is limited, though they struggle to handle large stormflows. Incorporating another means to delay water is ideal with these water treatment plants.



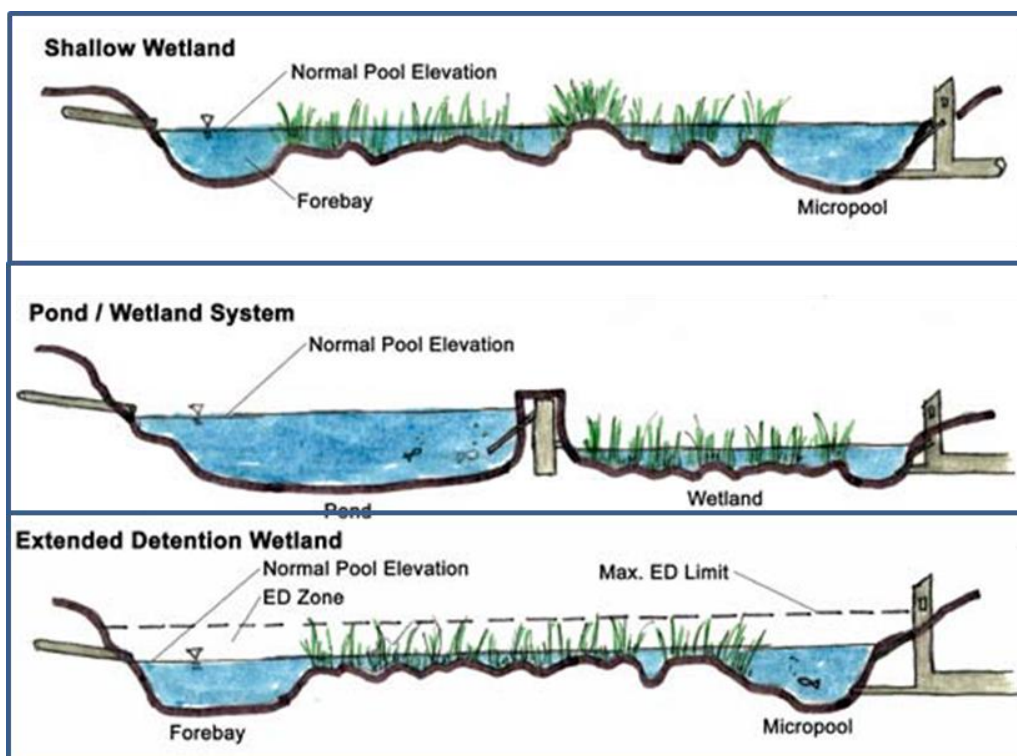
*Example of a water treatment plant, here exposed during construction.*

## Open Settling and Purification

Settling ponds and wetlands are some of the most common techniques of this biofiltration method. Both are intended to capture water from larger sources of runoff and can both delay and filter water over time. Designs for high water volume are also possible. These could also be a final step for water filtration following other mechanical filtering. The combination of these biofiltration techniques is regularly considered the ideal solution.

Yara's fertilizer terminal in the port in Norrköping, Sweden, highlights a proposed high quality stormwater management system, combining a number of mechanical and biofiltration techniques. This terminal has already achieved 100% covered handling of fertilizers to reduce dusting and spills, though water tests still show nutrients reaching the Baltic. The pre-filtration pollution levels from this relatively small business area amounted to 70kg of phosphorous and 3000kg of nitrogen annually. This equals the nutrients from raw sewage as phosphorous from about 100 people, and as nitrogen from about 650 people.

Starting with a separation of stormwater from polluted and non-polluted areas of the port facility, as determined by the consultant Water Revival Systems, polluted stormwater would be delayed in a separator tank before being pumped to an inclined green area. This green area, a sort of 'dry' wetland, converts



*Illustrations of three major stormwater wetland systems, from the Minnesota Stormwater Manual.*

ammonium into nitrate for further filtration. The following step in filtration is a phosphorous trap, after which a series of wetlands and ponds will handle the remaining nitrogen. This plant is designed to capture 80% of the initially identified pollutants.



Stormwater management system cross-section proposal for Yara fertilizer business area in Norrköping, SE

## Ship Hold Washing

Washing of ship holds, according to research noted earlier, could be a substantial source of additional nutrients into the Baltic. The Baltic is listed under MARPOL as an area of special concern, with more rigorous rules about how ships can discharge hold washing water. In the case of washing water contaminated with fertilizer and its chemical components, discharge into port reception facilities is required. IMO standards exempt the mandatory discharge of hold washing water into port facilities when none are present IF the hold wash water does not contain substances specifically classed as 'hazardous for the marine environment', with other rules for discharge at sea. The MARPOL regulatory standing of hold washing is discussed in Annex 3 and this [circular](#) from maritime insurance provider Skuld.

Despite the Baltic's listing as an area of special concern, few port reception facilities exist. This is a topic of marked concern across maritime industries and the International Maritime Organization (IMO) ([MEPC. 1/Circ. 834](#)), including for [cruise ship sewage](#) in the Baltic, recently discussed at the 73rd session of the IMO Marine Environment Protection Committee.

Securing information on the actual practice of ships in the Baltic has been elusive, since hold washing is a shipboard practice without any clear management from port operators, port administrations, or municipalities. What is clear is the industry-wide lack of port reception facilities for all types of cargo and passenger generated wastes.

This is echoed in a recent [study](#) on Baltic phosphorous flows, with the following conclusions on driving forces to address the ship-side challenge in reducing Baltic Sea nutrient loading.

- Regulations. In few years, the effect of regulations for the Baltic Sea as Special Area under Annex IV will be seen; however, it will only impact the passenger ship segment.
- Infrastructure on land. The presence of adequate capacity of PRFs and how smoothly the waste can be offloaded from ships is of importance. Another factor is the presence of well-working agreements between ports and the treatment facilities which enables unproblematic further treatment on land.
- Financial aspects. The cost of marine waste handling equipment and the waste fee charged in ports impact the handling strategies chosen by the shipping companies.
- Policies and practices on-board. Introduction of policies on how proactively the waste handling is performed on-board and engaging the crew and the passengers in contributing to sustainable travelling.

## Next Steps

The concept of a uniform collection of best technologies and techniques, or best practices, is relevant and necessary to consider for Baltic port authorities, terminal operators, shipping companies, and others involved in the fertilizer supply chain. This document is intended to highlight the diversity of technical solutions available and feed discussion among these peer industry organizations to further the process in an open innovation setting.

CCB sees this as perhaps the **opportunity** to capture a significant point-source of nutrient inputs so far insufficiently addressed. Given reports on contractually allowed losses well above estimates, and variability in losses ranging up to 3%, the urgency to pursue solutions is clear. The **need** at this time is to decide which solutions are best on a case by case basis, and to collect and verify all data on losses to support these decisions.

We **ask** for collaboration from industry and governments to meet this need with a unified sense of purpose, and willingness to employ creative, innovative solutions.



Annex 1. Baltic ports fertilizer statistics and estimated %0.05 losses, in tons (2013)<sup>2</sup>

Port Name		Fertilizer cargo turnover, t	Potential loss, t	Port Name		Fertilizer cargo turnover, t	Potential loss, t
1. Klaipeda	LT	8 574 000	4 287	39. Wolgast	DE	20 000	10
2. St Petersburg	RU	6 023 000	3 012	40. Koege	DK	19 000	10
3. Gdansk	PL	1 940 000	970	41. Grenaa	DK	19 000	10
4. Gdynia	PL	1 873 000	937	42. Kalmar	SE	19 000	10
5. Szczecin – Swinoujscie	PL	1 700 000	850	43. Hundested	DK	17 000	9
6. Port of Tallinn	EE	1 642 000	821	44. Holbaek	DK	17 000	9
7. Muuga (Tallinn)	EE	1 633 000	817	45. Vaasa	FI	16 000	8
8. Ventspils	LV	1 566 000	783	46. Klintehamn	SE	16 000	8
9. Rostock	DE	1 527 000	764	47. Luleå	SE	12 000	6
10. Riga	LV	1 414 000	707	48. Roedby	DK	10 000	5
11. Police	PL	1 255 000	628	49. Horsens	DK	10 000	5
12. HaminaKotka	FI	1 074 000	537	50. Umeå	SE	10 000	5
13. Uusikaupunki	FI	772 000	386	51. Pajassaare (Tallinn)	EE	9 000	5
14. Vyborg	RU	579 000	290	52. Berndshof	DE	9 000	5
15. Ust-Luga	RU	493 000	247	53. Roenne	DK	8 000	4
16. Lübeck	DE	316 000	158	54. Vejle	DK	8 000	4
17. Kokkola	FI	283 000	142	55. Mönsterås	SE	8 000	4
18. Sillamäe	EE	283 000	142	56. Nakskov	DK	7 000	4
19. Kolding	DK	222 000	111	57. Odense	DK	7 000	4
20. Kaliningrad	RU	207 000	104	58. Pietarsaari	FI	6 000	3
21. Wismar	DE	201 000	101	59. Guldborgsund	DK	5 000	3
22. Randers	DK	175 000	88	60. Skellefteå	SE	5 000	3
23. Lidköping	SE	134 000	67	61. Fredericia	DK	4 000	2
24. Siilinjärvi	FI	129 000	65	62. Pori	FI	3 000	2
25. Korsoer	DK	85 000	43	63. Vene-Balti	EE	3 000	2
26. Vierow	DE	84 000	42	64. Söråker	SE	3 000	2
27. Stralsund	DE	57 000	29	65. Bergkvara	SE	3 000	2
28. Liepaja	LV	56 000	28	66. Trelleborg	SE	3 000	2
29. Flensburg	DE	56 000	28	67. Tolkkinen	FI	2 000	1
30. Aarhus	DK	47 000	24	68. Svendborg	DK	2 000	1
31. Skulte	LV	45 000	23	69. Hobro	DK	2 000	1
32. Bekker	EE	44 000	22	70. Neustad / Holstein	DE	2 000	1
33. Kristinehamn	SE	40 000	20	71. Burgstaaken	DE	2 000	1
34. Greifswald, Landkreis	DE	33 000	17	72. Heiligenhafen	DE	2 000	1
35. Kalundborg	DK	32 000	16	73. Visby	SE	2 000	1
36. Aalborg	DK	25 000	13	74. Helsinki	FI	1 000	1
37. Kaskinen	FI	23 000	12	75. Kemiö	FI	1 000	1
38. Aabenraa	DK	23 000	12	<b>TOTAL</b>		<b>33 315 000</b>	<b>16 658</b>

<sup>2</sup> Based on %0.05 loss estimates from [Grote M., Mazurek N, Gräbsch C., Zeilinger J., Le Floch S., Wahrendorf D.-S., Höfer T. Dry bulk cargo shipping — An overlooked threat to the marine environment? Marine Pollution Bulletin 110 \(2016\) 511–519](#)

## Annex 2. Advantages and disadvantages of ship unloader types<sup>3</sup>

Ship Unloaders - Advantages			
Comparison point	Grab	Pneumatic	Vertical Screw
Spillage and dust		Clean operation with neither spillage nor dust pollution.	Totally enclosed, eliminates spillage. Keeps dust to an absolute minimum.
Digging capacity	Higher digging capacity, but average unloading capacity due to intermittent cycle.		
Material unloading efficiency		Unload efficiently free flowing products like cereals, nuts, beans, soybean meal, animal feeds.	Ideal for all dry agribulk material, alumina, biomass, cement, coal, fertilizers, grain, sand, and sulphur.
Material degradation	Taking into account the clam shell grabs the material, there is no degradation.		Transports the cargo gently, resulting in minimal degradation.
Equipment weight and required investment for infrastructure		The lower weight of the pneumatic unloader is a result of using conveying pipes instead of heavy mechanical conveying equipment. Lower operating weight and corner loads result in a lower investment requirement for the infrastructure.	
Ease of operation		Operates at higher efficiency, ability to remove material from the bottom of the hatch, thus reducing the required time consumed through clean-up operations.	
Feed device requirement		Does not normally require any mechanical feed device.	
Residual material in the vessel hold		No remaining material on the hold floor. Acts as a real vacuum cleaner.	Articulation of the complete arm system together with travelling along the quayside allows access to all parts of the cargo hold for unloading.
Noise during operation			Less noise during operation, considering the system is totally enclosed.
Maintenance facilities			Few wearing parts due to low conveying velocity. Reduced maintenance requirements.

<sup>3</sup> Adapted from: <https://www.linkedin.com/pulse/how-choose-right-ship-unloading-system-carlos-equi-1>

Ship Unloaders - Disadvantages			
Comparison point	Grab	Pneumatic	Vertical Screw
Spillage and dust	Can spill from clam shell lips. Significant dust during discharge into the hopper (some dust collection systems are available).		
Limitations for unloading		Only able to handle powders, pellets, grains, and materials of small lump size, with a specific weight of less than 1 tonne per cubic metre.	Can handle material of generally 50 - 75 mm and higher size. Lumps are difficult to handle.
Components and devices needed for operation		Requires the inclusion of several components such as telescopic spouts, airlocks, filter systems and the suction nozzle.	
Maintenance needs		Many parts require more maintenance, higher maintenance costs.	Screw damage/ accelerated wear is expensive and time consuming to replace.
Wear and failures		The high conveying velocity of the bulk material contributes significantly to the high level of wear and unexpected failures of the installation.	Concerns over wear rates of the screw and in all the resulting maintenance costs.
Equipment availability	Filling the grab is difficult and time wasting. Also the discontinuous operation is more difficult to patrol and requires constant attention from the operator.	The frequency at which parts must be replaced is naturally greater, which increases the amount of downtime of the installation and reduces availability of the system.	
Power consumption	Frequent accelerating and decelerating, starting and braking consume more power.	Consumes more energy, new pneumatic system is roughly 0.85-0.9 kWh/t. Older systems regularly exceed 1 kWh/t.	
Residual material in the ship hold	Difficult and time-consuming cleanup. Need to use other machinery in the hold to collect material for removal.		Remaining unloaded material in the hold requires extra unloading.
Operating noise		The air suction blower employed in these systems produces an annoying, far-travelling sound.	

## Annex 3. Applicability of MARPOL Annex V requirements to fertiliser cargo residues

### Disposal of solid bulk cargo residues and cargo hold wash water under MARPOL Annex V<sup>4</sup>

MARPOL Annex V deals with the regulations for the prevention of pollution by garbage from ships. The disposal of non-recoverable cargo residues and hold wash water is also governed under this annex. Although most Standard Club members are well versed with the requirements for the various garbage categories covered in MARPOL Annex V, there is some ambiguity regarding the disposal of cargo residues and hold wash water. This article aims to clarify the requirements and highlights the practical steps to be taken by the crew in order to ensure compliance.

#### Regulatory background

The revised MARPOL Annex V ([resolution MEPC.201\(62\)](#)), which entered into force on 1 January 2013, generally prohibits the discharge of all garbage into the sea, unless explicitly permitted under regulations 4, 5 and 6 of the annex. The only exceptions are food waste, animal carcasses and cargo residues (and cleaning agents) in wash water which are not harmful to marine environment. IMO's MEPC, during its 63rd session, adopted the 2012 guidelines for the implementation of MARPOL Annex V ([resolution MEPC.219\(63\)](#)) and the 2012 guidelines for the development of garbage management plans ([resolution MEPC.220\(63\)](#)). At the 64th session of MEPC (in October 2012), the IMO recognised that the toxicity data which is needed to classify a solid bulk cargo as harmful to the marine environment (HME) may not be readily available and established a timeframe (from 1 January 2013 to 31 December 2014) for provisional classification of solid bulk cargoes. From 1 January 2015, the shipper should provide a complete classification for the cargo to be shipped. As further stipulated by [MEPC.1/Circ.791](#) the shipper must also declare whether the cargo is classified as HME to the port state authorities at the port of loading and unloading.

During the 65th session of MEPC (in May 2013), the overall situation was reviewed again and, due to lack of adequate reception facilities, it was agreed that until 31 December 2015, wash water from cargo holds previously containing solid bulk cargoes classified as HME may be discharged outside special areas, under certain conditions as described in [MEPC.1/Circ.810](#). The proposal to extend the application of MEPC.1/Circ.810 was not approved during the [MEPC 69th session](#) (in April 2016). As a result, discharge of HME cargo residues and cargo hold wash water outside of the special areas (MARPOL Annex V) is now prohibited. Definitions 'Cargo residues' are defined under MARPOL Annex V as the remnants of any cargo that is not covered by other annexes and that remains on deck or in holds following loading or unloading. These include loading and unloading excess or spillage, whether in wet or dry condition, or entrained in wash water, but do not include cargo dust remaining on deck after sweeping or dust on the external surfaces of the ship.

#### Definitions

'Cargo residues' are defined under MARPOL Annex V as the remnants of any cargo that is not covered by other annexes and that remains on deck or in holds following loading or unloading. These include loading and unloading excess or spillage, whether in wet or dry condition, or entrained in wash water, but do not include cargo dust remaining on deck after sweeping or dust on the external surfaces of the ship.

Effectively, Annex V applies to all solid bulk cargo residues (as oil, noxious liquid and dangerous cargo carried in packaged form are covered by Annexes I, II and III respectively). However, the 64th session of MEPC agreed that when packaged cargoes (including tank containers) are damaged, the consequential spillage of cargo will no longer fall within the definition of packaged cargo and should be treated as residues or wastes, and therefore will also be covered by MARPOL Annex V. Such spillages will need to be treated in accordance with the guidance provided under the IMDG code supplement. Spillages from substances classified as marine pollutants will need to be contained/ collected on board for shore disposal. The cargo hold wash water is basically the waste water consisting of the nonrecoverable cargo residues and

<sup>4</sup> Source: <http://www.standard-club.com/media/2342257/standard-safety-september-2016.pdf>

hold cleaning chemical agents or additives. Cargo material contained in cargo hold bilge water is not considered to be cargo residue if it is not harmful to the marine environment and the bilge water is discharged from a loaded hold through the ship's fixed piping bilge drainage system. Vessels at anchor for a period of time with empty cargo holds may discharge hold bilge water that is not directly related to any hold cleaning activities.

#### HME substances

The term 'harmful to the marine environment' (HME) is not defined under MARPOL Annex V, but under the 2012 guidelines for the implementation of MARPOL Annex V (resolution [MEPC.219 \(63\)](#)).

Cargo is considered as HME if it fails any one of the seven criteria stipulated under the UN Globally Harmonized System of Classification and Labelling of Chemicals ([UN GHS](#)):

- Acute toxicity
- Chronic toxicity
- Carcinogenicity
- Mutagenicity
- Reproductive toxicity
- Repeated exposure of specific target organ toxicity (STOT)
- Presence of plastics, rubber or synthetic polymers

There are three main stages in the classification of a cargo using the seven UN GHS criteria:

- A literature search of available information.
- Laboratory testing for toxicity, biodegradation and bioaccumulation.
- The comparison of the biodegradation and bioaccumulation data with published carcinogenicity, mutagenicity and reproductive toxicity (collectively known as CMR) as well as STOT studies.

Shippers are required to use these seven criteria to determine whether the cargo is harmful to the marine environment. A declaration as to whether the cargo is HME is required to be made by the shippers in accordance with section 4.2 of the International Maritime Solid Bulk Cargoes ([IMSBC](#)) code. The table on the following page summarises the classification criteria.



SUMMARY OF CLASSIFICATION CRITERIA <sup>5</sup>								
No	CRITERIA		CATEGORY					
1	Acute aquatic toxicity		Category 1 96hr LC50 (fish), 48hr EC50 (crustacean) or 72/96hr ErC50 (algae) is ≤ 1.00mg/l		Category 2 96hr LC50 (fish), 48hr EC50 (crustacean) or 72/96hr ErC50 (algae) is > 1.00 but ≤ 10.0mg/l		Category 3 96hr LC50 (fish), 48hr EC50 (crustacean) or 72/96hr ErC50 (algae) is ≥ 10.0 but < 100mg/l	
2	Long-term (chronic) aquatic toxicity	Adequate chronic data	Category 1 Not rapidly degradable = chronic NOEC or ECx (fish), (crustacean) or (algae) is ≤ 0.1mg/l Rapidly degradable = chronic NOEC or ECx (fish), (crustacean) or (algae) is ≤ 0.01mg/l		Category 2 Not rapidly degradable = chronic NOEC or ECx (fish), (crustacean) or (algae) is ≤ 1.0mg/l Rapidly degradable = chronic NOEC or ECx (fish), (crustacean) or (algae) is ≤ 0.1mg/l		Category 3 Rapidly degradable = chronic NOEC or ECx (fish), (crustacean) or (algae) is ≤ 1.0mg/l	
		Inadequate chronic data	Not rapidly degradable <sup>2</sup> with high bioaccumulation <sup>3</sup> PLUS...	Category 1 Acute aquatic toxicity category 1	Category 2 Acute aquatic toxicity category 2	Category 3 Acute aquatic toxicity category 3	Category 4 Poorly soluble substances for which no acute toxicity is recorded	
3	Carcinogenicity			Category 1A Known human carcinogen based largely on human evidence	Category 1B Presumed human carcinogen based on demonstrated animal carcinogenicity	Category 2 Suspected carcinogen. Limited evidence of human or animal carcinogenicity		
4	Mutagenicity			Category 1A Known mutagens. Possible evidence from human epidemiological studies of mutagenicity	Subcategory 1B Positive results in: <i>In vivo</i> heritable germ cell tests in mammals or this combined with some evidence of germ cell mutagenicity or mutagenic effects in human germ cell tests without demonstration of progeny	Category 2 Suspected or possible mutagen. Positive evidence from tests in mammals and/or in some cases from <i>in-vitro</i> experiments		
5	Reproductive toxicity			Category 1A Known human reproductive toxicant based on human evidence	Category 1B Presumed human reproductive toxicant largely based on data obtained from animal studies	Category 2 Suspected human reproductive toxicant. Human or animal evidence possible with other information		
6	Repeated exposure STOT			Category 1 Substances that have produced significant toxicity in humans or that, on the basis of evidence from animal studies, have the potential to do so following repeat exposure	Category 2 Substances that are presumed to be harmful to human health at repeated exposure (animal studies with significant toxic effects relevant to humans at generally moderate exposure or human evidence in exceptional cases)			
7	Plastics		Cargo consists of, or contains: synthetic polymers, rubber, plastics or plastic feedstock pellets					

LC50 = The lethal concentration of the compound that kills 50% of test organisms in a given time

ErC50 = The EC50 in terms of reduction of growth rate

EC50 = Half max effective concentration

NOEC = No observed effect concentration

ECx = The concentration associated with x% response

1. Further detail can be reviewed in part 3 and 4 of the UN GHS 2011.

2. Essentially substances are considered rapidly biodegradable in the environment if >70% (based on dissolved organic carbon) or >60% (CO<sub>2</sub> generation or O<sub>2</sub> depletion) of the material is degraded within a 28 day period. If no other data is available then BOD<sub>5</sub>/COD<sub>5</sub> >0.5.

3. Bioaccumulation is measured through exposure studies in fish or shellfish and reported as a bioconcentration factor (BCF) where high = >500 or an octanol/water partition coefficient (log KOW) where high = >4

<sup>5</sup> Adapted from: <https://www.itopf.org/fileadmin/data/Documents/Papers/ITOPFMARPOLAnnexVAdvisoryNoteV2.pdf>

### Discharge requirements of cargo residues and cargo hold wash water

The guidelines stipulated under MARPOL Annex V state that discharge of cargo residue should be minimised and every effort should be made to ensure that as much of the cargo as possible is unloaded at port.

The ship's garbage management plan should include measures to reduce the amount of garbage generated. This includes measures to mitigate the cargo spillage and ensuring that upon completion of discharge, the cargo holds, decks and hatch covers are thoroughly cleaned and swept down, with any residual cargo being discharged to shore, as far as practicable.

The disposal requirements for cargo residues and hold wash water from ships are:

- No discharge of any cargo residues or cleaning agents specified as HME is permitted in cargo hold, deck and external surfaces wash water.
- Cargo residues not specified as HME may be discharged more than 12nm from land.
- Cleaning agents in cargo hold, deck and external surfaces wash water may be discharged to the sea provided they are not HME.
- Discharge of cargo residues is prohibited within the defined 'special areas' established under Annex V (the North Sea, Baltic Sea, Mediterranean Sea, Black Sea, Red Sea, Persian Gulf, Antarctic and the wider Caribbean Region). For cargo hold wash water containing residues, discharge may be permitted, provided the ship is transiting between ports, both of which are within the special area, and where no adequate reception facilities exist.

**However, it is unclear whether fertilizer cargos should be classified as HME, as those substances do not fall under any of the UN GHS criteria, except for oxidizing (toxic) properties e.g. of ammonium nitrate.**

## Amendments to the Annex of the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973 (Revised MARPOL Annex V), RESOLUTION MEPC.201(62), adopted on 15 July 2011

### Regulation 6

#### *Discharge of garbage within special areas*

- 1 Discharge of the following garbage into the sea within special areas shall only be permitted while the ship is en route and as follows:
  - .2 Discharge of cargo residues that cannot be recovered using commonly available methods for unloading, where all the following conditions are satisfied:
    - .1 Cargo residues, cleaning agents or additives, contained in hold washing water do not include any substances classified as harmful to the marine environment, taking into account guidelines developed by the Organization;
    - .2 Both the port of departure and the next port of destination are within the special area and the ship will not transit outside the special area between those ports;
    - .3 No adequate reception facilities are available at those ports taking into account guidelines developed by the Organization; and
    - .4 Where the conditions of subparagraphs 2.1, 2.2 and 2.3 of this paragraph have been fulfilled, discharge of cargo hold washing water containing residues shall be made as far as practicable from the nearest land or the nearest ice shelf and not less than 12 nautical miles from the nearest land or the nearest ice shelf.

## 2012 Guidelines for the Implementation of MARPOL Annex V, Resolution MEPC.219(63), adopted on 2 March 2012

### 3 Management of Cargo Residues of Solid Bulk Cargoes

- 3.2 Cargo residues are considered harmful to the marine environment and subject to regulations 4.1.3 and 6.1.2.1 of the revised MARPOL Annex V if they are residues of solid bulk substances which are classified according to the criteria of the United Nations Globally Harmonized System for Classification and Labelling of Chemicals (UN GHS) meeting the following parameters:
  - .1 Acute Aquatic Toxicity Category 1; and/or
  - .2 Chronic Aquatic Toxicity Category 1 or 2; and/or
  - .3 Carcinogenicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or
  - .4 Mutagenicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or
  - .5 Reproductive Toxicity Category 1A or 1B combined with not being rapidly degradable and having high bioaccumulation; and/or
  - .6 Specific Target Organ Toxicity Repeated Exposure Category 1 combined with not being rapidly degradable and having high bioaccumulation; and/or
  - .7 Solid bulk cargoes containing or consisting of synthetic polymers, rubber, plastics, or plastic feedstock pellets (this includes materials that are shredded, milled, chopped or macerated or similar materials).
- 3.4 Solid bulk cargoes should be classified and declared by the shipper as to whether or not they are harmful to the marine environment. Such declaration should be included in the information required in section 4.2 of the IMSBC Code.
- 3.5 Ports, terminals and ship operators should consider cargo loading, unloading and onboard handling practices in order to minimize production of cargo residues. Cargo residues are created through inefficiencies in loading, unloading, onboard handling. Options that should be considered to decrease the amount of such garbage include the following:
  - .1 ensuring ships are suitable to carry the intended cargo and also suitable for unloading the same cargo using conventional unloading methods;

.2 **unloading cargo as efficiently as possible**, utilizing all appropriate safety precautions to prevent injury or ship and equipment damage and to avoid or minimize cargo residues; and

.3 **minimizing spillage of the cargo during transfer operations by carefully controlling cargo transfer operations, both on board and from dockside**. This should include effective measures to enable immediate communications between relevant ship and shore-based personnel during the transfer operations and when feasible, enclosure of conveyance devices such as conveyor belts. Since this spillage typically occurs in port, it should be completely cleaned up immediately following the loading and unloading event and handled as cargo; delivering it into the intended cargo space or into the appropriate unloading holding area.

3.6 **When the master, based on the information received from the relevant port authorities, determines that there are no adequate reception facilities** at either the port of departure or the port of destination in the case where both ports are situated within the same special area, the condition under regulation 6.1.2.3 should be considered satisfied.

## CARGO RESIDUES

### Simplified overview of the discharge provisions regarding cargo residues of the revised MARPOL Annex V

DISCLAIMER: Additional requirements may apply.

This simplified overview is for information or reference purposes only and is not meant as a substitute for the comprehensive provisions in the revised MARPOL Annex V (resolution MEPC.201(62)) or the 2012 Guidelines for the Implementation of MARPOL Annex V (resolution MEPC.219(63)).

Type of garbage	Ships outside special areas	Ships within special areas	Offshore platforms and all ships within 500 m of such platforms
Cargo residues not considered harmful to the marine environment and not contained in wash water	Discharge permitted ≥12 nm from the nearest land and <i>en route</i>	Discharge prohibited	Discharge prohibited
Cargo residues not considered harmful to the marine environment contained in wash water		Discharge only permitted in specific circumstances* and ≥12 nm from the nearest land and <i>en route</i>	Discharge prohibited
Cargo residues considered harmful to the marine environment	Discharge prohibited	Discharge prohibited	Discharge prohibited

\* According to regulation 6.1.2 of MARPOL Annex V, the discharge shall only be allowed if: (a) both the port of departure and the next port of destination are within the special area and the ship will not transit outside the special area between these ports (regulation 6.1.2.2); and (b) if no adequate reception facilities are available at those ports (regulation 6.1.2.3).



## CCB's Working Areas:

- Water Protection in Agriculture
- River Basin and Wastewater Management
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- Biodiversity and nature conservation
- Hazardous substances and marine litter
- Sustainable development in coastal and marine areas
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