

**Preventing spills of
plastic pellets: a
feasibility analysis of
regulatory options**



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Preventing spills of plastic pellets: a feasibility analysis of regulatory options

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Summary

Plastic pellets (also called ‘nurdles’) are small pieces of plastics, typically between 1 and 5 mm in diameter, are produced by the petrochemical industry and serve as an input for the plastics industry to manufacture plastic products. Large quantities of pellets are transported over sea, typically in freight containers. As a result of damaged packaging or containers, pellets leak out of containers. In addition, occasionally, containers are lost at sea because they fall over board or because a ship sinks. When pellets are released into the water, they cause environmental damage and pollution of sea and the coastline.

The International Maritime Organization (IMO) is considering regulatory options for reducing the environmental risk associated with the maritime transport of plastic pellets. It found that the risks could be effectively reduced by a number of actions which could be taken individually or in combination:

- better packaging requirements;
- better notification requirements both within the transport chain and to authorities in case of an accident;
- stowing freight containers with pellets in slots where the risk of losing containers is smaller.

A correspondence group has identified three regulatory options to reduce the risks, namely:

1. An assignment of an individual UN number (class 9) for plastic pellets transported at sea in freight containers (UN number); such a number would be taken up in the International Marine Dangerous Goods (IMDG) Code, which would set provisions on packaging, stowage, labelling and notification, amongst others.
2. An amendment to appendix I of MARPOL Annex III that would recognize plastic pellets as a “harmful substance” (harmful substance); this would result in pellets being transported under UN number 3077, for which the IMDG code sets mandatory packaging, labelling and notification requirements and recommends stowage under deck or in sheltered areas.
3. A new chapter to MARPOL Annex III that would prescribe requirements for the transport of plastic pellets in freight containers without classifying the cargo as a harmful substance/dangerous goods.

This report analyses the effectiveness and feasibility of the regulatory options.

Different aspects of risk mitigation are tackled by the different options to different degrees. The options to apply for a new UN number or recognize pellets as a harmful substance by amending Appendix I of MARPOL Annex III would require better packaging of pellets, thus reducing the risk of chronic losses of pellets from containers and would reduce the risk of acute losses and dispersion of pellets in the marine environment if the container is lost overboard. Both of these options would trigger a preference for either below deck stowage or stowage in a sheltered location above deck but would require further amendment to the language of the IMDG Code to mandate safe stowage. In addition, classifying pellets as a harmful substance would improve disaster response and pollution preparedness. Out of these two options, the amendment of Appendix I of MARPOL Annex III could be implemented faster.



The option to add a chapter to MARPOL Annex III could include mandatory requirements for safe stowage, thus reducing the risk that containers with plastic pellets are lost at sea, but the current drafting does not require improved packaging requirements for plastic pellets being transported by sea nor notification of authorities in case of incidents or accidents. A combination of both mandatory packaging requirements and mandatory safe stowage requirements is needed to maximally eliminate the risks of pellet loss but is not guaranteed under any of the options unless additional changes are pursued.

All options would be feasible to implement by actors in the transport chain, regulators and inspectors. The additional costs of all options appear to be manageable, based on feedback from interviewees.



1 Introduction

1.1 Background and aim of the study

On 20 May 2021, the MV X-Press Pearl (IMO number: 987534), a Singaporean-flagged container vessel that was sailing from the Port Hazira, India to the Port of Colombo, Sri Lanka, caught fire and eventually sunk about 10 nautical miles off the coast of Sri Lanka. Some of the containers that the MV X-Press Pearl was carrying contained plastic pellets, also called nurdles, pieces of plastic typically 1-5 mm in diameter which are used to produce plastic products. After the incident, the pellets were released in the environment and polluted 750 kilometres of shoreline in Sri Lanka. Fish, turtles and other sea animals died from ingesting pellets or related causes. The clean up is still ongoing at the time of writing and tourism has been affected.

Drawing attention to the disaster, Sri Lanka requested the Marine Environmental Protection Committee (MEPC) of the International Maritime Organization (IMO) to classify plastic pellets as hazardous substances under the International Marine Dangerous Goods Code (IMO, 2020) (Sri Lanka, 2021).

MEPC's Subcommittee on Pollution Prevention and Response (PPR) established a Correspondence Group to 'further consider the options for reducing the environmental risk associated with the maritime transport of plastic pellets' (IMO, 2022).

The majority of the Correspondence Group found that the environmental risk associated with the maritime transport of plastic pellets would be reduced by (Norway & Spain, 2023):

- Introducing packaging requirements for plastic pellets carried at sea. The requirements should reduce the risk of release of pellets during normal operations and in incidents. In case of incidents, the packaging should remain intact so that the lost cargo can be more easily retrieved.
- Notifying carriers that containers contain plastic pellets. This could improve stowage of containers to reduce the risk of containers being lost at sea, and would facilitate a more focussed response to incidents.
- Introducing stowage provisions for freight containers containing plastic pellets. If containers are stowed below deck or inboard in sheltered areas of exposed decks, they would have a lower probability of being damaged or lost during transport.

The Group considered the advantages and disadvantages of these three primary measures, and subsequently identified mandatory instruments that could be used to implement provisions leading to a reduced environmental risk associated with the maritime transport of plastic pellets.

The Correspondence Group recommends to develop mandatory requirements for the maritime transport of plastic pellets and considered three options in detail (Norway & Spain, 2023):

1. An assignment of an individual UN number (class 9) for plastic pellets transported at sea in freight containers (UN number).¹

¹ Although the Correspondence Group focusses on transport at sea in freight containers, a UN Number has an impact on the entire transport chain by definition.



2. An amendment to appendix I of MARPOL Annex III that would recognize plastic pellets as a “harmful substance” (harmful substance).
3. A new chapter to MARPOL Annex III that would prescribe requirements for the transport of plastic pellets in freight containers without classifying the cargo as a harmful substance/dangerous goods.

The report of the Correspondence Group will be considered by PPR 10 in April 2023. In order to inform the debate, Fauna & Flora International has asked CE Delft to study the effectiveness of the three options; their impacts on actors in the transport chain; and the feasibility of implementation.

Textbox 1 - The environmental impacts of plastic pellet spills

In recent history, there have been several, serious cases of plastic pellet spills from ships that have resulted in billions of pellets ending up in the environment - the most recent examples have been recorded in France and Dubai in the first two months of 2023. In 2017, 50 metric tonnes of plastic pellets ended up on over 200 km of coastline in South Africa, which took around 3 years to clean. In 2020, a single damaged container spilled plastic pellets, which affected approximately 1,000 km of coastline in Norway and Sweden. In this case, the clean-up took more than a year to complete. Later in 2020, 6 containers of nurdles were lost off the coast of South Africa, polluting over 1,600 km of coastline. In 2021, the worst-ever plastic pellet pollution disaster happened off the coast of Sri Lanka. A ship containing 1,377 containers, of which 422 containers were carrying over 1,600 tonnes of nurdles, partly sank, dispersing pellets over 300 km of Sri-Lankan coastline. Estimates say that the clean-up will take another 2 to 3 years to complete. Nurdles are very mobile, because they are relatively small and buoyant. They can spread out over a large area due to the influence of tides, waves, ocean currents, weather and wind.

Large scale losses of plastic pellets can have a harmful impact on ecosystems and biodiversity. Certain species of fish and birds are known to ingest plastic pellets, which can lead to reduced feeding behaviour. Research has shown that microplastics have the potential to travel upwards in the food chain and induce an array of physiological effects, such as changes in reproduction, metabolism and behaviour (Karlsson et al., 2018). Microplastics are also able to absorb pollution, toxins and invasive (micro)organisms, such as harmful bacteria and viruses. Furthermore, plastic additives, such as colourants, stabilisers and softeners, can be toxic to a range of organisms. This means that plastic pellets can serve both as a transport medium for harmful substances and as a source of toxins in the environment themselves (Maes & Jefferies, 2022).

In addition to the direct and indirect impacts that pellet pollution has on biodiversity and sensitive coastal habitats such as seagrass mats, plastic pellet spills can also have broader socio-economic impacts, for example, by negatively affecting aquaculture and fisheries. In the case of Sri Lanka, where over 40% of the population depend on fish as their main source of protein, a decline in (healthy) fish availability jeopardised food security in the wake of the MV X-Press Pearl disaster. Pellet pollution also impacts the tourism industry due to the negative impacts on biodiversity, and diminished appeal of visibly polluted coastlines. Due to the persistent polluting nature of pellets and the length of time required to clean-up spills, these impacts can be long-lasting.

Cleaning up plastic pellets is a labour-intensive and time-consuming task. Furthermore, it is very hard to clean up plastic pellets without further impacting biodiversity as a result of the techniques used, because pellets are very small and can break-down down into smaller pieces of plastic due to UV light, heat exposure and abrasion. Weather plays an important role, as warm and dry weather facilitates the clean-up process and frost, rain and wind can be a large hindrance. (Norwegian Coastal Administration, 2020). There is a large diversity of clean-up methods for plastic pellets. They can be classified as labour-intensive (precise), and less labour-intensive (often less precise). Labour-intensive techniques would include: sieving, which uses a sieve to filter out the pellets; water bathing, which uses the buoyancy of plastic pellets to remove them; trap systems for streams/pools, which are efficient but require manual work to remove pellets from the pool; and collection by hand. Less labour-intensive techniques include suction vehicles and vacuum cleaners, which are mainly only used for



areas with high concentrations of pellets because they will indiscriminately remove natural materials too, increasing the risk of broader environmental impact.

Karlsson, T. M., Arneborg, L., Broström, G., Almroth, B. C., Gipperth, L. & Hassellöv, M., 2018.

The unaccountability case of plastic pellet pollution.

Maes, T. & Jefferies, K., 2022. *Marine plastic pollution - are nurdles a special case for regulation?*

Norwegian Coastal Administration, 2020. *Experience from the plastic pellets incident Trans Carrier, focusing on shoreline clean-up methods.*

1.2 Framework for the analysis

The risk of release of plastic pellets into the marine environment depends on three factors:

1. The risk that a container falls overboard.
2. The risk that the container has an opening (e.g. a crack from damage, or a door which accidentally opens).
3. The risk that the package containing the nurdles is punctured or teared.

All of these risks are potentially lowered by extra care in the handling of the packaged pellets and their containers, which is why notification of the presence of pellets to relevant actors is also very important.

The three risk factors above could be addressed by, respectively, the following primary measures:

- a Stowage of containers below deck or in inner stacks. This would reduce the risk of containers falling overboard in bad weather (e.g. MSC Zoe, The Netherlands and MSC Susanna, South Africa) but would probably not reduce the risk of containers ending up in the sea after a ship sinks, as was the case with MV Pearl Express in Sri Lanka.
- b Using only undamaged and properly sealed containers. This would reduce the risk of leakage of pellets from containers both overboard and on the ship.
- c Using packaging that is leakproof, able to withstand pressure from falling and remains intact in the marine environment. This would further reduce the risk of leakage of pellets.
- d Immediate notification of maritime authorities of the presence of pellets on board in case of accidents and incidents, so that they can take appropriate action. This could also give access to remediation under the HNS convention, once it enters into force.

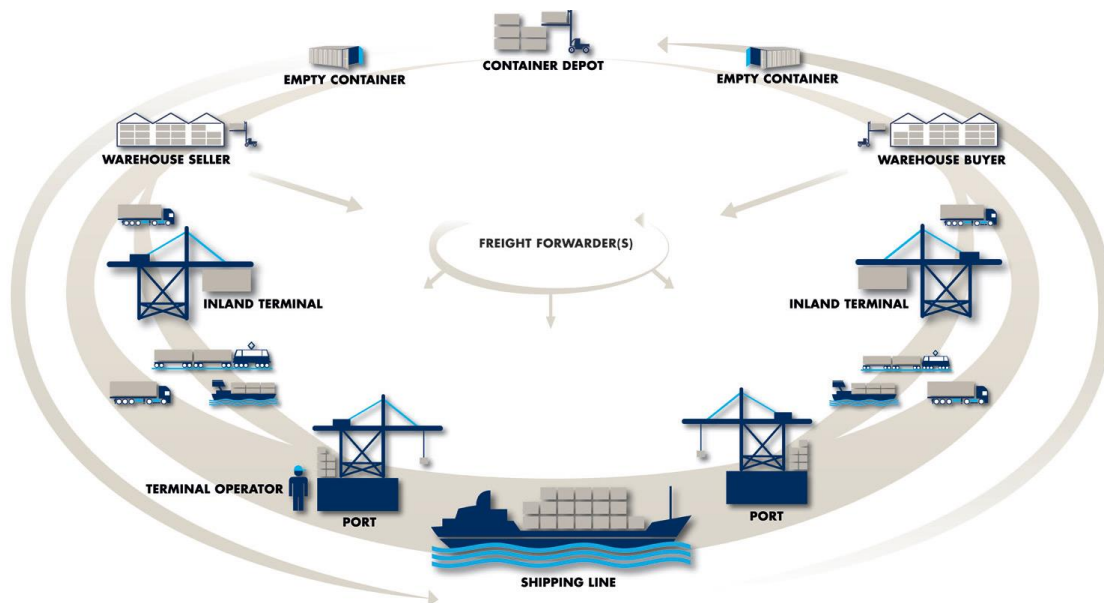
Within this framework, the effectiveness of the three regulatory options will be assessed by analysing whether and how the regulatory options require actors to take the primary measures above.

The effectiveness is also determined by the timeline to implement the regulatory options. The sooner an option requires changes in current practice to happen, the fewer pellets will be released in the marine environment.

In order to assess the feasibility of the options, we have analysed which requirements different actors in the production and transport chain of plastic pellets would have under each of the options. These actors are shown in Figure 1.



Figure 1 - Plastic pellet transport chain



Source: (Van den Berg, 2015).

Apart from desk research, we have conducted a dozen interviews with various actors in the transport chain, as well as with maritime authorities and port state control.

1.3 Outline of the report

Chapter 2 presents and analyses the three regulatory options identified by the Correspondence Group and their timeline for implementation. Chapter 3 analyses the feasibility of implementation of each of the options. The conclusions are presented in Chapter 4.

2 Overview of regulatory options

2.1 Introduction

This chapter analyses whether and, if so, how each of the three regulatory options identified by the Correspondence Group requires actors in the transport chain to take one or more of the three primary measures, namely improve the packaging, notify other actors in the transport chain, and stow the containers in such a way that the risk of containers falling overboard is minimised.

Note that not all the details of the three options are presented in the report of the Correspondence Group, so that the authors had to interpret the options. In relation to the respective option, the most important assumptions were:

1. For option 1, the assignment of a new UN number, we assumed that plastic pellets would be assigned a new UN number in class 9 (Miscellaneous dangerous substances and articles) and that this would require approval by the appropriate UN bodies.
2. For option 2, an amendment to appendix I of MARPOL Annex III, we assumed that an amendment to appendix I of MARPOL Annex III would either recognize plastic pellets as a “marine pollutant”, and that, in line with the IMDG Code, Article 2.10.2.3, they would be transported under UN number 3077 (“Environmentally hazardous substances, solid, n.o.s.”), or that they would meet the current criteria of the Appendix of MARPOL Annex III, so that they would be classified as “harmful substances”, in which case they would also be assigned UN number 3077 (IMO, 2020).
3. For option 3, a new chapter in MARPOL Annex III, we assumed that a new chapter to MARPOL Annex III would prescribe requirements for the transport of plastic pellets in freight containers without classifying the cargo as a harmful substance, and that this chapter would set requirements for notification and stowage but not for packaging or for using undamaged containers.²

The description of the options in Section 2.2 and the comparison of their effectiveness in Section 2.3 both assume that the options will be adopted as proposed, and that e.g. all square brackets in the proposed option 3 will be lifted. Section 2.4 analyses the timeline for adoption and implementation of the options and Section 2.5 the risk that the options may be substantially altered. Section 2.6 concludes this chapter.

2.2 Description of the three options

2.2.1 A new UN number of plastic pellets

This option would mean that the IMO submits an application for a new UN number to the UN Sub-Committee of Experts on the Transport of Dangerous Goods (TDG Sub-Committee) or any other UN body that has the authority to assign UN numbers. This body would then assign a new number, e.g. UN 3551 PLASTIC PELLETS. This UN number would be included in the IMDG Code with carriage requirements that are tailor-made to reduce the environmental risk associated with the maritime transport of plastic pellets, including at least the three

² As proposed by CEFIC in the second round of correspondence of the Correspondence Group on Marine Plastic Litter from Ships (Norway, 2023).



primary measures discussed by the Correspondence Group, i.e. packaging, notification and stowage.

With regards to stowage, it should be noted that the current version of the IMDG code contains mandatory stowage categories for ‘under deck’ and ‘on deck’, but not for e.g. inner or outer stacks, or the place in a stack (Article 7.1.3.2). In addition, the Code recommends to stow marine pollutants under deck or, when that is not allowed ‘on well-protected decks or to stowage inboard in sheltered areas of exposed decks’ (Article 7.1.4.2)³. Based on the interviews conducted for this study, we consider it unlikely that recommendations for stowage plans will always be followed because there is no penalty for not implementing them and because of the many mandatory and economic criteria that stowage plans have to meet, which makes them complicated to develop even without non-mandatory recommendations and thus non-mandatory directions end up being deprioritised.

2.2.2 Recognizing plastic pellets as a ‘harmful substance’ in MARPOL Annex III

This option could mean that the Appendix of MARPOL Annex III, which currently sets criteria for substances that are harmful, is amended in such a way that plastic pellets meet the criteria. Alternatively, this option could also mean that the Appendix of MARPOL Annex III is amended with criteria for ‘marine pollutants’ which plastic pellets would meet.

In both cases, the IMDG code would require containers loaded with plastic pellets to be transported under UN number 3077 (“Environmentally hazardous substances, solid, n.o.s.”). this would mean that:

- The pellets are packaged in ‘packagings, which shall be strong enough to withstand the shocks and loadings normally encountered during transport’, and which are sift proof (IMDG Code Article 4.1.1)
- The containers are labelled as UN 3077, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (PLASTIC NURDLES) (IMDG Code Article 3.3.1, provision 274).
- Packages of pellets are transported in BK2 containers (IMDG Code Article 3.3, provision 966).
- Consignors inform the carrier about the good (IMDG Code Article 5.4.1.1.1).
- appropriate information shall be immediately available at all times for use in emergency response to accidents and incidents involving dangerous goods in transport (IMDG Code Article 5.4.3.4.1).
- The containers can be stowed everywhere on the ship (Stowage Category A, IMDG Code Article 7.1.3.2), however, according to IMDG Code Article 7.1.4.2, stowage under deck is preferred.

2.2.3 A new chapter to MARPOL Annex III

In its current proposal, this option would mean that MEPC adopts an amendment to MARPOL Annex III which contains a new chapter specifically for ‘plastic pellets carried by sea in freight containers’. The chapter would set requirements for the documentation and stowage. Shippers would be required to inform the carrier that a container contains plastic pellets.

³ “Where stowage is permitted on deck or under deck, under deck stowage is preferred. Where stowage on deck only is required, preference shall be given to stowage on well-protected decks or to stowage inboard in sheltered areas of exposed decks.”



In addition, the new chapter would oblige the carrier to stow the containers “under deck, inboard in sheltered areas of exposed decks, or in the interior portion of container stacks on exposed decks”. Compared to option 2, this means that the ‘preferred’ stowage locations become mandatory.

Since the new chapter would neither classify pellets as ‘dangerous’, ‘hazardous’ or ‘marine pollutants’, it would probably not trigger amendments to the IMDG code, which, according to its title, governs the transport of dangerous goods.

2.3 Comparison of the options

Table 1 analyses how regulatory options require actors to take primary measures.

There are currently no requirements for packaging plastic pellets. In practice, pellets are sometimes transported in 25 kilogram film bags with cling film around a stack of bags on a pallet, sometimes in big bags and sometimes in bag in box containers. Transport of containers with plastic pellets under UN number 3077, as brought about by an amendment to the Appendix of MARPOL Annex III, would require that the pellets are packaged in sift-proof packages that are ‘strong enough to withstand the shocks and loadings normally encountered during transport’. Assigning a new UN number would allow packaging provisions tailored to preventing the risk of ruptures or damages in routine transport (preventing chronic losses) and as a result of maritime accidents (preventing acute losses). As currently proposed, the new chapter in MARPOL Annex III would not set requirements for packaging.

With regards to notification, current provisions are that the bill of lading indicates the contents of a container. When containers are imported, customs must be also informed about the products in the container. Both a new UN number and an amendment of the Appendix of MARPOL Annex III would result in pellets being labelled as ‘dangerous’ or ‘hazardous’ goods. The IMDG Code then requires that the “consignor who offers dangerous goods for transport shall give to the carrier the information applicable to those dangerous goods, including any additional information and documentation as specified in this Code.” (Article 5.4.1.1.1.). It would also require that this information is available immediately in case of accidents or incidents (IMDG Code Article 5.4.3.4.1). As currently proposed, the new Chapter of MARPOL Annex III would also require that shippers notify the carrier of the presence of pellets in a container (precisely how would need to be further defined), and that the carrier informs the port state from which it departs about where pellets are stowed on board. It does not, however, require that information about pellets is immediately available in vase of accidents or incidents.

The IMDG Code does not have specific mandatory stowage requirements for containers carrying Class 9 cargoes, except for SOLAS requirements to prevent fire, although stowage below deck is ‘preferred’ (IMDG Code Article 7.1.4.2). In its proposed drafting, the new Chapter of MARPOL Annex III would mandatorily require the containers to be stowed under deck, inboard in sheltered areas of exposed decks, or in the interior portion of container stacks on exposed decks.



Table 1 - How regulatory options require actors to take primary measures

	New UN number	MARPOL Annex III Appendix	MARPOL Annex III new chapter, as currently proposed
Packaging requirements	Adequate packaging, to be defined. Requirements could be tailored to the risks presented by pellets.	Packaging shall be strong enough to withstand the shocks and loadings normally encountered during transport, and which are sift proof. As indicated in the IMDG Code, Section 4.4.1	No requirements for packaging.
Notification requirements	The carrier is notified that a container contains plastic pellets which would be classified as 'dangerous' or 'hazardous'. Information that pellets are on board is available immediately in case of incidents and accidents.	The carrier is notified that a container contains plastic pellets ("UN 3077, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, SOLID, N.O.S. (PLASTIC NURDLES)"). Information that pellets are on board is available immediately in case of incidents and accidents.	Shipper shall notify carrier of presence of pellets.
Stowage requirements	To be defined in the IMDG Code. The Code currently has no mandatory stowage requirements for Class 9 goods, other than SOLAS requirements to prevent fire. Stowage below deck is 'preferred'.	No mandatory stowage requirements, other than SOLAS requirements to prevent fire. Stowage below deck is 'preferred'.	Containers to be mandatorily stowed under deck, inboard in sheltered areas of exposed decks, or in the interior portion of container stacks on exposed decks.

Source: This report.

The regulatory option to assign a new UN number for plastic pellets would trigger amendments to the IMDG code, specifically to Chapter 3, which would have to specify how goods classified under this new number would need to be transported. Amending the IMDG Code would not be necessary for the option to amend the Appendix to MARPOL Annex III, as this would imply that pellets are transported under UN number 3077. A new chapter in MARPOL Annex III, in its proposed drafting, would also not require changes to the IMDG code, because pellets would not be classified as dangerous goods. This regulatory option would therefore have the disadvantage that it would add a new legal instrument to the existing instruments regulating transport. This could trigger changes in inspection and enforcement procedures, as they would not only need to check conformity with the IMDG Code but also with MARPOL Annex III, Chapter 3.

2.4 Timeline for adoption and implementation

The time required for creating a new UN number for plastic pellets would probably amount to more than five years, according to the interviewees who answered this question. We have not been able to verify this statement by recent examples of new UN numbers or proceedings of the relevant UN bodies, however. A recent decision by the TDG



Subcommittee to assign a new UN number to lithium battery powered vehicles has been taken six months after (in this case) IATA submitted a request to do so. However, this case may not be representative for plastic pellets since UN numbers already existed for other articles containing lithium batteries (TDG Subcommittee, 2022). One interviewee noted that not all applications for UN numbers result in assigning a number, and that the environmental risks caused by plastic pellets may not fit the criteria usually applied by the TDG Subcommittee. After a UN number has been assigned, the IMDG code would probably need to be amended, which requires two more years.

Amendments to MARPOL Annex III, regardless of whether they add a new chapter or change an Appendix, could be made according to the so-called tacit amendment procedure (Article 16(2)(f)(ii) and (iii) of the International Convention for the Prevention of Pollution from Ships (MARPOL), 1973). This procedure requires that proposed amendments are circulated for a period of at least ten months. If less than one third of the parties, making up at least 50% of the gross tonnage of the world fleet, object to the proposal, the amendments are deemed to be accepted and enter into force six months after the end of the period (O’Leary & Brown, 2018). Hence, the amendments would enter into force sixteen months after approval by the MEPC.

2.5 Risks of change of the options

The option to create a new UN number would involve consideration and possibly negotiations by the TDG Subcommittee, during which the option may be altered. One interviewee noted that there are many types of pellets, with different polymers and additives, each with a different toxicological profile. This may give rise to the emergence of multiple UN numbers.

The option to recognise plastic pellets as a ‘harmful substance’ in MARPOL Annex III carries the risk that pellets do not meet all criteria for harmful substances.

The option to add a new chapter to MARPOL Annex III has the risk that several articles in the new chapter are currently in square brackets or contain options. During the consideration by the appropriate IMO body, these articles could be changed and their effects could be altered.

2.6 Conclusions

None of the three options requires that the two primary measures which are deemed most effective are both taken, i.e. packaging of plastic pellets in such a way that the risk of release in the marine environment is minimised, and stowing the containers filled with plastic pellets in such a way that the risk of falling overboard is minimised.

All the options would result in similar notification requirements for the consignor, but the options to apply for a new UN number and the option to amend the Appendix of MARPOL Annex III also require that information is immediately available in case of an incident or accident, which is not required in the proposed new chapter of MARPOL Annex III.

The regulatory option to assign a new UN number for plastic pellets and the option to amend the appendix to MARPOL Annex III would both result in a requirement to use sift-proof, strong enough packaging. The option to assign a UN number would even allow for packaging requirements that are tailor made to plastic pellets and potentially reduce the risk of rupture during accidents and during routine transportation. Thus, these options



would reduce the risk of release of plastic pellets in the marine environment both during regular transport and once a container has fallen overboard.

The regulatory option of a new Chapter in MARPOL Annex III would set a mandatory requirement for stowage that reduces the risk of containers falling overboard. Thus, this option would reduce the risk of release of plastic pellets in the marine environment caused by a container fallen overboard. The other options would result in a 'preference' for containers to be stowed in slots with a lower risk of falling overboard.

A new chapter would also add a new legal instrument to the existing instruments regulating transport. It is not clear that such an instrument could be adequately enforced, since new enforcement procedures would need to be established.



3 Feasibility analysis

In the feasibility analysis we have clustered the different impacts on stakeholders within the supply chain in four different topics:

- packaging and stowage;
- impact on costs and competencies;
- compliance and enforcement;
- impacts on production, handling and non-maritime transport.

Each topic will be discussed in a separate paragraph in which we start with a table summarizing the differences that will be further explained in the rest of the paragraph.

3.1 Impact on packaging and stowage

UN class 9 new number	Amendment to appendix I of MARPOL Annex III	New Chapter MARPOL Annex III
Packaging		
A new UN number can set requirement for packaging which could reduce the risk of spills. However, the contribution of UN certified packaging is heavily dependent on how well the packaging is sealed.	When UN number 3077 applies based on the amendment, the IMDG code prescribes a minimum type of packaging. However, it is not certain that this is sufficient to withstand longer period of time at sea without leakages	No requirements for packaging are included in the proposed new chapter. No impact is expected.
Stowage		
A new UN number will only have an impact on stowage if it specifically prescribes a location. The influence on stowage operations is larger when the containers need to be stacked below deck instead of the inner stacks above deck.	UN number 3077 does not have specific mandatory stowage requirements. Stowage below deck is 'preferred'.	The new chapter proposes stowage instructions. This will influence the stowage. Carriers need to instruct terminal operators where to stow the container. However, the absence of a UN number will reduce the potential extra attention that would be given to the container when stacking.

3.1.1 Packaging

With a *new UN number* packaging of the plastic pellets would need to comply with a specified UN standard. This will have a significant impact, since it requires a change to current practice (i.e. use of other packaging). In case of small (25 kg) packaging, which is generally done in an automated way, new packaging requirements might influence the packing processes. Big bags are available in various quality standards. Regarding the liner bags, which are often used for packing the plastic pellets in bulk in a container, it was unknown to the interviewees whether liner bags exist that comply with the relevant UN standards, although in principle it is likely that they will be manufactured if there is demand for them.



From a terminal perspective there is a strong preference to improve the packaging if this would lead to more flexibility on where the container may be stowed. The terminal operator indicated that there exists a risk of tearing the liner bag open if the spreader on the crane would be incorrectly placed on the container. Although this risk mainly exists with flexitanks which are used for liquids.

The *amendment to appendix I of MARPOL Annex III* leads to the application of UN number 3077 for plastics pellets, which prescribes, based on the IMDG codes, that only the following type of bags are allowed when transported in closed cargo units (packing instruction P0002):

- 5H1 Bags: woven plastics without inner lining or coating;
- 5L1 Bags: textile without inner lining or coating;
- 5M1 Bags: paper multiwall.

These packagings are able to withstand falling, toppling and tearing. However, based on the packaging codes we question whether this is sufficient to withstand longer periods of time exposed to seawater and avoid leakages and damage to the environment.

Alternatively, they could be packed in intermediate bulk containers (with packing instruction IBC08 and provision B3), meaning that they could be packed in big bags that are 'sift-proof and water-resistant'. We have not been able to ascertain that such packaging remain intact when exposed to seawater.

Under the proposal for a *New Chapter in MARPOL Annex III*, the draft chapter doesn't include packaging requirements and as such would not have an impact on packaging.

3.1.2 Stowage

Classification of plastic pellets as harmful substance can influence stowage but only when the *new UN number within class 9* specifically prescribes this. Currently, multiple class 9 products are allowed to be stowed above deck and on the sides of the vessel. Containers on the sides of the vessels, especially those that are on top of the stacks, face the highest risk of falling overboard. Given the weight distribution stacking the containers with pellets on the sides and/or at the bottom of the stack is not a preferred option as it would influence the stability of the ship. Still, the interviewees indicate that stowage of the containers at the inner stacks above deck will substantially reduce the risk of falling overboard.

A requirement for stowage below deck heavily influences the amount of positions available on board where the containers can be stacked. As a result, it is expected that the terminal operator would need more crane movements as it reduces its flexibility in stowing the containers. Also, it would make the stowage plan more complex.

Terminal operators receive stowage instructions from the carrier. If the stowage instruction is combined with an IMDG code extra attention is given to the container. According to the terminal operator, the added value of a container with UN number is that there is an obligation to know what kind of cargo the container contains and where it needs to be stowed.

Labelling of the container for stowage purposes is not of added value as the labels aren't visible for the crane operator.

When the *Amendment to appendix I of MARPOL Annex III* would apply, based on UN number 3077, there would be no specific mandatory stowage location onboard of the vessel. Interviewees have indicated that 'preferences' are often not implemented because they



further complicate the already complex stowage plans. As such this option would not have an impact on where containers are stowed.

When containers would neither be considered as harmful nor get a UN number, as could be the case with a *New Chapter in MARPOL Annex III*, the carriers only need to provide a stowage instruction to the terminal operator. The terminal operator will act accordingly. However, the risk exists that terminal planners and crane operators pay less attention to the need for a specific stowage location as there is no UN number.

3.2 Impacts on costs and competencies

UN class 9 new number	Amendment to appendix I of MARPOL Annex III	New Chapter MARPOL Annex III
Costs		
A new UN number will set requirements for both seaside and landside operations. As a result it will impact the costs for packaging (additional costs for higher quality packaging), stowage (fee for hazardous cargo and/or restow), documentation (fee for processing of the documentation) and handling (avoid leakages), storage (dedicated storage locations which comply to specific requirements) and non-maritime transport (other modes of transport need to have a permit to transport hazardous cargo).	As UN number 3077 will apply for maritime transport it will mainly affect the costs for packaging. When labelled as UN number 3077 it might also result in additional costs for documentation.	The proposed new chapter includes stowage requirements and notification to state authorities. Carriers may ask for additional fees based on stowage requirement. An additional fee for hazardous cargo will not apply. Costs for notification will be limited as notifications to authorities are already common practice.
Competencies		
The potential requirement for landside handling and transport could be more than the capabilities in place at the logistics service provider. Truck drivers need to have a permit to drive with hazardous goods.	Packaging requirements could lead to different way of handling of the product.	Stowage restrictions could lead to challenges in stowage plans if the volume limits the options. Notifications to authorities are already a common practice and will not require new competencies.



As a general remark it has been mentioned that the mandatory character of all options is important to ensure that options are implemented in a competitive environment (if certain actors implement a costly option but others don't, they put themselves at a competitive disadvantage). To put the costs in perspective, the costs of one kilogram of plastic pellets (polyethylene or polypropylene, the most common types of plastic pellets) is around one euro. As a result, a container which carries 20 tonnes of plastic pellets represents a value of roughly 20,000 euros (21,000 US dollars). The yearly volume of plastics produced worldwide is around 400 million tonnes.

3.2.1 Packaging

Currently, plastic pellets imported in containers in the US and Europe are normally packed in liner bags or big bags. After maritime transport, products are directly moved to large customers or temporarily stored in silos and sometimes repacked.

Additional costs of packaging might be in place based on the classification of plastic pellets in a *new UN number within class 9*. The costs that could increase are the result of the packaging that need to be used. For example, in the Netherlands the cost of a big bag (500 litre, holding 100-400 kg of pellets) that complies with the UN standard is 8,50 euros which is about 2 euros (30%) more than a standard big bag. It is expected that this will also apply for packaging under *Amendment to appendix I of MARPOL Annex III*.

When in addition to the packaging material, weight restrictions would be introduced, this would have an impact on costs and competencies. This would be the case if pellets are classified as 'substances with a high (or medium) hazard' and fall in packaging group I or II instead of 3 ('low hazard') in either regulatory option 1 or 2. If, for example, all of these volumes would need to be packed in 25 kg bags this would mean new and/or additional packing lines need to be installed. Also, more (UN certified) packing material would be needed which would further increase costs.

In addition to the cost difference between the standard and UN certified big bags, the crucial step in the packaging of the products is whether the bags are closed according to the requirements to contain the product as required, such as that they should be sift-proof.

For plastic pellets that are packed in a container in a liner bag there exists another challenge as the interviewees were not aware of the existence of liner bags that comply with the relevant UN standards. However, if these type of liner bags are needed it is assumed that producers will be able to supply in this new demand. The cost of liner bags in current use is currently 45 euros (price level in the Netherlands). In case UN certified liner bags need to be produced the costs will most probably increase with roughly 30%, just like with big bags.

3.2.2 Stowage

Stowage restrictions will influence both the operations at the terminal side as well as the capacity available onboard the vessel. When stowage restrictions are introduced, the flexibility in stowage plans will be reduced as well as the sequence of loading the containers, which would likely result in increased handlings. As such it results in additional costs. When a *new UN number within class 9* or *Amendment to appendix I of MARPOL Annex III* apply, plastic pellets are seen as hazardous or dangerous cargo or as a marine pollutant and a surcharge for such cargo might apply. Not every shipping line demands a surcharge but if it does, this surcharge could go up to several hundred euros (or dollars) per container. Under the option of a *New Chapter in MARPOL Annex III* it is expected that these surcharges would not apply. However, there will be stowage instructions which could lead to additional



handlings or restows by the terminal operator. The indicated costs of a restow in the port of Rotterdam is approximately 100 euros (105 US dollars) per container.

3.2.3 Labelling

In case of a *new UN number within class 9 or Amendment to appendix I of MARPOL Annex III* labelling will be necessary. Applying a label on a container cost approximately 15 euros (16 US dollars) (based on the information provided by a container terminal in the Netherlands, when a label needs to be bought at the terminal to be put on the side of the container). Since this is a common practice, this will not require additional competencies. With a *New Chapter in MARPOL Annex III* a label will not be required.

3.2.4 Documentation

The interviewees indicated that when plastic pellets will fall under the *new UN number within class 9 or Amendment to appendix I of MARPOL Annex III*, additional documentation (e.g. a dangerous goods declaration) is required that needs to accompany the container during transport. Also, it has an impact on the moment at which information needs to be provided. In contrast to non-classified containers, a carrier needs to inform the terminal 48 hours in advance about the containers with an UN number. Otherwise, the terminal is not able to process the information in a timely manner and the container cannot be loaded onboard the vessel. As a result, the administrative costs would increase. It is difficult to indicate how much, as it also depends on whether the consignor currently offers dangerous goods for transport (in which case the pellets could be added to existing information streams) or whether an entirely new data chain needs to be established. In the latter case, the costs could go up to a few hundred euros (or dollars) for the first containers as documentation needs to be made available to- and processed by multiple stakeholders in the supply chain. Subsequent shipping will probably have significantly lower administrative costs as the provision of information becomes a routine. Only under the *new UN number within class 9*, documentation is also required for land transport. For example, a transport document which indicates the hazardous substances for road transport is needed.

3.2.5 Inspections

The costs of inspections at the site of the terminal operator are limited since inspections hardly take place. To handle, store and pack hazardous substances, the site and processes of logistics service providers are audited. Such kind of audits are quite labour intensive. This will cost multiple days for the audit itself and also the preparation of the audit will cost several days. A rough estimate by a logistics service provider in Belgium indicated 10,000 euros (or dollars) per audit for the service provider. However, these audits will only be additional if the service provider currently does not transport any dangerous goods, and if pellets are assigned a *new UN number within class 9*. *In all other cases, the additional costs will be marginal.*

3.2.6 Insurance

According to the interviewees, protection and indemnity insurance premiums are independent of the number of containers shipped that carry dangerous cargoes, as would be the case with a *new UN number within class 9 or Amendment to appendix I of MARPOL Annex III* and therefore, *the classification of pellets under either of these options would not bear any implications on the cost of insurance to the carrier and/or cargo owner.*



3.3 Enforcement

UN class 9 new number	Amendment to appendix I of MARPOL Annex III	New Chapter MARPOL Annex III
Enforcement		
Depending on the provisions related to the new UN number, Class 9 (dangerous goods) could lead to an increase in audits, although the focus of inspections tends to be on flammable, explosive or corrosive cargoes.	UN number 3077 could lead to an increase in inspections, although the focus of inspections tends to be on flammable, explosive or corrosive cargoes.	A new chapter would lead to a new legal instrument to the existing instruments regulating transport. New enforcement procedures need to be established, which makes it currently unclear to which extent they can be enforced and what the associated costs would be.

Hazardous substances tend to be subject to more frequent inspections and audits. Audits can lead to substantial costs when preparatory work is taken into account (see Section 3.2.5). Inspections will likely be less costly, both to the inspectors and to the inspected. Port authority could check the cargo, but the focus is aimed more on matters that are not relevant to class 9 goods. If a container is placed on a truck, but a class 9 sticker is missing, a new sticker has to be purchased and applied to the container without further consequences. Inspections executed by the Inspectie Leefomgeving en Transport (the Dutch Inspection authority for the Living Environment and Transport) will likely be aimed at explosive and corrosive materials, so plastic pellets will not probably be subject to detailed inspections. A new MARPOL Appendix I Annex III chapter means that a new legal instrument should be added to the existing instruments that regulate maritime transport. A new legal instrument that has not been designed yet also means that new enforcement procedures need to be set up, which leads to uncertainty on whether it can be adequately enforced.

3.4 Impacts on production, handling and non-maritime transport

UN class 9 new number	Amendment to appendix I of MARPOL Annex III	New Chapter MARPOL Annex III
Production		
Influence on the production process with a UN number is unlikely, as a UN number mainly affects the transport chain.	UN number 3077 does not affect the production process.	No requirements for production are included in the proposed new chapter. No impact is expected.
Handling		
A new UN number could be given a new handling code, which could make transport or transshipment more complicated. It could potentially lead to new rules regarding the storage of plastic pellets, such as storage in smaller compartments, different safety measures in case of spills, etc. For repacking, the packaging	UN number 3077 does not have specific handling requirements. For repacking, packaging requirements in Section 2.3 must be complied with.	A new chapter would not have specific handling requirements. No impact is expected.



UN class 9 new number	Amendment to appendix I of MARPOL Annex III	New Chapter MARPOL Annex III
requirements in Section 2.3 must be complied with.		
Non-maritime transport		
Assigning a new UN number to containers containing plastic pellets would also affect transport in other modes. However, most drivers are licensed to transport dangerous goods, and the requirements for class 9 are generally less onerous than for other classes.	This will only affect the maritime transport sector, and will not influence road transport.	A new chapter will only set requirements that affect the maritime sector and will not have an effect on non-maritime transport.

3.4.1 Production

The production process will most likely not be affected by any of the three measures. The classification of plastic pellets as a dangerous or hazardous cargo affects transport of these goods, not their production. Some interviewees gave the response that classification as a dangerous or hazardous good could lead to the implementation of further measures and rules that would go beyond the general goal of decreasing the risk during maritime transport, also in the production process. From our research, the chance of the production process being affected by any of the measures seems unlikely. On the other hand, as production factories can also be located within port areas, measures to mitigate spills within this part of the supply chain could be beneficial as well.

3.4.2 Handling

All pellets that are transported need to be packaged. Section 3.1.1 analyses the impacts of the different regulatory options on packaging.

In line with the section regarding the production sector, some interviewees indicated that classification as a dangerous or hazardous substance could open the door to further measures, such as to obligatory storage in smaller compartments, new rules for storage, or new rules to mitigate plastic pellet spills during transshipment. If plastic pellets need to be repacked, e.g. from larger batches into smaller ones, the packaging requirements that have been defined in Table 1 for the new UN class 9 number and amendment to appendix I of MARPOL Annex III need to be pursued. This will have a significant effect on all actors that are dealing with plastic pellets before and after the maritime transport, with the exception of road hauliers who are commonly qualified to transport Class 9 goods. A new chapter within MARPOL Annex III would not affect the handling process, as documentation and stowage are the only parts that will be subject to change. If the goal is to prevent plastic pellets ending up in the marine environment, it would clearly be worth also tackling chronic spills caused by the transshipment and storage of plastic pellets. Logistic service providers that are active within this sector are often located in port areas, so spilled plastic pellets during transfer or storage often end up in the water.



3.4.3 Non-maritime transport

A new UN number will affect the entire transport chain, so also road transport will be affected. An interview with a road haulier indicated that, when plastic pellets would become a class 9 good, it would have a limited impact on the road transport sector, as most of the truck drivers possess a permit that allows them to drive with cargo that required an ADR license.⁴ In Europe, truck drivers are required to also get a *code 95* qualification, which is the main qualification that is required to drive a large vehicle for work and includes a minimum of 35 hours of additional education every five years. An ADR license requires 14 hours of education and is a frequently chosen additional option among truck drivers. It is expected that many truck drivers are thus already qualified to transport class 9 containers.

⁴ ADR, or Accord Européen relatif au transport international des marchandises dangereuses par route, is the European Agreement concerning the International Carriage of Dangerous Goods by Road. Truck drivers with an ADR licence are authorised to transport dangerous goods. There is a basic ADR license, which suffices for Class 9 goods, amongst others, as well as specific licenses for e.g. Class 1 (explosives) and 7 (radioactive substances).



4 Conclusions

The Correspondence Group on marine plastic litter from ships has considered three regulatory options to reduce the environmental risk associated with the maritime transport of plastic pellets, namely:

1. Assignment of a new UN number for plastic pellets transported at sea in freight containers.
2. Amending appendix I of MARPOL Annex III recognizing plastic pellets as a “harmful substance” and triggering the transport of pellets under the IMDG code.
3. Adding a new chapter to MARPOL Annex III that would prescribe requirements for the transport of plastic pellets in freight containers without classifying the cargo as a harmful substance/dangerous goods.

None of the regulatory options fully mitigate both the risk of containers with pellets falling overboard and the risk of pellet release in the marine environment during regular transport or after an incident. A new chapter, as currently proposed, would reduce the risk of containers falling overboard because it would require that these containers are stowed in slots that have a lower risk of loss of a container, provided that this new legal instrument can be adequately enforced. The two other regulatory options mitigate the risk of release of plastics during routine operations and after an incident. As these options would build upon existing legal instruments, the likelihood that they can be adequately enforced is higher.

Assignment of a UN number is likely to be a longer process than the other regulatory options. It may take five years or more after approval by IMO, whereas the other options could enter into force in less than two years after approval.

All options are feasible to implement: better packaging is available and stowage plans could be altered. The impacts throughout the transport chain are manageable. All options would lead to increased costs for notification and/or packaging and/or stowage, but to reduced costs for clean up, lower insurance premiums and lower environmental damage.

The feasibility of implementation of the regulatory options is dependent on the consequences it has primarily on packaging, stowage and on landside operations (i.e. handling, storage and transport).

An amendment to appendix I of MARPOL Annex III has limited packaging requirements and no mandatory stowage requirements. As a result, the additional costs to comply with the amendment is expected to be the least of the regulatory options considered in this report.

The stowage requirements included in the proposed draft for a new chapter will result in additional costs for stowage of the containers onboard the vessel. The requirements will increase the complexity of the stowage plan and reduce flexibility for stowing the containers but is not expected to make implementation infeasible.



From an operations point of view, the introduction of a new UN number is expected to require the largest changes in the transport chain of the options considered, although this is heavily dependent on the restrictions that will be included related to packaging and stowage. Given the assumption that a new UN number will impact both maritime and land transport, more players in the supply chain need to cope with new regulation which makes it more difficult and more costly. The consequences on handling when a new UN number is put into place is largely dependent on the design of the UN number.



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