OCS Europe Approach to the Evaluation of Pellet Loss **2023**

EUPC

Contents

I. Glossary

List of concepts	Definition
Plastic pellets	Mass of pre-formed moulding material, having relatively uniform dimensions used as feedstock in plastic product manufacturing operations (Source: EN ISO 472:2013+A1:2018 (modified)) NOTE 1 Throughout this document plastic pellets, powders, flakes and dust, including recycled material, are referred to as "pellets": a) Plastic powder: fine particulate matter that serves as a feedstock in plastic product manufacturing operations. b) Plastic flake: small flat shaped matter with regular or irregular form that serves as feedstock in plastic product manufacturing operations or plastic that has been shredded. Plastic flake can be manufactured or generated though the agglomeration of plastic dust or powder when plastics are processed. c) Plastic dust: fine particulate matter with irregular form and size, produced when plastics are manufactured, handled, conveyed, machined or processed. NOTE 2 Pellets are produced in many colours. Plastic pellets are also 4 OSPAR Commission OSPAR Agreement 2021-06 known as "granules" or "nurdles" and are normally spherical or lenticular in shape. NOTE 3 In some countries, plastic can also be termed "resin".
Facility/Plant	Facility means one or more pellet production and/or handling units within the same physical boundary (see definition above) that are operated or controlled by the same natural or legal person/organization.
Physical boundaries	Limit point of where land owned or controlled by the organization is legally recognized, including the point at which surface water drains and sewers discharge into the public sewer or controlled waters.
Incident	An unusual or unexpected event which either resulted in or had the potential to result in an environmental impact. It can also be detection of spills from chronic spills and losses.
Spill	One-off or prolonged release of pellets that when effectively contained do not result in a loss to the environment.
Loss	One-off or prolonged release of pellets outside the operating boundary into the environment (e.g. water, soil...) and which are not recovered.
Clean-up	Recovering pellets that have been spilled. Recovering pellets from historical pollution is covered through remediation.
Barrier	System in place that reduces the probability that an event occurs (physical *e.g.* filters or factual *e.g.* procedure, training).
Preventive barrier	Physical barrier that prevents a spill from occurring
Mitigating barrier	Specific barrier that prevents a spill to result in a loss to the environment.
Macro area	Area or sub operation where potential spillage can occur.
Critical point	Specific location or operation in a macro area where potential spillage can occur.
Throughput	Total amount of processed material
Plastics value chain	All companies handling plastics pellets, including pellet manufacturers, transporters, logistic providers, distributors, tank cleaning stations, converters, good producers, recyclers, etc.
Good Manufacturing Practices (GMP)	Practices required in order to conform to the guidelines recommended by agencies that control the authorization and licensing of the manufacture and sale of products.
Containment	Retainment of spilled pellets to make sure they do not become a loss to the environment.

II. Introduction

Unintentional loss of plastic pellets can occur at all stages along the value chain despite the application of the current standard environmental, safety and quality management controls. The Operation Clean Sweep® (OCS) programme was developed by the industry to help companies tackle pellet leakage by providing a series of key recommendations and guidelines. The OCS Europe certification scheme is aimed at controlling and documenting the compliance of companies throughout the entire plastics supply chain with requirements on the prevention of plastic pellets, powders and flakes loss to the environment. Considering that pellet loss can occur at any step of the supply chain, such requirements should apply to producers, compounders, converters but also to any third-party company handling pellets (transport and logistics, waste managers and recyclers).
By signing the European OCS pledge, each pellet-handling company recognises the importance of preventing spillages into the environment and commits to the following six core requirements:

1. Improve worksite set-up to prevent and address spills;
2. Create and publish internal procedures to achieve zero industrial plastic material loss;
3. Provide employee training and accountability for spill prevention, containment, clean-up and disposal;
4. Audit performance regularly;
5. Comply with all applicable state and local regulations governing industrial plastics containment;
6. Encourage partners (contractors, transporters, distributors, etc.) to pursue the same goals.

Plastic companies have a responsibility to prevent the release of microplastics and with few and simple tools, they can:

✓ Preserve the environment
✓ Comply with rules and avoid fines
✓ Guarantee their employees a safer workplace
✓ Optimize efficiency and reduce waste
✓ Strengthen the company's image and reputation

III. Scope of this document

This document intends to provide an overview on approaches developed by Plastics Europe and EuPC to evaluate the loss or spill of pellets in the environment including:

- an explanation of the relevant concepts;
- the types of spills we can get;
- a catalogue of preventive and mitigating measures with some examples of barriers and procedures;
- a focus on the model for risk analysis and risk mapping (bow-tie model);
- the scaling of the different approaches for the bow-tie model

OCS Europe's ultimate goal is to help keep plastic pellets out of the natural environment, but these efforts can also help improve relations with stakeholder groups and community organisations that expect the industry to minimise its environmental footprint.
The industry needs the help of every resin producer, every transporter or plastics processor to get results.

IV. What is pellet loss?

Plastic preproduction pellets are found in environmental samples all over the world and their presence is often linked to losses during production, transportation and any handling. For instance, the produced pellets can be subsequently transported from the production site, by train, truck and/or ship to the facility where the final product is being moulded or extruded from the virgin material. This material can however be lost in all steps during the production chain, from preproduction, to the final item production. Although the specific volumes of pellet spills may differ from site to site there is ample evidence of their occurrence; in that sense, it is hard to quantify. The release is expected to be a consequence of inadequate precautions during production, loading, transport and handling of the material. As a result, pellet loss means plastic waste finding its way into the environment potentially accumulating in the external water environment. That is why each pellet-handling company should implement measures to prevent plastic pellet loss.

The material flow diagram of a facility where spills or losses can occur is shown in *Figure1*.

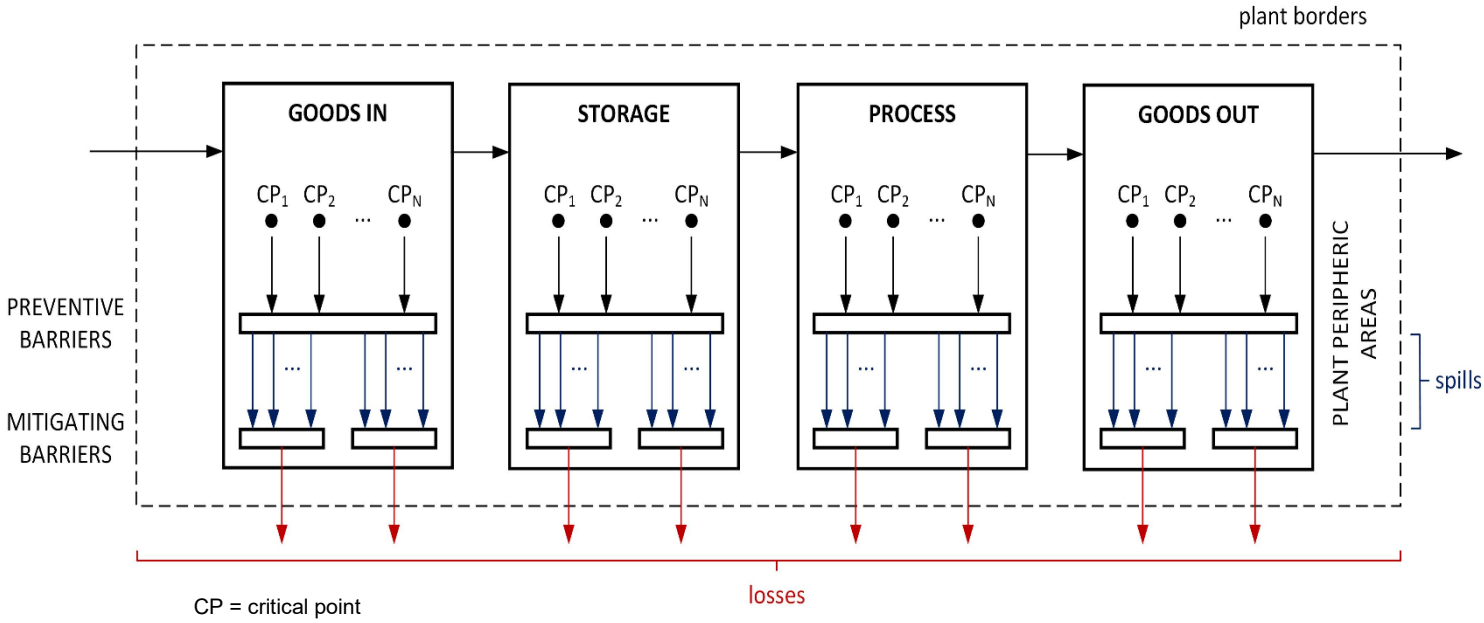

Figure 1. Pellet spills and losses – Plant Material Flow Diagram (example)

In premises where plastics pellets are produced or handled (resin manufacturing site, masterbatching, compounding, converting, distribution), pellet loss can occur in different stages of the handling process, thus different locations of the facility. In Figure 1, we can see that for each sub operation, spillage can occur at a specific location. The failure of containment at the source can either be collected in a preventive barrier or a mitigating one as a spill. If the mitigating barrier fails to keep the spill into the plant borders, the spill becomes a loss into the environment.

Hence the need for a qualitative risk assessment at hand to identify potential spillages/losses. The risk assessment should contain:

a) Locations where a pellet loss can occur within the facility boundary
b) An analysis of the process to assess where and during which operation a spill or loss of pellets may occur
c) The assessment of the likelihood of a loss and its magnitude in order to assign the appropriate priority

V. Preventing and mitigating spills, evaluating losses to environment

V.1. Preventing and mitigating spills – understanding material flows

For each process, the likelihood of spills may depend on various process layout: closed and continuous processes will reduce the occurrence of spills, while batch process may be required in some productions. Therefore, there is no definite GMP to prevent spillage of microplastics and that is compatible with every manufacturing process. Yet, despite the process variability, it is possible to identify some preventive and mitigating measures (*Table 1*) that are commonly used across different plants to contain pellet spill and pellet loss, respectively.

Preventive Barriers
collection trays, pellet/flake/powder disposal cans, retention trays (dry or wet), seals (on transfer equipment), buckets, outfitting forklifts with a clean-up kit, tools cleaning (shovel, vacuum cleaner, etc.), sumo gloves (forklift equipment), procedure for handling octabins, and procedure for handling sacks.
Mitigating Barriers
tools cleaning (shovel, vacuum cleaner, etc.), cleaning schedule and monitoring system, drain covers, surface skimmers or vacuum system, dust collection equipment or filters, water separation filter, ventilation filters.

Table 1. List of available preventive and mitigating barriers

Pellets should be contained in a mostly closed system, however depending on the set-up of the plant, either preventive or mitigating barriers might be self-sufficient. The more efficient those barriers are, the higher the waste collected and therefore the estimated loss.

Moreover, it is also important to highlight that the location of the process and the probability of spillage may directly influence the probability of a loss: processes outside buildings and processes without immediate containment are more at risk than fully confined processes. A location-specific assessment might be required in order to implement the necessary measures to prevent spill and loss.

A tool targeting at evaluating risk minimization potential, the bow-tie model has been developed. Different simplified versions of this tool have been developed in order to evaluate the overall pellet loss from a facility based on different input data/indicators.

V.2. Evaluating losses during operation: Bow-Tie Model

Production sites are strongly encouraged to use the bow-tie model. Applying the bow-tie and measuring spills enables companies to report them and plan risk reduction measures. The Bow-Tie model is a tool that gives a concrete view of where most losses occur within the value chain. The starting point diagram can be found in *Figure 2*.

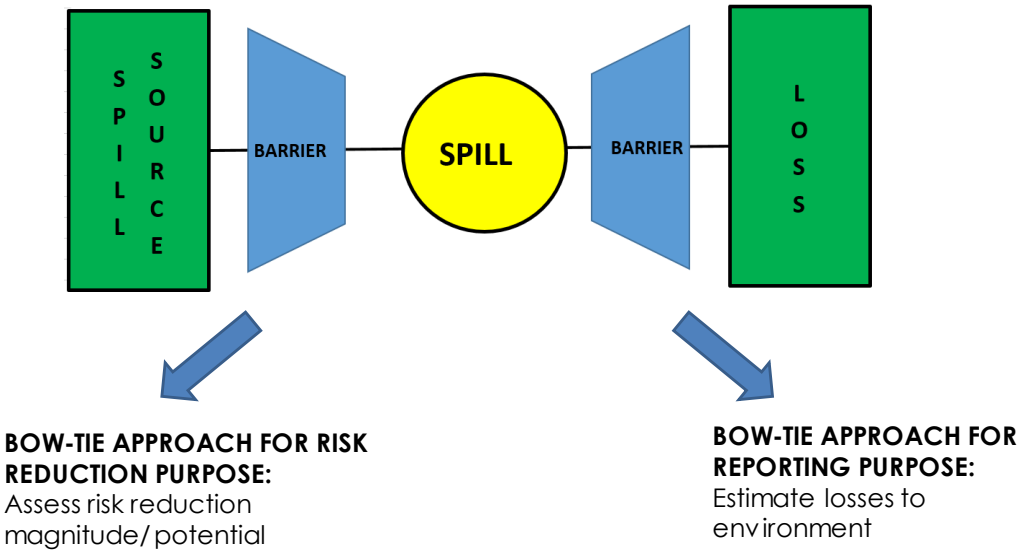

Figure 2. Bow-Tie Model

The Bow-Tie model is embedded in an MS Excel® workbook. Indeed, the data to feed the model must be available and provided by the facility. A plant has several areas or sub-operations where potential spillage can occur. It is very important to identify all possible sources. These sources can be areas (macro areas) or very specific points of spillage (critical points).

The Bow-Tie, as presented, is a comprehensive tool that complements a risk assessment in the context of the OCS Europe, but it is aimed at risk minimization, which might come only after the main elements of the initial qualitative risk assessment have been implemented. At this stage, the evaluation of pellet losses during operation may be done in a simplified way.

Hence a set of adaptations of the Bow-Tie model depending on the data provided, which are directed towards the objective of reporting the pellet losses across the plant. Each of these reporting models has a particular approach that makes it more adequate for different.

V.2.1. Bow-Tie Reporting Model - Case I (input data: collected material sent to recycling and/or waste management)

Input data

- Quantity of collected material sent to recycling and/or waste management ($\boldsymbol{DR}$)
- The mitigating barriers are in place and their efficiency is evaluated in the same way as in the Bow-Tie Risk Assessment model.

In this approach, preventive barriers are ignored.

This approach has the advantage to rely on the existing bookkeeping system of the facility since tonnages sent to waste treatment/ disposal will be readily available from invoices. However, this approach is not applicable if waste mainly contains other elements such as dirt or macroplastics since it would distort the output data. This approach should also be used only for mostly closed operations (e.g. production plant, converting plant with closed system/high level of automation).

V.2.2. Bow-Tie Reporting Model - Case II (input data: collected material at mitigating barrier)

Input data:

- Quantity of collected material at mitigating barrier level ($\boldsymbol{CMB}$)
- The mitigating barriers are in place and their efficiency is evaluated in the same way as in the Bow-Tie Risk Assessment model.

- In this approach, the contribution of the preventive barriers is not taken into account

This approach is useful for a first evaluation of the potential for pellet loss. It has the disadvantage to get focus away from preventive barriers and should therefore be combined with other inputs as the facility further minimizes pellet losses.

V.2.3. Bow-Tie Reporting Model - Case III (input data: collected material at preventive barrier)

Input data:

- Quantity of collected material at preventive barrier level ($\boldsymbol{CPB}$).
- The mitigating barriers are in place and their efficiency is evaluated in the same way as in the Bow-Tie Risk Assessment model.

An average by default efficiency was estimated for the body of preventive barriers, being 70-80%.

The most common type of barriers is collection, retention trays and buckets. According to the model estimation for barriers efficiencies:

- collection trays: efficiency 80-90% (assigning R = 2, A = 3, E = 2, and I = 3)

- buckets collection: efficiency 60-70% (assigning R = 2, A = 2, E = 3, and I = 2)

These results are in correspondence with available preventive barriers data (source: EuPC survey 2020).

This approach considers spills collected in preventive barrier in a more holistic way. This means that it is mainly applicable when preventive barriers have already been implemented in all the facility's macro-areas. This allows a wider consideration of barriers and can even be fine-tuned into a more detailed approach.

V.2.4. Bow-Tie Risk Assessment Model (detailed approach)

Input data:

- Estimate of annual spills without barriers
- Measurements/Estimates of spills after the application of preventive barriers
- Type of preventive barriers installed and their efficiencies

The model itself is used for risk minimization with a focus on preventive barriers. It is therefore used after most obvious prevention and mitigation measures have been put in place and especially when there is scope for preventive measures to be implemented. It considers an exhaustive analysis of critical spill points.

Overall, the choice of approach is specific to each facility. To sum it up, the possible approaches for reporting spills according to the level of detail provided can be found in *Table 2*.

Starting point	Information needed	Relevant parameters
Approach 1: Pellets sent to recycling/waste management	Quantity of pellets sent to recyclers and/or waste management companies	Quantity of collected material sent to recycling and/or waste management+ efficiency of mitigating barriers
Approach 2: Pellets collected in mitigating barriers	Quantity of pellets collected in the mitigating barriers	Quantity of pellets collected in the mitigating barriers+ efficiency of mitigating barriers
Approach 3: Pellets collected in preventive barriers	Quantity of pellets collected in the preventive barriers and a generic efficiency factor for the latter	CPB + average efficiency of preventive barriers+ efficiency of mitigating barriers
Approach 4: same as risk reduction	Detailed info on barrier efficiency, estimated and/or measured pellets in barriers	Same as risk reduction

Table 2. Possible approaches for reporting pellets spills

All approaches keep the same level of detail in terms of selection of mitigating barriers and estimation of the efficiency. All loss values that are calculated are related to a specific macro area of the plant. Yet, there is no specific need for a detailed approach to quantify spills and understand how they evolve.

V.3. Incidents and accident reporting

In normal conditions, the model can give an annual spill estimate. However, any unforeseen accident/incident which cannot be taken into account in the bow-tie model should be registered in the Reporting Template and added.

This is made possible by two procedures foreseen in the OCS Europe guidance**: internal** incident reporting and **external** reporting of incidents resulting in a loss.

In order to prevent pellet loss, companies are expected to keep track of pellet loss incidents. This not only helps to understand the actual probability of a loss scenario but also ensures a good practice of reporting and clean-up.

As a part of workers training programme, workers shall be instructed to report incidents of a pellet spill/loss to the management or the appropriate personnel. The worker shall report the cause of the incident, the area where the incident occurred, the approximate amount of spill and if any follow up actions have been taken or not. A role of responsibility shall be assigned to a person from the management to monitor incidents and follow-up on the clean-up actions. The amount of spilled pellets

shall be documented for reference. If the incident has occurred as a result of bypassing any preventive or mitigating barriers, this shall be reported with the barrier that has been bypassed. The management is obliged to inspect the barrier and come up with corrective measures to ensure the barrier is working properly. A table depicting the different levels of **internal** reporting of incidents based on the risk level is shown in the *OCS Risk assessment management and best practice guidance* (Table 1 - Level of incidents and their specifications).

If a loss has occurred instead of spill, the number and volume of incidents resulting in any unrecovered release (loss) of plastic pellets, flakes, powders, or granules, within the physical custody of a facility, from containment to ground or water outside member-operated facilities and estimated to be greater than 0.5 litres or 0.5 kilograms per incident (5US Operation Clean Sweep Blue definition), the incident would be not only reported to the person in charge of the monitoring of incident, but also higher management and should in addition be reported to the responsible trade association. The latter then constitutes the **external** reporting.

V.4. Estimating and (externally) reporting total pellet loss

In order to carry out a complete pellet loss evaluation for external reporting, the facility should perform:

1. The evaluation of recurring losses during operation (bow-tie result)
2. The recording of spill and incident resulting in loss to environment > 0,5 kg: this recording complements the evaluation of operating losses and may end up in a higher reported loss tonnage for incidents outside of normal operation
3. The recording of total estimated loss per year (1 & 2 may overlap) based on the facility management's expertise and knowledge

This provides an overall yearly reporting estimation that will be verified during the audit.

VI. Conclusion

Thebo bow-tie model as a tracking of incidents/accidents offers methodology and consistency of reported data from the entire value chain. With the aggregation of data, this model will give a better overview of the pellet loss issue in Europe based on data of consistent quality and facilitate the work of enforcement authorities.

To conclude, the aim is to bring transparency and accountability on pellet loss prevention at industry level, thus:

- **Prioritization of actions to minimize pellet loss** (guidance, procedures, best practices, performance targets)
- **Harmonization** of pellet loss prevention practices and common reporting format
- **Annual reporting** of industry progress
- **Bow-tie risk minimization model** as tool to evaluate loss and implement risk management at individual facilities

Although the bow-tie model is not an accurate loss quantification tool as there is uncertainty of measurement, it still allows tailored risk analysis and mapping throughout a plant. As the OCS Europe certification scheme will gradually be put into place in different companies, their task will be to apply the evaluation methodology according to the guidance and requirements.