SUT, MASTS & D’Arcy Thompson Forum
Session 3:
Environmental Impact
& Emergency Response
Plastic Nurdles & Environmental Impact

- The risks to the marine environment from plastic pellets (nurdles) has been highlighted by several shipping incidents.

- Carriage of plastic pellets (nurdles) in freight containers and the action taken within the maritime industry through IMO.
Nurdles

- Nurdles are small, lentil shaped, plastic pellets (about 2-5mm diameter)
- Ubiquitous in plastic production; they are the base material for almost everything made of plastic.
- Generally transported at sea in shipping containers.
- Although/because they are tiny, their potential to have an adverse environmental impact is huge when they enter the marine ecosystem.
- Pervasive and persistent in the marine environment.

Credit: Ed Marshall
Nurdle Numbers

600
nurdles required to make up one small plastic bottle

1,680 tonnes
of nurdles released from the X-Press Pearl

230,000 tonnes
of nurdles estimated to be lost to the environment annually

1 million
nurdles in a typical 25kg bag

58-70 million
tonnes of nurdles annual production in the EU

9.2 trillion
nurdles estimated to enter the oceans annually
X-Press Pearl Incident

A. Route of M/V X-Press Pearl

- May 11: Hamad, Qatar
- May 10: Jebel Ali, UAE
- May 15: Hazira, India
- May 20: catches fire

B. Nurdle tracker
- Burnt
- Unburnt

C. July 10

D. May 25 - Pamunugama Beach

E.

Credit://pubs.acs.org
Environmental Impact

Spilled Cargo of Concern
- plastic nurdles
- epoxy resin
- other plastics
- fuel oil

Fate and Transport
- fragmentation
- degradation
- buoyancy

Wildlife
- toxicity
- susceptibility
- starvation

Response
- cleanup & monitoring

Fire-induced changes to plastic nurdles

APPEARANCE
- unburnt
- burnt

DENSITY

EXTRACTABLES

Credit://pubs.acs.org
- Sub-Committee on Pollution Prevention and Response (PPR 10), 24-28 April 2023 (imo.org)
- Marine Environment Protection Committee (MEPC 80), 3-7 July 2023 (imo.org)
- Sub-Committee on Carriage of Cargoes and Containers (CCC 9), 9th session, 20-29 September 2023 (imo.org)
The PPR sub-committee proposed a two-stage approach to reducing the environmental risk associated with the maritime transport of plastic pellets in freight containers:

1. The development of a draft circular with recommendations for sea transport of plastic pellets in freight containers addressing packaging, notification, and stowage, with a view to approval by MEPC 81 in 2024.

2. The development of amendments to appropriate mandatory instruments, which could be informed by the experience gained from the implementation of the voluntary measures.

The MEPC noted that the PPR Sub-Committee has agreed that plastic pellets should not be carried in bulk – and this is rather good news!
**Notification** – transport information *should* clearly identify those freight containers containing plastic pellets. In addition, the shipper *should* supplement the cargo information with a special stowage request.

**Packaging** - pellets *should* be carried in good quality packaging which *should* be strong enough to withstand the shocks and loadings normally encountered during transport.

**Stowage** - freight containers containing plastic pellets *should* be stowed: under deck wherever reasonably practicable; or inboard in sheltered areas of exposed decks.
Lithium-Ion Batteries
Addressing the risks from Li-ion batteries

Lithium-ion (Li-ion) batteries are increasingly impacting shipping safety with a number of fires in shipping containers and onboard roll-on roll-off (Ro-ro) vessels where batteries were a contributing factor.

Decarbonization and electrification are increasing the number of shipping goods that contain Li-ion batteries, from electric vehicles to a wide range of consumer and electronic goods. The global Li-ion battery market is expected to grow by over 30% annually from 2022 to 2030, according to McKinsey. The number of electric vehicles (EVs) is also growing at a fast pace. Nearly 12% of global car sales were electric in 2021, four times the market share in 2019.

The main hazards of Li-ion batteries are fire, explosion, and “thermal runaway,” a rapid self-heating fire that can cause an explosion. They can also produce irritating, corrosive or poisonous gasses that cause an explosion in a confined space. The main causes of Li-ion fires are substations manufacturing or damaged battery cells or devices, over-charging, and short-circuiting.

Fires in EVs with Li-ion batteries can burn more fiercely, are very difficult to extinguish, and are capable of spontaneously reigniting hours or even days after they have been put out. Most ships lack the suitable fire protection, firefighting capabilities, and detection systems to tackle such fires at sea, which has been made more difficult by the dramatic increase in ship size.

“Li-ion batteries on their own are not new, and the risks are well documented,” says Captains Randel Lund, Senior Marine Risk Consultant at Allianz Global Corporate & Specialty (AGCS). “But the explosion of demand for these batteries is flooding the market with new manufacturers, raising questions around quality control. We have seen many fires where the cause has been traced to malfunctioning or damaged batteries.”

AGCS has worked closely with the risks associated with Li-ion batteries in shipping for a number of years. This highlights the issue in 2021 to bring this risk highlight to a wider audience.

Reference: Data from: AGCS
Electric vehicles on car carriers and within freight containers

The maritime industry continues to be concerned by fires on board vessels that are associated with Li-ion batteries in electric vehicles (EVs). Studies show that some of the common causes of fires in EVs with Li-ion batteries may be related to internal manufacturing defects, physical damage or substandard quality, internal electrical failure (over-charge, over-discharge, short circuit), and thermal runaway issues. Li-ion batteries are a relatively new technology and there is not yet a consensus on the best design and construction methods for their use in EVs.

Summary

With quickly evolving technology and a lack of consistent regulation, evaluation of the risks of Li-ion battery usage will need to develop over time. In this bulletin we have not addressed the transporting of used (privately owned) vehicles with Li-ion batteries, for example, or the transporting of used/expired or waste batteries. As we experience the life cycle of this battery type, both will need to be further addressed.

If the maritime industry is to improve its incident record related to the transport of these battery types, all parties involved in the supply chain must understand the hazards involved, the most common causes and problems associated with transporting in commerce.
Class 9
Miscellaneous
Lithium-Ion Batteries
UN 3480 Batteries
UN 3481 Batteries in equipment
UN 3171 EV vehicles
UN 3536 Cargo transport units
• **Mechanical abuse**
  i.e., puncture

• **Electrical abuse**
  i.e., overcharging.

• **Thermal abuse**
  i.e., next to an external fire
From an emergency responder perspective, thermal runaway looks & sounds like this:

- Popping - gunshots
- Hiss/whistle - gas venting
- 'Cherry bubblegum' smell
- Projectiles - cell debris

Dark vapour cloud, light vapour cloud (it's NOT smoke)

At this point, one of two things will occur:

- Ignition
  - Jet like, directional flames
- Vapour cloud explosion
  - Violent deflagration

~95% ~5%
- Hydrogen
- Carbon monoxide
- Carbon dioxide
- Hydrogen fluoride
- Hydrogen chloride
- Hydrogen cyanide
- Small droplets of the organic solvents
- Ethane, methane & other hydrocarbons
- Sulphur and nitrogen oxides.
Vapour Cloud Explosion
EV Cars

LIB into containers
Initial stages
Appears to be some form of explosion

Courtesy of Adrian Scales
SCR Fremantle Highway
Internal blast damage
Molten Alloy
stalagmites
Contamination
Fixed installations

Discussion on types and impact on LIB fire
6 sides - boundary cool

Contain & Maintain
CO2 in Containerships

1. CO2 drops to bottom
2. CO2 doesn't penetrate container
3. CO2 remains low
4. Smoke escape out hatch
5. Air enters via hatch
6. Heat spreads
Deck 9

Deck 8

1st car
Deck 9

Deck 8

1st car

EV1

EV2
High Expansion foam / inert gas

Deck 9

High Expansion foam / inert gas

Deck 8
High Expansion foam / inert gas
QUESTIONS?

Thank you.

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