NCEC RICARDO

The SPILL 2.0

CONTENTS

Listings below are interactive

Welcome to the second issue of the updated NCEC public sector newsletter, The Spill 2.0, which is designed to share chemical incident knowledge to ensure the safety of responders.

The Spill provides the latest information on chemical incident knowledge and effective emergency response from the National Chemical Emergency Centre (NCEC).

Funded by the Department for Transport and Chemical Industries Association, NCEC has delivered the Level 1 emergency response component of the UK Chemsafe scheme for over fifty years through a 365/24/7 dedicated telephone number provided only to the emergency services and other nominated organisations. We have an expert team of chemical emergency response specialists, who support emergency responders dealing with any chemical incident, regardless of scale or location. As well as providing advice, including hazards, decontamination, and reaction predictions, we will endeavour to contact the manufacturer if further assistance is necessary.

NCEC additionally delivers chemical advice through the European Intervention in Chemical Transport Emergencies (ICE) scheme, which provides a robust network of experts across Europe, who share information as required to facilitate response to incidents.

CAN SODIUM BATTERIES PROVIDE A SAFER SOLUTION TO OUR ENERGY STORAGE NEEDS?

Incidents with lithium-ion batteries are well documented and, with the drive towards a greener future, there is a constant interest in alternative solutions.

Lithium-ion batteries have been in commercial use since 1991, and provide a good, rechargeable source of energy. They have enabled the development of technologies from mobile phones to battery energy storage sites (BESS), which has allowed industry to move forwards towards a cleaner future.

Lithium-ion batteries have a high energy density, and relatively long lifespan, allowing them to have many technological applications, ranging from electric vehicles to life-saving equipment.

ISSUES WITH LITHIUM-ION BATTERIES

Despite their success, lithium-ion battery incidents are well documented and difficult to deal with as a battery can undergo a thermal runaway reaction.

One of the most common causes of a battery going into thermal runaway is overcharging. However, other common causes include physical damage, external heating, or intrinsic manufacturing defects. This can lead to pressure as the electrolyte expands and subsequent rupture / explosion of the battery, leading to the release of the flammable electrolyte inside, which can result in a fire.

Lithium-ion battery fires can be very difficult to extinguish. Unless the reaction within the battery is stopped, which is incredibly difficult to achieve as the battery is well sealed, there is a significant risk of reignition, or ignition of batteries which may not already be involved in the fire. Combustion products and decomposition products can pose major health and environmental hazards. Heavy metals, hydrogen fluoride and nitrogen dioxide can be released into the air and will contaminate any run-off water.

Alternatively, the thermal runaway reaction can create an unignited flammable, toxic and corrosive vapour cloud, which can pose a significant explosion risk, potentially endangering first responders.

Safe disposal of these batteries is also a significant challenge. The mix of rare metals make them difficult to recycle in a cost-effective way and most batteries end up in landfill as a result. Batteries contained in larger goods, such as phones and cars, are more likely to be disposed of safely as there are designated routes of disposal available to consumers. However, everyday items, such as vapes, are often placed in general waste bins for convenience, leading to incidents at waste and recycling centres. When batteries are disposed of correctly, there is technology in place to recycle the materials within them through processes such as hydrometallurgy and electrochemical recycling. However, it is estimated that only 5% of lithium-ion batteries around the world are currently recycled.

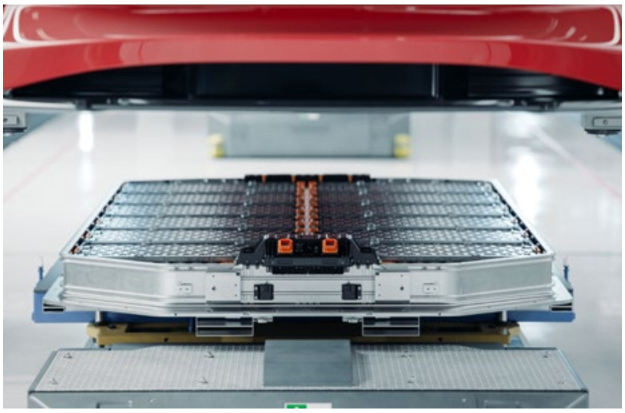
The quantity of lithium on earth is also very limited. This poses a problem with the need for greater energy storage through batteries to move towards a cleaner future. Due to this, research into batteries that can provide similar energy is of great interest, but are they any safer?

SODIUM-ION BATTERIES

Sodium is in the same column of the periodic table as lithium and possesses very similar electrochemical properties, meaning its function in a battery should be relatively similar. However, its chemical structure is larger, which presents a challenge.

The sodium in batteries is primarily generated using sodium chloride (table salt) and biomass from the forestry sector. Due to the abundance of sodium chloride in the world, there is much more available sodium than lithium, making this type of battery cheaper to produce.

Research has also moved sodium-ion batteries towards the use of safer electrolytes, including non-flammable and solid state, albeit many sodium-ion batteries do still contain similarly hazardous electrolytes to those used in lithium-ion batteries.



The energy density of sodium-ion batteries is currently lower than that of a lithium-ion, but this gap is expected to close over the next few years. This development potential means that they are expected to come onto the commercial market soon, demonstrated by the creation of three new sodium-ion battery related UN numbers (UN 3551 Sodium-ion batteries with organic electrolyte, UN 3552 Sodium-ion batteries contained in equipment, and UN 3558 Vehicle, sodium-ion battery powered) to be used from 2025, implying that they are expected to be transported in large numbers. These reflect the current lithium-ion battery UN numbers, UN 3480, UN3481 and the new UN number UN 3556 Vehicle, lithium-ion battery powered.

Despite the promising aspects of sodium-ion batteries, there is still the possibility for hazardous events to occur. Lithium and sodium have very similar chemical properties so they have similar hazards and once a battery is in thermal runaway, the same risk profile would be expected. They are also currently larger and bulkier than their lithium-ion counterparts, making them unfavourable for usage in small, portable electronic devices, but a promising possibility for larger battery energy storage systems.

Advantages vs lithium-ion

- Abundant resource and environmentally less damaging overall.
- Low cost.
- Faster charging.
- Able to be discharged to 0%, which could make them much safer in transport.
- Excellent temperature resistance and improved thermal stability, with lower overall temperatures reached in thermal runaway (also less prone to certain types of thermal runaway reaction).
- Lower risk of short circuit.
- High potential for building high safety energy storage systems.

Disadvantages vs lithium-ion

- Higher greenhouse gas emissions during production.
- Similar risk profile once in thermal runaway.
- Similarly hazardous electrolyte is used in many sodium-ion battery chemistries.
- Lower energy density.
- Lower longevity.
- Bigger and bulkier.

CONCLUSION

Research into sodium-ion batteries is still ongoing. The risks and hazards associated with them will continue to be highlighted in the same way as those for lithium-ion batteries. A potential solution to safety concerns could be the development of solid-state sodium-ion batteries, where the flammable organic electrolyte is replaced with a solid electrolyte to improve overall battery safety, but performance issues need to be addressed before commercialisation of these aspects can be exploited.

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ENCOUNTERING EXEMPTIONS TO ADR REGULATIONS

There are various derogations and exemptions to the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) that reduce the legal requirements for those transporting small quantities of dangerous goods by road.

Many businesses make use of exemptions to ADR, while still operating legally. These may be established hauliers regularly moving dangerous goods (DGs) packed in small quantities, tradesmen who need to carry one cylinder as part of their profession, or members of the public transporting DGs for domestic use.

What does this mean for first responders arriving at an incident involving a vehicle? Can you assume that because there are no markings on the vehicle that there are no hazardous materials on board? Unfortunately, you cannot.

SMALL LOADS

DGs moved in quantities less than those described in ADR 1.1.3.6 may be carried by road without applying full ADR regulations. Most importantly for first responders, they do not need to display placards or orange-coloured plates.

All DGs are assigned a transport category, which broadly aligns to their Packing Group. Table 1.1.3.6.3 outlines the maximum quantity of DGs, depending on its transport category, that can be carried on one transport unit before full ADR regulations apply. This is the small load threshold. It is possible that a curtain-sided lorry carrying one intermediate bulk container (IBC) of DGs (as well as other cargo) does not need to display any marking or plating. There are additional calculations that must be performed (ADR 1.1.3.6.4) if the load contains DGs with differing transport categories.

Furthermore, there is a UK derogation in the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG 2009), Ro-a-UK-2, meaning that no transport documentation is required for the journey unless Class 1 or Class 7 DGs are being transported. Drivers transporting DGs under the small load threshold are not required to be fully ADR trained and therefore will only have an awareness of DGs, not a comprehensive knowledge of the types of hazards they may present. Coupled with no requirement for transport documentation, it may be difficult to gather reliable information on the nature of the DGs being carried.

LIMITED QUANTITIES

Limited Quantities (LQ) is an amount (usually 1 or 5 L/kg) of a substance that can be transported in an inner packaging within an outer packaging (ADR 3.4). An example would be 18 x 1L plastic bottles shrink wrapped onto a cardboard tray. Each tray should not weigh more than 20kg gross mass and the shrink-wrapped tray should display the LQ mark. Only if the package is going on a multi-modal journey that involves air transport at some point, the ADR LQ mark must be replaced by the IACO (air) LQ mark which has a "Y" in the centre.

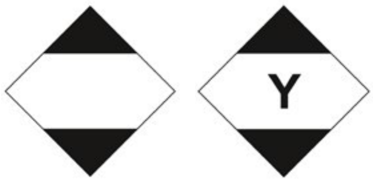


Figure 1: ADR (left) and IATA (right) LQ marks

If goods are moved in LQ, the vehicle will need to be marked front and rear if its unladen mass is greater than 12 tonnes and it is carrying more than 8 tonnes of LQ packaged goods. The LQ mark must also be on all four sides of shipping containers carrying more than 8 tonnes of LQ goods.

There is no need for a dangerous goods note (DGN) to be issued for an ADR shipment of LQ packed DGs. However, the consignor will need to inform the carrier in a "traceable manner" of the total gross mass of the goods packed in limited quantities. Since there is no need for a DGN, the information may only be available on a bill of lading or delivery note and it may only list "dangerous goods packaged in limited quantities – 4 x 20kg fibreboard boxes". Alternately, the information may have been sent separately to the transport documentation, so may not be available to the driver. Therefore, it is possible that you encounter a vehicle with no external markings that is filled with LQ DGs!

EXCEPTED QUANTITIES

Excepted quantities (EQ) are those packed in even smaller quantities than LQ and therefore need to comply with the fewest requirements to be shipped according to ADR (ADR 3.5). The driver of the vehicle only needs to have received awareness training on the nature of DGs, the goods need to have been assigned a Class, and their packaging must be suitable for purpose.

Figure 2: EQ mark

To be transported as EQ, packages must be marked with the EQ mark and not exceed the quantities in Table 3.5.1.2, which depending on the code assigned to the DGs permits a maximum of 30mL or g inner packaging in 1000mL or g outer packaging, for example 40 x 25mL glass bottles in a cardboard box. Due to the small amounts involved, EQ are only commonly encountered in certain industries and the exemptions are typically used to transport samples of substances such as oils or perfumes. It is unlikely there will be a large incident involving a shipment of EQ packed DGs as only 1000 of these packages can be carried on a transport unit without ADR applying.

EXEMPTIONS

Would you anticipate members of the public to be carrying large quantities of hazardous materials in their cars? It is possible they will carry some because there are exemptions to ADR which allow members of the public to transport DGs packaged for retail sale and used for their leisure or sporting activities (ADR 1.1.3.1.a). This includes flammable liquids, such as petrol, but there is a maximum of 60L per refillable receptacle and 240L per transport unit i.e. car.

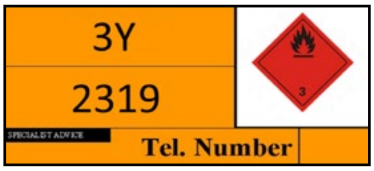
Another exemption would be ADR 1.1.3.1.c, which allows "enterprises" to carry up to 450L of a DG in one packaging, so long as the DG is "ancillary to their main activity". They must also be below the small load threshold previously described.

PLACARDING AND PLATING

Transporting DGs without using an exemption means that a plain, orange-coloured plate is required to be displayed front and rear of any vehicle carrying DGs or their residues (ADR 5.3.2.1). Tank-vehicles must also display an additional orange-coloured plate on either side that contains the Hazard Identification Number (HIN) and UN number. A UK specific derogation in CDG 2009 requires tank-vehicles on a UK domestic journey to display specific information on the sides and rear of the vehicle:

- Emergency Action Code (EAC).
- UN number.
- Emergency phone number for specialist advice.
- Placarding.

These details can be combined into a Hazard Warning Panel but may be displayed near each other if a Hazard Warning Panel cannot be fixed to the tank.



Placards are coloured diamonds that describe the hazards of the load according to their Class (ADR 5.3.1). They must be 250 x 250mm (ADR 5.3.1.7.1) and should be displayed on the front, rear and both sides of containers, portable tanks and tank-containers holding DGs or residues. Tank-vehicles must have placards affixed to the rear and both sides. Vehicles only carrying packaged DGs (such as 950L IBCs) do not need to display placards unless transporting Class 1 (excluding Division 1.4) or 7.

However, some vehicles (primarily vans) have much smaller 100 x 100mm placard-style labels on the rear without displaying orange-coloured plates. This contradicts ADR, but some operators believe this to be "best practice" and useful to the emergency services to indicate the hazards of DGs that may be carried by the vehicle. For example, Highway Maintenance vehicles could have a Class 2 compressed gas label to warn of cylinders that may be on board. Without an understanding of the regulations, it is possible that the vehicles are mis-labelled or simply do not contain DGs.

Small businesses, such as SCUBA diving instructors carrying cylinders of breathing gas, may be another example of the type of enterprise misinterpreting ADR requirements by placing a 100 x 100mm placard-style label on the rear of their vehicle when the exemption states that no type of placarding, plating or other marking is required. All of this can lead to responder misunderstanding and confusion during an incident, which highlights the complexity of transport regulations and accurate compliance. along with the importance of Dangerous Goods Safety Advisors and the support they provide.

CHEMSAFE CASE STUDY: AMMONIUM NITRATE (MV RUBY)

Between September and November 2024, Chemsafe received multiple calls relating to the MV Ruby, a damaged cargo vessel carrying 20,000 tonnes of ammonium nitrate.

Ammonium nitrate (AN) has made headlines in recent years because of several large-scale incidents, causing numerous fatalities and extensive infrastructure damage, for example the 2020 Beirut blast involving an estimated 3,000 tonnes of AN, which had a blast radius of greater than 2km and killed more than 70 people.

Ammonium nitrate is produced globally by reacting nitric acid and ammonia and it is shipped worldwide, predominately for its use as a nitrogen-rich fertiliser. Its secondary use is as a component in explosive mixtures used in mining. In its pure form, it can be classified as UN 0222 (Division 1.1 explosive) or UN 1942 (Class 5.1 oxidising substance).

MV RUBY

A vessel that had sustained storm damage needed to dock in British waters to undergo repair while carrying significantly more AN than involved in previous high-profile incidents. This had raised concern among authorities over the potential for a major incident affecting people, infrastructure and the environment.

Call 1

Chemsafe was initially called in September to discuss the potential blast radius of approximately 17,000 tonnes of AN that was aboard the MV Ruby. She was in Danish waters but had not been allowed to anchor to repair. We were asked to contribute to a risk assessment to inform a decision on whether she would be allowed to enter UK waters. We explained that since the AN was being shipped under UN 1942, it was classed as an oxidising substance and therefore, under normal conditions, it posed no threat of an explosion. However, we confirmed that it could produce a significant blast if it was involved in a fire and it decomposed. We provided generic cordon guidance based on the data available but advised that Explosive Ordnance Disposal (EOD) may be able to provide additional guidance on the explosive properties.

Call 2

Chemsafe was subsequently asked about the possible risks associated with ammonium nitrate entering the seawater environment. We explained that it could have a significant impact on the local marine ecosystem and would likely cause eutrophication since it is a fertiliser. However, we judged that the impact would be appreciably different compared to a spill into a river, since the sea is large, and the AN would readily solubilise in an unusually endothermic process and disperse. We confirmed that it would not react with seawater or promote off-gassing, however the resultant solution would retain oxidising properties.

We elaborated on the explosive risk and advised that UN 1942 is pure AN, containing less than 0.2% combustibles so it would have an extremely low risk of spontaneous combustion in normal conditions. However, this risk would increase as contamination of the AN increased. We also highlighted that it was possible for an external heat source to cause the AN to burn.

We advised that AN in a fire will melt at approximately 170°C to create a molten slurry, which is more shock sensitive than the solid so the likelihood of an external force causing it to detonate is increased. Equally, when

AN approaches 210°C, it will begin to decompose and release toxic gases, primarily nitrogen dioxide, which is a characteristic orange / brown colour and a key indicator that the AN may be about to detonate. We added that all these factors are worsened by confinement and the ship's hold would be considered a highly confined environment.

We advised that water could be used to fight an AN fire. We highlighted that seawater could introduce contamination, which may be of concern but this should be balanced against the overall risk of not tackling the fire. We then discussed appropriate precautionary measures that could be taken to reduce the likelihood of an AN fire, such as opening hatches to attempt to reduce any confinement and using thermal imaging cameras to detect hotspots (areas of potential decomposition). We also highlighted the need for respiratory protection to enter the hold.

We caveated all our advice by saying unless something adverse occurred (e.g. a fire or an issue with the ship), there should be no additional risk to the AN aboard the MV Ruby beyond those associated with standard transportation procedures.

Call 3

Chemsafe was contacted again in October as the MV Ruby was due to dock in Great Yarmouth for repair while carrying 20,000 tonnes of AN across three holds. There was no incident but we were asked why salt water was not recommended to fight a fire if required.

We advised that there were several different reasons historically why salt water was not recommended. Salt water from the sea could contain organic matter, which could contaminate the AN and increase its explosive potential. There was also a chance that copious amounts of salt water could cause encrustation on the AN as the water evaporated, leading to an increase in confinement and explosivity of the product when decomposition gases were unable to escape. However, we stated that it would be extremely difficult to quantify the risk as it would be determined by a variety of factors including the contamination level of the seawater. Furthermore, contamination of the AN would require scientific testing to assess but this may vary throughout the AN load. A representative sample may also be difficult to obtain. We emphasised that the explosive risk would be increased with more carbon and organic material present as this would act as a fuel but a low ratio of organic matter to oxidiser can still result in an explosion.

We explained that it would therefore be a balance of the positive cooling effect of water with contamination or conducting a controlled burn to avoid the risk of contamination as both scenarios could ultimately result in an explosion in a fire situation.

We elaborated that the preferred method of fighting an AN fire would be to use flooding quantities of fresh water to remove the heat. Ideally the stack would then be dismantled to encourage the heat to dissipate but we acknowledged that this would be difficult to achieve in the hold of a ship.

Call 4

In November, the MV Ruby had been accepted into a UK port for unloading so that repairs could be safely carried out. However, approximately 300 tonnes of AN remaining in the hold was found to be contaminated with seawater. There had been some oil in this water, which had coated some of the lower product bags but this had not permeated through to come into direct contact with the product. Unloading had been placed on hold until a safe removal plan could be agreed as there was concern from the authorities over the possible contamination risk. Chemsafe was again asked whether there were any issues with the use of seawater to extinguish a fire involving AN.

We stated that we were aware of previous concern around the use of seawater on AN as potential contamination can result in the decomposition temperature of it being lowered so it could detonate at a temperature below 210°C. We explained that, ideally, freshwater should be used to extinguish such a fire but, on balance, the use of seawater would be preferable to allowing the load to burn as in a fire the temperature would likely exceed 210°C anyway. We concluded that the risk associated with lowering the decomposition temperature was therefore not significant enough to outweigh the need to apply flooding quantities of water from any source to try to extinguish a fire.

OUTCOME

NCEC later learnt that the remaining 300 tonnes of AN had been discharged into the sea at a location that offered the lowest environmental impact, for safety reasons. The unanticipated arrival of the MV Ruby demonstrated the importance of emergency preparedness when handling huge quantities of hazardous materials, with complex properties and the potential for significant danger.

CHANGES TO DFT ADR REPORTING SYSTEM

The Department for Transport (DfT) has recently overhauled its online incident reporting form for incidents involving the transport of dangerous goods. This is part of a concerted effort to improve the reporting rates of dangerous goods incidents, with the ultimate end goal of making the transport of dangerous goods safer and reduce the occurrence of incidents.

Under the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) regulations, serious dangerous goods incidents must be reported to the Competent Authority, within one month of an occurrence, which in Great Britain is the DfT. What counts as a serious incident will depend on whether one of the following events has happened and meets at least one of the corresponding criteria:

Event	Criteria
Immediate risk of, or confirmed loss of product	• Transport category 0 / 1: > 50 kg or litres • Transport category 2: > 333 kg or litres • Transport category 3 / 4: > 1,000 kg or litres *There are also additional stipulations for Class 6.2 and Class 7 materials.*
Personal injury or fatality	• Death • Unable to work for at least three consecutive days • Hospital stay of one day or more • Intensive medical treatment
Material or environmental damage is sustained	• Damage value more than £50,000
Involvement of the authorities (fire, police, ambulance, etc.)	• Evacuation or route closure for three hours or more

The table summarises the thresholds that constitute a serious incident, but the full legal definitions and details can be found in ADR 1.8.5. This covers more than the movement of goods on public roads. It also encompasses loading and unloading operations. Therefore, there may be reporting obligations on the loader, filler, carrier, or consignee. If in doubt over whether at least one of the criteria is met, an incident report should be submitted to the DfT regardless.

WHY HAS THE REPORTING FORM BEEN OVERHAULED?

You may think that companies involved in the transport of dangerous goods would understand their reporting responsibilities. However, due to the low number of incident reports they were receiving, DfT became concerned about the possibility of underreporting so they commissioned Ricardo in 2022 to carry out some research on the reporting rates of dangerous goods incidents.

Department for Transport

NCEC RICARDO

This involved the collection and analysis of incident data from secondary sources to determine an accurate national picture of the number of dangerous goods incidents that occurred that year. Data was collected from fire and rescue services, the Environment Agency, and Chemsafe, the 24/7 emergency hotline used by emergency services to provide expert chemical advice at the scene of an incident.

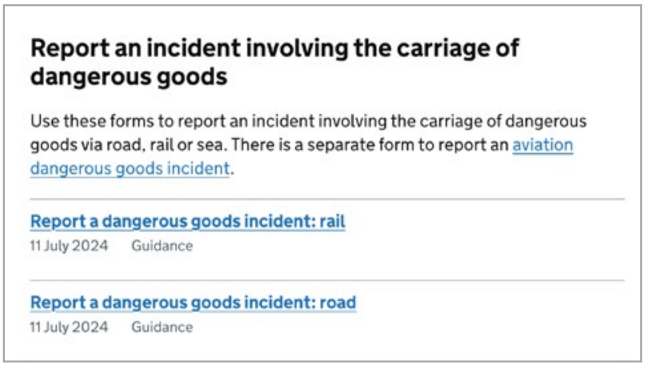
The report published by Ricardo found that of 89 dangerous goods incidents that occurred in 2022, the DfT was only notified of 23% of incidents that met the severity threshold for reporting. It should be noted that many of the 89 incidents will not have met the legal threshold for reporting, however there is still cause for concern given that less than one in four serious incidents are reported to the Department despite the legal requirement. This also means that the data to shape policy and ultimately make the road network safer for all users may not be fully available to the department so efforts to achieve a reduction in incidents cannot be concentrated in the correct place.

Following the report, a review of the reporting processes was conducted. As part of this, stakeholder feedback on the old online reporting form was sought and the decision was made to improve the form's accessibility and user experience.

WHAT CHANGES HAVE BEEN MADE?

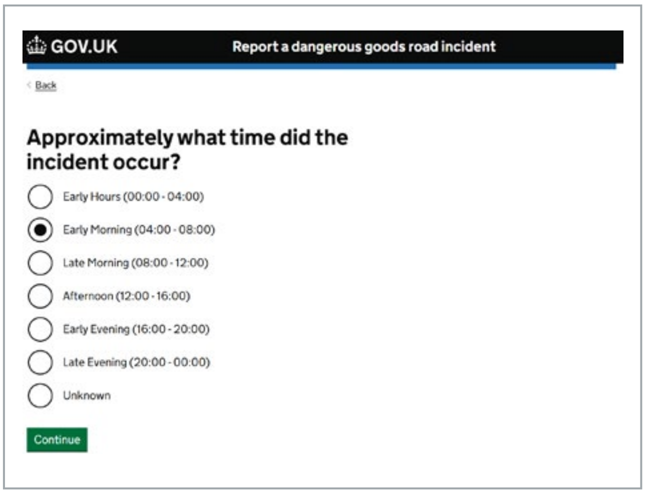
The new online incident reporting form has been designed to resolve some of the issues that were fed back on the previous form. The most notable change has been the separation of the transport modes into their own unique forms. Dangerous goods in the UK are carried primarily by road but some freight is also moved by rail, sea and air. The Department for Transport is primarily responsible for dangerous goods carriage by road and rail and therefore must be notified of serious incidents for these modes.

Previously one form was used for both road and rail incidents, which resulted in road users being questioned on rail transport, making the form confusing to use. With the new reporting system, there are separate landing pages for road and rail and mode specific forms located at: Transporting dangerous goods - GOV.UK (www.gov.uk).



Also linked on the landing pages are the reporting forms for sea and air modes, for which the Maritime and Coastguard Agency (MCA) and the Civil Aviation Authority (CAA) are respectively responsible.

Additionally, the new form has an updated user interface to improve accessibility and ease of use. This will make it quicker and easier to report incidents whilst minimising input errors. Drop down menus and multiple-choice checkboxes will save user time and ensure that necessary information is not skipped. Finally, an email confirmation will be sent to respondents to assure them that their response has been received.



RELEVANCE TO FIRST RESPONDERS

Whilst it is not the responsibility of the emergency services to report incidents to DfT, the department would highly encourage you to highlight the reporting responsibilities to any company involved in a transport incident. Additionally, if you are concerned that a company is unlikely to report the incident correctly then DfT would welcome direct notification of the incident details to the department for review.

It is only by understanding a true reflection of where and why incidents are occurring that DfT can inform and shape policy and help to reduce incidents and therefore the associated burden on response agencies.

The DfT is always looking for feedback and ways to improve user experience of the form. This can be provided by emailing DangerousGoods@DfT.gov.uk.

HYDROGEN FLUORIDE AND HYDROFLUORIC ACID

Hydrofluoric acid (HF) is a high hazard substance. Its unique properties pose a significant challenge for first responders attending incidents where it is present. Although it is a weak acid, even a small exposure via any route can cause severe effects.

Anhydrous hydrogen fluoride is an inorganic acid and dehydrating agent. In its pure form, it is a highly corrosive and toxic fuming liquid that is harmful to the aquatic environment and a strong air pollutant. It will turn into a gas at 19.5°C, which has a sharp, acrid odour and is highly irritating to the respiratory system. It is miscible in water and more commonly found as a colourless to slightly yellow tinted aqueous solution, known as hydrofluoric acid (HF) – an essential liquid with a wide variety of uses, including stainless steel production, glass etching and pharmaceutical manufacturing.

Exposure to HF is usually by accidental skin contact. The complex way it acts on the body means that exposure can result in severe and fatal side effects if appropriate medical attention is not obtained. HF is highly lipophilic, meaning it readily penetrates through the skin into deeper tissues. There are three mechanisms through which HF can cause injury.

1. At concentrations above 50%, the acid will cause immediate corrosive burns with visible tissue damage, ulceration, necrosis and intense pain in contact with the skin, eyes, respiratory system and gastrointestinal mucous membrane.
2. At all concentrations, the fluoride ion will penetrate the skin and cause destruction of nerves, blood vessels and soft tissue via liquefaction and cellular death.
3. Unless treated, the fluoride ion will continue to penetrate deep into the skin to reach the bloodstream and cause systemic toxicity. It achieves this by binding to positive ions in the body, notably calcium and magnesium. The depletion of calcium causes a chain reaction of electrolyte imbalance, which results in cardiac arrhythmias, potentially leading to death.

HF in the eye can cause eye burns, destruction of the cornea and blindness.

Inhalation of vapours can cause burning of the airways, glossitis (inflammation of the tongue leading to airway obstruction) and acute or delayed (up to 48 hours) pulmonary oedema.

TREATMENT

Any exposure to HF requires immediate and specialised medical treatment, with first aid carried out as soon as possible and continued whilst en route to hospital. The most widely used treatment for HF exposure is **calcium gluconate.** All facilities handling HF should have appropriate treatments on-site to mitigate any exposure.

SYMPTOMS OF EXPOSURE

Pain may not be felt immediately after exposure to HF. It is possible that a person may be exposed and unaware of the situation until symptoms develop hours after the event. This is highly dangerous because HF is not self-limiting so it will continue to act on the body until treated.

Any person with suspected exposure to HF must seek immediate medical treatment.

For skin exposure, the affected area should be held under running water until calcium gluconate gel can be provided. The gel should be applied every 15 minutes and continually massaged into the skin. The person applying it MUST wear gloves that offer protection against HF (manufacturer / scientific advice should be sought if necessary). Double gloves are encouraged as a precaution. If the pain lessens during application of the gel, this is an indication that the treatment is having a positive effect. For this reason, use of painkillers is discouraged.

If HF is in the eye, contact lenses should be removed if safe to do so and the eye rinsed with water for 20 minutes minimum, taking care not to get water run-off into the unaffected eye or on the rest of the body. If possible, aqueous calcium gluconate solution should be applied before seeking specialist assistance.

A person exposed to HF vapours should be immediately removed to fresh air and given 100% oxygen. If breathing has stopped, CPR should be performed using a bag valve mask. Do not use mouth-to-mouth resuscitation or a pocket mask as this will pose a much higher risk to the first responder. Nebulised calcium gluconate should be administered, and the patient observed for several days to ensure there is no delayed pulmonary oedema.

Ingestion of HF is uncommon, but frequently fatal. The individual should not be induced to vomit but instructed to rinse their mouth with water and given 1 – 3 glasses of water to drink. They should then drink aqueous calcium gluconate. Milk of magnesia or other alkali products may be administered to attempt to neutralise the acid on the advice of a medical professional. If breathing has stopped, CPR should be performed as above for inhalation.

COMMON EXPOSURE SCENARIOS

First responders are most likely to encounter high (>48%) aqueous concentrations of HF at metalwork sites, electronic manufacturing sites and university laboratories. Unless it has escaped containment, the scene should be relatively stable. Where containment has been lost, it is critical that any actions taken by first responders are well planned and risk assessed.

Furthermore, lithium-ion (Li-ion) batteries in thermal runaway can release small quantities of HF. This may be when the battery is directly involved in fire, so HF will be in the plume. Alternatively, they can produce unignited vapour clouds, which are commonly mistaken for smoke or steam. Individuals will approach a Li-ion battery believed to be on fire to extinguish it without wearing appropriate respiratory protection, so unwittingly inhale HF. Recent studies have shown that symptoms caused by inhaling these vapour clouds have a faster recovery time and better prognosis when treated with nebulised calcium gluconate, indicating that despite the small proportion of HF present, it has a significant contribution to the symptomology of inhalation exposure.

SPILLAGE REMEDIATION

Clean-up of a spill should only be carried out following a risk assessment by the Incident Commander and if calcium gluconate gel is readily available.

For small spills, breathing apparatus, fire kit and suitable gloves (as above) would be appropriate if all contact with the chemical can be avoided, and the product involved is not anhydrous hydrogen fluoride or fuming HF. If engaging with the product, regardless of spill size, and as a default for large spills, higher levels of protection (as a minimum liquid-tight suit) should be worn to prevent skin contact. In areas where there may be vapours produced (including all spills involving anhydrous hydrogen fluoride or fuming HF), personal protection should be upgraded to gas-tight suits.

Small quantities of HF can be absorbed using polypropylene absorbents. If these are not available, the use of a large excess of dilute, aqueous calcium or magnesium hydroxide can be considered to neutralise the acid but this must be done slowly to prevent an exothermic reaction and vaporising the HF. It is not recommended to absorb it in sand, earth, cellulose, mineral or clay-based absorbents, as it will slowly react to produce heat and additional toxic and corrosive substances, such as silicon tetrafluoride. If there are no suitable absorbent materials, sand et al. may be used if suitable precautions are taken.

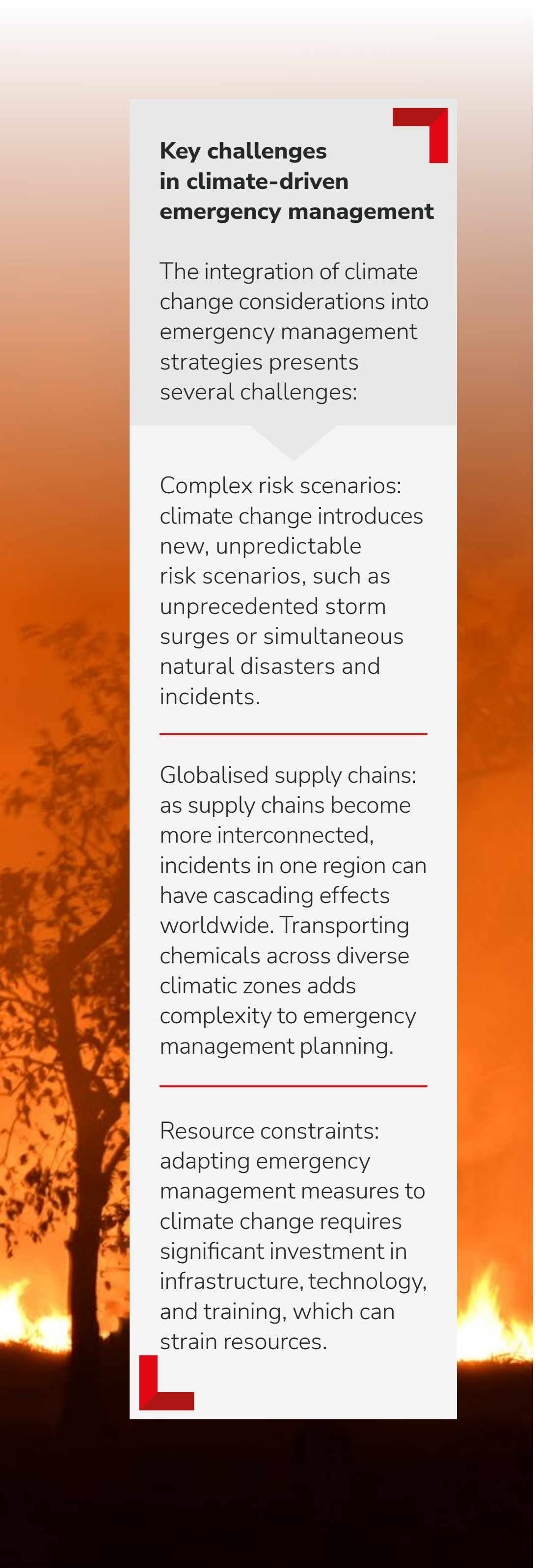
Damaged containers and materials used to absorb the spill should be placed into clearly labelled compatible containers, such as polyethylene or Teflon, and closed to prevent vapours escaping. Glass must not be used as it will react with HF. Equipment can be cleaned using copious amounts of water and pH paper can be used to confirm that all residues of the chemical have been removed. Any heavily contaminated items should be inspected before re-use to confirm there is no lasting damage.

Specialist clean-up companies should be employed to remediate large spills but, in the meantime, the spill should be contained using compatible bunding (as above) and the use of water spray can be considered to knock down any vapour.

References:
HF Burns - StatPearls - NCBI Bookshelf
safetygram-29_HF first aid_revised.pdf
https://www.chemistry.harvard.edu/sites/g/files/omnuum7776/files/chemistry/files/safe_use_of_hf_0.pdf

THE GROWING IMPACT OF CLIMATE CHANGE ON EMERGENCY RESPONSE MANAGEMENT

From extreme weather events to the implementation of climate adaptation plans, as the impacts of climate change become more pronounced, the role of emergency management is becoming increasingly critical.



Key challenges in climate-driven emergency management

The integration of climate change considerations into emergency management strategies presents several challenges:

Complex risk scenarios: climate change introduces new, unpredictable risk scenarios, such as unprecedented storm surges or simultaneous natural disasters and incidents.

Globalised supply chains: as supply chains become more interconnected, incidents in one region can have cascading effects worldwide. Transporting chemicals across diverse climatic zones adds complexity to emergency management planning.

Resource constraints: adapting emergency management measures to climate change requires significant investment in infrastructure, technology, and training, which can strain resources.

CLIMATE CHANGE AMPLIFIES HIGH HAZARD INCIDENT RISKS

Climate change exacerbates the frequency and intensity of extreme weather events, including hurricanes, floods, wildfires, and heatwaves. These events pose significant risks to chemical storage facilities, transportation networks, and industrial operations. Floods, for instance, can compromise the integrity of chemical storage tanks, leading to leaks or spills that threaten nearby communities and ecosystems. Similarly, wildfires can ignite flammable chemicals, causing catastrophic incidents.

The increased frequency of these events heightens the probability of high-risk incidents. Facilities located in climate-vulnerable areas, such as coastal zones or floodplains, are particularly at risk. According to the Intergovernmental Panel on Climate Change (IPCC), the likelihood of compound hazards (where multiple events occur simultaneously or sequentially) is increasing, further complicating emergency planning and response efforts. The heightened risks faced demand robust, proactive emergency management measures from both industry and the emergency services and strategies must adapt to address evolving challenges.

CLIMATE ADAPTATION PLANS AND REGULATORY CHANGES

Governments and industries worldwide are developing climate adaptation plans to address the long-term impacts of climate change. These plans often include measures to strengthen resilience in critical sectors, including high hazard industries, by considering the following:

- Stricter regulations: regulatory bodies are implementing stricter safety and environmental standards to mitigate risks associated with climate change. Frameworks such as the European Union's Chemical Strategy for Sustainability and the United Nations Sendai Framework for Disaster Risk Reduction emphasise proactive risk management and preparedness.
- Enhanced reporting requirements: businesses are increasingly required to disclose their climate risks and emergency preparedness strategies as part of Environmental, Social, and Governance (ESG) reporting. This includes demonstrating how emergency management plans align with climate adaptation efforts.

- Resilient infrastructure mandates: adaptation plans often mandate upgrades to chemical storage and transportation infrastructure to withstand extreme weather events. This includes flood-proofing storage tanks, reinforcing transportation routes, and implementing advanced monitoring systems.

MITIGATING ASSOCIATED RISKS

To address these challenges, proactive and integrated emergency management strategies that align with climate adaptation goals must be adopted. Organisations should initially conduct comprehensive risk assessments that account for climate projections. This process will identify vulnerable facilities, evaluate supply chain risks, and update emergency management plans to reflect emerging threats.

The integration of advanced technologies, such as thermostatic sensors, drones, and predictive analytics, can enhance incident monitoring, early warning systems, and management coordination. For example, sensors can detect changes in chemical storage conditions during extreme weather, allowing for preventive action.

Technology can only identify issues however, which means team training remains essential to ensure effective emergency management measures are in place.

CLIMATE-DRIVEN EMERGENCY MANAGEMENT IN ACTION

- Hurricane Harvey (2017): local industry faced significant challenges during Hurricane Harvey, which caused extensive flooding in Texas. Several facilities experienced chemical spills and fires, highlighting the need for robust emergency response and management plans that account for extreme weather.
- European Floods (2021): severe flooding across Europe disrupted industry production and transportation, leading to multiple incidents. Companies with advanced emergency management measures, such as real-time monitoring and cross-border collaboration, were better equipped to manage the crisis.
- California Wildfires (2025): the devastating and recurrent wildfires have underscored the importance of fire-resistant storage solutions and rapid-management capabilities to protect facilities in high-risk areas.

THE ROLE OF EMERGENCY MANAGEMENT PROVIDERS

Specialised emergency management providers play a crucial role in supporting businesses as they adapt to climate-related challenges. These providers offer expertise in incident management, regulatory compliance, and technology integration, including immediate access to advice and support during incidents, ensuring swift containment and mitigation and integrated support across all stages of crisis management. Their specialised knowledge and first-hand experience in handling complex and high-risk scenarios can provide a strong basis for developing emergency management plans that align with climate adaptation goals and regulatory requirements.

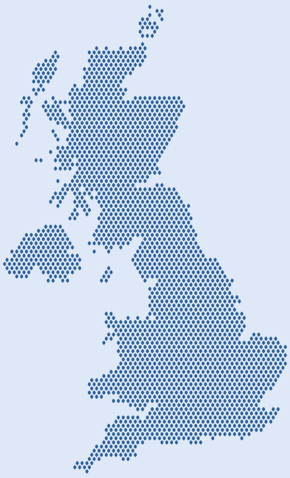
RELEVANCE TO EMERGENCY RESPONDERS

As climate change continues to reshape the operational landscape, emergency management is becoming more critical than ever. Businesses must embrace proactive, climate-resilient emergency management strategies to safeguard their operations, protect communities, and meet regulatory and stakeholder expectations. By integrating advanced technologies, collaborating with experts, and aligning emergency management initiatives with sustainability goals, high hazard industries can enhance resilience and ensure a safer future. However, to guarantee effective response when things do go wrong, collaboration with local authorities and emergency services and other first response agencies is critical. Regular joint training and exercises that simulate climate-driven incidents, such as flood-induced chemical spills, can improve planning, preparedness, response and management capabilities. Through joint working, both public and private sector participants can provide different, but equally valuable, operational insight to ensure shared learning and develop best practice procedures.

LATEST CALL STATISTICS AND TRENDS

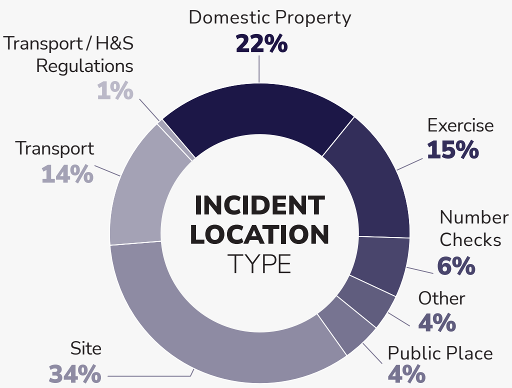
CHEMSAFE INCIDENT TRENDS

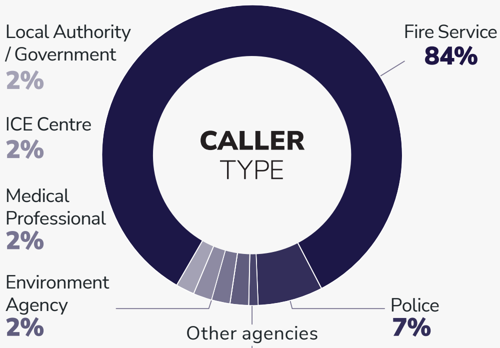
April 2024 - March 2025



- **Suspicious activity** in terms of drugs, IDL's, finds by the authorities, suspicious purchase activity, hobby chemists etc.
- **Unknown substances**
- **Cleaning chemical spillages / reactions / fires**
- **Batteries**
- **Suspected gas leaks / fires**
- **Explosive material / explosions (non-terrorist)**
- **Fuel / heating oil leaks / fires**
- **Water treatment chemicals** (water supply and pool chemicals)

CHEMSAFE April 2024 - March 2025

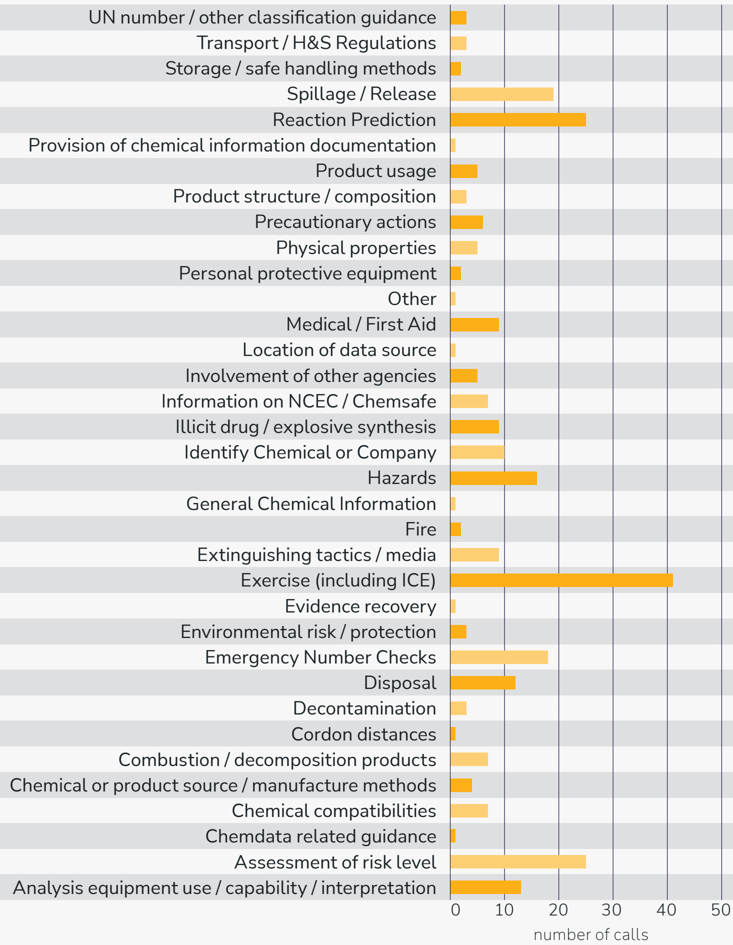




Other agencies calling Chemsafe (at less than 2% per agency)

Maritime and Coastguard Agency	National Crime Agency	Animal and Plant Health Agency
Ambulance Service	National Highways	Other Company

MAIN ENQUIRY TYPE



Chemsafe

NCEC provides refresher training for all eligible Chemsafe users.

The objectives of the training are to provide:

- A better understanding of the Chemsafe scheme and the role of NCEC within it.
- Technical training on individual chemical exposure (ICE) incidents.
- Technical training on waste fire incidents.

We discuss and review examples of the calls we have taken and run interactive scenarios based on real Chemsafe calls to enhance knowledge and promote shared learning.

Emergency Services Refresher Training

FREE

The training is approximately 6 hours long if every element is required but it can be tailored according to which sessions you want to receive (the core Chemsafe session must be delivered).

It is completely free of charge and can be delivered in person or virtually.

Contact details:
01235 75 3363
chemsafe@ricardo.com
www.ricardo.com/chemical

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KEEP IN TOUCH

If you have any comments about 'The Spill' or experiences of using the Chemsafe service that you would like to share, please contact us using the details below.

You can also contact us if you would like to know more about Chemsafe, and the other services and products provided by NCEC.

NCEC will be exhibiting at the Emergency Services Show at the NEC on the 17th – 18th September

Please come and visit us on Stand 5/CZ27

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