CLEAPSS

SCHOOL SCIENCE SERVICE

Transporting chemicals for lecture demonstrations & similar purposes

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RSC | Advancing the Chemical Sciences

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About the RSC

The Royal Society of Chemistry (RSC) is the UK professional body for chemical scientists and an international learned society for advancing the chemical sciences. Supported by a network of over 43,000 members worldwide and an internationally-acclaimed publishing business, its activities span education and training, conferences and science policy, and the promotion of the chemical sciences to the public.

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About CLEAPSS and SSERC

CLEAPSS and Scottish Schools Equipment Research Centre (SSERC) are advisory services supporting practical science and technology in schools and colleges, including independent schools, in the UK. CLEAPSS provide for those in England, Wales and Northern Ireland and SSERC for those in Scotland. Both organisations, which are largely funded by their local authorities and independent schools, have a focus on health and safety and produce publications and resources for their members. These include bulletins and newsletters, handbooks and guidance on practical work and health & safety. These resources are also available electronically on CD-ROMs and web-sites. Both organisations have helplines and run many courses for their members. The two organisations also have close links with the Association for Science Education, the Health and Safety Executive, the Health Protection Agency, the British Standards Institution, the Environment Agency and the Scottish Environment Protection Agency, and also with those professional bodies with particular interests in different subject areas such as the IoB, the IoP, the RSC and the respective examination boards.

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1 Introduction

It is often necessary to move chemicals around for the purposes of lectures, demonstrations, competitions or other hands-on practical activities. The RSC, CLEAPSS and SSERC all want to encourage such activities as a way of stimulating an interest in chemistry amongst young people and, indeed, the public at large. This document has been produced at the request of the RSC to support such activities. We are grateful to the Health and Safety Executive (HSE) in Edinburgh who clarified several areas, to a number of demonstrators who supplied information about the chemicals they use, to staff from CLEAPSS and SSERC and members of various RSC committees for their comments on the drafts and to others who helped in the consultation process. SSERC has produced a wider guidance document which is available on its website.

Those involved in demonstration lectures and other hands-on activities come from a variety of backgrounds. Some may be volunteers who are retired or currently working in schools, industry or higher education. Although there will be no restriction on certain chemicals, some of those they wish to move around will be classified as "Dangerous Goods" and account must therefore be taken of the *European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)*[1,2] implemented in the UK via the *Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations* (the *Carriage Regulations*)[3] This legislation is aimed particularly at large commercial loads. For the small quantities likely to be required for demonstrations, etc (see *Appendix 2*) there are, fortunately, complete or partial exemptions from the *Carriage Regulations*, providing certain rules are adhered to. However, since different exemptions apply in different contexts, the position can be very complicated. The *Simple rules* in Section 2 cover the most likely situations and in some cases do more than the law would require. This is all that most demonstrators will need. The justification for these rules is explained in Section 5 on *Exemptions to ADR* and some *Special cases* are considered in Section 8. The transport of a few items is effectively banned (see *Appendix A1.6*). A *Flow diagram* summarising the options is given in Section 9. The status of the individual can affect the exemptions and this is discussed in Section 3. The status can also affect the vehicle insurance, discussed in Section 4. Note that the use of trade names in this document, or references to a particular company, do *not* constitute an endorsement; they are given by way of example only.

Rather than the demonstrator transporting chemicals, **in some cases it will be more straightforward for the host venue to be asked to supply them**. If these are not available at the venue then it may still be possible to ask a supplier to deliver them directly to the venue although this incurs significant costs. After the event, it may be possible to leave the surplus chemicals as a gift to the host. However, it is important that schools do not accumulate unwanted exotic chemicals and it may be necessary to arrange disposal, in accordance with relevant legislation.

If the hazards of transporting chemicals have been reasonably considered, appropriate measures taken to minimise risk and the simple rules given in Section 2 applied, then this will demonstrate an adequate duty of care.

[1] The term ADR originated as an abbreviation for L'Accord Européen Relatif au Transport International des Marchandises Dangereuses par Route, the French translation of the European Agreement Concerning the International Carriage of Dangerous Goods by Road. However, neither term is used in UK legislation, which universally refers to ADR.

[2] See http://www.unece.org/trans/danger/publi/adr/adr_e.html.

[3] The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007 can be downloaded from http://www.opsi.gov.uk/si/si2007/uksi_20071573_en.pdf.

2 Simple rules

These simple rules have been drawn up with a knowledge of the chemicals likely to be transported for lecture demonstrations and the quantities involved. They make use of the various exemptions from ADR. If followed they should cover most of the likely situations.

In summary:

- ✔ **The demonstrator should try to avoid transporting chemicals. Where practicable, ask the host venue to provide them or have them delivered direct to the venue by a supplier.**
- ✔ **The driver should have an inventory of the chemicals carried.**
- ✔ **Chemicals which are being transported should be kept out of sight, eg carried in the boot of cars.**
- ✔ **Vehicles should be kept locked at all times when parked.**
- ✔ **Chemicals should not be left in vehicles overnight. If this is unavoidable, park the vehicle in as secure and well-lit an area as possible, in sight of any surveillance cameras present.**
- ✔ **Transport the smallest amounts of chemicals possible. For many (but not all) substances, if a total of less than 20 kg / 20 litres (see Appendices 1 and 2) of chemicals is being transported, very few of the regulations apply (Small Load Exemption).**
- ✔ **Where possible, use the bottles and outer packaging in which the chemicals were originally supplied, complete with original labels and hazard warnings. (This is essential for a small number of chemicals – see Section 5.4 and Appendix 1).**
- ✔ **Caps and stoppers on bottles should be securely fastened, and, if necessary, sealed with adhesive tape.**
- ✔ **Bottles should be supported with bubble-wrap or similar packing material in a robust outer container with a lid which is fastened closed (eg, with parcel tape). The container should carry a label indicating the contents and the hazards each presents.**
- ✔ **Support or pack outer containers so that bottles, or any box etc in which they are carried, cannot slide about or tip over.**
- ✔ **Chemicals should be separated by hazard type. Incompatible chemicals (eg, acids and bases, oxidising and reducing agents, alkali metals and water/aqueous solutions) and flammables should be in separate containers (eg, separate boxes).**
- ✔ **The demonstrator should be personally responsible for loading and unloading the chemicals and not delegate these tasks to others.**
- ✔ **For the more-hazardous loads, consider carrying a spills kit (see Section 7) and ensure that the person accompanying the chemicals knows how to use it to deal with a spill.**

3 Status of the demonstrator

The status of the individual transporting the chemicals is important because:

- private individuals are exempt from some of the regulations governing the transport of chemicals by road; and
- the insurance cover of the driver may also be affected.

A retired volunteer will not be in employment and thus can be regarded as a private individual. However if volunteers accept fees, as opposed to expenses, then they may be considered in employment. In any case, a private individual would not be able to obtain some chemicals. In that situation, a school or university might supply them (free of charge) but it does raise questions about the status of the individual. A university lecturer, for example, may be encouraged by her/his department to give lectures to feeder schools, may be supplied at no cost with the relevant chemicals but may still be regarded as a private individual working in his/her own time. Similarly, some teachers in secondary schools may be encouraged, or even required, to liaise with feeder primary schools. Needless to say, few of these distinctions have been tested in court.

4 Motor insurance considerations

Some of the more popular private motor insurance policies do not appear to have any specific restrictions with regard to the carriage of chemicals (although radioactive materials may be treated differently). There is a general duty to take reasonable care to prevent loss or damage. Therefore, if chemicals were transported in an inappropriate manner, a claim might be rejected. The Simple Rules in Section 2 give guidance on good practice.

The car insurance held by most school teachers will cover them for business use as a teacher (but this needs to be stated on the certificate of insurance). Named drivers on another person's insurance policy (eg, spouses) are unlikely to be insured for business use unless this is explicitly stated. Primary school liaison is an important part of the job of some teachers in secondary schools and hence occasionally moving a few chemicals to a neighbouring feeder school should be covered by their insurance. University staff may also be covered for undefined business use, although most universities will have vans routinely employed for transporting chemicals between sites which it may be possible to use. In some cases different rules apply when employers are transporting chemicals between their own sites, even if public roads are involved.

When insurance cover is being arranged, questions are asked relating to the occupation of the proposer and the requirement for cover. The policy is then framed around this. Therefore, someone without a paid job, who stays at home to care for children or others, is likely to have a policy that restricts cover to Social, Domestic and Pleasure purposes only and this may be similar for a retired person. Beyond that there is a range of uses allowing for Social, Domestic and Pleasure purposes together with commuting and / or full business use. Sometimes "commuting" is restricted to a permanent place of work, therefore travel to alternative sites is not always allowed for. It could be argued that an unpaid volunteer travelling to a lecture / demonstration would be for Social, Domestic and Pleasure purposes because no payment is involved, whereas a paid volunteer is acting in a business capacity. Note, however, the some Social, Domestic and Pleasure policies do not cover a volunteer working unpaid for a charity.

Therefore, it is important that individuals check their policies (and certificates of motor insurance) to ensure they have the correct cover for their activities. For example, a retired person might add the term, "volunteer lecturer in chemistry" to his/her "occupation".

5 Exemptions from ADR

The rules governing the transport of chemicals by road are extremely complex and not always entirely logical to the chemist's mind. In general, carriage must conform with the requirements of ADR as implemented by the *Carriage Regulations*[4]. Terminology can be very complicated. A partial ***Glossary*** is given in *Appendix 1*. Labelling and packaging must conform to Part 4 of ADR. Table A [3.2.1] of ADR[5] is the *Dangerous Goods List*. It runs to 277 pages!

There are exemptions from ADR (section 1.1.3) under several categories, of which the most relevant in the context of this document are as follows.

- Private individual
- Ancillary to main activity
- Limited quantities
- Small loads

The issues are discussed in more detail below, but the above list is given in order of preference for demonstrators needing to transport chemicals by road. As you descend the list, the legal requirements become more onerous.

5.1 Private individuals

Private individuals are exempt [ADR 1.1.3.1(a)] **if carrying dangerous goods packed for retail sale and intended for personal, domestic and leisure use,** provided steps have been taken to prevent leakage. This should cover individuals carrying out lectures and similar activities as a hobby as long as the original containers are used but obviously some chemicals are not available for retail sale to private individuals. If a university, for example, provided the chemicals for a former lecturer, that lecturer might be regarded as working (unpaid) for the university.

In addition, private individuals are allowed to carry up to 50 kg of fireworks (or a combination of 30 kg of fireworks and other explosives) [*Carriage Regulations* 89(4)].

5.2 Ancillary to main activity

Carriage by organisations which is "ancillary to their main activity" [ADR 1.1.3.1(c)] is also exempt from ADR, providing quantities are restricted. Thus, if the main activities of a university are research and degree-level teaching, a lecture for school students could be seen as ancillary to its main activity. However, there is no clear definition of "ancillary to their main activity" and, for example, outreach work might be seen as part of the recruitment process of a university.

5.3 Limited quantities

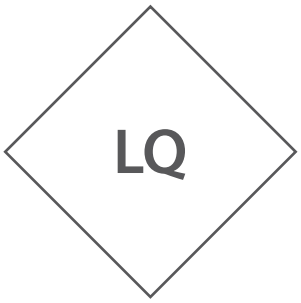
Limited quantities of most substances (except those in category LQ 0, see below) are exempt from the provisions of ADR providing they are well-packaged and labelled in a specified way. There are 27 LQ categories [ADR 3.4.6] listed in ADR Table A (see *Appendix 1.3*). Unfortunately, there is no limited quantity exemption for those in category LQ 0 which includes some substances that volunteers might want to transport. Compressed gases such as hydrogen are in category LQ 0. Also, surprisingly, is methanol[6]. However, at least 500 g or 500 ml is permitted for most other categories (see the table in *Appendix 1.3*). The total allowed in any one box is also restricted but unlikely to be an issue in the context of this guidance. The Limited Quantity Category of the chemicals which the demonstrators consulted reported that they used is given in *Appendix 2*. It is

[4] The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007 can be downloaded from http://www.opsi.gov.uk/si/si2007/uksi_20071573_en.pdf.

[5] See http://www.unece.org/trans/danger/publi/adr/adr_e.html.

[6] The documentation [ADR 3.3.1 Note 279] admits that this classification is not justified by a strict application of the ADR rules.

generally preferable to use the LQ exemption if possible because fewer regulations would then apply. For example, the hazard warning diamond is not required on the outside of the vehicle. However, each package should have on its outside a warning diamond, at least 100 mm x 100 mm, with the letters UN followed by the UN number(s) of the goods contained within it[7]. If there is more than one type of chemical in the package (which will nearly always be the case in the context of this guidance), then the symbol LQ can appear in place of the letters UN and all the UN numbers, see below.



Note that it will not be possible to use the LQ exemption for substances in LQ 0 (which includes the alkali metals, some compressed gases and other chemicals possibly used in demonstrations).

5.4 Small loads

There are also exemptions for small loads, i.e. where the total quantity of dangerous goods carried is restricted. It is the transport category of each substance, listed in ADR Table A (see *Appendix 1.4*), which determines what is regarded as a small load. There is a weighting system to deal with a mixed load having substances in different categories. For the situations covered in this document, the Small Load Exemption will almost certainly apply (see *Appendices 1* and *2*). This means that many of the requirements of ADR do not apply. However, some of the requirements ***do*** apply, which is why it is generally preferable to use the Limited Quantity Exemption if possible. **The following requirements of ADR must be followed even for small loads unless the private individual or other exemptions apply.**

- The driver must have awareness training [ADR 8.2.3] and a record of this should be kept [ADR 1.3.3]. The legislation assumes that the driver is in employment. Awareness involves both an understanding of transport legislation and of the hazards of the goods being transported. Familiarity with the joint Department for Transport / HSE publication *Working with ADR. An introduction to carriage of dangerous goods by road*[8] should suffice for the former. As far as the latter is concerned, since the driver will be using the goods her- or himself in demonstrations or similar, s/he should self-evidently be fully aware of the hazards.

- The vehicle should carry one 2 kg dry powder fire extinguisher or equivalent [ADR 8.1.4.2].

- The goods should be stowed properly [ADR 7.5.7], i.e., to prevent sliding etc.

- For some categories of chemicals (i.e., those in categories LQ 0 and LQ 1), the full ADR packaging requirements must be met, irrespective of the quantities carried. This includes UN approved containers, combination packaging, hermetic seals, etc. It is very unlikely this could be satisfied except by use of the original packaging in which the chemicals were supplied. Chemicals likely to be used by demonstrators etc for which the full packaging requirements would apply include sodium, potassium and bromine[9].

[7] Demonstrators could easily print their own diamonds on a computer, as long as they make sure it complies with the minimum size requirement.

[8] Working with ADR. An introduction to carriage of dangerous goods by road, DfT 2004. Product code 04DFT01. Free from DfT Publications, PO Box 236, Wetherby, West Yorkshire LS23 7NB, tel 0870 1226 236, fax 0870 1226 237.

[9] For a complete list see http://www.unece.org/trans/danger/publi/adr/adr2007/English/03-2%20E_tabA.pdf and look for packing code LQ0.

6 Use of specialist contractors or carriers

In many cases the demonstrator will transport her/his own chemicals and equipment. This obviates most of the need for driver training because s/he will certainly know the properties of the chemicals very well, including how to handle them and deal with emergencies. However, this will NOT be the case if a carrier is used. Some chemical suppliers do have trained drivers but some suppliers have ceased supplying particular chemicals because they do not have trained drivers. Trained drivers are not required for all chemicals and so, in principle, a carrier could be used. However, there may be difficulties in persuading the carrier that this is the case. It may be possible to pay a carrier to move chemicals between sites. Firms specialising in waste disposal, especially the smaller ones[10], are sometimes willing to do so.

7 Spills kit

The following general purpose kit is suggested, although modification may be needed for particular loads.

Item	Explanation
Mineral absorbent, eg 'cat litter'	1 kg is enough to soak up about 400 ml of liquid and, if sprinkled around the spill, it will stop a larger spill spreading. The cheapest supply of mineral absorbent is cat litter. One type is based on Fuller's Earth, which is often red, and the other on clay, which is often white or grey; either is suitable and safe but the latter is preferable as it does not break up once wet. It can be bought in 10 kg bags from most supermarkets. Some cat litter may be calcined and thus effervesce for a short time when applied to an acid but this is not hazardous. Other possibilities include Vermiculite and sand.
1 plastic bucket	Many of the items may be carried in the bucket.
1 plastic dustpan & brush	
1 pair chemically-resistant gloves	Nitrile preferred.
1 chemical scoop	
Scissors and adhesive tape	
Eye protection	Goggles preferred, to BS EN 166 3.
3 'floor' cloths	
(1 pack of) plastic 'pedal-bin' bags	Choose a size which fits over the bucket, for the disposal of small amounts of wet absorbent.
0.5 kg of anhydrous, technical-grade sodium carbonate	To neutralise up to 250 ml of concentrated sulfuric(VI) acid, for example.
0.5 litre of undiluted dispersing agent	Teepol is a general-purpose detergent for laboratories but others will suffice and may be cheaper.
0.5 kg of citric acid	To neutralise up to 250 ml of concentrated ammonia solution or 2.5 l of 2 M sodium hydroxide solution.

[10] For example, Chemgo, tel: 07739 415061; fax: 0121 453 7887; web site: www.chemgo.co.uk; e-mail: peter.foulkes@tiscali.co.uk.

8 Special cases

8.1 Fireworks and explosives

Under section 89(4) of the *Carriage Regulations*, private individuals are allowed to carry up to 50 kg of fireworks or 30 kg of other explosives (or mixed loads), ie, they are covered by exemption 1.1.3.1(a) of ADR. However, smoking and naked flames are prohibited in and near the vehicle.

8.2 Gas cylinders

To avoid potential problems it is much simpler if demonstrators use the very small, non-refillable canisters. Under the *Carriage Regulations* these are regarded as "gas cartridges" not gas cylinders. For example, a standard 50 litre water capacity, refillable cylinder filled to 200 bar will yield 10 000 litres of gas when released, as against the mid-range, non-refillable canister containing 34 litres of gas from a company such as Cryoserve[11].

Alternatively, a common size of cylinder of hydrogen or oxygen gas holds 1.0 to 1.5 m^3 and such cylinders can be carried as small loads, providing there is close observance of the rules (see Section 5.4).

The British Compressed Gas Association (BCGA) produces a number of Codes of Practice. These industry codes are non-statutory but a court would probably decide that they represent good practice. However, there may well be alternative, and equally safe, ways of complying with the actual requirements of the Regulations, which in the end is what matters. The BCGA Code probably does not extend to non-refillable canisters although the Association still has to rule on this point.

8.3 Liquid nitrogen

Under the *Carriage Regulations*, liquid nitrogen must only be transported in vessels which are suitable for this purpose. Open vessels are ***not*** suitable, because of the risk of splashing and spills. Equally, ordinary vacuum flasks ('thermos' flasks) are ***not*** suitable. 2 litres of liquid nitrogen will become 1366 litres of gaseous nitrogen. In an enclosed vessel this will give rise to a huge increase in pressure. Because liquid nitrogen is cold, it will condense any moisture in the atmosphere, possibly forming a water-ice plug which may seal an open vessel, causing the pressure to build up. To our knowledge this has caused at least two explosions in schools/colleges. Liquid nitrogen therefore must be transported, kept and used only in a vented Dewar flask, specially designed for cryogenic work.

If liquid nitrogen is transported by road, the *Carriage Regulations* require that the driver shall have had special training. The BCGA Code of Practice CP30 *The Safe Use of Liquid Nitrogen Dewars up to 50 litres*[12] states that Dewars must be transported separately from driver or passeng¬ers. Flat-back pick-ups, trailers, roof racks or vehicles fitted with a separating bulkhead should be used. It is important to remember that small-capacity Dewars have a relatively low base area. Thus there is a distinct risk of the Dewar falling over, eg, if the driver has to brake suddenly. This could lead to a major spill of liquid nitrogen, increasing greatly the risk of asphyxiation. Thus the Dewar must be transported in such a way that it cannot fall over or spill, for example, by standing it in a large, deep cardboard or plastic box filled with crumpled newspaper or similar packing material.

[11] Available from Scientific & Chemical Supplies Ltd, tel: 01902 402402; fax: 01902 402343; web site: www.scichem.co.uk; e-mail: education@scichem.co.uk.

[12] BCGA Code of Practice CP30 The Safe Use of Liquid Nitrogen Dewars up to 50 litres (British Compressed Gases Association, 2000). Can be ordered from http://www.bcga.co.uk/preview/products.php?g1=3ff921&n=2.

8.4 Radioactive materials

The transportation of radioactive substances (UN Class 7, see *Appendix 1.1*) is treated rather differently to other Dangerous Goods. However, it should be possible to treat the sources likely to be transported, eg typical school sources, as an "Excepted Package" under the regulations. Because the effective dose is so low and the quantities so small, no special driver training is required. Even so, the driver should be responsible for the safety and security of the sources throughout, ensuring that they are stored properly when they reach their destination. They must never be left unattended if they are not secure.

A Transport Document must be prepared and carried. Regulations require the package to retain its contents under conditions likely to be found in routine transport. The dose rate at any point on the external surface of the package must not exceed a specified limit (5 μSv/h). If the guidance in *Appendix 3* is followed, all these requirements will be met.

9 Flow diagram

This flow diagram summarises the options for transporting chemicals. It has been adapted from a document produced by SSERC. For many substances, the classification is given in *Appendix 2*.

Carriage of substances for personal use, or transport which is ancillary to the main activity, may be exempt from ADR. These options may often be unavailable. See Sections 5.1 and 5.2 of this document.

↓ *If not for personal use nor ancillary to the main activity*

To see if Limited Quantity or Small Load Exemptions apply, look up
(i) the list in ADR 3.3 to see if substance is "not subject to the requirements of ADR" and
(ii) the packing group in Transport section (14) of a reputable supplier's Safety Data Sheet. *See Appendix 1.5* of this document.

↓

Look up the chemical in alphabetical index of the Dangerous Goods List in Table B in ADR 3.2.2 and obtain its UN number or look in section (14) of a reputable supplier's Safety Data Sheet. See *Appendix 1.2* of this document.

↓

Go to Dangerous Goods List in Table A in ADR 3.2.1 which contains chemicals in order of their UN number and consult column 7 ("Limited quantities"). See Section 5.3 and *Appendix 1.3* of this document.

↓ *If column 7 contains LQ and a number not zero*

It will be exempt from the provisions of ADR provided:

- **it is packed in "Limited quantities" with the quantities in table ADR 3.4.6 not being exceeded for both inner packaging and the outer package;**
- **the packaging is stout and suitable;**
- **the outer package is clearly labelled with UN number (or the LQ diamond).**

Other general legislation always applies, eg *Health & Safety at Work Act*, including the duty of care, *COSHH* Regulations, Management Regulations.

↓ *If column 7 reads "LQ0"*

It is not exempted from most provisions even for small quantities, unless specifically stated elsewhere for that chemical. But it may still attract some exemptions via the Small Load Exemptions.
See Section 5.4 of this document.

↓

Look up the transport category in column 15 in Table A in ADR 3.2.1. See *Appendix 1.4* of this document.

↓

Consult the three column table in ADR 1.1.3.6.2 as modified by the Carriage Regulations. The maximum quantity of dangerous goods in each transport category, which can be carried and still attract some exemptions, can be found in Column 3.

↓

Consult ADR for exemptions and remaining restrictions which apply under this option.

See if there are any other special provisions needed for the chemical by consulting Table A in ADR 3.2.1.

↓

The other columns in Table A in ADR 3.2.1 may show restrictions and provisions which apply to that chemical.

Note that many are blank. That means those types of provisions do not exist for the chemical concerned.

[13] See www.unece.org/trans/danger/publi/adr/adr_e.html.

Appendix 1: Glossary

A1.1 UN hazard codes

Dangerous Goods are categorized according to their UN Class Number, as follows.

Class 1 Explosive

1.1 *Substances with a mass explosion hazard*
1.2 *Substances which present a projection hazard but no mass explosion hazard*
1.3 *Substances which present both a fire hazard and a minor blast or projection hazard (or both) but not a mass explosion hazard*
1.4 *Substances which present only a slight risk of explosion (**This would include 'domestic' fireworks**)*
1.5 *Very insensitive substances with a mass explosion hazard*
1.6 *Very insensitive articles with no mass explosion hazard*

Class 2 Gases

2.1 *Flammable gases*
2.2 *Non-flammable, non-toxic gases*
2.3 *Toxic gases*

Class 3 Flammable liquids

Class 4 Flammable solids

4.1 *Flammable solids, self-reactive substances and solid desensitized explosives*
4.2 *Substances liable to spontaneous combustion*
4.3 *Substances which, in contact with water, release flammable gases*

Class 5 Oxidizing substances and organic peroxides

5.1 *Oxidizing substances*
5.2 *Organic peroxides*

Class 6 Toxic and infectious substances

6.1 *Toxic substances*
6.2 *Infectious substances*

Class 7 Radioactive material

Class 8 Corrosive substances

Class 9 Miscellaneous dangerous substances and articles

A1.2 UN numbers

For transport purposes, common and/or industrially-important chemicals are assigned "UN Numbers". These are listed alphabetically in Table B of section 3.2.2 of ADR[13]. A mixture of IUPAC and older chemical names is used. For less-common chemicals, the list includes categories such as *Amines, solid, corrosive, not otherwise specified*. If required, the UN Number is given in section 14 of manufacturers' safety data sheets.

A1.3 Limited quantities

The following is a simplified extract from the Table in section 3.4.6 of ADR. It gives the maximum size of the innermost packaging for various categories. There are also restrictions on the total outer packaging size and slightly different rules for shrink-wrapped packaging. Neither of these will be relevant in the context discussed in this document and are omitted. (Note that some LQ codes are no longer used.)

LQ Code	Maximum contents of inner packaging
0	No exemption
1	120 ml
2	1 litre
3	500 ml
4	3 litre
5	5 litre
6	5 litre
7	5 litre
8	3 kg
9	6 kg
10	500 ml
11	500 g
12	1 kg
13	1 litre

LQ Code	Maximum contents of inner packaging
14	25 ml
15	100 g
16	125 ml
17	500 ml
18	1 kg
19	5 kg
22	1 litre
23	3 kg
24	6 kg
25	1 kg
26	500 ml
27	6 kg
28	3 litre

A1.4 Transport category

Small loads are exempt from some of the requirements of ADR. What constitutes a small load depends on the transport category. The following is a simplified extract of the Table appearing in section 1.1.3.6.3 of ADR, as modified by the *Carriage Regulations*.

Transport category	Maximum total quantity per vehicle*
0	0
1	20
1A	50
3	333

Transport category	Maximum total quantity per vehicle*
2A	500
3	1000
4	unlimited

* *For articles, the quantity is the gross mass in kg (except for articles in UN class 1, where it is the net mass of explosives in kg); for liquefied, refrigerated or dissolved gases or for solids, it is the net mass in kg; for liquids and compressed gases it is the nominal capacity in litres.*

The above table applies if all the substances are in the same transport Category. If they are not, the following weighting system applies (again this is a simplified version).

> *The sum of [20x (the quantity in category 1)] + [3x (the quantity in category 2)] + [1x (the quantity in category 3)] shall not exceed 1000.*

Even when transporting mainly transport Category 1 items, demonstrators should be able to stay within the 20 kg or 20 litre limit.

A1.5 Packing group

The Packing group for a chemical indicates the degree of hazard associated with its transportation. The highest is Group I (great danger); Group II is next (medium danger), while Group III chemicals present the lowest hazard (minor danger). The transport Category is nearly always the same as the packing group except that packing groups are often shown on safety data sheets for chemicals under the heading "Transport Information". Some chemicals can be in different packing groups, depending on the nature of the packaging used. This can also affect the transport category and the LQ Category.

A1.6 Substances not accepted for carriage

Chemically-unstable substances in UN Class 5.1 "shall not be accepted for carriage unless the necessary steps have been taken to prevent their dangerous decomposition or polymerisation during carriage. To this end it shall in particular be assured that receptacles and tanks to not contain any material likely to promote these reactions" [ADR 2.2.51.2.1].
ADR specifically lists the following substances and mixtures, although some would be of little relevance in the context of this document. Note that where mixtures are referred to, the components could be transported separately and mixed on site.

- Oxidizing solids, self-heating, assigned to UN No. 3100, oxidizing solids.
- Water-reactive, assigned to UN No. 3121 and oxidizing solids, flammable, assigned to UN No. 3137, unless they meet the requirements for Class 1 (see also ADR 2.1.3.7).
- Hydrogen peroxide, not stabilized or hydrogen peroxide, aqueous solutions, not stabilized containing more than 60% hydrogen peroxide.
- Tetranitromethane not free from combustible impurities.
- Perchloric acid solutions containing more than 72% (mass) acid, or mixtures of perchloric acid with any liquid other than water.
- Chloric acid solution containing more than 10% chloric acid or mixtures of chloric acid with any liquid other than water.
- Halogenated fluor compounds other than UN Nos. 1745 bromine pentafluoride, 1746 bromine trifluoride and 2495 iodine pentafluoride of class 5.1 as well as UN nos. 1749 chlorine trifluoride and 2548 chlorine pentafluoride of Class 2.
- Ammonium chlorate and its aqueous solutions and mixtures of a chlorate with an ammonium salt.
- Ammonium chlorite and its aqueous solutions and mixtures of a chlorite with an ammonium salt.
- Mixtures of a hypochlorite with an ammonium salt.
- Ammonium bromate and its aqueous solutions and mixtures of a bromate with an ammonium salt.
- Ammonium permanganate and its aqueous solutions and mixtures of a permanganate with an ammonium salt.
- Ammonium nitrate containing more than 0.2% combustible substances (including any organic substance calculated as carbon) unless it is a constituent of a substance or article of Class 1.
- Fertilizers having an ammonium nitrate content (in determining the ammonium nitrate content, all nitrate ions for which a molecular equivalent of ammonium ions is present in the mixture shall be calculated as ammonium nitrate) or a content in combustible substances exceeding the values specified in special provision 307 except under the conditions applicable to Class 1.
- Ammonium nitrite and its aqueous solutions and mixtures of an inorganic nitrite with an ammonium salt.
- Mixtures of potassium nitrate, sodium nitrite and an ammonium salt.

Appendix 2: Chemicals list

The following list was compiled from lists supplied by about a dozen demonstrators who recorded what they sometimes used in their demonstration lectures. No one individual ever uses more than a tiny fraction of what is listed here and the *Maximum Quantity Carried* column is just that – many demonstrators carried much less. The total load was rarely more than one tenth of the 20 kg / 20 litre small load limit. Where a particular chemical is not listed in the *Approved Supply* List (made under the *CHIP Regulations*) the hazard label and risk phrases are taken from suppliers' safety data sheets. These are not always consistent between different suppliers. Where a particular chemical can be in two or more packing groups, transport categories or LQ Categories, depending on the packaging used, those figures NOT in parentheses give the form in which it would normally be supplied as a laboratory chemical.

Maximum quantity carried	Name	Hazard label	Risk phrases	LQ category	Trans-port category	Packing group
11 g	aluminium powder	F	15, 10	12	2 , (3)	II, (III)
0.7 g	3-aminobenzene-1,2-dicarboxylic hydrazide (luminol)	Xi	36/37/38	not subject to ADR		
100 ml	ammonia solution (conc "880")	C, N	34, 50	19	3	III
600 ml	ammonia solution (2M)	None	-	not subject to ADR		
100 g	ammonium chloride	Xn	22, 36	not subject to ADR		
10 g	ammonium dichromate(VI)	E, T+, N	2, 8, 21, 25, 26, 42/43, 45, 46, 48/23, 50/53, 60, 61	11	2	II
4 g	ammonium nitrate(V)	O	8, 9	12	3	III
10 g	ammonium thiocyanate	Xn	20/21/22, 32, 52/53	not subject to ADR		
10 g	barium chloride-2-water	T	20, 25	(18), 9	2	(II), III
32 g	barium hydroxide-8-water	C	20/22, 34	(18), 9	2	(II), III
?	barium nitrate(V)	O, Xn	8, 20/22	11	2	II
10 g	boric acid	None		not subject to ADR		
?	bromine	T+, C, N	26, 35, 50	0	1	I
?	bromothymol blue	None	-	not subject to ADR		
2 canisters	butane gas	F+	12	0	2	-
?	butanol(s)	Xn	10, 22, 37/38, 41, 67	(4), 7	(2), 3	(II), III
100 g	calcium chloride (anhydrous)	Xi	36	not subject to ADR		
5 g	calcium dicarbide	F	15	(0), 11	(1), 2	(I), II
?	carbon dioxide (dry ice)	None	-	not subject to ADR		
5 ml	carbon disulfide	F, T	11, 36/38, 48/23, 62, 63	0	1	I
13 ml	chloric(VII) acid (perchloric acid)(<50%)	O, C	5, 8, 35	22	2	II
?	cobalt(II) chloride-6-water	T, N	22, 42/43, 49, 50/53	27	3	III
20 mg	coomassie red 2B	?	?	?	?	?
2 g	copper(II) nitrate(V)-3-water	Xn	22, 36/38	11, (12)	2, (3)	II, (III)

Maximum quantity carried	Name	Hazard label	Risk phrases	LQ category	Trans-port category	Packing group
20 g	copper(II) sulfate(VI)-5-water	Xn, N	22, 36/38, 50/53	27	3	III
2 ml	decanedioyl dichloride (sebacoyl chloride)	C	34, 37	(0), 22, (7)	(1), 2, (3)	(I), II, (III)
20 mg	diazol light blue	?	?	?	?	?
?	1,2-diaminoethane	C	10, 21/22, 34, 42/43	22	2	II
14 g	disodium disulfate(IV) (sodium metabisulfite)	Xn	22, 31, 41	not subject to ADR		
8 g	disodium tetraborate-10-water	None		not subject to ADR		
1 g	dispersal yellow AG	?	?	?	?	?
0.1 g	eosin	Xi	36	not subject to ADR		
30 ml	ethanoic acid (glacial)	C	10, 35	22	2	II
1000 ml	ethanol	F	11, 22	4, (7)	2, (3)	II, (III)
10 ml	ethoxyethane	F+, Xn	12, 19, 22, 66, 67	3	1	I
25	fireworks, commercial		(No significant hazard)	0	(1), 2, (4)	-
0.1 g	fluorescein	None	-	not subject to ADR		
5	gas discharge tubes (low pressure)	None	-	not subject to ADR		
26 g	D-glucose	None	-	not subject to ADR		
5 g	hexane-1,6-diamine	C	21/22, 34, 37	24	3	III
?	hydrochloric acid (2M)	Xi	36/37/38	22, (7)	2, (3)	II, (III)
200 ml	hydrochloric acid (conc.)	C	34, 37	22, (7)	2, (3)	II, (III)
1 lecture bottle	hydrogen	F+	12	0	2	-
500 ml	hydrogen peroxide (100 volume)	Xn	22, 41	10	2	II
500 ml	hydrogen peroxide (20 volume)	Xi	36	not subject to ADR		
?	indigo carmine	None	-	not subject to ADR		
?	iron(III) chloride (anhydrous) (ferric chloride)	Xn	22, 38, 41	24	3	III
35 g	iron(III) oxide	None	-	not subject to ADR		
3 g	lead(II) nitrate(V)	T, N	20/22, 33, 50/53, 61, 62	11	2	II
1 g	lithium	F, C	14/15, 34	0	1	I
0.5 g	lithium chloride	Xn	22, 36/38	not subject to ADR		
10 g	magnesium ribbon or turnings	None		9	3	III
20 g	magnesium sulfate(VI)-7-water	None	-	not subject to ADR		
10 g	magnesium powder	F	11, 15	(0), 11, (12)	(1), 2, (3)	(I), II, (III)
5 g	manganese(II) sulfate(VI)-7-water	Xn, N	48/20/22, 51/53	27	3	III
5 g	manganese(IV) oxide	Xn	20/22	(0), 11, (12)	(1), 2, (3)	(I), II, (III)

Maximum quantity carried	Name	Hazard label	Risk phrases	LQ category	Trans-port category	Packing group
3 g	mercury(II) chloride	T+, N	28, 34, 48/24/25, 50/53	18	2	II
2 g	mercury(II) thiocyanate	T+, N	26/27/28, 33, 50/53	18	2	II
50 ml	methanol	F, T	11, 23/24/25, 39/23/24/25	0	2	II
5 ml	methylene blue	Xn	22	not subject to ADR		
?	nickel(II) chloride-6-water	Xn, N	22, 42/43, 50/53	(0, 18), 9	(1, 2), 3	(I, II), III
100 ml	nitric acid (conc.)	O, C	8, 35	22	2	II
10 litres	nitrogen (liquid)	None	-	1	3	-
glass tube	nitrogen monoxide (nitric oxide) (not compressed)	T+	26/27	0	1	-
1 lecture bottle	oxygen	O	8	0	3	-
0.1 g	phenolphthalein	None	-	not subject to ADR		
0.1 g	phosphorus (white) (under water)	F, T+	17, 26/28, 34	0	0	I
2 g	phosphorus (red)	F	11, 16, 52/53	9	3	III
1000 ml	polyethenol	None	-	not subject to ADR		
500 ml	polyethylene oxide solution	None	-	not subject to ADR		
40 g	polyurethane mix (daltafoam)	?	?	?	?	?
40 g	polyurethane mix (suprasec)	Xn	20, 36, 37, 38, 42	not subject to ADR		
1 g	potassium	F, C	14/15, 34	0	1	I
8 g	potassium bromate(V)	O, T	9, 25, 49	11	2	II
2 g	potassium chloride	None	-	not subject to ADR		
20 g	potassium hexacyanoferrate(III)	None	-	not subject to ADR		
16 g	potassium hydroxide (solid)	C	22, 35	23	2	II
43 g	potassium iodate(V)	O	8	(0), 11, (12)	(1), 2, (3)	(I), II, (III)
50 g	potassium iodide	None	-	not subject to ADR		
5 g	potassium manganate(VII) (permanganate)	O, Xn, N	8, 22, 50/53	11	2	II
5 g	potassium nitrate(V)	O	8	12	3	III
?	potassium persulfate (peroxodisulfate)	O Xn	8, 22, 36/37/38, 42/43	12	3	III
1 ml	propane-1,2,3-triol	None	-	not subject to ADR		
16 g	propanedioic acid (malonic acid)	Xn	22, 36	not subject to ADR		
5 ml	resazurin	Xn	22	not subject to ADR		
200 mg	rhodamine	Xi	41, 52/53	not subject to ADR		
9 g	silver nitrate(V)	C, N	34, 50/53	11	2	II

Maximum quantity carried	Name	Hazard label	Risk phrases	LQ category	Trans-port category	Packing group
4 g	sodium arsenite	T, N	45, 23/25, 50/53	18	2	II
100 ml	sodium chlorate(I) (hypochlorite) (5%) (domestic bleach)	None	-	not subject to ADR		
5 g	sodium chlorate(V)	O, Xn, N	9, 20/22, 51/53	11	2	II
10 g	sodium chloride	None	-	not subject to ADR		
4 g	sodium ethanoate	None	-	not subject to ADR		
125 g	sodium ethanoate-3-water	None	-	not subject to ADR		
10 g	sodium hydroxide (solid)	C	35	23	2	II
100 ml	sodium hydroxide (2M)	C	35	22, (7)	2, (3)	II, (III)
1 g	sodium metal	F, C	14/15, 34	0	1	I
10 g	sodium nitrate(V)	O, Xn	8, 22, 36	12	3	III
5 g	sodium peroxide	O, C	8, 35	0	1	I
500 g	sodium polyacrylate	None	-	not subject to ADR		
?	sodium thiocyanate-2-water	Xn	20/21/22, 32, 52/53	not subject to ADR		
42 g	sodium thiosulfate-5-water	None	-	not subject to ADR		
0.2 g	starch	None	-	not subject to ADR		
10 g	strontium chloride-6-water	Xn	22	not subject to ADR		
5 g	strontium nitrate(V)-4-water	O	8	12	3	III
5 g	sucrose	None	-	not subject to ADR		
75 ml	sulfuric(VI) acid (conc.)	C	35	22	2	II
?	sulfuric(VI) acid (2.5M)	C	35	22	2	II
250 g	superglue (methyl 2-cyanoacrylate)	Xi	36/37/38	not subject to ADR		
40 ml	tetrachloromethane	T, N	23/24/25, 40, 48/23, 52/53, 59	17	2	II
100 mg	thymolphthalein	None	-	not subject to ADR		
12 g	thyodene iodine indicator	None	-	not subject to ADR		
?	universal indicator solution	F	11	4	2	II
4 g	zinc powder	F	10, 15	(0, 11), 12	(1, 2), 3	(I. II), III
20 g	zinc sulfate(VI)-7-water	Xi, N	36/38, 50/53	27	3	III

Appendix 3: Radioactive materials

Strontium-90, plutonium-239 and americium-241 cup sources, in their normal containers, can be transported in any outer container.

Radium-226 and almost new cobalt-60 sources will require shielding to bring the surface dose rate below specified limits. This can be achieved by filling an ordinary plastic bucket with polystyrene foam with the source box at its centre. Alternatively, a large cardboard box can be used, packed with smaller boxes, such that the wooden source box is at least 5 cm from the wall.

A **uranium or thorium compound** (in an appropriate container) must be carried within robust containers, usually metal (eg, a tool box) such that damage is extremely unlikely in the event of a road accident.

Transportation of **radioactive material in solution** should be restricted to a 30 ml protactinium generator. This should be kept upright and surrounded by a mineral absorbent (eg, cat litter) in a sturdy, water-tight outer container, wrapped in a strong plastic bag. This is tied and securely packed in robust containers, usually metal (eg, a tool box) such that damage is extremely unlikely in the event of a road accident. It should carry the hazard warning signs CORROSIVE, HIGHLY FLAMMABLE. A carbon dioxide fire extinguisher should be carried.

All packages should be loaded securely, as far as possible from the occupants, and out of sight, in the boot of the vehicle. The vehicle must be locked whenever it is left unattended. In the event of any theft or loss, the police should be informed without delay.

There should be a regular check of the packages used for transport of radioactive material to confirm that they have not become contaminated. Records must be kept for at least two years.

Each item *inside* a package should be suitably labelled. The package must have the marking "Radioactive" on the internal surface in such a way that a warning of radioactive material is visible on opening the package.

There is *no requirement* to label the *outside* of an excepted package other than with the UN number and the name of either the consignor or consignee or both. The UN number is 2910 for sealed sources, protactinium generators, uranium and thorium compounds, cloud chamber sources or radioactive materials. The UN number is 2911 for "instruments and articles", eg, spinthariscopes, expansion cloud chambers with non-detachable radioactive material, clocks or instruments with radioluminescent paint. Suitable labels are shown below. There is n*o requirement* to label the outside "Radioactive" and it is better that it is not labelled as such.

No *external* signs are required on the vehicle.

In the event of an accident, contact the police and Name: Address: Telephone:
Excepted package, UN Class: 7, UN Number: 2910 The driver of this vehicle carries a transport document.

In the event of an accident, contact the police and Name: Address: Telephone:
Excepted package, UN Class: 7, UN Number: 2910 The driver of this vehicle carries a transport document.

In addition to labelling the containers as above, a Transport Document ('Consignment Note') must be carried by the driver and a copy kept at the work or home address. A third copy could be attached to the container or kept inside the packaging. Examples of Transport Documents are given below.

Transport Document	
The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007	
Consignor and carrier (Address of person sending the package)	
Telephone number (of person sending the package)	
Contact name	
Consignee (Address of school etc receiving package)	

Shipping name	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE LIMITED QUANTITY OF MATERIAL			
United Nations Number	UN 2910			
Nuclide(s) (name(s) of radioactive material)				
Physical/chemical form (solid or liquid)				
Activity/quantity				

DECLARATION	
I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked and labelled, and are in all respects in proper condition for transport by road according to the applicable international and national governmental regulations.	
Signed by (Consignor)	
Date of commencement of journey	
Vehicle registration number	
Name and signature of driver	

This vehicle is carrying

small amounts of

RADIOACTIVE MATERIAL.

In case of accident, get in touch with

THE POLICE

and ,

Tel. No.

Transport Document	
The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2007	
Consignor and carrier (Address of person sending the package)	
Telephone number (of person sending the package)	
Contact name	
Consignee (Address of school etc receiving package)	

Shipping name	RADIOACTIVE MATERIAL, EXCEPTED PACKAGE LIMITED QUANTITY OF MATERIAL
United Nations Number	UN 2911
Instruments and articles	

DECLARATION	
I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packaged, marked and labelled, and are in all respects in proper condition for transport by road according to the applicable international and national governmental regulations.	
Signed by (Consignor)	
Date of commencement of journey	
Vehicle registration number	
Name and signature of driver	

This vehicle is carrying

small amounts of

RADIOACTIVE MATERIAL.

In case of accident, get in touch with

THE POLICE

and ,

Tel. No.

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