NCEC is conducting a project on behalf of the UK Department for Transport (DfT), part of which aims to raise awareness and promote the reporting requirements for dangerous goods incidents that occur on the road network.

Welcome to our final newsletter to support this.

Road (ADR) Incident Reporting Requirements

Imagine you are the Dangerous Goods Safety Advisor (DGSA) for a haulage company that (among other shipments) has stored a shipment of 40 x 1000-litre intermediate bulk containers (IBCs) of UN2031 that contain 68% nitric acid. During its temporary storage, the nitric acid begins to unexpectedly leak from the valve assembly of approximately half of the IBCs, pool on the floor of the warehouse, destroy nearby products and corrode the metal racking. Several employees inadvertently inhale the acidic vapours when they discover the leaking containers and need medical treatment, including hospitalisation for two days. After a successful clean-up, an investigation reveals that the nitric acid was packaged in incompatible IBCs, with metal fixtures in the valve. You estimate the loss to your business to be £1 million due to clean-up costs, replacement of the racking and loss of revenue.

From your training and information contained in previous versions of this bulletin, you are aware that your warehouse is part of the transport chain. Due to the required hospital stays of the injured employees and since the damages you suffered amount to more than the €50,000 threshold, you report this incident to your Competent Authority.

The Agreement concerning ADR states that it is a legal requirement to report certain serious incidents involving dangerous goods to the Competent Authority when they meet the criteria outlined in ADR 1.8.5. In Great Britain, this authority is the DfT. In Northern Ireland, operators would be required to report to the Health and Safety Executive for Northern Ireland (HSENI). It must be reported within **one month** of the incident occurring. To ensure that your organisation is accurately fulfilling its legal responsibilities, you may implement an internal best practice incident reporting process so that key stakeholders are promptly alerted when an incident meets the criteria outlined in ADR 1.8.5.

A report is required when an incident involving dangerous goods fits into one of the following events **AND** it is serious enough to meet at least one criterion.

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	• Evacuation or route closure for three hours or more

This table provides a brief summary of criteria, however for full legal definitions please refer to ADR 1.8.5.

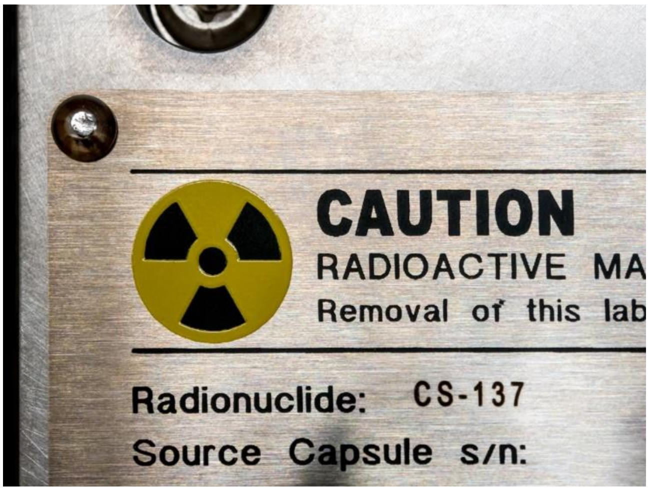
ADR 1.8.5 covers more than the movement of goods on public roads. It also encompasses **loading and unloading operations.** Therefore, there may be reporting obligations on the loader, filler, carrier or consignee.

Some scenarios that may require reporting to the DfT (or other Competent Authority) are detailed below for you to consider. They are designed to demonstrate the breadth of dangerous goods incidents that must be reported.

- ❖ A tradesman's van that contains a 30-litre acetylene cylinder is involved in a road traffic collision and becomes involved in fire. Despite the subsequent explosion of the cylinder, there are no injuries. Although the road was closed to contain the incident, as the acetylene is designed for professional use to support the tradesman's job, the carriage of acetylene is exempt from ADR under 1.1.3.1(c) and therefore the Competent Authority does not need to be made aware of the incident.

- ❖ A dark-coloured 250-litre drum of UN 2014 HYDROGEN PEROXIDE, 50%, is transported to a warehouse ahead of distribution to the final customer. It is stored outside in direct sunlight on a hot summer's day. The peroxide begins to decompose and pressurise the container until it explodes, and the blast injures a passing worker who is hospitalised for two days. Despite the low quantity involved in the incident, it would need reporting to the Competent Authority due to the hospital stay of the employee.

- A radioactive capsule containing Caesium-137 was lost during transport. It is not known how it escaped its original containment within the vehicle as its absence was only discovered during the unloading process. Although the capsule was found undamaged, further shielding and containment had to be reapplied to the capsule to allow it to resume its journey i.e. it was placed inside a lead-lined container. As additional safety measures were applied to the radioactive capsule, the Competent Authority would need to receive a report of the incident. In addition to notifying the Competent Authority, further stipulations on the transport of Class 7 materials means that the Office for Nuclear Regulation (ONR) must be notified without delay by phone or email, and the incident must also be reported using the ONR incident notification form (INF1) at www.onr.org.uk.



- Embrittlement on a compressed hydrogen (UN 1049) tanker valve caused a low-level leak that was only noticed when the vehicle's pressure alarm activated. The high flammability of hydrogen meant that the fire service closed the road to remove potential ignition sources from the area. Although a replacement tanker could be readily found, the load was unable to be transferred across due to the lack of grounding equipment. It was decided to allow the hydrogen to vent, resulting in a road closure for 14 hours. This must be reported to the Competent Authority for several reasons: the loss of thousands of litres of hydrogen and the prolonged road closure. Hydrogen is looked at in more detail here.

- UN 1823 SODIUM HYDROXIDE, SOLID has spilt from a damaged 25kg bag and out of the side of a curtain-sided lorry, causing a small trail along the road. The incident will not need reporting to the Competent Authority as the spill is not large enough for a transport category 2 dangerous good.

If you are the person responsible within your organisation for reporting dangerous goods incidents to the Competent Authority, you should familiarise yourself with the full criteria of ADR 1.8.5, which defines when you need to submit a report. It is a legal requirement for incidents and accidents meeting the requirements of ADR 1.8.5 to be reported to the Competent Authority who, on receipt of the report, are entitled to request further relevant information. The online reporting form for Great Britain can be found here:

Transporting dangerous goods - GOV.UK (www.gov.uk)

If an incident occurs during an international journey covered by ADR 1.8.5, a report must be submitted to the Competent Authority of the territory where the incident occurred.

The DfT, in conjunction with NCEC, has collated events such as this one into a study to gain an understanding of the types of incidents involving dangerous goods in transport, which is detailed in the final article of this bulletin, and would like to thank those who are fulfilling their legal obligations! If you have any questions on the reporting requirements of ADR 1.8.5 or other regulatory obligations, please contact the DfT at dangerousgoods@dft.gov.uk or call 020 7944 2271 / 2058.

The National Chemical Emergency Centre and UK Regulations – where it all began

On 8 December 1972, a serious incident occurred in a natural dip on the northbound carriageway of the M6, just north of the Skelmersdale link at Orrell. The incident happened shortly before 21:00 when a tanker carrying oleum (containing 80% sulfuric acid) travelling from St Helen's to Whitehaven, slowed to a stop because of traffic build up. It was a foggy evening, so visibility was poor, causing a container lorry travelling behind to swerve and collide with the back corner of the vehicle. Immediately, thousands of gallons of acid were released. A 48-year-old off-duty nurse from Birmingham had been travelling to Scotland with friends and family when she witnessed the collision. She left the safety of the car she was travelling in to try to assist.

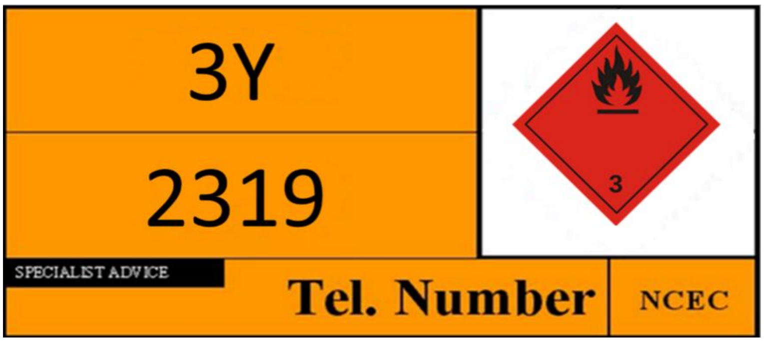
The driver of the tanker tried desperately to warn of the danger posed by the acid by banging on his cab windows and gesturing for people not to approach. Unfortunately, these actions were mistaken for cries for help, leading the nurse to approach the tanker closely. As it was a foggy night, the release of the material was not visibly obvious. It is thought that any gaseous material would have blended with the fog in the orange lights of the motorway and any liquid material would have looked like water. It is not entirely clear whether the lady was overcome by fumes from the acid and collapsed into a pool of the material, whether she slipped on the acid, or if she walked directly into the stream of acid spilling from the tanker. However, she was found in a pool of acid and sustained such serious injuries that she sadly passed away.

There were other casualties of the incident who sustained burn injuries, including the daughter of the nurse involved and the tanker driver. Cars also came to a halt behind the accident, with their occupants leaving vehicles to investigate the situation. Members of the emergency services attempting to help saw their footwear disintegrating as they walked in the acid. 20 people suffered minor burns as a result, but some required ongoing treatment for several years.

The oleum involved was for use in the detergent industry. The vehicle owners, Leather's Chemicals from St Helen's, sent 10 tonnes of soda ash to neutralise the acid but the clean-up process took over 12 hours and the motorway was closed until 13:00 the following day.

This prompted a call from the local MP for a full Whitehall investigation into the cause of the incident and a thorough review of the risk posed by the transport of dangerous goods (DGs). Questions were also asked about the resources the emergency services had available for dealing with incidents involving dangerous substances. As a result, the UK Government decided that something had to be done with regards to substances like this being transported by road and emergency services not knowing what they were dealing with. New control measures were introduced to ensure that bulk loads of corrosive substances were properly carried in suitable vehicles, that the loads were properly marked and that measures were taken to alert other road users and the emergency services of the hazards involved. In 1973, the National Chemical Emergency Centre was set up by the UK Government to provide 24/7 emergency response support to incidents involving hazardous chemicals. Whilst NCEC was privatised in 1996 and has been a part of Ricardo for some time now, this core service is still provided under the Chemsafe scheme with funding support from the Chemical Industries Association (CIA) and the Department for Transport (DfT).

A working group was also set up to examine what could be done to reduce the risks of a similar event happening again and 3 key developments were introduced. Transport emergency instructions, commonly referred to as Tremcards, were initially introduced as a voluntary code of practice before being adopted as mandatory documents that contained important safety information about the vehicle's load. Hazchem plates displaying an Emergency Action Code (EAC) were also introduced, again initially as a voluntary initiative. Lastly, a scheme was set up between 3 trade association, the Freight Trade Association (FTA), now known as Logistics UK, the Road Haulage Association (RHA) and the CIA to introduce a voluntary scheme for DG driver training, which became known as the National (Dangerous Substances) Driver Training Scheme. Companies were encouraged to take part and CIA member companies would only accept tanker drivers that had gone through the training.



In the late 1970s/early 1980s the first substantial set of regulations for the transport of DGs in the UK by road and rail in tanks of any kind was introduced. These translated the Hazchem system into law and made driver training compulsory. It was still left up to individual companies to determine what constituted a satisfactorily trained driver, but guidance was issued in the form of Approved Codes of Practice (ACOP). The regulatory body at the time was the Health and Safety Executive. ACOPs were also produced for other areas, such as tank operations and tank testing. The requirement for driver training was later written into UK law but drivers of vehicles containing dangerous goods were subsequently required to hold an ADR Driver Training Certificate, so the UK implemented the Dangerous Goods Driver Training Scheme (ADR) to transition from the previous scheme and comply with the ADR regulations.

By the late 80s, it was clear that directives would come from the European Commission (EC) requiring all EU Member States, in the early 90s, to apply ADR as their national regulation. However, Member States highlighted that they had small national variations that would make direct application not practicable and possible, and four countries had substantive differences that they were not prepared to give up. The UK fought to continue to use Hazchem plates instead of ADR orange boards, which displayed a Hazard Identification Number in place of the EAC. It was thought that the extinguishing media and personal protective information contained within the EAC was preferable. As a result, the UK were allowed to keep this system domestically.

NCEC would like to thank Wigan Council Archives and Roy Boneham (New Alchemy Training and Consultancy) for their contributions to the content of this article.

Hydrogen: the alternative fuel of the future?

Hydrogen is currently a frontrunner for alternative-fuelled vehicles. It is the first and most abundant element in the known universe and has been used in numerous industrial sectors for hundreds of years. It is a component in the production of a variety of chemicals such as ammonia (an essential component of fertilisers), the processing of electrical semi-conductors and it is a vital ingredient in the food, pharmaceutical, and petrochemical industries; and, of course, within the energy sector. Until as recently as 50 years ago, it was a major constituent of 'town gas' in UK's domestic and industrial fuel network before it was removed over safety concerns. Indeed, several events over the years have contributed to hydrogen obtaining a marred reputation (the 1937 Hindenburg Disaster perhaps the most infamous), yet the industrial world is increasingly turning back towards hydrogen as a versatile and clean energy source. This is for several reasons: hydrogen has an incredibly high energy density per kilogram compared to typical petroleum-based fuels, when burnt it only produces water as a by-product, and the invention of hydrogen fuel cells have produced an efficient source of power. Therefore, for a more sustainable future and to reduce reliance on fossil fuels, it becomes paramount to ensure hydrogen's safe production, storage, and transport.

Hydrogen fuelled vehicles

Hydrogen can be used in internal combustion engines and within fuel cells. Fuel cells use the electrochemical properties of hydrogen and oxygen, encouraging them to react and produce water, which releases electricity that can be used to power a vehicle. While hydrogen contained in fuel tanks for the propulsion of vehicles is excluded from ADR by sections 1.1.3.2 and 1.1.3.3, an increase in hydrogen-fuelled vehicles (both domestic and industrial) will increase demand for hydrogen to be transported across the country. Indeed, the process of filling a hydrogen vehicle can occur in a similar manner to petrol, diesel, LNG and CNG powered vehicles: via a pump at a refuelling station. To maintain as much of the current infrastructure as possible, hydrogen would need to be transported by tanker to required locations. In the UK, hydrogen is most transported by road in its compressed form, although it may be transported under three different UN numbers according to different physical forms:

UN Number	Proper Shipping Name	Special Provisions	Tank Codes
1049	HYDROGEN, COMPRESSED	378, 392, 653, 622	CxBN(M) TA4, TT9
1966	HYDROGEN, REFRIGERATED LIQUID	-	RxBN TU18, TE26, TA4, TT9
3468	HYDROGEN IN A METAL HYDRIDE STORAGE SYSTEM or HYDROGEN IN A METAL HYDRIDE STORAGE SYSTEM CONTAINED IN EQUIPMENT or HYDROGEN IN A METAL HYDRIDE STORAGE SYSTEM PACKED WITH EQUIPMENT	321, 356	-

Note that UN 3468 has fewer restrictive special provisions associated with it. This is of importance as special provisions must be read and where appropriate, enforced to ensure that tighter control, or an exemption can be applied. Special provision (SP) 321 merely states that the product is assumed to contain hydrogen, and SP356 decrees that the Competent Authority of the manufacturer's country must issue a certificate determining that the metal hydride storage system and its packaging is approved for transport. The flexibility of SP356 is due to the relative newness of the metal hydride storage systems, but also their innate safety compared to storing hydrogen as a compressed or liquefied gas.

Hydrogen safety concerns

- Embrittlement

As it is the smallest molecule and the lightest element, hydrogen can permeate through materials and cause embrittlement, whereby it interacts with the lattice structure of certain metals, and affect their physical properties – notably reducing ductility and therefore tensile strength. Embrittlement is well understood within the established hydrogen industries because it shortens the life of their infrastructure. For this reason, pipe networks to move hydrogen would need constant monitoring, and are therefore considered a more challenging prospect. In road transport, it will shorten the working life of cylinders, storage vessels and road tankers etc., which would ideally be in operation for decades. To prevent having road tankers in use that may have been damaged by embrittlement, there are provisions in place for those transporting UN 1049 and UN 1966 to conform to the provisions of TA4 and TT9 which describe the tank construction and the nature of periodically pressure testing the tankers to ensure they are fit for purpose according to EN ISO 9712:2012 (except clause 8.1.3 type A).

In the UK, hydrogen is usually transported in compressed form in tube trailers which is at lower pressure than 1,000 bar carbon-fibre composite road tanks which are in limited use in other countries. Embrittlement increases as the hydrogen pressure increases and if hydrogen is to be bulk transported more regularly, transport companies will want to increase the quantity of hydrogen that can be delivered in a single tank, therefore will need to compress hydrogen to higher pressures. There are few suitable materials that can withstand the pressure (up to 1,000 bar) and are also resistant to embrittlement.

ADR does not explicitly account for the embrittlement of tankers, other than requiring periodic tank inspections and testing. At this time, UN 1049 road tank must conform to CxBN(M), meaning they must be suitable for compressed gases (and may be carried in multi element gas containers) which meet the necessary pressure tests of 4.3.3.2.5, be bottom filling/discharging with 3 closures and have a non-hermetically sealed safety valve. RxBN road tanks have the same conditions applied, although they must be suitable for refrigerated gases. Specialised materials are used in construction of hydrogen containers, such as 316 steel (as per the typical tube trailers used in the UK) or carbon fibre composites. The carbon fibre composites are often used for higher pressure containers, and while not yet widely used, they are able to transport a greater mass of hydrogen so are likely to become more commonplace. New technologies will need to be considered and subsequent derogations written into ADR for the maintenance of such tanks.

- Flammability

The greatest hazard of hydrogen, if it escapes containment, is its wide flammable range, between 4-77% fuel in air concentration. In addition, when hydrogen is present in the air at its optimum combustion ratio of 29%, the minimum ignition energy (smallest amount of energy required to begin combustion) is equivalent to the static discharge from synthetic clothing. Theoretically, the action of running your hand through your hair can produce enough static energy to cause an explosion. For comparison, the flammable range of petrol vapour is approximately 1.5-7.5% and it takes around 12 times as much energy to set alight. This risk is offset by the innate safety feature of hydrogen: it is extremely light, meaning it will readily disperse upwards and no longer be within its flammable range.

Liquified hydrogen is severely cryogenic and the second coldest (non-critical) liquid in existence. There are additional safety measures that must be accounted for when carrying UN 1966 HYDROGEN, LIQUIFIED as described by:

- TE26 – there must be an instant closing automatic stop valve on the tanker;
- TU18 – there is a limit to the degree of filling such that if the pressure increases inside the tanker such that the pressure release valve opens, the minimum ullage would equal 5% of the tanker’s capacity.

These measures are designed to prevent excess cryogenic material spilling, reduce the risk of cryogenic burns and the evolution of hydrogen gas. The liquified hydrogen will rapidly boil off into its gaseous state and has the potential to cause asphyxiation in an enclosed space or create an explosion after dispersing to an ignition source.

Regardless of state, hydrogen is also odourless and unlike CNG and LNG, a stenching agent cannot be added because it will not ‘travel with’ the hydrogen molecules. If it does catch alight, hydrogen flames are invisible in daylight and produce very little radiant heat, so they are incredibly hard to detect. The predicted increase in vehicles powered by hydrogen and hydrogen transported around the country may see a change in the regulations to prevent the impact of hydrogen leaks. An example could be making hardwired and portable hydrogen sensors mandatory to be carried by those transporting hydrogen, so it can be readily detected in a leak or fire scenario.

The current landscape

The main challenge surrounding the increase in hydrogen for use in domestic and industrial application (and the corresponding increase in its transport) is the lack of familiarity with the element. This can be considered as general lack of awareness of the hazards and can potentially be dealt with by mass re-training of the public around good practice at fuelling stations; raising the profile of the hazards of hydrogen for emergency responders and staff working at fuelling stations; and increasing the level of guidance for ADR drivers who transport hydrogen.

It is intriguing to consider all the different areas where actions would need to be taken to ensure safety during mass transport. They may include identifying key risks during transport (i.e. filling and unloading) and applying control measures to mitigate these risks and their impact. Training of employees working with hydrogen as a fuel will also be critical. Increasingly in the UK, emergency responders such as the fire and rescue authorities have been campaigning to increase safety for emerging, clean energy technologies such as battery energy storage systems. However, there is no reason yet to believe that adopting hydrogen fuel cell technology will lead to regulation tailored to address the specific hazards it poses.

The expansion of hydrogen fuel cells into the domestic market will introduce a wider range of hauliers transporting such products. The current regulations are not specific around the transport of hydrogen – for example, there is little ADR regulation on types of tanks used for hydrogen transport and the dangers of embrittlement, although the risks are well known within industry. Equally, as more industrial vehicles become hydrogen-powered, it is possible that amendments to ADR 1.1.3.2/1.1.3.3 will be needed to account for the increased capacity of hydrogen fuel tanks powering vehicles that move dangerous goods.

If you have any questions on the ADR requirements for hydrogen transport or other regulatory obligations, please contact the DfT at dangerousgoods@dft.gov.uk or call 020 7944 2271/ 2058.

ADR Reporting and Data Collection Project

Under road transport (ADR) regulations, serious accidents or incidents that take place during loading, filling, carriage or unloading of DG must be reported to the Competent Authority, within one month of their occurrence. As current reporting levels to the Authority for Great Britain (the DfT) are low, it is suspected that there may be an element of underreporting. DfT wished to better understand the frequency, location and details of DG incidents that are occurring and encourage incident reporting where appropriate. NCEC therefore conducted a project on behalf of the DfT to achieve these aims.

The first phase of this was to collect data from different agencies to understand the level of reportable incidents that are likely to be occurring within Great Britain and understand how accurate the reporting levels to DfT are.

Department for Transport

NCEC RICARDO

Data was received and analysed from five different sources to identify 198 incidents involving DG transport on roads. It was noted that many of the incidents within the data sets were not true DG road transport incidents so they could be discounted for the purpose of the project, leaving 46 true DG incidents and a further 43 that were possibly true DG incidents. Due to the lack of detail and consistency in reporting between agencies and within a single agency, NCEC had to make several assumptions over incidents that were likely to be reportable. We split the true DG incidents into those we thought would definitely be reportable and those we thought would possibly be reportable. By considering within this only the incidents we felt were definitely reportable, we were able to conclude that the best case was likely to be 77% underreporting. However, this figure would rise to give a worst-case picture of 89% if we considered the possibly true DG incidents and all within both categories that were potentially reportable.

It was anticipated that a social value (with economic and environmental benefits) would result from the project, by enabling consideration to be given to measures that might reduce DG incidents. The low occurrence of DG incidents can be seen as a positive illustration that the current safety measures and regulations have the desired consequence in most transport movements. However, no real patterns in location were identified within the data gathered. A high proportion of the incidents identified involved Class 3 products, with Class 2 and Class 8 also prevalent.

As this was a very small data set and some agencies were very England centric, it would be beneficial to repeat the exercise with a higher number of agencies/over a longer period so a larger data set could be analysed. We did encounter barriers in engaging with stakeholders and obtaining their data sets, which could also prove problematic in any future study. We also know that some agencies simply do not hold data of this kind in a consistent way at a national or local level.

The second phase of the project was to raise awareness of the reporting requirements in an engaging way as well as promote other subjects of concern. A key part of this was the production of this quarterly newsletter covering compliance issues, transport regulations and example incidents. If the project was run again, it would be useful to see if the reporting compliance improved because of the awareness activity conducted.

We hope you found this newsletter useful and informative. If you have any questions regarding the information in the newsletter, please contact us at info@ricardo.com.