

Load security on curtain sided lorries

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Load security on curtain sided lorries

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This report seeks to establish good practice for securing loads on curtain sided lorries across various industry sectors and direct the reader to practical, robust guidance on load restraint to enable them to minimise the risks to health and safety of all those working on and around curtain-sided vehicles. Good practice in this case is defined as those systems of work that are the most practical, involve the least risk of loads becoming unstable or falling, least risk to the operator/driver, and are practicable.

The report reviews existing legislation and guidance in the UK, Europe, and in North America and Australasia and current practice across a cross-section of UK industry, and assesses the mechanics of load shift and what systems of load securing are most effective in restraining loads.

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EXECUTIVE SUMMARY

The project seeks to establish good practice for securing loads on curtain sided lorries across various industry sectors. Good practice in this case is defined as those methods that are the most practical, involve the least risk of loads becoming unstable or falling, least risk to the operator/driver, and are practicable.

Objectives

1. To consider the range of methods currently used in the UK and abroad to secure loads for road transport on curtain sided lorries.
2. To assess the level of risk for the various systems under a range of normal vehicle manoeuvres with different load types.
3. To establish good practice for securing loads on curtain sided lorries

Main Findings

1. Loads should be secured so that they do not move relative to the trailer bed during transport.
2. Load restraint is not the same as load containment. Some loads may require a combination of both.
3. Loads should be placed against the trailer headboard if possible. If this is not possible for reasons of weight distribution, the gap to the headboard should be filled or an intermediate bulkhead could be used.
4. The curtains and the weather-protection structure of a curtain-sided vehicle are generally not suitable for load securing.
5. Friction alone should not be relied on as a method of load securing.
6. Overstrapping the load was identified as the least-risk method for load restraint, however it would not be suitable for all types of load. There is no 'one size fits all' solution to securing a load safely.
7. There are costs involved in securing a load, both in terms of equipment and additional time, however against this must be set the costs of the potential consequences of load shift, such as product damage, vehicle damage, delays, death or injury, and prosecution in the event of an accident.
8. Communication between all parties involved in the loading, transport and unloading may help to avoid or ameliorate problems surrounding load securing.
9. Risk assessment and a loading plan prepared by someone competent to do so is the key to good load security. This does not have to be an onerous process but 'thinking through' the operation in advance may identify potential issues before they become a problem.

Recommendations

- Guidance on load securing has been in existence for many years and further generic guidance may not be helpful. However, industry-specific additional guidance, particularly in the form of case studies, may help to illustrate ways particular loads could be secured for.
- Existing good practice developed by some companies as a result of their own research could be shared more widely with other employers in the industry e.g. via their trade associations. This might avoid duplication of effort and assist in sharing good practice.
- The recent European Guidance on load security could be more extensively promoted in the UK in addition to the existing Department of Transport guidance, as they gives detailed, clear guidance on how to secure many types of loads safely.
- Examples of loading plans and risk assessments for the haulage industry could be made available to help companies plan their loading.

1 INTRODUCTION

1.1 SCOPE OF THE PROJECT

The project seeks to establish good practice for securing loads on curtain sided lorries across various industry sectors. Good practice in this case is defined as those methods that are the most practical, involve the least risk of loads becoming unstable or falling, least risk to the operator/driver, and are practicable.

The scope of the project includes consideration of a range of methods currently used in the UK and abroad, as well as alternative methods for securing of different heavy cargoes on curtain-sided lorries. Reference will be made to current European Standards and good practice guidelines, as well as regulations and guidance from countries outside the EU.

The project will involve assessment of the level of risk for the various systems under a range of normal vehicle manoeuvres with different load types. Each method will bring its own risks and benefits and these will be considered. Consideration will also be taken of the differing cargo that may be transported and the risks and issues associated with them.

The ultimate aim of the project is to deliver a comprehensive review of practical methods of securing loads on curtain sided lorries and direct the reader to practical, robust guidance on load restraint to enable them to minimise the risks to health and safety of all those working on and around curtain-sided vehicles.

This report was prepared by N. Day, Engineering Safety Unit, HSL, with the exception of Section 4.1, which was prepared by G. White, Engineering Safety Unit, HSL, and Section 5, which was prepared by A. McGillivray, Risk Assessment Section HSL, and the ergonomic assessment and cost benefit analysis found in the Appendices which were prepared by A. Jones, Ergonomics Section, HSL, and D. Hodges, Economic Analysis Unit, HSE, respectively.

This report should be read in conjunction with the HSE Research Report *Information collection and data mining in relation to accidents/incidents involving loads falling from vehicles/shifting loads* (Corbett, 2008).

1.2 DEFINITIONS

1.2.1 Terms

The term 'HGV' has been used in this report to refer to a goods vehicle over 3.5 tonnes.

The following definitions have also been used:

Load restraint: securing the load to the trailer such that it cannot move independently of the trailer.

Load containment: ensuring that, while the load may slide, it does not move outside the confines of the trailer.

Attachment point: rigid part of the load on which the load restraint assembly is placed

Direct lashing: lashing procedure where the lashings are fixed directly to solid parts of the load or to attachment points

Frictional lashing: lashing procedure whereby the friction force is enhanced by adding a vertical force component to the weight of the load

Lashing: flexible device used in the securing of the load on a load carrier

Lashing point: securing device on a load carrier to which a lashing is directly attached

Load restraint assembly: systems and devices for securing of loads

Web lashing: means of securing, consisting of a tensioning device or tension retaining device and flat woven textile webbing with or without end fittings.

Sidestrapping: Method of containing a load, where webbing straps are suspended from a rail/s in the roof of the trailer and then secured to the side of the chassis.

Overstrapping: Method of restraining a load where a webbing strap passes over the load and is secured at each side of the chassis.

Side slats: Wooden or aluminium slats that slot into the upright pillars of a trailer to provide lateral containment.

Tautliner: A trade name for vehicles built by Boalloy, now used as a generic name for curtain-sided vehicles.

Tilt: These are trailers where a metal frame is fitted to a flatbed with a canvas cover known as a tilt. They allow for cargo to be transported covered but with good access for loading and unloading. They are most common on international work¹.

¹ As defined in *Truck specification for best operational efficiency*, Department for Transport; <http://www.freightbestpractice.org.uk/imagebank/TE252.pdf>

1.2.2 Types of HGV

HGVs can be categorised² according to three main body types:

- articulated: that is, with a pivot point between the driver's cab and the actual body of the vehicle. The trailer is attached to the tractor unit via a special coupling known as the fifth wheel;
- rigid: that is, with the cab and body built onto the same chassis unit and unable to pivot.
- Drawbar: that is, a rigid vehicle coupled to an entirely self-standing trailer via a drawbar.

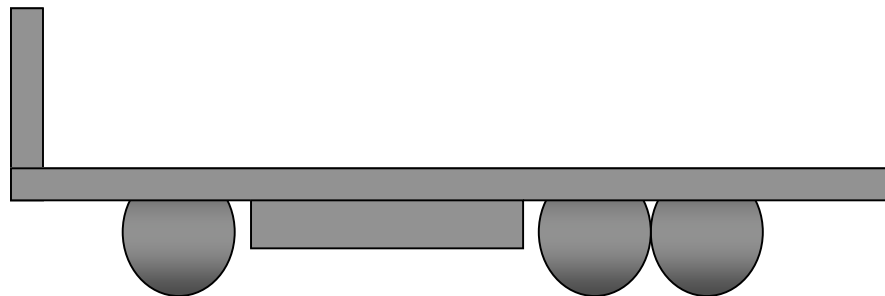
Rigid vehicles are the most common type of truck, comprising approximately 73% of vehicles over 3.5 tonnes³.

With articulated and drawbar HGVs, the tractor unit can generally be detached from the trailer it pulls. The trailers used in articulated vehicles rely on the tractor unit for front support and are therefore fitted with 'landing legs' to provide support when detached from the tractor unit.

There are myriad body and trailer types, including flatbed, low loader, curtain sider, tilt, rigid (box) sider, temperature controlled body, doubledeck and skeletal (used to carry shipping containers). Three types are discussed in more detail in the following sections.

1.2.2.1 Flatbed trailers

Flatbed trailers feature a flat deck, usually wooden, mounted on the chassis with a headboard at the front end.



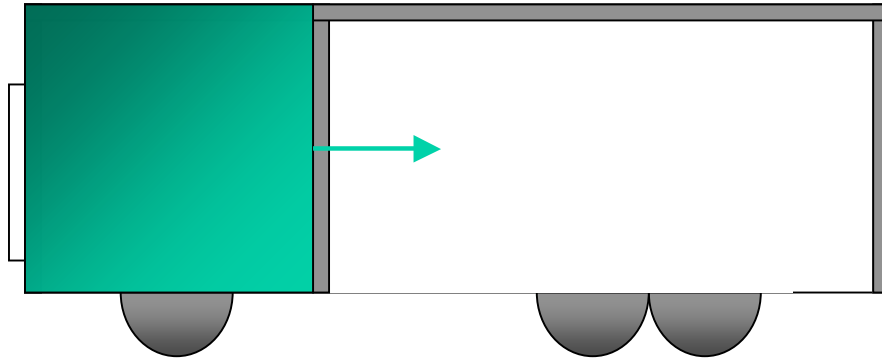
Flatbeds are used to transport a wide variety of loads. They are easily loaded because of the lack of restriction on access. Loads transported on flatbeds should always be secured to the vehicle chassis and, if possible, loaded so that they are in contact with the headboard.

² As categorised in the DfT publication *Truck Specification for Best Operational Efficiency* (2005)

³ DfT – *Transport Statistics 2003*

1.2.2.2 *Curtain sider trailer*

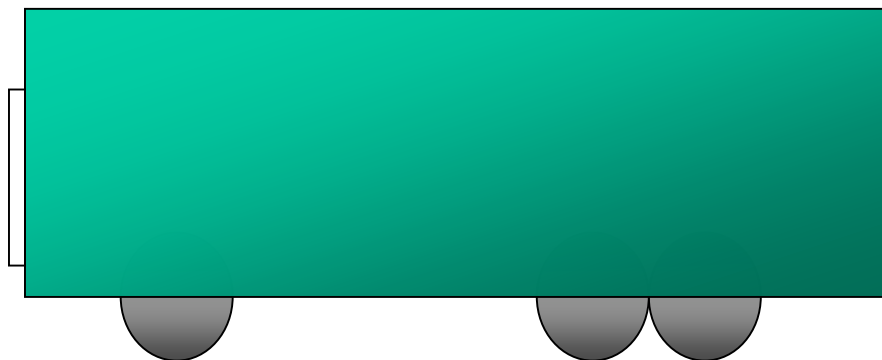
Curtain sider trailers are essentially flatbed trailers with a weather-protection structure mounted on the bed of the trailer. They allow goods to be transported and protected from the weather, as well as providing the advantages of easy access to the sides of the trailer for loading and unloading as would be found on a flatbed trailer.



Generally the weather protection structure is not rated for load restraint and should not be used to secure load restraint equipment, although trailers with a reinforced and rated superstructure are allowed for in European Standards.

1.2.2.3 *Rigid (box) sider trailer*

Rigid siders comprise a rigid box body, with solid sides and usually solid rear-opening doors, although other options are available. Some rigid-sided vehicles are refrigerated, for the transport of chilled and frozen goods.



Rigid siders are loaded via the rear doors. If the trailer is tightly loaded there may be limited access to the load to fit load restraint equipment.

1.2.3 Load security measures

Load security measures can be broken into three categories: restraint, containment and combined. Different loads on different vehicles will require different methods of securing – what may be appropriate for one load may not be appropriate for another.

Friction between the load and the trailer bed helps to prevent the load from moving, however it is difficult to ensure a consistently high coefficient of friction and it provides no security against tipping of unstable loads. Even very heavy loads may not remain in place under their own weight. For these reasons friction should be seen as an aid rather than the sole load securing measure.

1.2.3.1 Load restraint measures

Load restraint measures involve the load being directly restrained from moving relative to the trailer bed. Examples of load restraint include direct strapping with straps or chains (this is often used with large machinery being transported) and overstrapping with webbing straps.

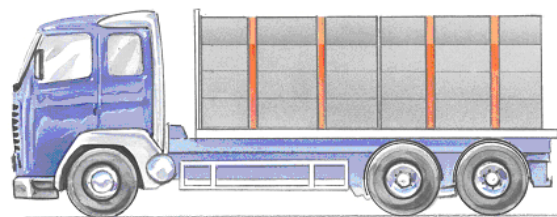


Diagram taken from the cargo securing guidelines⁴

Positive fit (also referred to as positive blocking, positive locking) is a method by which the load is loaded so that it is in tight contact with part of the vehicle, for example the headboard, or an accessory secured to the chassis, such as a chock for reels. It is important to ensure that whatever the load is placed against is strong enough to restrain the load in that direction, and that other directions of movement are also guarded against, for example a load loaded tight against the front headboard may still slide to the side and to the rear.



Photograph taken from cargo securing guidelines

1.2.3.2 Load containment measures

Load containment measures aim to ensure that all or part of a load cannot be ejected from the vehicle. Examples of load containment include the rigid sides of a box-sided vehicle, or sliding gates and side slats on a curtain-sided vehicle.

⁴ European Best Practice Guidelines on Cargo Securing for Road Transport

1.2.3.3 Combined measures

Combined measures offer a combination of load restraint and load containment. The WALKI[®] Fix Road suspended tarpaulin with built-in restraint straps is an example of a combined measure, but this requires a roof structure to be suspended from. An example of a suspended system is shown in the photograph below. Other systems are available that can be used on flatbed vehicles, as shown in the picture on the right.



Photograph from cargo securing guidelines



Suspended tarpaulin system used on a curtain-sided vehicle

1.2.3.4 Additional measures

Friction Matting: The purpose of friction matting is to increase the coefficient of friction between the load and the trailer bed. This method is not considered practical for use on its own; it is more effective when it is used in addition to other safety measures. This method may prevent the goods slipping but may not prevent the load from toppling over. As a result all the issues described in the base case are relevant for this measure. There will be additional hazards due to working at height as well as possible MSD injuries.

Air bags: These can be suspended from the trailer roof, attached to the sides of the trailer, or placed between the load and the vehicle structure. They act to fill the voids either between parts of the load and/or between the load and the vehicle structure.

Nets: Often used on flatbed trailers, these can be used in curtain-sided double decked trailers, but there are issues concerning the load shifting over the side of the top deck and being caught between the curtain and the trailer. This could potentially be a cause of rollover by making one side of the trailer unstable.



Airbag

Intermediate bulkheads: These can be fitted when the load cannot be placed against the headboard of a trailer. Some have attachment points for webbing straps for additional restraint.

Reinforced curtains: The majority of curtains used in the UK are not reinforced and are nothing more than weather-protection tarpaulins. Reinforcing the curtain does not appear to damage the structure of the curtain. However, the curtain could become heavier which introduces greater possibility of MSDs to personnel, as well reducing the payload of the vehicle.

Horizontal straps: Containment is provided to a certain extent, but there is minimal restraint of the load. The straps are not anchored to the rigid trailer bed but to the trailer's weather-protection structure.

1.3 THE UK ROAD HAULAGE INDUSTRY

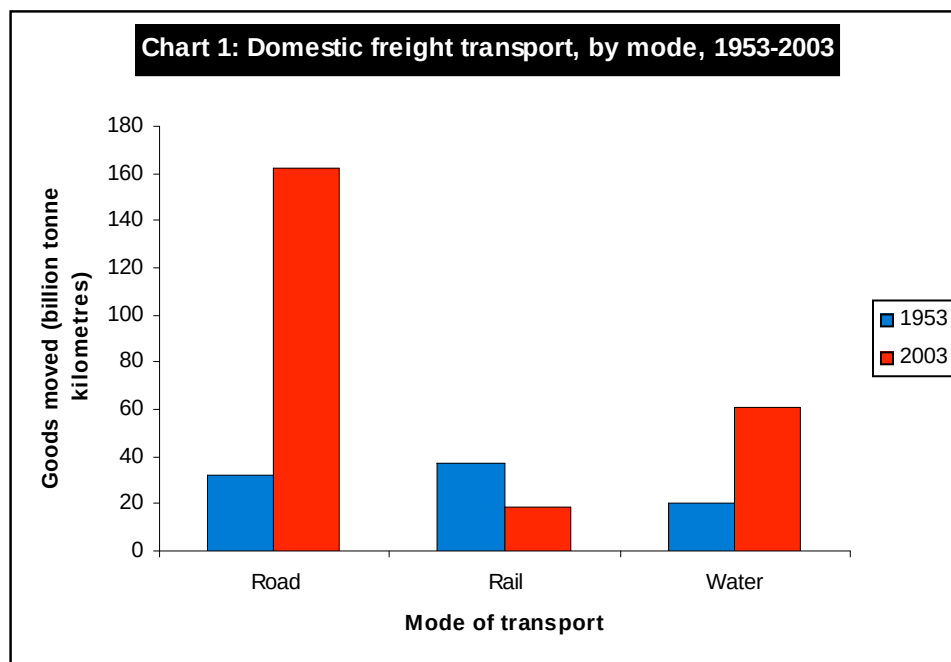
The information detailed in this section of the report is based on statistics presented the Department of Transport publication *Transport Statistics for Great Britain: 2007 edition* and is intended to give an overview of the UK road haulage industry.

1.3.1 Make up of the industry

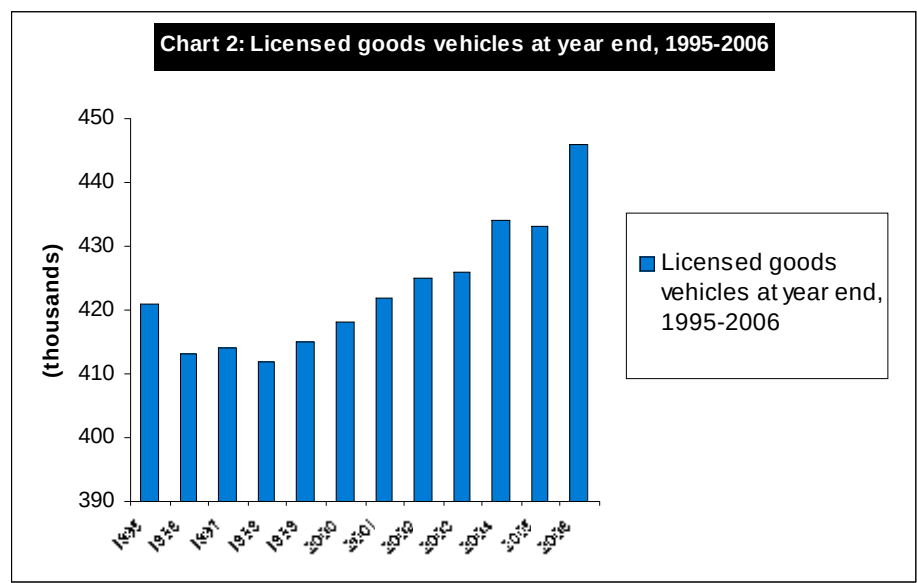
The majority of the raw materials and goods used or sold by UK business are transported by road. The road haulage industry transports a diverse range of loads, including food and agricultural products, bulk liquids, car components, container transport, express parcels, furniture removal, heavy haulage, livestock, tipping and waste disposal.

According to *Transport Statistics for Great Britain: 2007 edition*, the UK road network as of 2004 comprises 413,000 thousand kilometres, of which 3,600 kilometres (0.9%) are motorways.

The profile of UK freight transport has changed significantly since the early 1950s, not only the quantity of goods moved but also the mode. Chart 1 below shows the shift from rail transport to road transport.

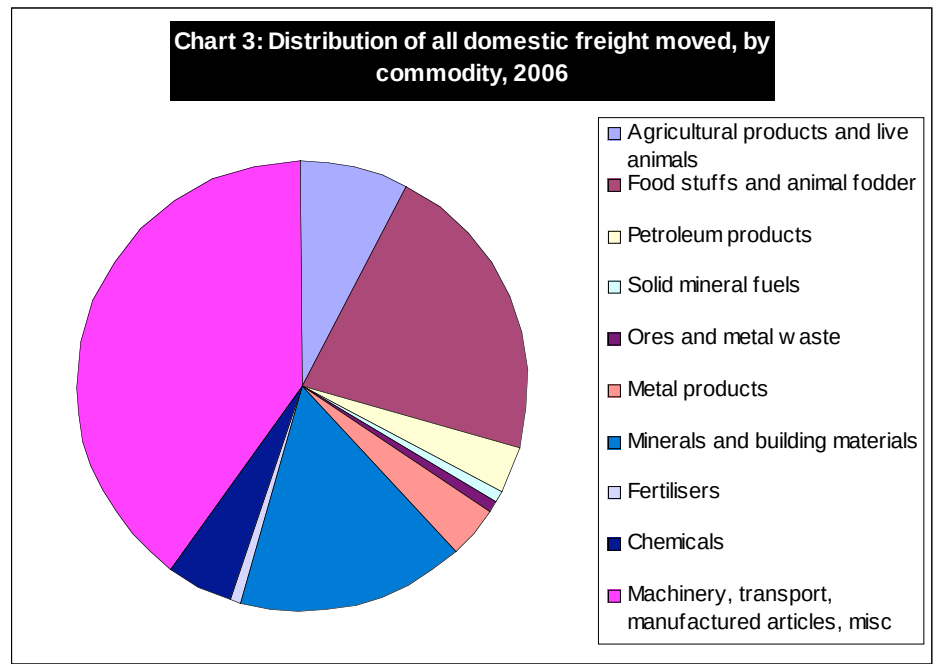


The number of licensed goods vehicles has increased significantly in recent years, and Chart 2 illustrates this trend.

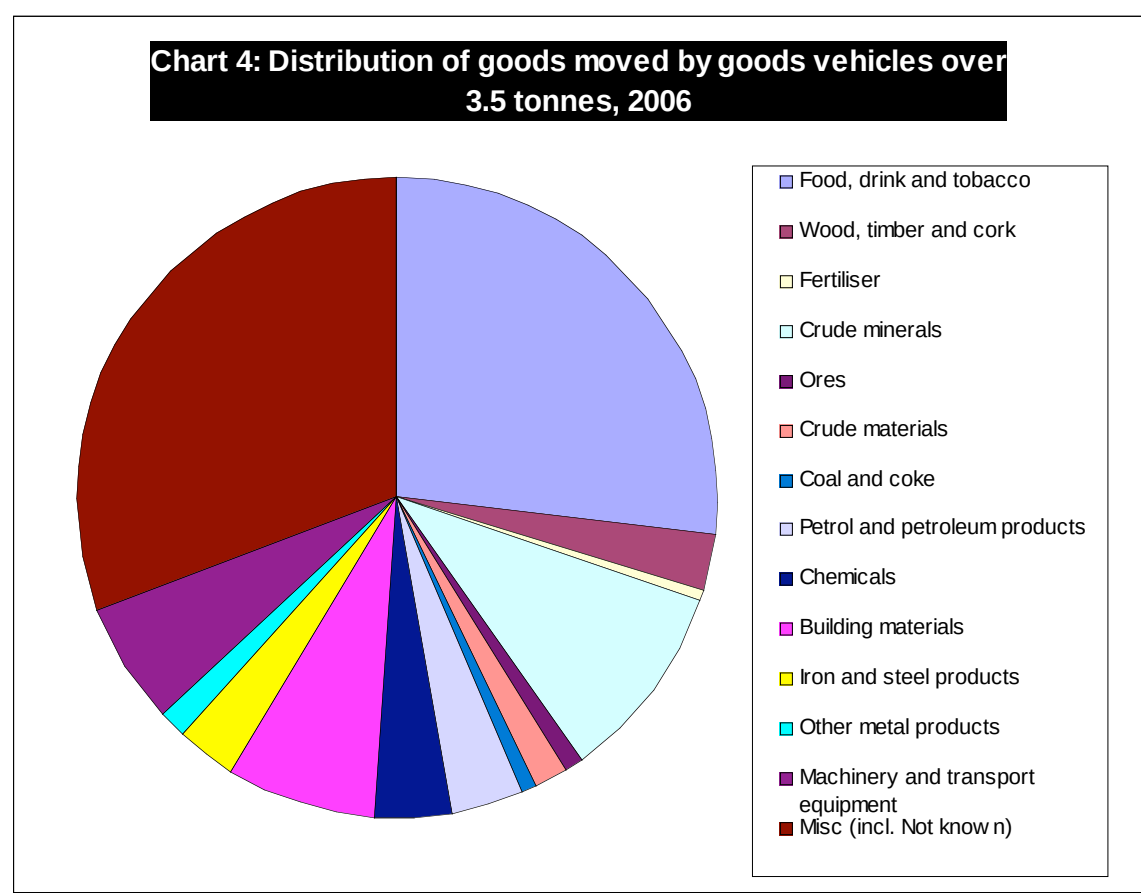


Box vans constituted almost 30% of the total number of HGVs over 3.5 tonnes, while tippers constituted a further 15.9%.

As can be seen from Chart 3 below, overall the majority of goods transported within the UK comprises machinery, transport, manufactured goods and other miscellaneous items, with food stuffs and animal fodder the next most significant sector.

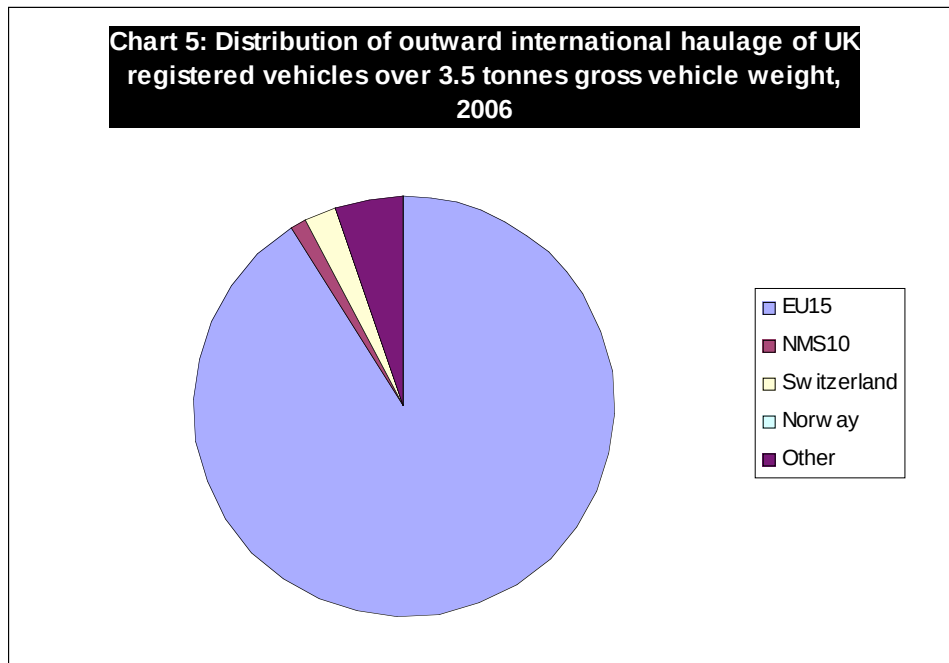


However, the majority of goods transported by HGVs comprises food, drink and tobacco (27%), and miscellaneous (30%), as shown in Chart 4.



1.3.2 International haulage

According to DfT statistics, UK-registered vehicles are primarily involved in transporting goods to the EU15 countries⁵, with the NMS10⁶ as the next significant block. This is illustrated in Chart 5.



France, Spain and Germany combined make up nearly 60% of all outward EU15 haulage destinations for UK-registered vehicles over 3.5 tonnes GVW.

⁵ 'EU15' refers to Austria, Belgium, Denmark, Finland, France, Germany, Greece, Eire, Italy, Luxembourg, Netherlands, Portugal, Spain and Sweden.

⁶ 'NMS10' refers to Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

2 INFORMATION GATHERING

2.1 LITERATURE REVIEW INTRODUCTION

For ease of reference, the literature review has been broken down into four sections:

- Legislation, guidance and codes of practice in the UK and internationally
- Accident data
- HGVs 'on the road' behaviour
- Previous research on load securing

It should be noted that it was difficult to obtain accurate statistics on the number and severity of incidents involving load shifts, and often an accident was not categorised as a load shift incident. For example, many of the RIDDOR-reportable accidents identified as having a load shift as the initiating event had been classified as 'falls from height' or 'struck by falling object'. With accidents on the road, it was difficult to identify whether the load shift had been the initiating event or whether the load had shifted as a result of the accident.

2.2 LEGISLATION AND CODES OF PRACTICE

This section of the report has been divided into subsections for ease of reference.

- UK legislation and Standards
- UK Guidance and Good practice
- EU legislation, Standards and guidance
- North American legislation and guidance
- Australasian legislation and guidance

The similarities and variations between the material is discussed at the end of this section.

2.2.1 UK legislation and Standards

Legislation in the UK primarily focuses on the condition of a vehicle on the road, and there is specific legislation that encompasses the condition of the load. The UK Construction and Use Regulations⁷ state:

The load carried by a motor vehicle or trailer shall at all times be so secured, if necessary by physical restraint other than its own weight, and be in such a position, that neither danger nor nuisance is likely to be caused to any person or property by reason of the load or any part thereof falling or being blown from the vehicle or by reason of any other movement of the load or any part thereof in relation to the vehicle.

The Health and Safety at Work Act 1974 places duties on employers to ensure the health and safety of their employees and those who may be affected by their work activities. The Act states:

2 General duties of employers to their employees

(1) It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.

(2) Without prejudice to the generality of an employer's duty under the preceding subsection, the matters to which that duty extends include in particular—

(a) the provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health;

(b) arrangements for ensuring, so far as is reasonably practicable, safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances;

(c) the provision of such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employees;

(d) so far as is reasonably practicable as regards any place of work under the employer's control, the maintenance of it in a condition that is safe and without risks to health and the provision and maintenance of means of access to and egress from it that are safe and without such risks;

(e) the provision and maintenance of a working environment for his employees that is, so far as is reasonably practicable, safe, without risks to health, and adequate as regards facilities and arrangements for their welfare at work.

And

⁷ Road vehicles (Construction and Use) Regulations 1986 – SI 1986 No 1078

3 General duties of employers and self-employed to persons other than their employees

(1) It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety.

(2) It shall be the duty of every self-employed person to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that he and other persons (not being his employees) who may be affected thereby are not thereby exposed to risks to their health or safety.

And

4 General duties of persons concerned with premises to persons other than their employees

(1) This section has effect for imposing on persons duties in relation to those who—

(a) are not their employees; but

(b) use non-domestic premises made available to them as a place of work or as a place where they may use plant or substances provided for their use there, and applies to premises so made available and other non-domestic premises used in connection with them.

(2) It shall be the duty of each person who has, to any extent, control of premises to which this section applies or of the means of access thereto or egress therefrom or of any plant or substance in such premises to take such measures as it is reasonable for a person in his position to take to ensure, so far as is reasonably practicable, that the premises, all means of access thereto or egress therefrom available for use by persons using the premises, and any plant or substance in the premises or, as the case may be, provided for use there, is or are safe and without risks to health.

The Act sets a standard of *reasonably practicable* for measures that may be taken to mitigate risks to employees or others affected by work activities. The Act states:

40 Onus of proving limits of what is practicable

In any proceedings for an offence under any of the relevant statutory provisions consisting of a failure to comply with a duty or requirement to do something so far as is practicable or so far as is reasonably practicable, or to use the best practicable means to do something, it shall be for the accused to prove (as the case may be) that it was not practicable or not reasonably practicable to do more than was in fact done to satisfy the duty or requirement, or that there was no better practicable means than was in fact used to satisfy the duty or requirement.

The Management of Health and Safety at Work Regulations 1999⁸ state:

3-(1)

Every employer shall make a suitable and sufficient assessment of -

(a) the risks to the health and safety of his employees to which they are exposed whilst they are at work; and

(b) the risks to the health and safety of persons not in his employment arising out of or in connection with the conduct by him of his undertaking

and

5-(1)

Every employer shall make and give effect to such arrangements as are appropriate, having regard to the nature of his activities and the size of his undertaking, for the effective planning, organisation, control, monitoring and review of the preventive and protective measures

The Road Traffic Act 1991 states:

A person is also guilty of using a vehicle in a dangerous condition if he uses, or causes or permits another to use⁹, a motor vehicle or trailer on a road when the purpose for which it is used or the weight position or distribution of its loads, or the manner in which it is secured is such that the use of the motor vehicle or trailer involves a danger of injury to any person.

The maximum penalty for this offence if committed in respect of a goods vehicle is a £5000 fine, plus 3 penalty points and disqualification.

There are a number of British Standards relating to load security; these are primarily national implementations of European EN Standards.

The constituent parts of BS EN 12195 set out the standards required for securing loads by chains or webbing straps.

BS EN 12195-1:2003, gives detailed guidance on lashing forces for load restraint assemblies and the calculation of restraint required. The Standard states:

The general requirements for safe transport are:

- *the sum of forces in any direction equals zero*
- *the sum of moments in any plane equals zero*

...

Generally, load securing consists of balancing the forces of a load by locking, blocking and/or lashing. Locking, a completely positive connection, is mainly used in the transport of containers and is not usually combined with lashings. Blocking results in a positive connection in the blocked direction only and therefore is often combined with lashings.

⁸ Statutory Instrument 1999 No. 3242; *The Management of Health and Safety at Work Regulations 1999*; HMSO

⁹ My emphasis

The two basic lashing methods are:

- *frictional lashing is characterized by a restraint that is produced by force on the loading area and a positive connection in the direction vertically down;*
- *direct lashing is a completely positive connection which permits the load to make small movements, the magnitudes of which depend on the flexibility of the lashing and forces acting on the load.*

For a load restrained by frictional lashing, the Standard provides a formula for calculating the number of lashings required to secure the load against sliding.

$$n \geq \frac{(C_{xy} - \mu_D \cdot c_z) m \cdot g}{k \cdot \mu_D \cdot \sin \alpha \cdot F_T}$$

Where n is the number of lashings, m is the mass of the load, g is the acceleration due to gravity, μ_D is the dynamic friction factor, k is a factor given by tables in the Standard and α is the vertical angle.

The Standard also states:

Even if the tension forces are adjusted very carefully prior to the transport, there may be changes during transport. As a general rule, the tension forces during transport have to be checked at specified intervals.

A further basis, that the calculation of the tension forces can be replaced during frictional lashing by:

- *the presence of tension force indicators or other equipment for verifying or adjusting the tension forces;*
- *tensioning devices can be used, which are marked with the standard tension force S_{TF}*

If the basic requirements of the two preceding clauses are being observed, the following coefficients k are valid for the following values:

- *$k = 1.5$ when using one tensioning device for the lashing*
- *$k \leq 2.0$ when using a lashing with two tensioning devices per lashing, or if the value is proved by a tension force indicator on the other side than the tensioning device.*

BS EN 12195-2: 2001 gives performance characteristics for textile webbing;

The textile webbing shall be produced wholly from high tenacity yarns fast to light and heat stabilised with a tenacity of not less than 60 cN per tex from one of the following materials:

*Polyamide (PA), high tenacity continuous multifilament
Polyester (PES), high tenacity continuous multifilament
Polypropylene (PP), high tenacity continuous multifilament*

All seams shall be made from thread of the same material as that of the webbing and shall be made with a locking stitch

The Standard also specifies how webbing straps should be marked:

Each complete web lashing, if it is intended that parts be separable, shall be marked with the following information if applicable on a label:

- *lashing capacity LC*
- *lengths L_G , L_{GF} and L_{GL} in metre*
- *standard hand force S_{HF}*
- *standard tension force S_{TF} (daN) or winch force, based on the level for which the tensioning device has been type tested, when designed for frictional lashing*
- *warning: "Not for lifting!"*
- *material of the textile webbing*
- *manufacturer's or supplier's name or symbol*
- *manufacturer's traceability code*
- *number and part of this European Standard*
- *year of manufacture*
- *elongation of textile webbing in % at LC*

End fittings, tensioning devices, tension retaining devices and tension indicators of $LC \geq 5$ kN shall be marked with the manufacturer's or supplier's name or symbol.

The value of LC shall be marked on parts with $LC \geq 5$ kN in kN, on parts with $LC \leq 5$ kN in daN.

Labels shall have the following colours:

- *blue: PES webbing*
- *green: PA webbing*
- *brown: PP webbing*

The Standard goes on to give direction on the information on use and maintenance of webbing to be provided by the manufacturer:

In selecting and using web lashings, consideration shall be given to the required lashing capacity, taking into account the mode of use and the nature of the load to be secured. The size, shape and weight of the load, together with the intended method of use, transport environment and the nature of the load will affect the correct selection. For stability reasons free-standing units of load have to be secured with a minimum of one pair of web lashings for frictional lashing and two pairs of web lashing for diagonal lashing.

The selected web lashings shall both be strong enough and of the correct length for the mode of use. Basic lashing rules:

- *plan the fitting and removal operations of lashing before starting a journey*
- *keep in mind that during journeys parts of the load may have to be unloaded*

- calculate the number of web lashings according to BS EN 12195-1
- only those web lashings designed for frictional lashing with S_{TF} on the label are to be used for frictional lashing
- check the tension force periodically, especially shortly after starting the journey

Because of different behaviour and elongation under load conditions, different lashing equipment (eg lashing chain and web lashings) shall not be used to lash the same load. Consideration shall also be given to ancillary fittings (components) and lashing devices in the load restraint assembly are compatible with the web lashing

...

Release of the web lashing: Care should be taken to ensure that the stability of the load is independent of the lashing equipment and that the release of the web lashing shall not cause the load to fall off the vehicle, thus endangering the personnel. If necessary attach lifting equipment for further transport to the load before releasing the tensioning device in order to prevent accidental falling and/or tilting of the load.

...

Web lashings shall not be overloaded. Only the maximum hand force of 500 N (50 daN on the label; 1 daN = 1 kg) shall be applied. Mechanical aids such as levers, bars etc as extensions are not to be used unless they are part of the tensioning device

The Standard also gives a list of hazards that may occur due to improper use of web lashings or non-use of securing devices.

- a) *Hazards of being hit by tilting or shifting loads, losing balance or falling during application and tensioning of the lashings due to defective equipment, sudden breakage or malfunction of the tensioning device leading to the sudden absence of the hand reaction force.*
- b) *Injuries by pinching and shearing, hand and arm injuries during manipulation of tensioning devices due to sharp edges.*
- c) *Hazards to the unloading personnel due to loads having moved or being tilted during transport because of inadequate securing, malfunction like recoil or breakage of equipment or defective equipment and then which may fall onto the personnel, especially when opening the side-panels.*
- d) *Hazards due to wrong combinations made up by the operator.*
- e) *Hazards to the unloading personnel by using tensioning devices in web lashings which do not permit their controlled release so allowing an unstable load to move suddenly.*
- f) *Hazards to operators from excessive recoil of levers and cranks of the tensioning devices.*

BS EN 12195-3:2001¹⁰ for chains is similar in scope to Part 2 of BS EN 12195, and states:

...chains and tensioning devices conforming to this European Standard are designed and dimensioned such that the following hazards are taken into account, if they are used in accordance with the manufacturers instructions:

- a) Hazards of being hit, losing one's balance or falling during application of force, due to defective equipment, sudden breakage or malfunction of the tensioning leading to the sudden absence of the hand reaction force.*
- b) Injuries by pinching and shearing, hand and arm injuries during manipulation of tensioning devices due to sharp edges of the chain and tensioning devices.*
- c) Hazards to the unloading personnel due loads (sic) having moved during transport, because of inadequate securing, malfunction like recoil or breakage of equipment or defective equipment and then may fall onto the personnel, especially when opening the side-panels.*
- d) Hazards due to wrong combinations made up by the operator.*

BS EN 12640:2001¹¹ gives specific guidance on the number of lashing points required for vehicles in order to secure loads. It also states:

Vehicles with lashing points in compliance with this standard, shall be fitted with a marking plate ... in a clearly visible place. For the convenience of users the tensile load should be indicated in daN.

In relation to the use of curtain-sided vehicles for road transport, BS EN 12642:2001¹², which specifies minimum requirements and suitable test methods for the body structure of road vehicles, states:

Fittings for securing of cargo are mandatory required for vehicles with curtainsiders.

The Standard allows for two types of trailer structure: L and XL. For the L-type, the curtain should not see any loading. A trailer designed and tested to the XL-type can utilise the curtain to provide a degree of load containment. The strength of the structure is proved by calculation, static testing and dynamic (driving) testing. An example of an XL test certificate is shown in Appendix G.

BS EN 284:1991; *Swap bodies – Testing*¹³, states:

Cargo securing devices are mandatory for swap bodies of curtainsider type.

The Standards are in agreement that loads on curtain-sided vehicles are not sufficiently secured for road transport by the curtain.

¹⁰ BS EN 12195-3:2001; *Load restraint assemblies on road vehicles – Safety – Part 3: Lashing chains*; British Standards Institution

¹¹ BS EN 12640:2001; *Securing of cargo on road vehicles – Lashing points on commercial vehicles for goods transportation – Minimum requirements and testing*; British Standards Institution

¹² BS EN 12642:2001; *Securing of cargo on road vehicles – Body structure of commercial vehicles – Minimum requirements*; British Standards Institution

¹³ BS EN 284:1991; *Swap bodies – Testing*; British Standards Institution

2.2.2 UK guidance and Codes of Practice

Within the UK, load security practice is guided by the Department of Transport Code of Practice¹⁴ ('the DfT guidance'). This states:

The basic principle upon which this CoP is based is that the combined strength of the load restraint system must be sufficient to withstand a force not less than the total weight of the load forward, so as to prevent the load moving under severe braking, and half of the weight of the load backwards and sideways.

...

Friction alone cannot be relied upon to keep the load in place. When the vehicle is moving, vertical movement caused by bumps will reduce any restraining force due to friction. This can reduce to zero if the load even momentarily leaves the bed of the truck.

And:

The total load restraint system will generally consist of a combination of:

- a. lashings secured to anchorage points attached to the vehicle chassis, which includes cross bearers, outriggers etc;*
- b. bulking arrangements including headboards, bulkheads, spigots, transverse beams, shoring bars etc which are securely attached to the vehicle;*
- c. friction between the load and the vehicle platform.*

In most circumstances it would be appropriate to obtain the majority of the total restraint required from (a), and the remaining part from (b). Benefits accrued from (c) should be regarded as a bonus.

The DfT guidance also states:

All equipment used for securing loads should be regularly inspected for wear or damage. Inspection arrangements should be in accordance with the manufacturer's instructions. Special attention should be paid to webbing and rope to ensure that there is no visible deterioration due to constant use, due to fraying of the strands. They should also be inspected to ensure that they have not been cut or damaged in any other way through misuse.

...

Sleeves and corner protectors should be used to prevent damage to both the load and the restraint equipment where it passes over a sharp corner.

¹⁴ Department of Transport; *Code of Practice – Safety of Loads on Vehicles* (3rd Edition)

When a vehicle changes direction – cornering on roundabouts, overtaking etc – friction is not enough to stop unsecured cargo moving. It is wrong to assume that the weight of the load will keep it in position.

In order to achieve maximum vehicle stability the load should be placed so that the centre of gravity is kept as low as practicable and near to the vehicle's centre line. This means that, where possible:

- a) The load should be spread to give an even weight distribution over the whole floor area;*
- b) When a load is stacked the larger and heavier items should be placed at the bottom;*
- c) The heavier items should be placed nearer to the centre line of the vehicle and the lighter ones towards the sides;*
- d) When a load is stacked the lower packages should be strong enough to support the others when the vehicle is braking, cornering or accelerating.*

Driving Standards Agency guidance¹⁵ states:

Sudden acceleration forward might cause an insecure load to fall off the back of a vehicle. Similarly, if harsh braking is applied the load may attempt to continue moving forward.

...

Any sudden steering movement may also unsettle the load and cause it to move. Any movement of the load is likely to make the vehicle unstable.

The DSA guidance deals specifically with load restraint, stating:

When securing a load you need to take into account

- The nature of the load*
- The suitability of the vehicle*
- The stability of the load*
- The type of restraint*
- Protection from weather*
- Prevention of theft*
- Ease of delivery*

The object is to ensure a secure load and a stable vehicle when

- Braking*
- Steering*

Even in emergency situations

...

A load may consist of large heavy pieces of machinery but that doesn't mean it will stay in place throughout a journey. Fatal accidents have occurred through such items falling from a vehicle or shifting under braking or cornering, therefore they should always be secured solidly and carefully.

...

¹⁵ The official DSA guide to driving goods vehicles, DSA 2006

It's important that the correct anchoring points are employed irrespective of the type of restraint being used. Remember, however, that the hooks fitted under some decks are only intended for fastening sheeting ropes.

...

The manufacturers of vehicles fitted with curtain-side bodies may be satisfied that a high degree of protection is given by the material used in their construction. This, however, doesn't relieve the driver of the responsibility for ensuring that a load is properly stowed and secured so that it won't move while in transit.

INDG379¹⁶ states that almost all deaths in the haulage and distribution industry are due to four types of accident – being struck by a moving vehicle, falling loads, falls from vehicles and collapsing or overturning vehicles. It also states that more than seven out of ten major injuries are due to slips and trips, being struck by moving or falling objects, falls from less than 2 metres and manual handling. It goes on to list issues employers should consider, including:

Are there systems for checking whether a load has shifted in transit and for dealing with bulging loads on curtain-sided vehicles?

The Freight Transport Association's leaflet, *Safe loading* allows the use of curtains for load containment while underlining the need for load restraint. It states:

Curtain-sided vehicles or tautliners often have built-in reinforcements to restrain lateral movement of the load. This can work well ... however there is still a need to apply internal restraints on most loads, particularly those of high mass. Opening a curtain after a journey should be carried out with extreme care. Items that may be lodged will fall out when the curtain is removed.

...

Wherever possible suitable webbing restraint assemblies in conjunction with suitable dunnage, bolsters and frames should be used as the primary means to secure all heavy load items.

In terms of responsibility for the load, The DfT guidance states:

The driver is ultimately responsible for the load carried on their vehicle, whether or not they were involved in the securing of the load.

If a load, or part of a load, falls into water and causes pollution, and the waters are controlled, this is an offence under the Water Resources Act 1991. This could attract a maximum fine of £20,000, together with the cost of cleaning up the affected water.

¹⁶INDG379 - Health and safety in road haulage; <http://www.hse.gov.uk/pubns/indg379.pdf>; HSE

While the DSA guidance states:

The driver is responsible for the contents of their vehicle and needs to ensure that it is loaded correctly for stability and ease of access.

HSE workplace transport guidance¹⁷ states:

By law, employers have a general duty to ensure that the health and safety of their employees and members of the public is not put at risk as a result of the work that they do.

...

The law requires that health and safety risks at work are controlled as far as is 'reasonably practicable'.

...

By law, every employer must make sure that work equipment (including vehicles) is suitable for the purpose for which it is provided or used.

...

Vehicles should be suitable for any loads carried, and there must be well-placed anchor points that are strong enough to allow the load to be properly secured.

Workplace transport guidance does not cover transport on the public highway, however it does cover large goods vehicles off the public highway, for example during loading and unloading.

HSE guidance on the sheeting and unsheeting of tipper lorries¹⁸ sets out the legal duties covering adequate risk assessment, safe systems of work, use and maintenance of work equipment and training and supervision that apply to all work activities and workplaces. The risks identified relating to accessing the trailer bed would appear to be equally applicable to working on curtain-sided trailers, and the approach to be taken in assessing the risks of work activities is detailed.

The insurance company Norwich Union produces a guidance leaflet, *Safe loading, cargo handling and the transit of goods*, which states:

It is easier to prevent a load from moving in the first place than to stop it once it has started moving, thus a load must be restrained in such a way that no part of it can move in any direction relative to the vehicle.

The leaflet gives practical advice in the form of "do's and don'ts" to assist in the loading and securing process.

¹⁷ Workplace transport safety – An overview; Health & Safety Executive (2005)

¹⁸ Sheeting and unsheeting of tipper lorries: Guidance for the road haulage industries; HSE (1996)

2.2.3 EU guidance and legislation

The European *Best Practice Guidelines on Cargo Securing for Road Transport*¹⁹ provide detailed guidance on securing many common types of load on common types of vehicles. The basic physics of load shift are explained and guidance is given on the different types of restraint and containment that can be used to effectively secure a load.

The Guidelines give 'Ten Commandments' for load security:

- *Before the vehicle is loaded, check that its load platform, bodywork and any load securing equipment are in sound and serviceable condition.*
- *Secure the cargo in such a way that it cannot shove away, roll-over, wander because of vibrations, fall off the vehicle or make the vehicle tip over.*
- *Determine the securing method(s) best adapted to the characteristics of the cargo (locking, blocking, direct lashing, top-over lashing or combinations of these).*
- *Check that the vehicle and blocking equipment manufacturers' recommendations are adhered to.*
- *Check the cargo securing equipment is commensurate with the constraints it will encounter during the journey. Emergency braking, strong cornering to avoid an obstacle, bad road or weather conditions have to be considered as normal circumstances likely to happen during a journey. The securing equipment must be able to withstand these conditions.*
- *Each time cargo has been (un)loaded or redistributed, inspect the cargo and check for overload and/or poorly balanced weight distribution before starting. Ensure that the cargo is distributed in such a way that the centre of gravity of the total cargo lies as close as possible to the longitudinal axis and is kept as low as possible: heavier goods under, lighter goods above.*
- *Check the cargo securing regularly, wherever possible, during the journey. The first check should preferably be done after a few kilometres drive at a safe place to stop. In addition the securing should also be checked after heavy braking or another abnormal situation during driving.*
- *Wherever possible, use equipment which supports the cargo securing such friction mats, walking boards, straps, edge beams, etc.*
- *Ensure that the securing arrangements do not damage the goods transported.*
- *Drive smoothly, i.e. adapt your speed to the circumstances so as to avoid brisk change of direction and heavy breaking. If you follow this advice, the forces exerted by the cargo will remain low and you should not encounter any problems.*

The Guidelines also state:

As a general rule, goods carried within curtain-sided vehicles should be secured as if they were being carried on a flat, open-bed vehicle. If the loading configuration, or its securing, would cause concern when used on an open vehicle, then it should be considered equally unacceptable with a curtain-sided vehicle.

¹⁹ http://ec.europa.eu/transport/roadsafety/vehicles/best_practice_guidelines_en.htm

Unless they are purposely designed according to EN12642-XL, the curtains of curtain-sided vehicles MUST NOT be considered as part of any load restraint system. If the curtains have been designed as a restraint system, the load capability should be clearly marked on the vehicle – if no mark can be seen, then it should be assumed that the curtain has NO load-bearing function.

Similarly, where vertical inner curtains are fitted and they are not purposely designed for a specific load, they also MUST NOT be considered as part of the load restraining system. Curtains and vertical inner curtains should be considered purely as a means of containing within the vehicle any small, loose items that may have become dislodged during the journey.

In terms of responsibility for load securing, the Guidelines state:

Loading and unloading should be carried out by appropriately trained staff that are aware of the risks involved. Drivers should also be aware of the additional risk of the load, or parts of the load, moving when the vehicle is being driven. This applies to all vehicles and to all types of load.

From a legal point of view, the liability for the loading/unloading operations should be assumed by the driver, within his responsibilities, and the person(s) who have executed them. In practice quite often the driver has to couple to a pre-loaded trailer or pick up a pre-loaded and sealed container. Another frequent situation is where the loading operation is carried out by the shipper's employees, even obliging the driver to wait elsewhere until the loading of the vehicle has been completed.

Therefore, all involved parties must be aware of their respective responsibilities. One cannot state that in all circumstances the driver is the sole person responsible for the load carried on his vehicle.

The Guidelines also state:

Planning is the key to achieving efficient, reliable and safe transportation of cargo.

It should be noted that the EU Guidelines are extremely comprehensive and it is not proposed to detail every section of the Guidelines.

The Nordic Road Association report, *Equipment for efficient cargo securing and ferry fastening of vehicles*, states:

Many road authorities in Europe have also clearly stated that cargo securing against curtain sides is not allowed. The reason for not allowing cargo securing against curtain sides is the flexibility of the sides.

...

Vehicles must be equipped with effective technical equipment for lashing and securing cargo to ensure safe road transport

In road transportation accelerations occur due to:

Heavy breaking (sic)

Driving in sharp curves

And forward accelerations or immediately after heavy breaking

The magnitude of the accelerations and forces in the above situations are according to most authority regulations the following:

<i>Forward</i>	<i>Backwards</i>	<i>Sideways</i>
<i>0.8g or 1.0g</i>	<i>0.5g</i>	<i>0.5g</i>

The German VDI 2702 guidelines provide detailed guidance on lashing procedures and calculating the minimum number of straps required to secure a load depending on the type of lashing used.

The IMO/ILO/UN ECE *Guidelines for packing Cargo Transport Units* takes a slightly different approach to calculating the number of lashings required to the method given in EN 12195-1, since it uses the static coefficient of friction (typically higher than the dynamic coefficient of friction), uses the same lateral acceleration for tipping as well as sliding, uses a different factor for the total pretension of overstraps and takes account of internal friction between rows within the load. The effect of the guidelines is to reduce the number of overstraps required. The cost burden of securing to the EN Standard has been represented to be uneconomical²⁰. It should be noted that example calculations²¹ used to promote the IMO/ILO/UN ECE guidelines as superior to EN 12195-1 assume that overstraps are the only method of restraining the load and it might be expected that if the load is particularly vulnerable to tipping some other method of securing would be used in combination with overstrapping.

The EU Guidelines state that either the IMO/ILO/UN ECE or EN 12195-1 can be used as the basis for calculating the number of lashings required.

²⁰ <http://www.mariterm.se/download/Difference%20IMO%20and%20CEN.pdf>.

²¹ Verification of level of basic parameters important for the dimensioning of cargo securing arrangements (VERIFY) www.mariterm.se/download/Cargo%20Securing%20Standards.ppt

In Belgium load security is governed by the following guidance²²:

VEHICLE LOADS: GENERAL REQUIREMENTS

45.1 Vehicle loads must be arranged (if necessary secured, covered with a tarpaulin or net) in such a way that they cannot:

- 1. Impede the driver's view;*
- 2. Constitute a danger for the driver, people being transported and other users;*
- 3. Cause damage to the highway, its fixtures, works which are established on it, or public or private property;*
- 4. Drag or drop onto the highway;*
- 5. Compromise the stability of the vehicle; or*
- 6. Conceal the lights, reflectors, or registration number.*

45.2 If the load consists of cereals, flax, straw or forage, loose or in bales, it must be covered by a tarpaulin or net. However, this arrangement does not apply if this transport is being carried out within a 25 km radius of the place of loading, and provided that it is not carried out on a motorway.

45.3 If the load consists of pieces with a long length, these must be firmly lashed together and to the vehicle, in such a way that they do not extend beyond the extreme lateral contour of the latter in their oscillations.

45.4 The accessories which are used to lash or protect the load, such as chains, tarpaulins, nets, etc., must surround the load closely.

45.5 The driver of the vehicle must take the steps necessary to ensure that the noise made by the accessories which are used to lash or protect the load cannot distract the driver, inconvenience the public, or frighten animals.

45.6 If, exceptionally, the side or rear doors have to remain open, they must be secured so that they do not extend beyond the extreme lateral contour of the vehicle.

²² Translated from the original French by HSE Translation Services – the original text can be found in Appendix A

2.2.4 North American guidance and legislation

The US Cargo Securement Rules, which became effective from January 2004, implemented the North American Cargo Securement Standard Model Regulations, which were developed to reflect a multi-year research program to evaluate US and Canadian cargo Securement regulations, industry good practice and recommendations presented during a series of public meetings involving US and Canadian industry experts. The guidance document on the Rules²³ states:

FMCSA requires that cargo Securement systems be capable of withstanding the forces associated with following three deceleration/accelerations, applied separately:

- (1) 0.8 g deceleration in the forward direction;*
- (2) 0.5 g acceleration in the rearward direction; and*
- (3) 0.5 g acceleration in a lateral direction.*

These values were chosen based on researchers' analysis of studies concerning commercial motor vehicle performance. The analysis indicated that the highest deceleration likely for an empty or lightly loaded vehicle with an antilock brake system, all brakes properly adjusted, and warmed to provide optimal braking performance, is in the range of 0.8-0.85 g. However, a typical loaded vehicle would not be expected to achieve a deceleration greater than 0.6 g on a dry road.

The typical lateral acceleration while driving in a curve or on a ramp at the posted advisory speed is in the range 0.05-0.17 g. Loaded vehicles with a high center of gravity roll over at a lateral acceleration above 0.35 g. Lightly loaded vehicles, or heavily loaded vehicles with a lower center of gravity, may withstand lateral acceleration forces greater than 0.5 g.

and

Cargo must be firmly immobilized or secured on or within a vehicle by structures of adequate strength, dunnage or dunnage bags, shoring bars, tiedowns or a combination of these.

Articles of cargo that are likely to roll must be restrained by chocks, wedges, a cradle or other equivalent means to prevent rolling. The means of preventing rolling must not be capable of becoming unintentionally unfastened or loose while the vehicle is in transit.

Articles of cargo placed beside each other and secured by transverse tiedowns must be:

- (1) Placed in direct contact with each other, or*
- (2) Prevented from shifting towards each other while in transit.*

...

²³ US Department of Transportation; Understanding the Federal Motor Carrier Safety Administration's Cargo Securement Rules; Publication No. MC-P/PSV-04-001

The aggregate working load limit of any securement system used to secure an article or group of articles against movement must be at least one-half times the weight of the article or group of articles.

The Rules make a distinction between prevention against loss of load (load containment) and prevention against shifting of load (load restraint).

The Rules also state:

When an article of cargo is not blocked or positioned to prevent movement in the forward direction, the number of tiedowns needed depends on the length and weight of the articles. There must be-

*One tiedown for articles 5ft²⁴ or less in length, and 1,100 lbs²⁵ or less in weight;
Two tiedowns if the article is-*

- (1) 5ft or less in length and more than 1,100 lbs in weight; or*
- (2) Greater than 5ft but less than 10ft, regardless of weight*

If an article is blocked, braced or immobilized to prevent movement in the forward direction by a headerboard, bulkhead, other articles that are adequately secured, or other appropriate means, it must be secured by at least one tiedown for every 10 ft²⁶ of article length, or fraction thereof.

The Rules also echo UK Standards in the importance of checking webbing straps at intervals during transit.

The Rules specify particular conditions for transporting shipments of particular goods, such as paper reels that, individually or together, weigh 2,268 kg (5,000 lbs) or more. The guidelines are dependent on the method of loading and the type of vehicle used. For example, paper reels on curtain-sided vehicles should be secured as follows:

- (1) Paper rolls with eyes vertical or with eyes lengthwise.*
 - (i) The paper rolls must be loaded and secured as described for a sided vehicle, and the entire load must be secured by tiedowns ...*
 - (ii) Stacked loads of paper rolls with eyes vertical are prohibited.*
- (2) Paper rolls with eyes crosswise.*
 - (i) The paper rolls must be prevented from rolling or shifting longitudinally by contact with vehicle structure or other cargo, by chocks, wedges or blocking and bracing of adequate size, or by tiedowns.*
 - (ii) Chocks, wedges or blocking must be held securely in place by some means in addition to friction so that they cannot become unintentionally unfastened or loose while the vehicle is in transit.*

²⁴ Approximately 1.5m

²⁵ Approximately 499 kg

²⁶ Approximately 3m

Similarly, the Canadian National Safety Code for Motor Carriers – Standard 10: *Cargo Securement*, states:

Cargo transported by a vehicle shall be contained, immobilized or secured so that it cannot

- a) leak, spill, blow off, fall from, fall through or otherwise be dislodged from the vehicle, or*
- b) shift upon or within the vehicle to such an extent that the vehicle's stability or manoeuvrability is adversely affected.*

...

A carrier shall not permit a driver to operate a vehicle where the cargo transported in or on the vehicle is not contained, immobilized or secured in accordance with this Standard.

...

FMCSA requires that cargo securement systems be capable of withstanding the forces associated with following (sic) three deceleration/accelerations, applied separately:

- (1) 0.8g deceleration in the forward direction;*
- (2) 0.5g acceleration in the rearward direction; and*
- (3) 0.5g acceleration in a lateral direction.*

...

On and after January 1, 2010, a person shall not use a tiedown or a component of a tiedown to secure cargo to a vehicle unless it is marked by the manufacturer with respect to its working load limit.

The North American guidelines are generally consistent with each other and also with UK and EU guidance.

2.2.5 Australasian guidance and legislation

The Australian Road Transport Suppliers Association (ARTSA²⁷) publication, *Design of Vehicle Body Systems for Load Restraint Compliance*, states:

Load shift and loss of vehicle stability can cause vehicle rollover. All loads should be packed firmly and tightly in the vehicle body “containing” the load.

In Australia the use of curtain sides as a method of load containment is recognised, with certain limitations. The *Load Restraint Guide* states:

A ‘curtain-side’ cannot restrain a load properly unless it is part of a certified load restraint system.



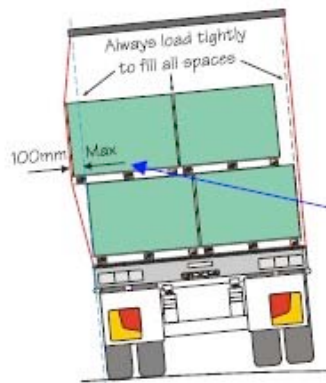
Australian reinforced curtain system

While *Design of Vehicle Body Systems for Load Restraint Compliance* states:

Side curtains may be used to contain loads provided that the vehicle body and curtain system are certified for the particular application and mass.

A maximum deflection of 100mm under load is quoted as acceptable for curtain performance in relation to the use of curtains for load restraint. A diagram from the guidance showing this deflection is shown on the following page.

²⁷ ARTSA is an industry association comprising component and OEM sector



This very popular vehicle type must be fully assessed to confirm if any load containment capability of the finished body can be claimed and correctly certified as such.

Some curtain-side systems after testing may meet the performance standard in the lateral direction for lighter loads up to a rated load. In such cases curtain deflection must not exceed 100mm.

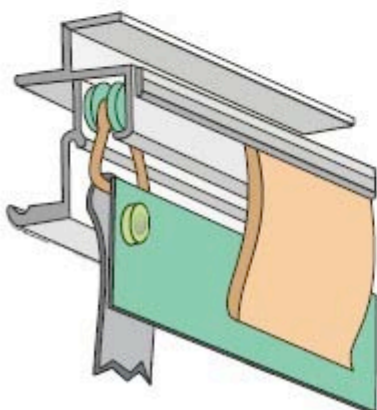
All loads should be firmly and tightly packed in the vehicle body to ensure load movement is kept to a minimum.

Guidance on the design of curtains and rails is also given.



Curtain design and component selection contain a very large range of assembly choices for both the builder and the transport operator. Critical factors include:

- Stitch pattern, welding or sewn webbing
- Bolt & washer sizes on tensioner poles
- Tensile strength & thickness of webbing straps & cam locks
- Height of curtain & strap spacing positions
- Type of coaming hook & keepers selected
- Strength & thickness of curtain material
- Number, spacing & strength of side posts



Roof track assemblies and strength are not all the same.

Tracks, roof bows and curtain attachment rollers are all critical to overall curtain strength that may give restraint (blocking) to some loads.

Design and strength of the roof structure, including the type and placement of side posts, also affects load restraint potential.

The roof structure itself has little strength & deflects when the curtain strap tension is applied.

The test method is shown in Appendix I.

In New Zealand, the Land Transport Rule, *Heavy Vehicles 2004*, states, with regard to curtain-sided vehicles:

A curtain-sided body that is constructed to secure a load on a vehicle must have a curtain and curtain anchorage system that:

- a) has a manufacturer's load rating*
- b) is clearly marked (with that load rating and an expiry date for the safe working life of the curtain)*

The Rule stipulates that the curtain should not deflect more than 100mm, and that the curtain should not fail when the load is subjected to a uniform and sustained lateral acceleration of 0.5g.

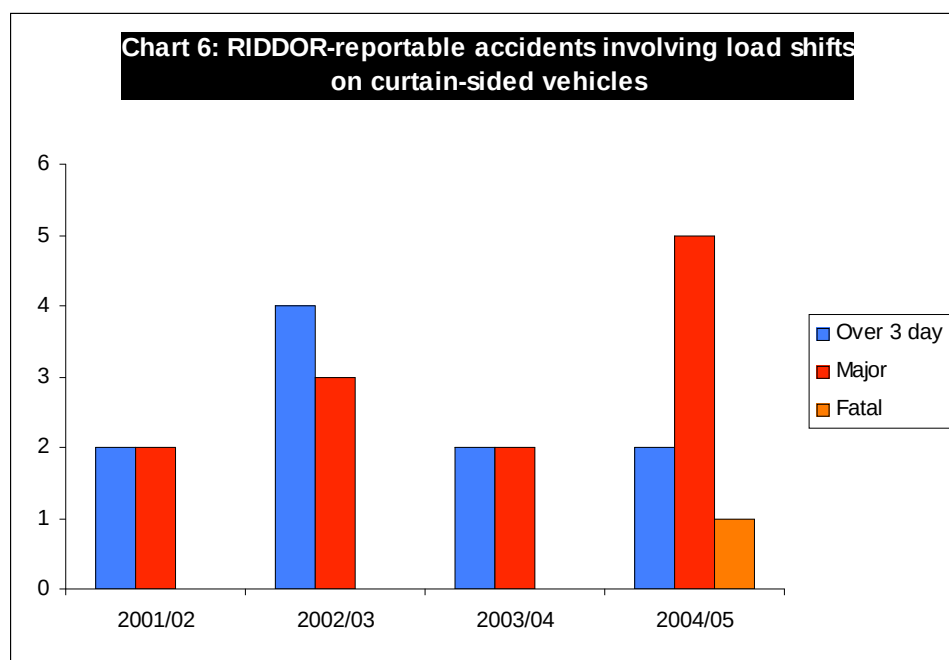
2.3 ACCIDENT DATA, INSURANCE CLAIMS AND LOAD OFFENCES

2.3.1 RIDDOR accident data

HSE supplied RIDDOR data for all accidents notified to HSE and local enforcing authorities where the word 'lorry' was mentioned in the notifier, identified using kind codes 0220 (Hit by object(s) free falling from lifting machinery, vehicles and other equipment); 0630 (Tripped over obstruction); 07 (Falls from a height). The data was then filtered where the word 'curtain' was mentioned in the notifier.

The reported incidents were assessed to identify the incidents directly due to load shift (where someone had been struck by all or part of an unstable load) or where load shift was the initiating event (e.g. falls from the trailer bed occasioned by a load shift). Injuries caused by the operation of the curtain itself, falls from the trailer bed not due to a load shift and injuries from being struck by fork lifts during loading/unloading were not considered.

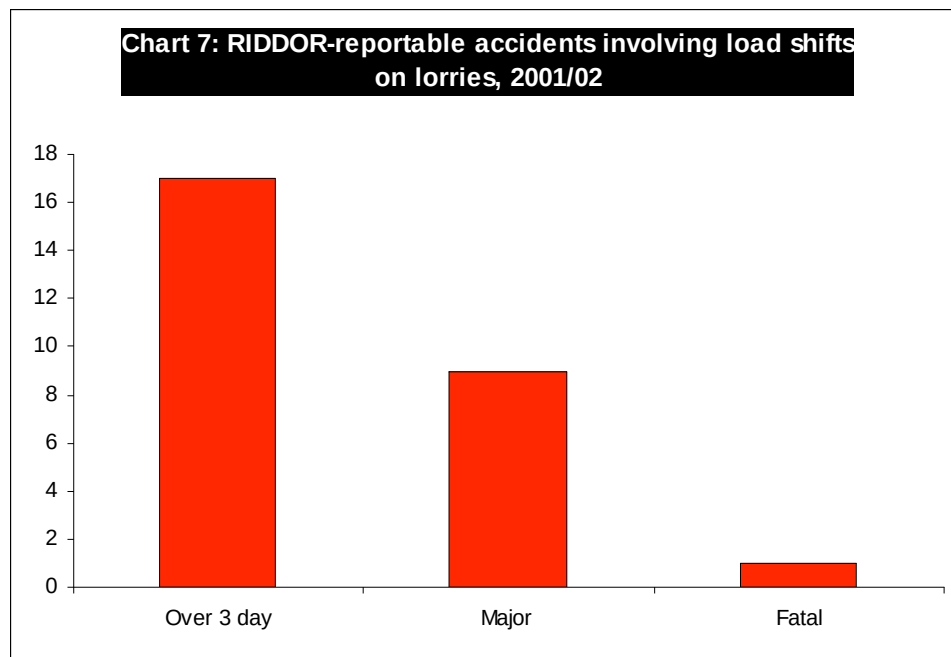
The data (Chart 6) indicated that there are between four and seven Over-three day and Major injuries a year directly attributable to load shift on curtain-sided vehicles.



It should be noted that there were a number of incidents reported in the full data set where it was not clear as to the type of vehicle involved and therefore the incidents did not appear in the filtered data set although they may in fact have involved a curtain-sided vehicle²⁸.

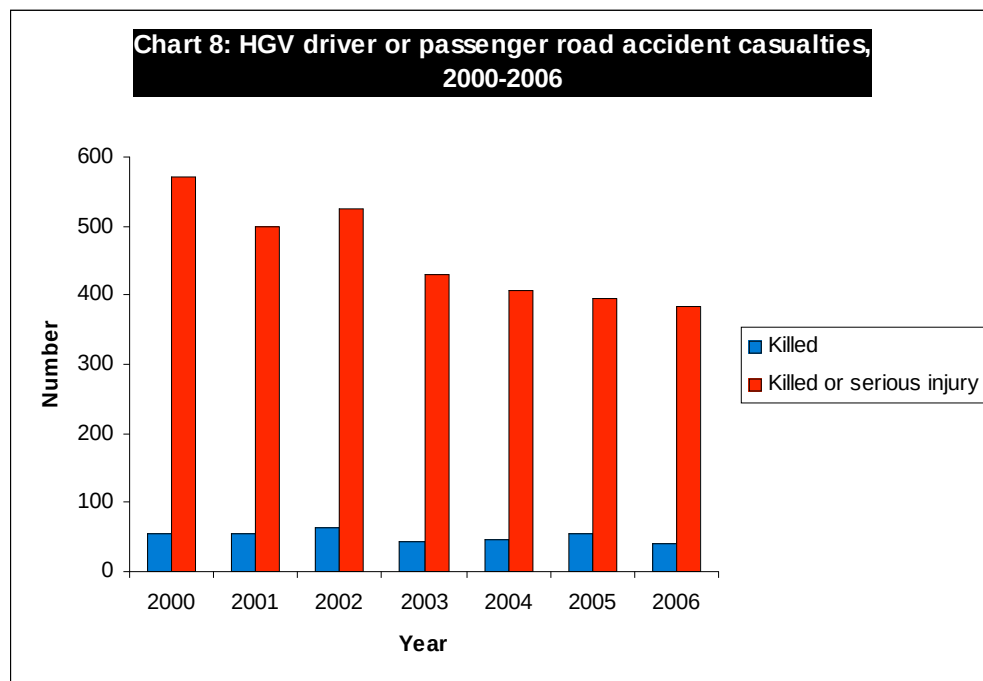
The full data set for 2001/02 (637 incidents) was therefore examined to provide a reference set for comparison. Incidents that occurred after restraint straps were removed/cut or by roll cages becoming jammed were not included. 27 incidents were identified and these are broken down further in Chart 7.

²⁸ Corbett (2008) analysed RIDDOR reports to identify the number of accidents attributable to load shift, however this analysis was not confined to curtain-sided vehicles and hence the data sets are not directly comparable.



2.3.2 Accidents on the road involving HGVs

2.3.2.1 Statistics



HGV drivers or passengers constituted approximately 1.2% of the road accident fatalities in 2006. The low fatality rate most likely reflects the protection afforded to drivers and passengers by the vehicle cab.

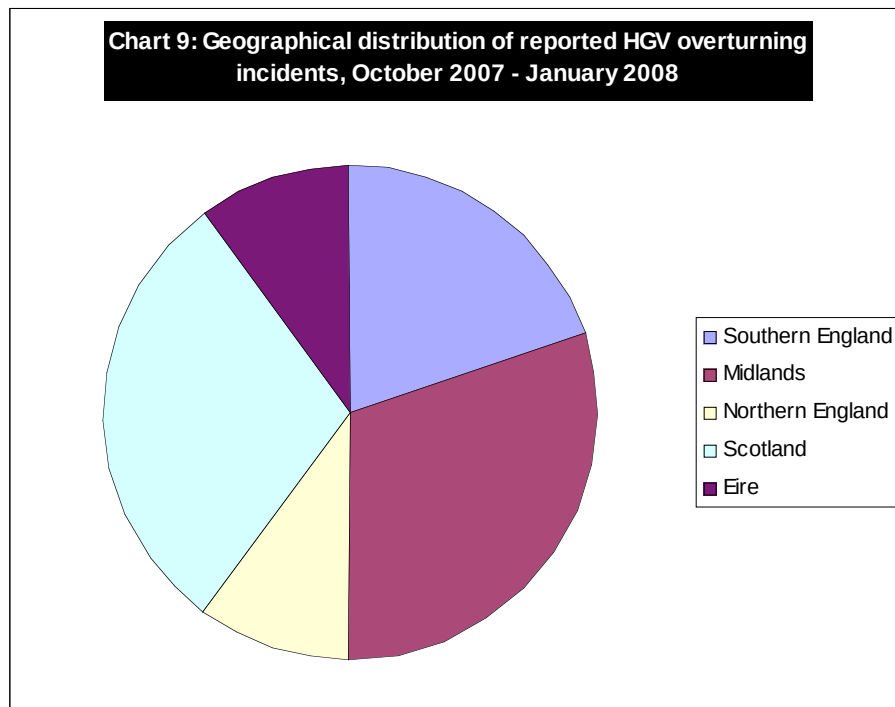
Overall, the rate of road deaths per 100,00 population in the UK (5.5) compares favourably with other EU countries, such as Belgium (10.4), Greece (15.0) and Spain (10.3), and also other OECD countries, such as New Zealand (9.9) and the USA (14.7).

2.3.2.2 *Reported accidents*

To obtain a 'feel' for the frequency of road accidents involving HGVs, a search was made of a news archive²⁹ from October 2007 to January 2008 for HGV overturning incidents.

Ten incidents were identified, of which two had a defined initiating event: a bridge strike in one case and a collision with another vehicle in another. The other eight incidents did not have an identified cause.

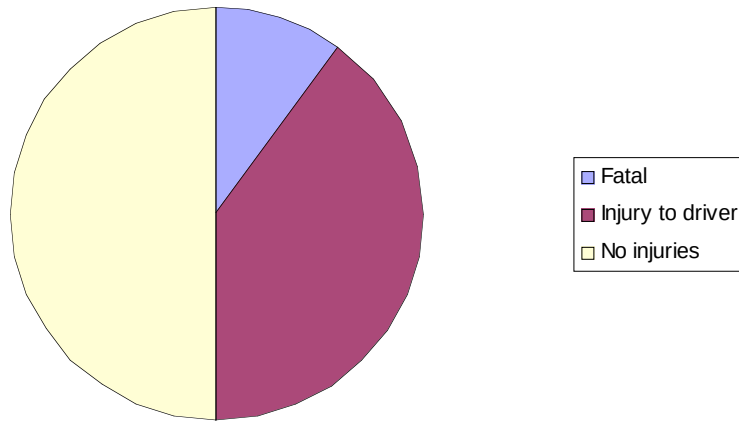
The majority of the incidents occurred in the Midlands and in Scotland, as shown in Chart 9 below. The frequency in the Midlands is unsurprising, given the concentration of warehousing/distribution centres and motorways in this area.



The severity of the incidents in terms of injury varied, as shown in the chart on the following page.

²⁹ <http://news.bbc.co.uk/>

Chart 10: Severity of injuries in HGV overturning incidents, October 2007 - January 2008

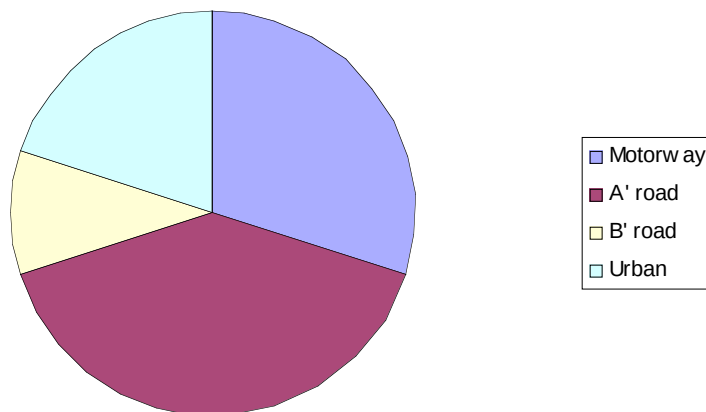


In 90% of the incidents either there were no injuries incurred, or the driver suffered relatively minor injuries.

All of the incidents caused disruption and temporary road closure. Four of the incidents were identified as causing major disruption: two caused the M1 to be closed (and, in one of those cases, the road surface also needed to be repaired), one closed a major route into Glasgow during the afternoon rush hour, and one led to 20-mile tailbacks around Dublin and over seven hours of disruption.

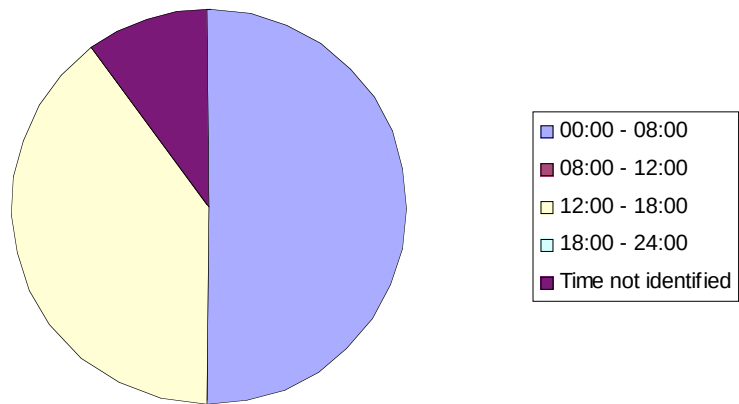
70% of the incidents occurred on motorways or 'A' roads. The two 'urban' incidents were also the two incidents where there was a clear initiating event for the overturn.

Chart 11: HGV overturning incidents by road type, October 2007 - January 2008



50% of the incidents occurred in the early morning (00:00 – 08:00 hours), while 40% occurred in the afternoon (12:00 – 18:00 hours).

**Chart 12: HGV overturning incidents by time of day,
October 2007 - January 2008**



The one incident for which a time was not given occurred in the morning.

2.3.2.3 Insurance claims

It can be seen from the DfT data below that although HGVs have approximately one quarter of the exposure of private cars³⁰, the total estimated cost of their claims is almost a third of that of private cars and their average claim is broadly comparable³¹ with the average claim by private car drivers.

8.8 Collation of motor insurance figures: United Kingdom: 1999-2005

	Million vehicle years						
(a) Exposure	1999	2000	2001	2002 ¹	2003 ¹	2004 ¹	2005 ^{1,2}
Private car (comprehensive):	15.4	16.7	16.9	17.9	18.0	18.5	19.5
Private car (non-comprehensive):	3.0	2.9	3.3	3.3	3.3	2.9	2.7
Motor cycle	0.5	0.5	0.5	0.5	0.5	0.5	-
Commercial vehicle (including fleet)	4.9	4.8	4.2	4.5	4.5	4.8	5.2
All vehicles	23.8	24.9	25.0	26.2	26.4	26.7	-
(b) Number of claims	Millions						
Private car (comprehensive):	2.78	2.93	2.99	3.05	3.10	3.06	3.09
Private car (non-comprehensive):	0.27	0.24	0.29	0.29	0.25	0.31	0.21
Motor cycle	0.03	0.03	0.04	0.03	0.04	0.03	-
Commercial vehicle (including fleet)	1.08	1.03	0.95	0.88	0.85	0.83	0.96
All vehicles	4.16	4.23	4.26	4.25	4.24	4.23	-
(c) Estimated cost of claims	£ million						
Private car (comprehensive):	3,969	4,479	4,644	4,841	5,174	5,307	5,902
Private car (non-comprehensive):	630	643	756	846	889	862	850
Motor cycle	87	72	77	84	94	82	-
Commercial vehicle (including fleet)	1,882	1,885	1,835	1,904	2,052	2,157	2,380
All vehicles	6,568	7,078	7,311	7,675	8,210	8,408	-
(d) Claim frequency	Percentage						
Private car (comprehensive):	18.0	17.6	17.6	17.0	17.2	16.5	15.9
Private car (non-comprehensive):	8.9	8.2	8.9	8.7	7.7	10.5	7.8
Motor cycle	6.9	5.9	7.1	6.4	6.9	6.0	-
Commercial vehicle (including fleet)	22.0	21.3	22.3	19.8	18.8	17.3	18.6
All vehicles	17.5	17.0	17.1	16.2	16.1	15.8	-
(e) Average claim	£'s						
Private car (comprehensive):	1,429	1,527	1,553	1,590	1,671	1,734	1,908
Private car (non-comprehensive):	2,345	2,649	2,614	2,906	3,492	2,796	3,987
Motor cycle	2,722	2,623	1,985	2,437	2,632	2,639	-
Commercial vehicle (including fleet)	1,748	1,833	1,939	2,157	2,407	2,612	2,478
All vehicles	1,580	1,673	1,714	1,804	1,936	1,967	-
(f) Annual percentage change in claim frequency	Percentage						
Private car (comprehensive):	-	-2.2	0.3	-3.6	1.1	-4.1	-4.0
Private car (non-comprehensive):	-8.2	-7.9	8.2	-2.0	-11.4	36.1	-24.7
Motor cycle	-2.8	-14.5	19.5	-9.6	7.6	-12.6	-
Commercial vehicle (including fleet)	3.8	-3.2	4.9	-11.3	-5.1	-8.0	9.0
All vehicles	1.2	-2.9	0.4	-5.0	-0.8	-1.8	-
(g) Annual percentage change in average claim	Percentage						
Private car (comprehensive):	5.2	6.9	1.7	2.4	5.1	3.8	10.0
Private car (non-comprehensive):	12.7	13.0	-1.3	11.2	20.1	-19.9	42.6
Motor cycle	18.9	-3.6	-24.3	22.8	8.0	0.3	-
Commercial vehicle (including fleet)	-1.5	4.9	5.8	11.2	11.6	8.5	-5.1
All vehicles	3.5	5.9	2.5	5.3	7.3	1.6	-

The frequency of claims for HGVs increased by 9% in 2005, while in the same year the claim frequency for cars declined by 4% (comprehensive insurance) and 24.7% (non-comprehensive insurance). However, the figures for other years suggest there is little correlation between the type of vehicle and the frequency of claims.

³⁰ 'Private Cars' has been used to refer to private vehicles with both comprehensive and non-comprehensive insurance

³¹ Average claim of 'private car' drivers: £2,948

2.3.2.4 Load offences

The Home Office *Statistical Bulletin (England and Wales)* states that in 2004 12,800 load offences were dealt with by official police action³², however it is not clear from the bulletin what constitutes a load offence.

UK Courts have found drivers liable for loads shifting. In 2003, an HGV driver was stopped by police on the M25 with the nearside wheels of his curtain-sider trailer six inches off the carriageway. Two pallets laden with tinplate coils, completely unsecured to the trailer, had moved in transit and were only contained within the trailer by the curtain. The owner/driver was prosecuted for dangerous driving and was sentenced to £1000 fine, £235 costs, a 12-month disqualification and ordered to take a retest before renewing his licence³³.

While drivers can be prosecuted for insecure loads, action can also be taken against employers for insecure loads. A steel company and haulage firm were fined a total of £37,500 after steel beam fell from a vehicle and fatally injured the driver in 2005³⁴.

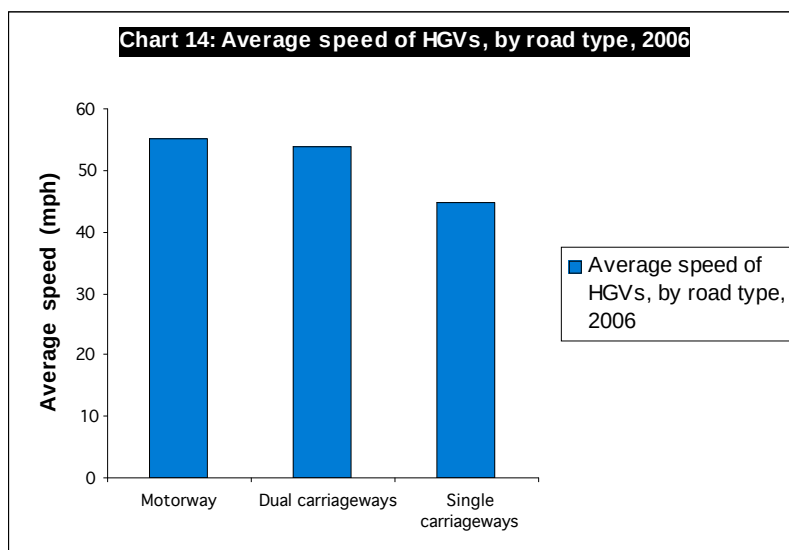
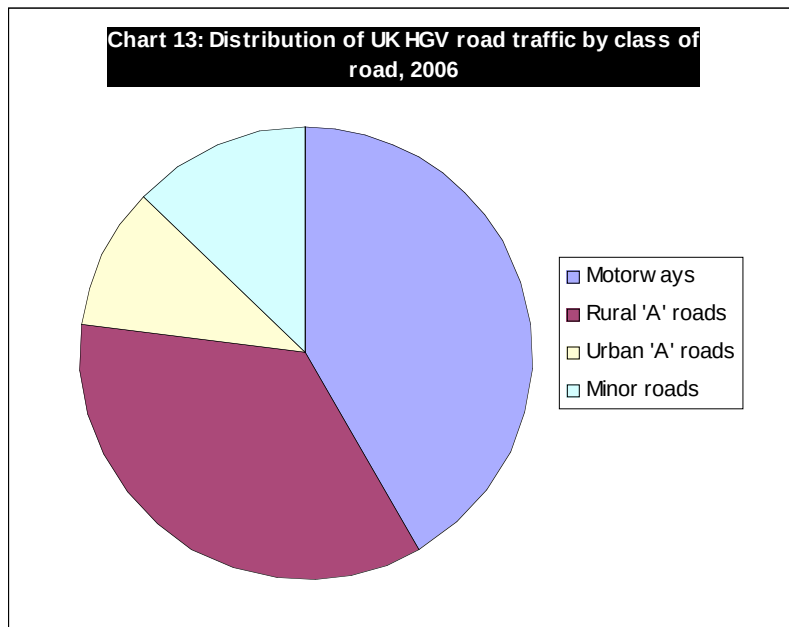
³² 'Official police action' being defined in this case as court proceedings, written warnings, fixed penalties and vehicle defect rectification notices.

³³ Source: Surrey Police – see Appendix E

³⁴ Source: GNN – see Appendix E

2.4 HGVS ON THE ROAD

The DfT statistics indicate that the vast majority of HGV journeys in the UK are either on motorways (42%) or rural 'A' roads (35%).



NB: The speed limit for HGVS is as follows: Motorways – 60mph; Dual carriageways – 50mph; Single carriageways – 40mph.

Although the data indicated that, on average, HGVs travelled below their speed limit on motorways, on other roads and particularly on single carriageway roads the average speed was above their speed limit.

2.5 PREVIOUS RESEARCH

The System Concepts Ltd scoping study for HSE³⁵ identifies particular areas of concern for falling loads, notably the paper industry (paper reels), and brewing (kegs).

While the focus of this project is primarily the issue of loads falling during loading/unloading and causing injury to those involved in these operations, the consequences of load movement during transit can also be serious. The TRL research report, *The Security of Cross Loaded Round Timber*³⁶, identified that, between 1991 and 1994, there were 1,202 incidents in the UK where a dislodged vehicle load in the carriageway caused an accident leading to injury.

Research carried out by Sheffield Hallam University for HSE³⁷ in 2003 concluded that there was little evidence to support changes in what was referred to as “existing best practice” (side strapping), except in the transportation of high centre-of-gravity loads where the risk of rollover could be mitigated by careful driving and maximum speed recommendations. The research focused on the risks of rollover during transit rather than load movement during loading/unloading.

TFK – the Swedish Transport Research Institute, in co-operation with MariTerm AB, prepared a report on the securing of paper reels, *Verification of level of basic parameters important for the dimensioning of cargo securing arrangements*³⁸, in 2004 to compare existing IMO/ILO/UN ECE Guidelines with the German VDI Standards for load securing and EN 12195-1. (The EU Best Practice Guidelines state that either the IMO/ILO/UN ECE Guidelines or EN 12195 can be used to dimension load securing arrangements.)

The efficacy of round-turn lashing³⁹ was also compared with that of over-top lashing and it was concluded that over-top lashings were more effective at preventing reels from tipping than round-turn lashings.

The US Society of Automotive Engineers carried out extensive research on the rollover of heavy commercial vehicles⁴⁰. The research suggested that:

...it is relatively hard for truck drivers to perceive their proximity to rollover while driving.

The report also states that, by their nature, HGVs are inherently less stable than small goods vehicles and private cars, and that high lateral accelerations can occur at relatively low speeds.

Sampson & Cebon, 2001⁴¹, looked at the roll stability of HGVs using numerical models and concluded that it was not possible to control simultaneously and independently all axle load transfers and body roll angles.

³⁵ System Concepts Ltd for HSE; *Sheeting and unsheeting of non-tipper lorries – A health and safety scoping study*; 2000

³⁶ TRL Limited for HSE; *Research report 077: The security of cross loaded round timber*; 2003

³⁷ Sheffield Hallam University for HSE; *Transport at Work: Rollover of lorries transporting paper reels*; 2003

³⁸ Nordstrom, R; Andersson, P; Sokjer-Petersen, S; *Verification of level of basic parameters important for the dimensioning of cargo securing arrangements*; 2004

³⁹ ‘Round-turn lashing’ refers to the practice of binding a number of items together to form a single unit. This can be horizontal or vertical, and it is intended to increase stability.

⁴⁰ WINKLER, C.B, BLOWER, D.F, ERVIN, R.D & CHALASANI, R.M; *Rollover of heavy commercial vehicles*; SAE 2000

⁴¹ SAMPSON, D.J.M. & CEBON, D; *Achievable roll stability of heavy road vehicles*; Proc. IMechE, Journal of Automobile Engineering (2001)

Transport Engineering Research New Zealand (TERNZ) carried out research⁴² for the New Zealand Land Transport Safety Authority to investigate the effect of vehicle stability on accident rates. The study found that, compared to Australia, USA and Europe, New Zealand has a high percentage (29%) of reported rollover incidents. Of the incidents investigated as part of the study, 40% involved vehicles that did not meet the SRT⁴³ (Static Roll Threshold) target value of 0.35g expected in New Zealand.

The inherent instability of HGVs was also investigated the *Guidance on Good Practice*⁴⁴ produced by the Corrugated Packaging Association, Paper Agents Association and The Paper Federation of Great Britain.

Testing of reels with diameters of 2.5 and 2.8 m was carried out by MIRA and this appeared to show that the reels were stable when sidestrapped, although the speed of the vehicle and details of the test track for the tests were not quoted.

The Guidance considers the use of sidestrapping for paper products and states:

Curtain sides trailers, with rated load bearing curtains are to be used in preference to those that merely provide weather protection.

...

It is always better, if possible, to load from the headboard. This will help to minimise any forward movement of the load during transit. When load distribution does not permit this due to drive axle overload or other weight constraints, then forward restraining measures must be employed with the first reel on the off side to help counter natural road camber.

The Guidance also gives examples of Safe Systems of Work for loading reels.

MIRA carried out research for HSE in 2004 to investigate the stability of Tarmac products and the report⁴⁵ recommended that, amongst other points:

Payloads should be loaded tight to the headboard to prevent load shift during braking.

...

Webbing ratchet straps are the preferred method of load restraint, but should only be used on centre gap payloads in conjunction with adequate dunnage...

...

The headboard should be considered to be an integral part of the restraint method.

...

Anchorage points on the semi-trailer should be distinguished from roping hooks and should have their rating indicated on the vehicle.

⁴² MUELLER, T.H, DE PONT, J.J & BAAS, P.H; *Heavy vehicle stability versus crash rates*; TERNZ

⁴³ The SRT is defined as the maximum steady turning lateral acceleration without rollover

⁴⁴ *Safe transport of reels of corrugating case materials by road – Guidance on Good Practice* (2001)

⁴⁵ Research report 272; *Load Security Investigation*; MIRA Ltd

BOMEL Ltd carried out research for DfT to investigate the link between company safety culture and work-related road accidents⁴⁶. The research found that, although smaller companies often lacked the safety management systems of larger companies, the larger companies were not necessarily better at addressing driver safety management.

Time pressure was identified as a significant risk factor for HGV drivers, along with road design, other road users and loading/unloading restrictions. The three most significant factors for risk reduction for HGV drivers were found to be planning, fatigue and management/supervision.

Case studies in the research report identified issues such as poor route planning, carried out in an ad hoc fashion, and confused lines of responsibility for self-employed contract drivers.

PSL carried out research for HSE⁴⁷ to investigate drivers' perceptions of the hazards surrounding loading and unloading of HGVs and LGVs. The report identified a number of issues, including manual handling, vehicle/pedestrian segregation, load security and training. Lack of communication was also identified as an issue, particularly in terms of identifying possible hazards such as restricted access for unloading in advance and passing that information on to the driver.

Middlesex University Business School carried out research for HSE⁴⁸ to investigate health and safety attitudes and behaviour in small businesses. The report identified that although awareness of specific health and safety legislation and guidance in small businesses was considered to be low, this did not necessarily correlate with poor practice and/or an unwillingness to operate safely. Risk assessment and health and safety management tended to be more informal and less structured, however, than the more systematic approach that might be adopted by a larger company. Cost was considered to be a significant issue for small businesses in complying with health and safety requirements.

IWHO and Loughborough University carried out research for HSE⁴⁹ on industry perception of the cost implications of health and safety failures. The research identified that organisations were concerned about the potential costs of major incidents but appeared to be less concerned about actual costs due to more frequent, minor accidents and/or work-related ill-health. Other concerns were identified which appeared to be more influential in improving health and safety performance; this included increased insurance premiums, effect on corporate image and reputation, customer and client expectations, lowered staff morale, and reduced productivity.

⁴⁶ BOMEL LTD; *Road Safety Research Report No. 51 – Safety Culture and work-related road accidents*; Department for Transport, 2004

⁴⁷ PSL; *Safe sites: Driver's perceptions*; HSE Research Report 276 (2004)

⁴⁸ Middlesex University Business School; *Cultural influences on health and safety attitudes and behaviour in small businesses*; HSE Research Report 150 (2003)

⁴⁹ HAEFELI, K, HASLAM, C, & HASLAM, R; *Perceptions of the cost implications of health and safety failures*; Institute of Work, Health & Organisations and Loughborough University for HSE (2005)

2.6 SEMINARS, CONFERENCES AND OTHER INFORMATION SOURCES

2.6.1 Paper industry seminar

A seminar was held at HSL in June 2007 to explore a number of issues related to load security within the paper industry. Attendees were split into four focus groups and the three main issues discussed are dealt with separately in the following sections.

2.6.1.1 *Experience of load shift*

Most companies had experience of load shift on their vehicles, which was felt to have contributed to rollover on the road and to incidents during unloading. It was noted that, after an accident on the road, it was often difficult to conclude whether a load shift had initiated a rollover or loss of control, or whether the accident itself had caused the load to shift.

Some companies had specific procedures for dealing with vehicles arriving with shifted loads, such as moving them into an isolation area and unloading from the other side of the vehicle. Others had no specific procedure for dealing with such loads.

It was recognised that load shifts had implications for product damage as well as the risk of death and injury to workers. The financial implications of such product damage could be significant.

2.6.1.2 *Methods of load restraint*

Many companies relied on a combination of the friction between the load and the trailer bed and the suspended sidestraps.

A number of attendees expressed concerns about the side slats used primarily by European vehicles. It was felt that the slats restricted the load that could be carried, slowed down loading, and had implications in terms of manual handling and working at heights.

There was considerable awareness of different methods of load containment, such as secondary curtains and side gates. There appeared to be less awareness of the difference between load containment and load restraint.

Concern was expressed regarding the risk of using load securing equipment, particularly in terms of accessing the trailer bed. It was also felt by a number of attendees that fitting load securing equipment significantly slowed down the loading and unloading time.

2.6.1.3 Responsibility

Responsibility for load security was a much-discussed issue at the seminar, as it would prove to be during site visits. All attendees were very aware of the requirement of the Road Traffic Act that the driver be responsible for the load at all times, but a number also admitted that on their premises the driver was not allowed to witness the loading and was not encouraged to inspect the load prior to taking charge of the vehicle.

2.6.2 5th DEKRA/VDI-Symposium 2007 "Securing of Loads on Road Vehicles"

The load security symposium held by DEKRA/VDI in October 2007 brought together industry and regulatory stakeholders from across Europe to discuss issues relating to load securing for road transport.

The majority of issues raised reflected those raised by UK industry in the course of the research. The suitability of packing materials, particularly shrinkwrapping as a method of load containment, was discussed. It was felt that often shrinkwrapping alone was insufficient, particularly with heavier loads, and some packaging material was not rigid enough to sustain the forces applied by load restraint equipment.

A paper⁵⁰ was presented by the Norwegian Public Roads Administration on the current state of affairs regarding load security in Norway. Norwegian HGV drivers are required to undertake 9 hours of study specifically on load securing as part of their commercial licence and the criteria for this study is set out below:

The candidate must:

1. know

- a) the main requirements regarding securing of loads and securing equipment*
- b) that there are special requirements regarding securing when two or more different means of transport are used in the same chain of transport*
- c) that it may be necessary to obtain further information when securing special loads*

2. experience through demonstrations and practical work

- a) that loads that are incorrectly secured may fall off*
- b) the forces which affect the loads in the forwards, backwards and sideways directions during driving*
- c) how normal goods will move by increased speed and by braking*
- d) how goods that may roll move during increased speed and during braking*
- e) that movement of the goods and braking are influenced by friction*
- f) whether different weight influences on the movement of the goods or not*
- g) whether heavy weight (1000 kg) prevents the movements of the goods or not*
- h) that use of incorrect securing equipment may lead to displacement of goods or to goods falling off*
- i) consequences of miscalculation regarding the quality of the equipment*

3. be able to estimate e and choose correct securing equipment by

- a) planning the securing of different types of goods*
- b) be able to assess methods for securing of loads such as winding, locking and covering*

⁵⁰ FUHR, K.I. & TOVEN, D; *Ladungssicherung auf Straßenfahrzeugen in Norwegen*

4. be able to safely secure various types of loads by

- a) securing different types of goods, including goods that may roll, stacked goods and loads with a high net weight
- b) carry out assault winding, halter winding, loop winding, direct winding/cross winding, locking, closing and covering

5. have someone demonstrate to find out whether the securing of goods has been safely done or not by

- a) braking and turning of vehicle
- b) tipping of load to current angle
- c) inspecting the securing equipment after testing

6. be able to

- a) maintain and to decide whether the equipment for securing of loads is in a satisfactory condition or not
- b) use necessary protective equipment such as working clothes, gloves and protective footwear.

This training is reinforced by inspection by the Public Roads Administration and the police. 48,517 vehicles were inspected in 2006, of which 88% were found to have acceptably-secured loads.

Speakers from the German haulage industry commented on the time pressures drivers and loaders were under, and the problem of insufficient training on load securing. It was stated that drivers do not have the time (or necessarily the ability) to carry out complex calculations as to whether load securing on their vehicle is adequate or not.

Comment was made as to the lack of understanding among drivers of how much lashing is required, how the lashing angle affects the number of lashings required and the importance of tensioning the lashings correctly. An over-reliance on the (often unknown) strength of the trailer superstructure was also mentioned as an issue.

The condition of load securing equipment was felt to be a significant issue, with straps and chains often used well beyond their service life.

Inconsistency in enforcement was cited as a particular issue in Germany, with the comment made more than once that what would be deemed acceptable in Bavaria would lead to a fine in Rhineland-Palatinate.

Examples were given by an accident investigator of accidents that had occurred on German roads due to insufficient load securing. It was noted that, following accidents, the company concerned would often state that they had experienced no issues prior to the accident.

Three examples were given: one was a rollover on a slip road, one a rollover on a long, sweeping bend and the third was an incorrect axle load.



The consequences of accidents on the road can be severe, as the photograph above, taken from the presentation, shows.

The photograph shown on the right was presented as an example of good load securing practice. The load is secured through a combination of load restraint (webbing overstraps with edge protectors) and load containment (chocks and side slats).



2.6.3 Other information sources

Information and anecdotal information was collected from a number of sources during the course of the research project from events such as the Commercial Vehicles Show, informal stakeholder discussion, unpublished research reports commissioned by individual companies, and the RDAG⁵¹ Working Group. Four fatal/serious injury accidents involving load shifts on trailers were also investigated by HSL during the life of the project.

It is not proposed to detail the information received from each of these sources; in some cases information was given to HSL in confidence, and in some cases the information cannot be disclosed as court proceedings are pending. However, information obtained from these sources generally reflected information obtained during site visits and quoted sources.

One issue that was brought out was that load shift on the road leading to vehicle loss of control and/or rollover often occurred in particular circumstances; specifically, roundabouts, bends in the road and evasive manoeuvres (for example, if a car pulled out in front of the HGV, causing the HGV driver to swerve).

Often the resultant accident appeared to be blamed on the driver, excessive speed often being quoted, or the road surface. Comment was made that, in the wake of an accident, it was often difficult if not impossible to ascertain whether a load shift had been the causative event or whether the load shift was a consequence of the accident.

The GDV Transport Information Service gives monthly examples of bad practice in load securing in European countries (primarily Germany) and several examples have been taken from this as illustrations of the consequences of load shift. These can be found in Appendix F.

Poor communication was identified as an issue in accidents. In one case, the accident could probably have been prevented by the use of a simple sketch showing the type and position of the restraints. BS EN 12195-1 gives an example of a docket⁵² that can be used to convey information about a load and the restraint methods used, and it was felt that this system could be easily adapted to suit an individual company's methods of working.

⁵¹ Road Distribution Action Group

⁵² Shown in Appendix J

2.7 SITE VISITS

Site visits were carried out to eight companies on eleven sites between October 2006 and March 2008. The normal loading/unloading operation was observed and, where possible, drivers and/or loaders were questioned.

2.7.1 Company 1

Company 1 are a major distributor of printed matter such as newspapers and magazines. Palletised goods are transported to the distribution centres from the publishers of these titles, primarily using curtain-sided lorries operated by three main hauliers. The hauliers are contracted by the publishers rather than by Company 1.

Prior to the visit, Company 1 estimated that approximately 10% of the loads delivered to their distribution centres arrive with all or part of the load having shifted.

Newspapers and magazines are delivered to the distribution centre from the printers by a contract haulier and its subcontractors on curtain-sided vehicles, although occasionally “late runs” of particular titles are delivered by light van. Deliveries of newspapers to the warehouse begin at 1/1.30 am in the morning and are supposed to be completed by 3.30am so that delivery rounds to retailers can begin. Deliveries are made 7 days a week, although Saturday is the busiest day of the week.



Each title generally arrives in bundles on a pallet, although some (typically magazines with free gifts or part-works⁵³) arrive in low stillages or stacked cardboard boxes. The bundles, which appear to generally comprise 14 items, are cross-banded together. The Company stated that a bundle should weigh no more than 17kg and that a pallet load

⁵³ Part-works are magazines produced in a series to build a collection.

generally consists of 60 or more bundles, hence the weight of a single pallet can be in excess of 1 tonne. Brown paper is sometimes placed between layers of bundles and some, but not all, pallet loads are shrinkwrapped. The maximum height of the load in the trailer is supposed be no more than 1.8m but The Company stated that it often exceeds this, as the pallets can be stacked.



Once the curtain-sided vehicles arrive at the distribution centres, the pallets are unloaded using forklift trucks. There are no pedestrians apart from the lorry driver in the vicinity of the unloading bay. The palletised loads are then sorted for distribution to retailers, generally transported using small vans.

There are two areas for sorting the deliveries: one for newspapers and one for magazines. The bundles of each title are separated by the packers and sorted into new bundles for deliveries to retailers (i.e. a retailer's bundle might consist of only 8 copies of a particular title, from the original bundle of 14).



There is a distinction between newspapers and magazines – the newspapers are re-packed in cross-banded bundles at the packing station (above), while magazines are sorted on a conveyor belt system and packed into stackable plastic boxes that are then security sealed.

The newspaper bundles and magazine boxes for the retailers are then loaded into light vans for delivery.



There are 60 employees at the site visited, as well as 23 contractors. The contractors are “white van” self-employed drivers – 7 of them pack their own rounds while 16 solely deliver. The contractors are employed on fixed-term contracts and most work every night of the week. They are paid based on the number of deliveries and their mileage.

Employees in the warehouse generally work 6 nights on/1 night off. The Company stated that formal and on the job training on loading is given to both employees and contractors. The Company stated that there are moves to reduce the number of contractors by employing more drivers directly.

The warehouse has 42 customers, however 4 of those customers collect from the warehouse rather than receive deliveries.

During the visit, 8 deliveries arrived at the warehouse. 7 of these were made by curtain siders; 1 (a late run) was made by light van. 4 of the curtain siders were TNT vehicles; the other vehicles were operated by sub-contractors.



Only one of the curtain siders arrived at the warehouse with a full load. Two of the vehicles had already made a delivery to another warehouse and subsequently arrived at the Company with pallets on only one side of the vehicle. In both cases this had led to a noticeable tilt to the vehicle. In every delivery apart from that made by light van at least some of the bundles had shifted and, in one case, a pallet load had fallen from the pallet and had to be manually unloaded by the driver. Shrinkwrapping did not appear to offer much resistance to load shift. None of the trailers arrived with any method of load restraint in use.



The Company stated that the Company's staff are under instructions not to climb onto trailers to assist in unloading if a load has shifted. However, the Company stated that on one occasion this had been done due to an escalating situation with the haulage contractor.

Generally, if the load has shifted to the extent that it is judged unsafe to be unloaded by the company's personnel, the Company that it should either be manually unloaded by the driver or the trailer sent away.



The light van arrived heavily loaded with three pallets. The pallets were unloaded by fork lift.

It was estimated that more than half of the loaded pallets arriving at the warehouse during the visit had at least minor damage. The Company stated that if the load arrived severely damaged (unsaleable), it would be the publisher who bore the financial cost of reprinting and the later delivery.

The Company had 478 RIDDOR-reportable accidents in 2005/06 across all 45 sites, although the Company stated that there was significant variation in levels of reporting at different sites. Approximately 30% of those were manual handling injuries, with slips and trips and being struck by falling objects being the next two most significant categories.

Issues for Company 1

- Unloading is extremely time-critical.
- Loads arriving having shifted in transit, causing difficulties and delays in unloading.
- Load shifts leading to manual handling of heavy bundles and risk of falls from vehicles.
- Company 1 does not employ the hauliers and therefore feels unable to improve the current situation.

2.7.2 Company 2

The Company operates from four mills and has a turnover in excess of £300 million per annum and around 1700 employees. The four mills, producing corrugated case materials and specialist industrial products have a combined production capacity of almost 900,000 tonnes per annum.

The site visited, the largest in the Company's group and one of the largest recycling mills in Europe, has a capacity in excess of half-a-million tonnes per annum.

The Company has its own in-house haulage operation which operates 210 vehicles and has 730 trailers on the road. Paper in its various guises makes up over 90% of its workload and represents the full cycle of paper use, from new reels to finished packaging and then collecting waste for recycling.

Waste paper is brought in to the site in bundles to be pulped; the pulp is then used to manufacture paper, which is sent out in reels.

The Company stated that there are 250 employed drivers working from the site, with a further 15 sub-contract hauliers who are expected to follow the Company's procedures. Loading is carried out by employed loaders (40 staff over 3 shifts) and drivers are not intended to be part of the loading process, although areas are provided for them to watch the loading if they wish to.



Approximately 100 loads a day are sent out from the site. Reels are loaded with clamp trucks and restrained using side strapping. Rails at the sides of the trailer are preferred

to a central rail. One strap per reel is standard. The Company stated that the loading time per trailer was between 20 and 40 minutes, but that overstrapping increased that to 2 hours.

No rating labels were observed on the sidestraps; the comment was made that straps usually break before the rail fails.

The Company stated that tilt trailers are not allowed on site due to the delays caused in the loading process.

Some of the sub-contract hauliers operate trailers without side straps; these loads are overstrapped by the driver.



Edge protectors are used with these straps.

Access steps are provided for the drivers. The driver alone carries out the overstrapping.

Bundled waste for recycling is brought into the site with side strapping.



Reels generally weigh between 1 and 2 tonnes, while I was informed that waste bundles weigh between 0.3 and 0.6 tonnes.

The Company stated that, per annum, they transport 175,000 loads and vehicles travel 18.5 million miles.

Accident rates and typical injuries were also discussed. The Company stated that the majority (62%) of the injuries were due to slips/trips and what was termed “trailer issues”. This included injuries due to use of straps. A further 12% of injuries were due to falls from height.

Issues for Company 2

- Sidestrapping was preferred as it was felt that overstrapping would significantly increase loading times.
- Loading is carried out by employed loaders and the driver is not directly involved.
- The haulage operation is largely in-house.

2.7.3 Company 3

Company 3 is one of the world's leading forest products groups. The company's businesses focus on magazine papers, newsprint, fine and speciality papers, converting materials and wood products.

The Company has production in 15 countries and an extensive sales network comprising over 170 sales and distribution companies. The Company's main market areas are Europe and North America. The group employs approximately 28,000 people.

Two sites were visited: a ferry port terminal where goods are received and loaded onto trailers for distribution and a mill.

The ferry port terminal receives goods for three companies, however it is primarily for the Company's use. The terminal normally receives three shipments a week.



Paper is unloaded from incoming ships on reels of varying sizes. It is stored in a warehouse and then distributed using curtain-sided lorries. The Company employ hauliers to transport the reels and have recently produced a guide to load handling which they distribute to their hauliers.

Loading of the curtain-siders is carried out by employees of ABP⁵⁴ using clamp trucks, with an employee of the haulier acting as banksman. The driver is not usually present, although in one observed loading operation the driver was present.

⁵⁴ Associated British Ports

The first trailer to be observed during loading is shown below.



The reels are loaded in the horizontal position, held in place with chocks and overstrapping. Although webbing straps can be seen on the trailer, The Company stated that they do not use side strapping because they do not feel these are effective as a method of load restraint.

The trailers are fitted with the Joloda loading system and the chocks fit into holes in the floor of the trailer. The photograph below shows the older design of chock (painted black) and the new design (painted yellow).



The chocks can be seen in more detail in the photograph on the following page:



The chocks are manually adjusted and it was noted that there was a potential issue in the banksman having to climb onto the trailer to secure the chocks in the middle of the bed, although the outer chocks could be secured from ground level. It was stated that the chocks in the middle were secured into place before the reels were loaded onto the trailer, and adjustments were only made to the chocks on the outside of the bed. The method of adjustment is shown in the photograph below.





The type of clamp truck used in the loading operation is shown in the photograph to the left.

The reels are lifted onto the trailer by the clamp truck, as shown in the photograph below.



The position of a reel against a chock is shown in the photograph above.

It was noted that there were problems with the new design of chock tending to “flip up” underneath the reel. The Company acknowledged that this was an issue with the new design and stated that they did not know why Joloda had changed the design but that it was likely to be an issue of manufacturing costs.

Once the reels are in place, overstrapping is carried out. Two straps per reel are used.



It was noted that there were substantial voids in the trailer and that the reels were not placed up against the headboard. The Company were aware of this as an issue but expressed concern at whether airbags would be substantial enough to restrain the load in the longitudinal direction and stated that they could not load such large reels further forward due to weight distribution on the trailer.

It was stated that the straps on the rear reels were “worn” however there seemed to be no formal system for inspection and replacement of webbing.

The Company felt that the current system of load restraint was not sufficient in the longitudinal direction. They were considering using the Joloda chocks to restrain the load. There was a discussion regarding the possibility of constructing a frame secured

to the Joloda floor system, and the Company stated that they were intending to consult with Joloda over the feasibility of this. It was acknowledged that there were problems with this idea because the reels were not necessarily loaded so that they lay exactly in line, as shown in the photograph below:



Any misalignment could cause issues for fitting longitudinal restraints.

The photograph below shows the second loading operation observed. In this case the reels were loaded against the headboard.



This trailer was also fitted with side straps. These were attached to a single central rail rather than a continuous rail around the sides of the trailer.



Following the visit to the ferry terminal site, a further visit to the Company's paper mill was carried out. Between 70 and 120 loads are sent out from the mill every day, and each load is worth approximately £10,000. Reels are loaded in both horizontal and vertical orientation. Most reels weigh between 1000 and 1500kg⁵⁵.



⁵⁵ Approximately 2200-3400 lbs



The Company currently use two hauliers for UK deliveries, one specifically for the Isle of Man and two for export, however they are moving to a system of a lead haulier and subcontractors when required.

The reels loaded horizontally are restrained by the same type of chocks seen at the ferry terminal site, however it was noted that the reels were loaded so that they were tight against the headboard. Visually the chocks appeared to be used differently and it was suggested by employees that they were not being adjusted correctly at the terminal.



Loading was carried out using clamp trucks as at the terminal, however these clamp trucks had side shift, enabling the reels to be placed with more precision.



The loading and load restraint was carried out by employees of the haulier and the driver was not involved in the process. The particular loaders at the time of the visit had been following the new system for two weeks. The Company stated that often the warehouse shunters were former HGV drivers who had lost their HGV licences for various reasons⁵⁶.

The issue of training was raised and the Company stated that training was on-the-job but they were considering bringing in a more formal system.

The securing system for carrying reels in a vertical configuration was that, after the trailer was backed into the warehouse, strips of friction matting were laid along the trailer bed, as shown in the photograph below.



⁵⁶ Diabetes was mentioned as a specific example as a reason for not being able to drive on the highway



The trailer was then loaded by clamp truck, before a mobile gantry was brought to the side of the trailer when the trailer was fully loaded. The use of the clamp truck is shown in the photograph to the left.

The gantries were used as a working platform for the two loaders to fit edge protectors to each reel and strapping across each pair of reels. The loaders noted that the gantries enabled them to remain in visual contact.

The Company stated that two of them could do this in 15 minutes for most loads, though a more awkward load with smaller reels stacked two high⁵⁷ might take them up to 30 minutes. Both also reported back and shoulder pain that had started within the previous two weeks.



⁵⁷ The loaders have been instructed to split blocks of two reels and place friction tape between the reels

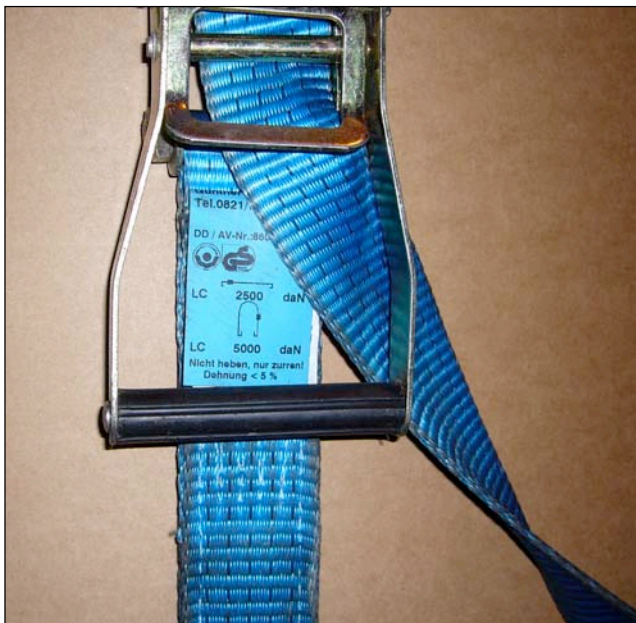
Unlike the loading seen at the terminal site, the reels were loaded tight against the headboard.

The Company had been trialling different types of edge protectors for their reels.



The type in the photograph to the left was considered to be too flimsy for use and a more substantial design had been decided on instead, however the Company felt there were issues with removing edge protectors from reels after use and are investigating methods of removing them from ground level.

The webbing straps were provided by the haulier. Responsibility for inspecting the straps was described as being down to the driver and there seemed to be no formal discard criteria.



The straps observed on site had a lashing capacity of 5000 daN, as shown in the photograph on the left.

As an alternative to using curtain-siders, the Company have begun to use solid-sided trailers to transport reels. These are already used to bring in loose waste and hence there is some impetus to get double use from these vehicles.

The reels are loaded onto the trailer by a clamp truck and the trailer itself is fitted with a walking floor.



The material underneath the reels is purely to prevent the reels spinning on the walking floor and is not friction matting. No restraint is applied to the reels. It was noted that there were substantial voids (approximately 20 cm) along both side walls and down the centreline of the trailer between the two rows of reels. It was stated that there was no need to use load restraint in a solid-sided trailer.

Company 3 issues

- Loading is carried out by either the haulier or by a third party at the ferry terminal. Drivers are not usually involved.
- Overstrapping is used but there are issues with edge protectors becoming dislodged during unloading, with the risk of them striking personnel.
- New loading methods had led to complaints of MSDs amongst loaders. An ergonomic study was commissioned and this is detailed in Appendix B.

2.7.4 Company 4

Company 4 is one of the world's leading logistics company's with 54,000 employees, at 850 locations in over 100 countries. The company delivers end-to-end supply chain solutions for major industries including high-tech, retail, fast-moving consumer goods, pharmaceutical/healthcare, industrial, chemical, aviation and automotive industries. In the UK, the Company operates across England, Scotland, Wales and Northern Ireland.

The site visited is a warehousing and distribution centre run as a partnership between Company 4 and the client.

The site visited is a warehousing and distribution centre for the drinks logistics division, where two sizes of curtain-sided vehicle for distribution are in use: larger vehicles for the "primary" transportation of goods to the warehouse and from the warehouse to retailers and wholesalers, and smaller vehicles for the "secondary" distribution of goods from the warehouse to pubs and clubs. On a daily basis the warehouse sees approximately 80 "secondary" and 50-60 "primary" loads leave, as well as 80-90 loads in. The average value of a load on a "primary" vehicle is £80,000. It was stated that, in case of loss, the company would cover it due to the large excess on its insurance policy.

The Company employs approximately 40 "primary" drivers and 65 "secondary" drivers at this site, with agency drivers employed to meet additional seasonal demand. Within the warehouse, there are 12 shunters (working 3 shifts, 4 per shift) and 45 forklift drivers (15 per shift). The warehouse is shown below.



There are 95 sites in the UK of which 30 are dedicated to drinks logistics. Most of the drinks division sites are “secondary” operations.

The primary and secondary operations are run differently, and have different load security issues as a result of the types of operation involved. The secondary operations are multi-drop and town centre focused whereas the primary operations have less drops and tend to deliver to other distribution centres.

Drivers of the “secondary” vehicles have an increased risk of manual handling injury since deliveries involve a considerable amount of lifting and access to confined spaces/cellars. I asked about injuries to the “primary” drivers and was told that when an injury occurs, it is generally as a result of pulling the curtains across.”

On both “primary” and “secondary” vehicles, the Company use inner curtains as a method of load containment. The inner curtain on a “primary” vehicle is shown in the photograph below.



A “sail” is fitted at the rear of the trailer to provide rear containment, and this is shown in the photograph on the following page.



An example of the curtain fitted to a loaded trailer is shown in the photograph below



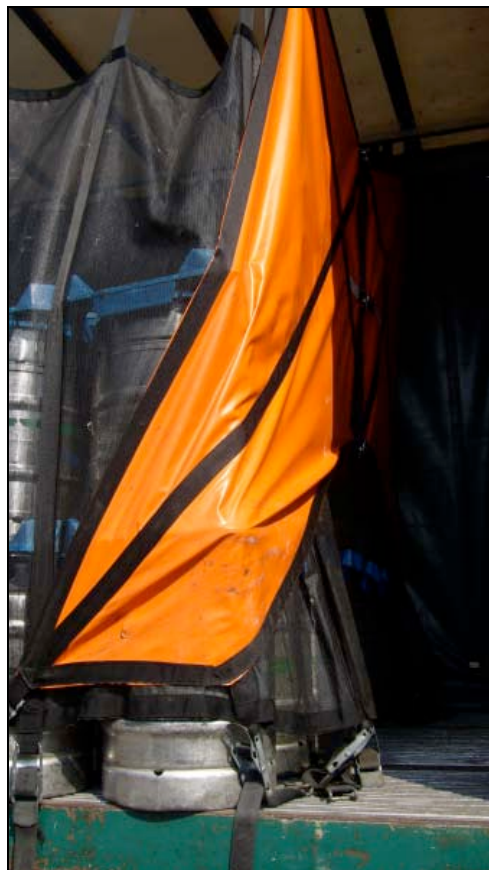
The inner curtain on another trailer is shown in the photographs on the following page.



There was damage to the inner curtain in the form of a tear approximately 500x500 mm but this did not seem to be a cause of concern to the operator. I asked what would contain the load if the inner curtain failed and was told "the curtain". I was told that the Company had suffered a number of tipovers but loads had not been ejected from the trailers, although in each case the roof of the trailer had been destroyed.



The inner curtain was secured to a rail running the length of the trailer. Again, the “sail” was used to provide rear containment



A “secondary” vehicle is shown below. No inner curtains were fitted to this vehicle.



The “secondary” vehicle below had inner curtains fitted but the driver indicated that they were often not used, or pulled only partly across, because of the frequency of loading and unloading.



I noted that the “secondary” vehicles carried a greater variety of loads, and that the load was arranged primarily by the delivery order, hence there were often voids or loosely stacked items.



Kegs are stacked for delivery on plastic moulded pallets. It was observed that there were different designs of pallet and it was stated that design depended purely on manufacturer rather than application.

Two different designs are shown below.



The pallets are also used to store kegs in the warehouse and outside



Drivers are not involved in loading/unloading, although it was stated that the driver is allowed to inspect the load if they wish.

Company 4 issues

- Losing a load due to rollover is a significant financial loss for the Company, as the financial loss would be borne by themselves rather than the insurance company.
- Most loads are mixed loads consisting of different sizes of kegs, perhaps mixed with palletised loads.
- On the secondary vehicles multiple stops may be made, necessitating repeated access to the trailer bed to manually unload and then rearrange the remaining load.

2.7.5 Company 5

The Company supply car parts to a major car manufacturer on a Just In Time (JIT) basis. Their lorries go out to a number of suppliers on a set weekly timetable and bring palletised loads back to the warehouse, where they are stored ready to be dispatched to the car manufacturer as and when they are required. The JIT system means that any delay on the Company's part holds up the car manufacturer production line. The specific load of any particular lorry is dictated very much by the car manufacturer, who also impose constraints on other aspects of the loading. The car manufacturer contract brings in £7 million a year in revenue for the Company; each lorry load has a value of approximately £200,000.

The Company employ 39 drivers and 21 warehouse staff at their site, which runs 24 hours a day. The warehouse staff are organised into three shifts of 6 workers per shift, plus a team leader.

Car components arrive at the warehouse in a variety of containers; eight different types of container were counted on one lorry. Some of these interlock vertically, such as the stillages. Smaller containers stacked on pallets were sometimes, but not always, banded.

The car manufacturer dictate the loading plan for the journey from the site to the car factory i.e they know which components they want to unload first and hence the lorry is loaded accordingly by the Company. The Company operate a policy of loading using fork lift trucks and personnel are not allowed to climb onto the trailer.

The time taken to load at each separate supplier was estimated to be around 30 minutes. However, loading each lorry for the car manufacturer was estimated to take 3-4 hours.

It was initially stated that the driver was responsible for overseeing the loading operation, although no drivers were observed within the warehouse. Later, it was conceded that each trailer was loaded solely by the warehouse staff. Once the trailer was fully loaded (but before the curtains were fastened), the team leader was responsible for checking the load and the trailer would then be shunted into the yard. Only at this point would the driver arrive; it was stated that the driver should check the load and then fasten the curtain; however, at this point, it seems likely that that check would involve simply lifting the edge of the curtain for a brief visual inspection as it would not be possible to fully check the load.

The current primary method of load restraint appeared to be friction between the load and the bed of the trailer. The Company stated that, if the driver knew the receiving loading bay was sloping, the rearmost two stillages would be restrained with webbing straps, but that webbing straps were not generally used. It was stated that the car manufacturer actively discouraged the use of webbing straps as they unload by driving fork lift trucks onto the trailer bed and felt that straps were a potential hazard to the fork lift drivers. It was noted that two trailers had remnants of webbing straps attached to the centre pole in the roof; the straps had clearly been cut.

The difficulties of fitting straps with the high pallet stacks used without personnel climbing onto the trailer was discussed. Those interviewed estimated the extra time

required to fit straps to be 15-30 minutes. All three drivers said they personally had used webbing straps.

I observed some new webbing straps in the warehouse. These were marked as rated for 2000 daN. It was stated that there was no system for inspection as straps tended to “vanish” within a very short time. Reference was made to side slats being mandatory in Europe, with the comment that such things were not needed in the UK.

None of the drivers had received training on securing loads. The warehouse staff received in-house training but the actual details of this were rather vague, other than the requirements for driving a fork lift truck.

Employees were adamant that responsibility for the load lay solely with the driver.

During the visit two foreign trailers were examined: a Dutch trailer and a Slovakian trailer. The Dutch trailer was not fitted with side slats however the Slovakian trailer was. The slatting took the form of short aluminium sections mounted into three pillars to divide the length of the lorry into 4 bays. To a height of approximately 400 mm, the slats were stacked to form a solid side, with three additional slats then spaced to the top of the trailer.

The feasibility of modifying the Company's existing vehicles to use these side slats was discussed however there were concerns over the cost of aluminium slats and the practicality of modifying pillars.

It was later stated that the car manufacturer had proposed a slatted design to prevent their forklifts running over the edge of the trailer when unloading.

The Company have had a previous incident, which is part of an ongoing investigation. The general view appeared to be that the main problem was loads moving forwards or backwards, and that lateral load shift was not a significant issue. It was noted that on many of the packed lorries waiting to go out there were gaps at the front or rear of the trailer.

The frequency of such longitudinal shifts was estimated at approximately once every six months. Most near-misses were said to be due to pallets falling from fork-lift trucks and indeed one such incident was witnessed during the visit.

The contract with the car manufacturer seemed to preclude a certain amount of rethinking on the Company's part: they themselves did not dictate the loading plan. Any intervention that significantly increased the loading/unloading time (> 1 hour) was seen to have the potential to adversely affect their relationship with the car manufacturer. Slowing down the line to implement new methods of load restraint would probably require a complete overhaul of their loading schedule to ensure they still made their deliveries at the times dictated by the car manufacturer.

The Company build in a 4 hour cushion for deliveries to the car manufacturer and insist they have never missed that, apart from the previous accident. Recurring late deliveries risked the car manufacturer switching to another logistics company, since their entire production line depends on the Company's deliveries.

The issue of staff absent from work was discussed, for both drivers and warehouse staff. In the short term (1-7 days), an absence could be covered through paid overtime;

however the issue became more problematic with longer absences. Drivers could be replaced by agency drivers, but the warehousing system the Company operate is relatively complex and it would be difficult to recruit and train new warehouse staff. This did not seem to be an issue which had been given a great deal of consideration.

Company 5 issues

- Loading is dictated by their customer. Losing the contract with that customer would be financially disastrous.
- Deliveries are extremely time-critical and any delay would incur the customer's displeasure.
- The customer does not wish sidetrapping to be used.
- Drivers and loaders are mainly employed directly, although some deliveries to the warehouse are made by sub-contracted drivers.
- Drivers are not involved in the loading.

2.7.6 Company 6

Company 6 is a global consumer goods and paper company, producing and marketing personal care products, tissue, packaging solutions, publication papers and solid-wood products. Annual sales in 2006 amounted to €11bn. The Company has approximately 51,000 employees in some 50 countries. Its ten largest markets are (in order): UK, Germany, USA, France, Sweden, Italy, Netherlands, Spain, Denmark and Australia.

The site visited produces and distributes approximately 65,000 tonnes of products such as facial tissues, kitchen towels and toilet roll a year at the paper mill. Approximately 50% of the output from the mill is shipped to other sites, while the remainder – along with product brought in from other sites – is taken the short distance to the conversion⁵⁸/distribution facility, which outputs approximately 60,000 tonnes a year. Goods are transported by two contractors, primarily using tautliners. The Company stated that goods are always transported in full pallets, and trailers are always full.

The photograph below shows product as delivered from the mill, in reels:



Reels are unloaded using clamp trucks and taken to the conversion facility.

⁵⁸ Paper conversion is a process by which paper is used to fabricate another paper product.



Inside the conversion facility

The conversion process is largely automated and human intervention is required only if a fault occurs on the line.



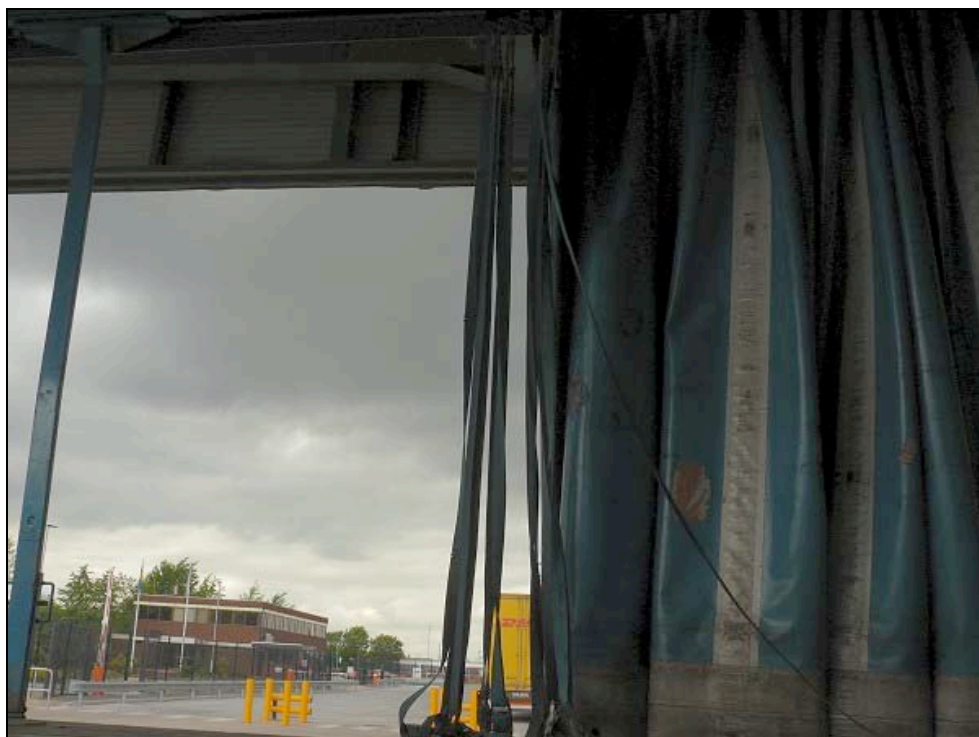
Finished products are shrinkwrapped onto pallets and collected by forklift.



The company use an electronic wireless system to track goods and to direct forklifts around the warehouse, however the system is not yet fully automated.



Finished products ready for transport – goods are supplied boxed as well as in rolls.



Trailer with side straps – some nicks and fraying were observed on the straps.

Loading operation:



Goods are loaded onto the trailer by forklift. The pallets are stacked two-high. No load restraint is used.



To completely fill the trailer, the last row of pallets is loaded via the rear doors and the entire load is pushed up against the headboard, as seen on the following page. It was stated that the load “never moves”.

It was also stated that trailers with side slats were used sometimes, primarily for longer journeys in Europe. Italy was quoted as an example of a destination for which a trailer with side slats would be used. However, most vehicles are tautliners. Containers are used for consignments being transported by ship.

Goods are loaded by employees of the Company and the driver is generally not involved, although in the loading operations witnessed the driver was present. The Company were clear that load security was the driver's responsibility but there was some uncertainty over what would happen if a driver was unhappy with the load and asked for it to be repacked, with reference to the delays this would cause.

Company 6 issues

- Loading is carried out by employed loaders but the driver witnesses the loading.
- Haulage is contracted rather than in-house.
- Load restraint is not used, although vehicles with side slats are used for longer journeys in Europe.

2.7.7 Company 7

At the site visited Company 7 has one million square feet of warehousing, including freezer space equivalent to 23 million domestic freezers, and distributes frozen foods to 70% of the UK as well as 6,500 different clothing product lines to more than 770 outlets.

Company 7 operate a number of warehouses at the site visited – the warehouse visited on 29 March deals with clothing, which is sorted for distribution to retail stores by road and rail. The warehouse dispatches approximately 200 loads a day. Loading is done from the rear of the trailer and the curtains are not opened.



Interior of the warehouse

Three types of trailer/container are loaded from the warehouse: Company 7's own trailers, a haulier's trailers (sometimes branded as Company 7 trailers) and containers for rail transport. Loading is carried out by warehouse staff and the drivers are not involved, neither do they witness the loading although the Company stated that the drivers have the right to request to inspect the trailer once it has been loaded. The rail containers have to be signed-off by the loaders and their team leader, and the documentation sent with the container.

Goods are transported on the trailers on shrinkwrapped pallets, small crates on pallets or in roll cages.



Company 7 trailer

Company 7 trailers have two rails running either side of the trailer, one along the roofline and another running along the bed of the trailer.



Lower rail on a Company 7 trailer

Webbing straps rated for 1 tonne are used in conjunction with these rails to strap across the width of the trailer. Each row of roll cages is cross-strapped. Voids within the roll cages do not appear to be filled and it can be seen from the photograph on the following page that some items have little or no direct restraint.



Cross-strapping on Company 7 trailers

The haulier's trailers are somewhat different as they do not have the rails at the top and bottom. Instead they use a combination of a roof-mounted rail and removable side slats with webbing straps.



Pallets are stacked against the rear pallets (or roll cages) so that the straps do not damage the product. It was stated that there were issues with the hooks on the straps becoming disengaged from the holes in the slats. These hooks are shown in the photograph on the following page.



The original side straps could still be seen stored against the front bulkhead and it was stated that the haulier preferred to keep these along with the removable slats to give them the greatest flexibility in terms of loads that could be carried.



Roof mounted rail on the haulier's trailer



Side slat on haulier's trailer

The slats are made of steel box section and, when not in use, are stored in a frame against the front bulkhead of the trailer. It was noticed that the loaders seemed to have difficulty lifting the slats out of the frame and it was subsequently stated that each slat weighed approximately 20kg.



Side slat storage frame

It was stated that straps are inspected along with the vehicles every 8 weeks. Company 7 provide straps to the haulier for use with their goods.

Goods sent by rail are transported in more rigid containers but are strapped using the same method.



Rail freight container



Loaded roll cages

There seemed to be a general belief that loads transported in roll cages would not shift under any circumstances, except possibly in a road traffic accident.

However, in discussion with the haulier later in the day their "Bad load report" file was produced. A form is filled in for a number of reasons, including every time a trailer arrives at a retail store with a shifted or collapsed load, or if an accident occurs due to load shifting.

The haulier had collated the data since March 2006 and had 117 instances, however it should be noted that not all were relevant. "Poor strapping" was quoted on 33 reports, with "Poor loading" on 22 and "Poor stacking" on 40. Since Company 7's scanning system can identify the loader/s responsible for any loads that do shift in transit, the Bad Load report system is used as part of the disciplinary system for loaders.

Company 7 personnel were adamant that the majority of incidents occurred on the haulier's trailers due to what they considered to be a less rigorous strapping method.



Crates ready to be loaded

Company 7 issues

1. There were sometimes difficulties with the haulier, who did not necessarily want to modify their vehicles too much as this would restrict their use for general haulage.
2. Drivers are not involved in the loading process.
3. Metal slats are heavy and cumbersome for loaders to lift.
4. Not all loads were directly restrained.

2.7.8 Common issues

During the course of the site visits and stakeholder consultations, it became clear there were a number of common issues, regardless of the industry sector or size of company. Not every site had these issues however they appeared to be common enough to warrant comment.

- **Lack of communication between interested parties.** Some sites had a number of companies/self-employed drivers working together and communication was often not optimal between them in terms of planning the loading of the vehicles to minimise the risk of the load moving and inconvenience at the unloading point/s.
- **Driver being isolated from the loading of his trailer.** The majority of those consulted were very clear regarding the legal responsibilities of the driver for his load, however it was clear that in many cases the driver was not present during loading. Safety was cited as a reason for this isolation, as loads were often loaded onto the vehicle by fork or clamp truck.
- **Time pressure.** Almost every stakeholder cited time pressure as a significant stressor and resistance to load securing often appeared to centre on time (and cost). Conversely, time pressure also came into effect at the unloading point/s: if the load had shifted, causing unloading to be delayed, there were issues with unhappy customers who might suffer considerable economic loss if their production was affected as a result.
- **Perceived cost of securing loads.** Many of those consulted cited the cost – in terms of equipment⁵⁹ and slower loading times – as a deterrent to securing loads in accordance with the DfT Code. Within an industry under tight financial constraints, it was not perceived to be a commercial advantage to insist on rigorous load securing. It should be noted that companies were suffering financial loss in terms of product damage, vehicle damage, lost time and (generally) minor injuries due to loads shifting, leading to disruption and employee time off work/cost of employing temporary cover, but these costs appeared to be accepted as inevitable.
- **Misunderstandings over load ratings.** There appeared to be considerable confusion over what the labels on load restraint equipment actually mean in practice and it was stated on more than one occasion that, for example, a strap rated for 5 tonnes would restrain a load weighing up to 5 tonnes in all circumstances when this is not necessarily the case.
- **Commercial disadvantage.** There was reluctance among some companies to bring in load securing methods that would place them at a commercial disadvantage against competitors who did not secure their loads.

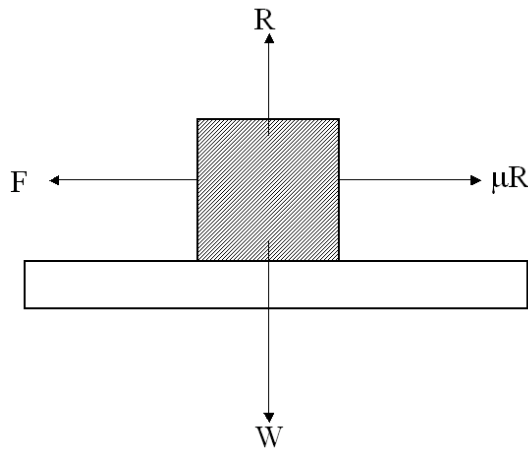
⁵⁹ This was often cited as an issue with webbing straps. A box of 8 straps manufactured to BS EN 12195 from a UK manufacturer costs in the region of £50.

3 TECHNICAL ASSESSMENT

3.1 THE MECHANISM OF LOAD SHIFT

Without restraint an object at rest is held at rest on a surface by static friction. The object will not begin to move unless a force is applied to it that is of sufficient magnitude to overcome the static friction. Newton's 3rd Law⁶⁰ states that for every force acting on an object, there is an equal and opposite reaction.

For example, the weight of an object, W , which acts vertically downwards, has an equal and opposing reaction force, R , which acts vertically upwards. If an attempt is made to pull the object sideways using a force, F , an opposing force, μR , resists the movement of the object.



Only when F is greater than μR will the object move. At the point of movement $F = \mu R$, hence if the weight of the object is known and the force required to just move the object is measured, we can calculate the coefficient of friction, μ , between the object and the surface it rests on, can be calculated from the equation:

$$\mu = \frac{F}{R}$$

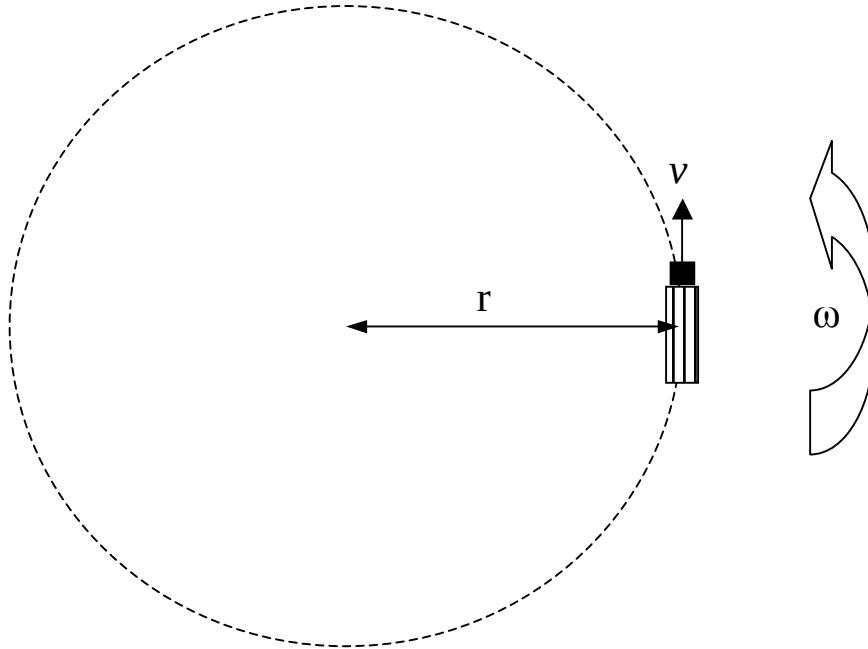
Up to the point of the object moving, μ is known as the coefficient of static friction, μ_S . Once the object is moving, μ is known as the coefficient of dynamic friction, μ_D . μ_D is generally less than μ_S – it is generally easier to move an object that is already in motion than to get it moving from rest.

This principle is important for load transport, since the trailer and its load should ideally behave as one object and the aim of load securing should be to prevent the load from moving relative to the trailer. The load securing system should be capable of withstanding forces exerted on the load and hence keep the load in place.

⁶⁰ Sir Isaac Newton developed three laws of motion, presented in the *Principia Mathematica Philosophiae Naturalis*. These are commonly referred to as Newton's Laws.

3.2 FORCE REQUIRED TO OVERCOME FRICTION DURING CORNERING

Loads often begin to move in cornering, as evidenced by the reported 'hot spots' of corners, roundabouts and motorway slip roads. A vehicle going round a corner is in fact travelling around an imaginary circle with a radius, r .



At any moment in time the vehicle has a linear velocity, v . This is the speed the vehicle travels in a straight line. If the vehicle stopped travelling in a circle at that moment in time, it would continue in a straight line at this velocity, v .

However, assuming that it continues to move around the circumference of the imaginary circle, the vehicle also has an angular velocity, ω . This is the speed at which the vehicle travels in a circle. The angular velocity is related to the linear velocity and the radius of the circle by the equation:

$$\omega = \frac{v}{r}$$

As the vehicle travels around the corner, there is an acceleration towards the centre of the circle known as the centripetal acceleration, Ω . Ω is given by the equation $r \times \omega^2$. Once the acceleration is known, the 'centrifugal force' F can be calculated. Since $F = m \Omega$ and $\Omega = r \times \omega^2$, $F = mr \omega^2$.

This force, in the case of a load on the trailer bed, is not a force pushing the load outwards; rather, it is the force the trailer must exert on the load (via the load restraint system) to turn the load into the corner with the trailer.

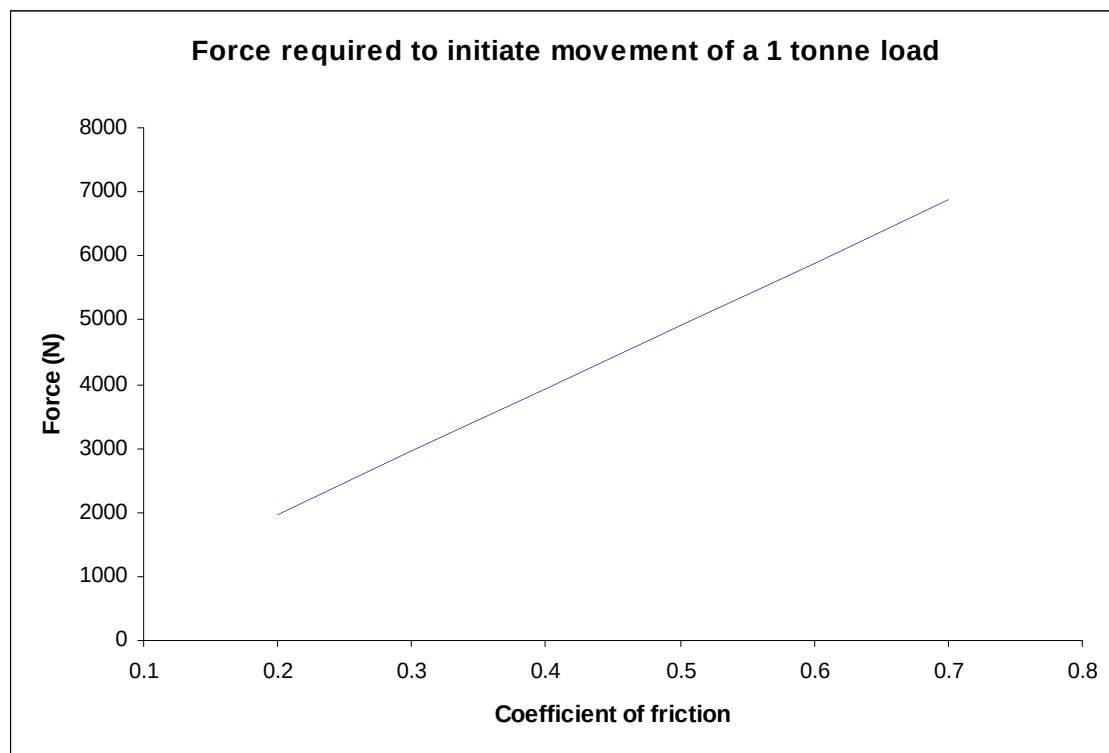
An everyday example of this effect is that of a passenger in a car that is going round a corner: it seems, to the passenger, that they are being 'pushed' against the car bodywork by a force acting outwards.

However, what is actually happening is that the car is turning, while the passenger's body – being separate from the car – is not turning at the same rate. The car is exerting a force on the passenger so that the passenger travels around the corner with the car.

Ideally, therefore, a load should be secured to the trailer it is carried on so that it and the trailer move as one. If the load is not secured, it may continue to move in the original direction of travel as the trailer turns into the corner and thus be ejected from the trailer.

The friction between the load and the trailer bed should not be relied on as a method of load restraint: the DfT guidance makes it clear that friction is an added bonus and even a high-friction floor surface may become damaged or contaminated in such a way that its efficacy is affected.

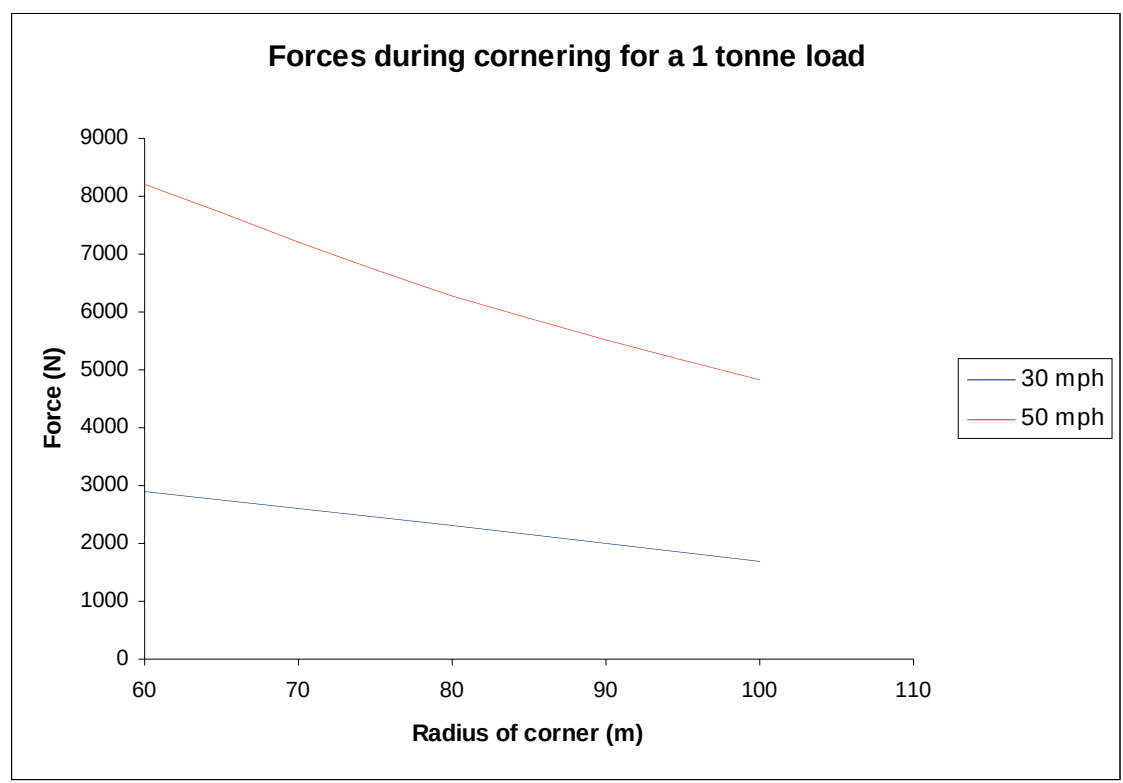
The graph below shows the force required to initiate movement of an unrestrained load with a mass of 1 tonne kg (1000 kg) in relation to the coefficient of friction between the load and the trailer bed.



It can be seen from the graph that the force required to initiate movement declines with the value of the coefficient of friction.

If the same 1 tonne load is placed, unrestrained, on a trailer bed as the trailer negotiates a corner, the load will tend to move independently of the trailer. With a corner radius of 60 m, for example, a force of 2904 N could be applied with the vehicle travelling at 30 mph; at 50 mph the force would be 8214 N. From the graph above it can be seen that even with a high-friction floor there is still potential for the load to shift at the higher speed and hence friction alone should not be relied on to hold a load in place.

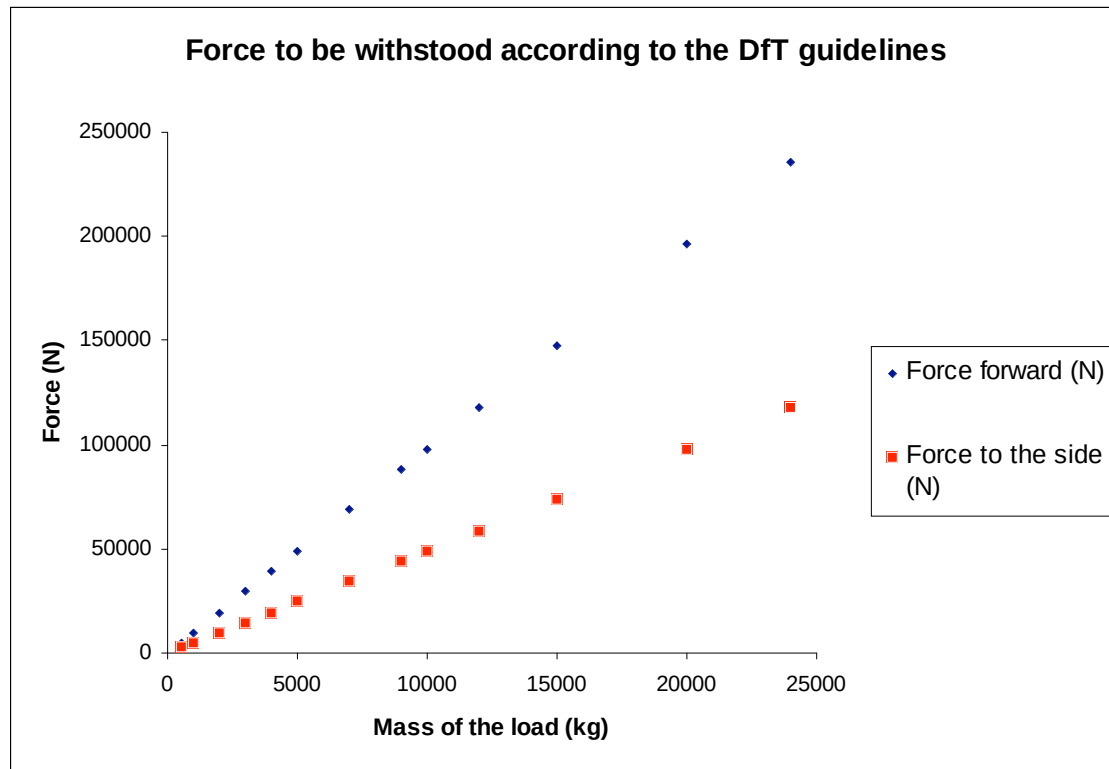
The forces acting as the vehicle traverses the corner are related directly to the vehicle speed and to the radius of the corner. Higher speeds and tighter corners will lead to higher forces, which lower speeds and gentler corners will lead to lower forces. This is illustrated by the graph on the following page.



The load restraint system needs to be capable of withstanding these forces and preventing the load from moving relative to the trailer bed.

3.3 STRENGTH OF THE LOAD RESTRAINT SYSTEM

The DfT guidance indicates that the combined strength of the load restraint system should withstand a force not less than the total weight of the load forward and half of the load to the side and to the rear.



Hence, a load with a mass of 15 tonnes should be transported with a load restraint system capable of withstanding 14.7 tonne force in the forward direction and 7.4 tonne force to the side and rear.

The headboard can act as part of the load restraint system, according to the DfT guide, and should withstand at least half the rated payload of the vehicle, i.e a trailer rated for 20 tonnes should be fitted with a headboard capable of withstanding a force of 10 tonne force.

However, the headboard rating is dependent on the load being as close to the headboard as possible. For weight distribution reasons it is not always possible to place the load so that it is in contact with the headboard. A gap between the load and the headboard has a significant effect on the force exerted on the headboard in the event of a sudden deceleration, particularly if the load is free to move on the trailer bed.

As the trailer slows, the load continues to move forward at essentially its original speed until it impacts the headboard. Both the load and the headboard may be damaged by the impact or, particularly if the load has a small contact area with the headboard, all or part of the load may penetrate the headboard and impact the rear of the driver's cab.

3.4 LOAD STRAPPING

There are many different ways of securing loads; this section looks specifically at overstrapping, since industry consultation and site visits indicated that the mechanics of this method often appeared to be misunderstood.

3.4.1 How overstrapping works

The purpose of strapping a load in this way is often misunderstood: the straps are not fitted to prevent resistance to movement directly; rather, they are fitted to increase the vertical force acting on the trailer bed and hence increase the amount of lateral force required to overcome the static friction and initiate movement of the load.

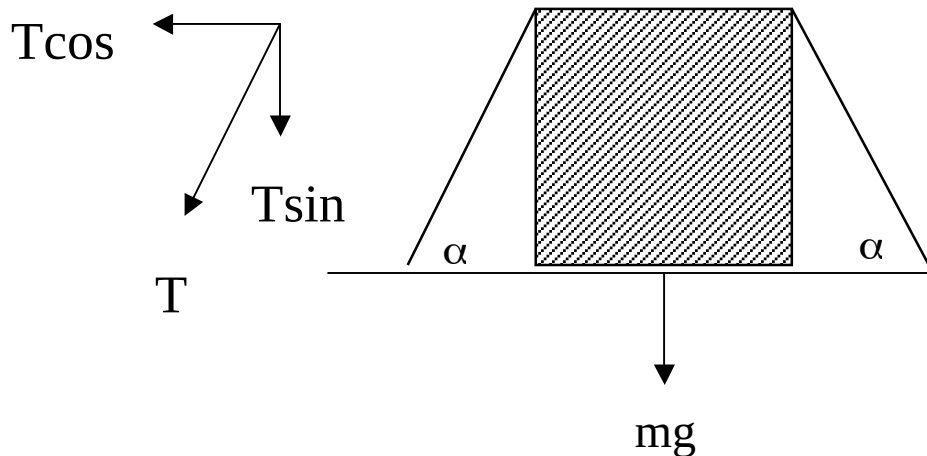
Without any form of strapping, the vertical force acting on the trailer bed is mg , the weight of the load.

With strapping providing an additional vertical force of $T\sin\alpha$, the total downwards force is:

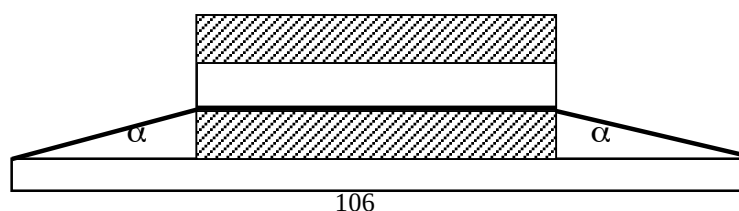
$$mg + T\sin\alpha$$

where T is the tension in the strap.

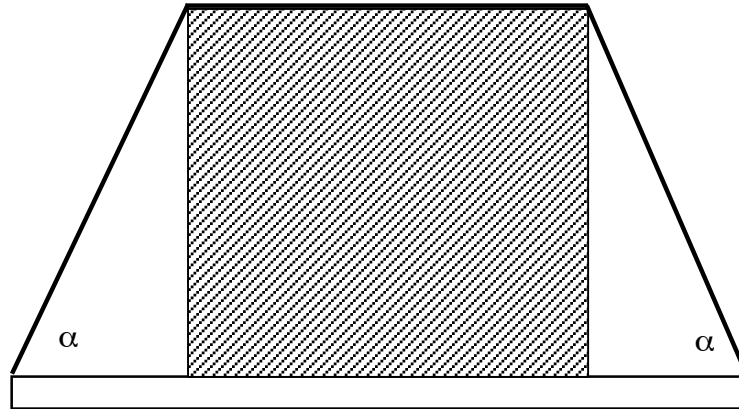
The angle between the strap and the trailer bed has an important effect on the vertical force exerted downwards on the load. For example, if α is 90° , $\sin\alpha = 1$ and the downwards force component = T , while $\cos\alpha = 0$ and hence the horizontal force component = 0.



If α is low, the vertical component of the tension force will be small, i.e:



Ideally, therefore, α should be as close to 90° as possible to maximise the vertical component of the tension force, i.e.



If the size or shape of the load precluded effective strapping, other, additional methods of load restraint could be considered, for each direction of motion.

3.4.2 Example of the effect of strapping angle

The number of straps required to strap a load is found from the equation:

$$n \geq \frac{(c_{x,y} - \mu_D \cdot c_z) \cdot m \cdot g}{k \cdot \mu_D \cdot \sin \alpha \cdot F_T}$$

$c_{x,y} = 0.8$ for movement in the forward direction for road transport and $k = 1.5$ where one tensioner is used. F_T is the S_{TF} of the strap.

Using the example of a load with a mass of 2 tonnes and straps with a lashing capacity of 2500 daN and an S_{TF} of 350 daN, and assuming a dynamic coefficient of friction between the load and the trailer bed of 0.3:

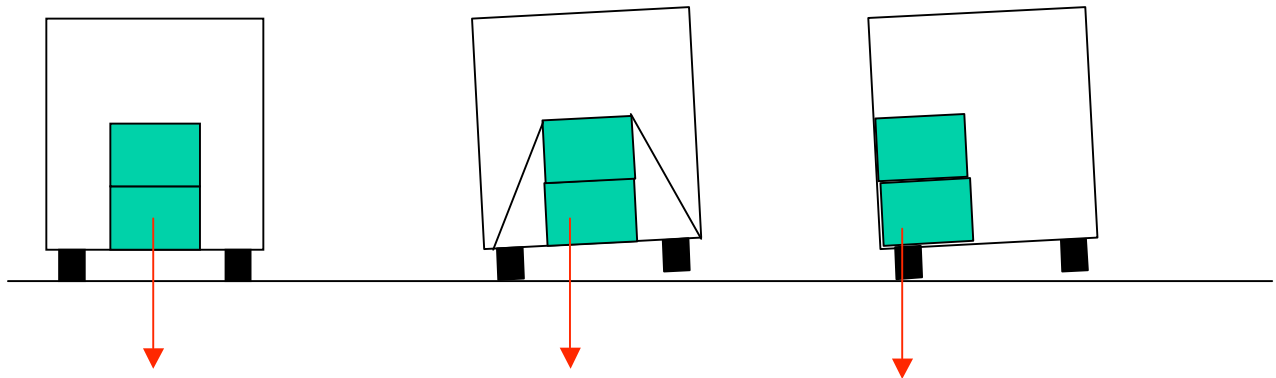
- If the straps formed an angle of 80° with the trailer bed, seven straps would be required to secure the load.
- If the straps formed an angle of 40° with the trailer bed, ten straps would be required to secure the load.

These calculations assume that the straps are the only method of preventing the load moving in the forward direction, i.e. the load is not placed against the headboard or an intermediate bulkhead. They also assume that the load itself is intrinsically stable.

3.5 ROLLOVER

A number of those consulted during the research voiced the opinion that securing loads so that they did not move adversely affected vehicle stability.

The position of the line of action of the centre of gravity is shown in red in the three diagrams below, representing – from left to right – a stable trailer, an unstable trailer with a strapped load, and an unstable trailer with a load that has slid to one side.



Once the line of action of the centre of gravity moves outside the lines of contact with the road surface (the tyres), the trailer will roll over. It can be seen from the third diagram that an unsecured load sliding to one side of a trailer can significantly contribute to the likelihood of vehicle rollover.

4 TESTING

4.1 COMPUTER MODELLING

4.1.1 Introduction

The computer modelling was intended to predict the likely movement of various loads and to assess the effectiveness of different restraint methods whilst the lorry carried out various manoeuvres (e.g. braking in a straight line, manoeuvring round a roundabout, setting off up an incline etc.).

Section 4.1.2 is a brief description of the software that was used to carry out the simulations.

4.1.2 AutoDesk Inventor/VisualNastran Motion

For a number of years HSL staff have used 3 dimensional (3D) computer simulations to carry out dynamic modelling of engineering components and mechanisms.

For this project 3 dimensional (3D) parts and assemblies were created using a computer aided design (CAD) program called AutoDesk Inventor (AI). The parts/assemblies were then transferred into a dynamic modelling program, called Visual Nastran Motion (VNM).

In VNM individual parts are treated as rigid bodies. Constraints (e.g. rigid joints, revolute joints etc.) are used to define/control the relative motion of connected parts. Collisions between parts can also be modelled. Parameters such as coefficient of friction and coefficient of restitution are defined for those parts that are set to collide.

The motion of parts (e.g. accelerations, velocities and displacements) can be specified using formulae, input tables or slide controls. Output data such as accelerations, velocities, displacements, torques, forces etc. can be obtained from simulations. The simulations are based on the laws of physics with the relative motion of parts being calculated on a time step basis.

Once a simulation has run successfully and a time-history has been generated individual bitmap images and animation (.avi) files can be exported. Bitmap images have been used to create a number of Figures used in this report.

4.1.3 AI part geometry

4.1.3.1 Trailer geometry

The geometry for the curtain sided trailer parts, used in the simulations, was obtained from the Fruehauf website (www.fruehauf.com). The diagram on the following page shows the curtain sided trailer drawing that was used as a basis for these AI parts.

As shown in the diagram, the overall length of the trailer was 13.6 m its height was 2.7 m and its width was 2.6 m. The bed of the trailer was modelled as a flat surface (i.e. not as shown in the diagram). The cross-section and position of each upright and horizontal member of the frame was based on the information given in the drawing. This was also true for the geometry and position of each wheel and axle.

4.1.3.2 Load geometry, configuration and other physical parameters

An initial set of simulations were created that were intended to predict the likely motion of unrestrained paper reels on the bed of the trailer whilst the trailer was braked in a straight line and when it was manoeuvred round a roundabout.

For these simulations, the reels were defined as either 1.0 m diameter x 1.2 m long with a mass of 1000 kg or 1 m diameter x 2.0 m long with a mass of 1667 kg.

In VNM, for each simulation, the reels were set to collide with relevant parts of the trailer (i.e. the bed of the trailer, uprights, bulkhead etc.) and the ground/road. The coefficient of friction and coefficient of restitution was defined as listed in Section 5, Tables 1 and 2.

For the initial simulations, when 1.0 m diameter x 1.2 m long reels were used, they were arranged such that they stood on end and were lined up in 2 rows, 1 row at either side of the centreline. The diagram on page 113 consists of a plan view of a trailer fully loaded with this type of reel configuration. In the 1 m diameter x 2.0 m long reel simulations, a single reel was positioned on its side with its centreline coincident with that of the trailer and with its end face up against or 1 m from the bulkhead.

4.1.4 Trailer motion and path geometry

As with all computer-based simulations, assumptions were made and hence, there were limitations. For this project, the most important issue was to assess which constraint system would be the most effective for each type of load. Therefore, the intention was to keep the modelling assumptions as consistent as possible from model to model.

At an early stage it was decided that a model of a lorry bed with full suspension etc. would be too complex and that a more feasible option, within the time constraints, was to define the motion of the trailer bed as remaining parallel to the ground.



4.1.4.1 *Straight line braking simulations*

For the straight line braking simulations, parts to represent a straight section of road and the land at the side of the road were created in AI. In each braking simulation the braking was carried out, from a constant speed of 30, 50 or 80 kmh⁻¹, at a constant deceleration of 3.573 ms⁻². Hence, the motion of the trailer was as follows: -

Initial velocity (kmh⁻¹)	Stopping distance (m)	Braking time (s)
30	9.7	2.3
50	27.0	3.9
80	69.1	6.2

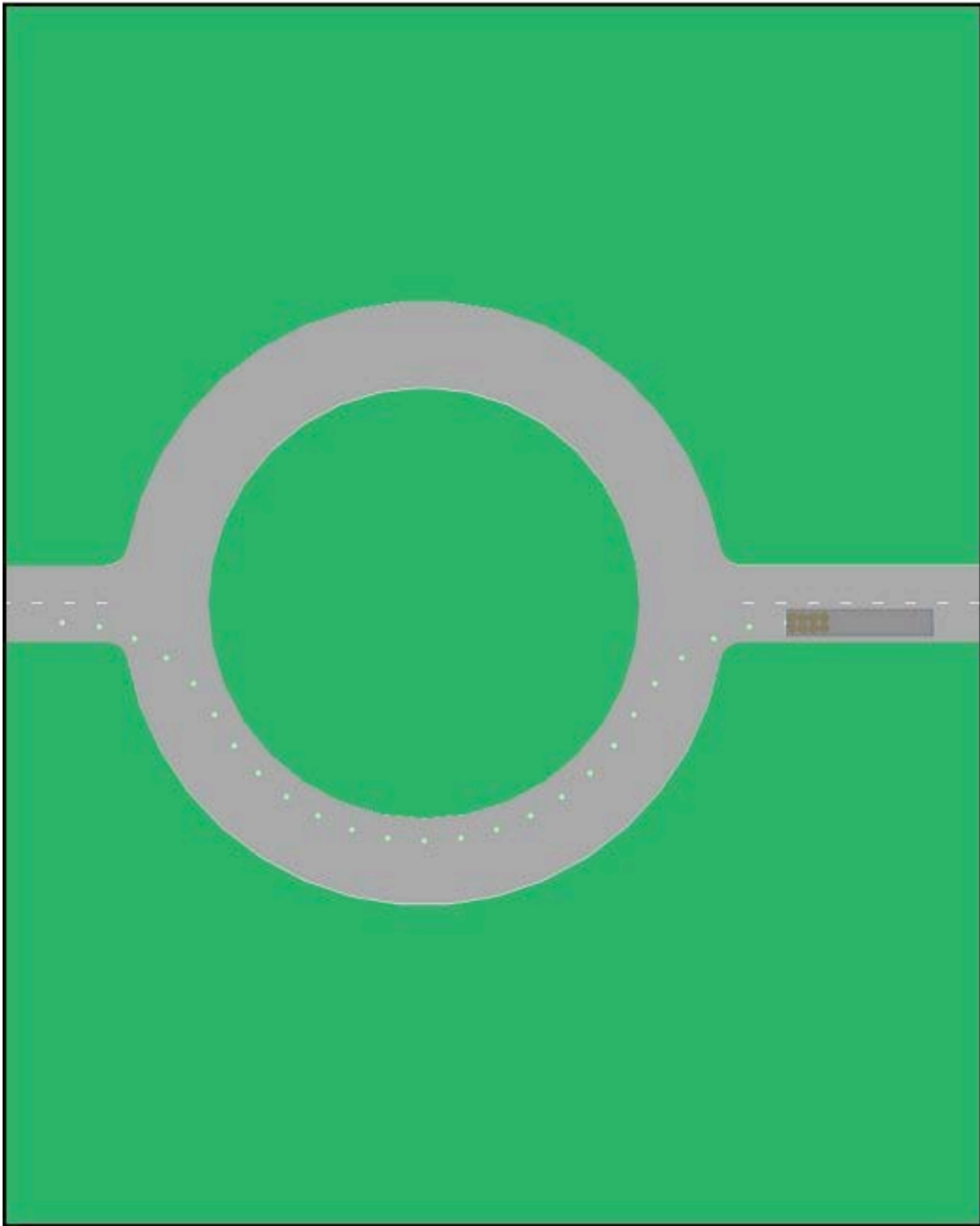
4.1.4.2 *Roundabout simulations*

For the roundabout simulations, parts to represent a roundabout with a radius of 20 m were created. The path of the trailer was such that two points on the trailer, one at the centre of the bulkhead and one at the centre of the middle axle, followed the same path when viewed in plan. This was achieved by defining the motion of the bulkhead (i.e. time, x position and y position) and by creating a spherical joint on a curved slot for the centre point of the middle axis of the trailer. Simulations were created with the centre position of the bulkhead travelling at a resultant constant velocity of either 20 or 30 kmh⁻¹.

The diagram on the following page shows the assumed roundabout path geometry. The entry and exit radius of the trailer path was 16 m with a radius of 22 m concentric to the roundabout. The transition between radii was tangential.

4.1.5 *Simulation parameters*

In VNM, numerous parameters can be defined, for each part and in order to control the accuracy of the simulation. From previous experience, a simulation has to be re-run a number of times before satisfactory results are obtained. For example, if the user sets parameters that are too stringent i.e. when attempting to achieve very accurate results, the simulation can run impractically slowly. If the parameters are not set to be stringent enough, peculiar results may be obtained in which the behaviour of parts can clearly be seen to be incorrect. As such a number of simulations, for this project, had to be re-run a number of times with different combinations of parameters until satisfactory results were obtained.



It became apparent as the work progressed that to expect realist impact forces from initial collisions between parts (i.e. between the reels and the trailer bulkhead) was not possible. This was due to VNM assuming rigid bodies and due to the way that it deals with collisions. In VNM, when two bodies, that are set to collide, do come into close proximity, they are allowed to overlap to a degree. The amount of overlap is defined by a simulation “overlap” parameter. When the overlap parameter is exceeded a force is applied to separate the two parts. The version of VNM used at HSL is not capable of modelling elastic or plastic deformation of parts etc.

4.1.6 Simulation results

A number of simulations were created in order to illustrate the likely movements of unrestrained reels during straight braking and during manoeuvres round a roundabout. Some of the simulations ran successfully and others did not or they had to be stopped due to impractical run times. To avoid confusion only complete simulation runs have been summarised in this Section of the report.

The simulations are summarised in Tables 1 and 2 in Appendix H.

4.1.6.1 Straight braking simulation results

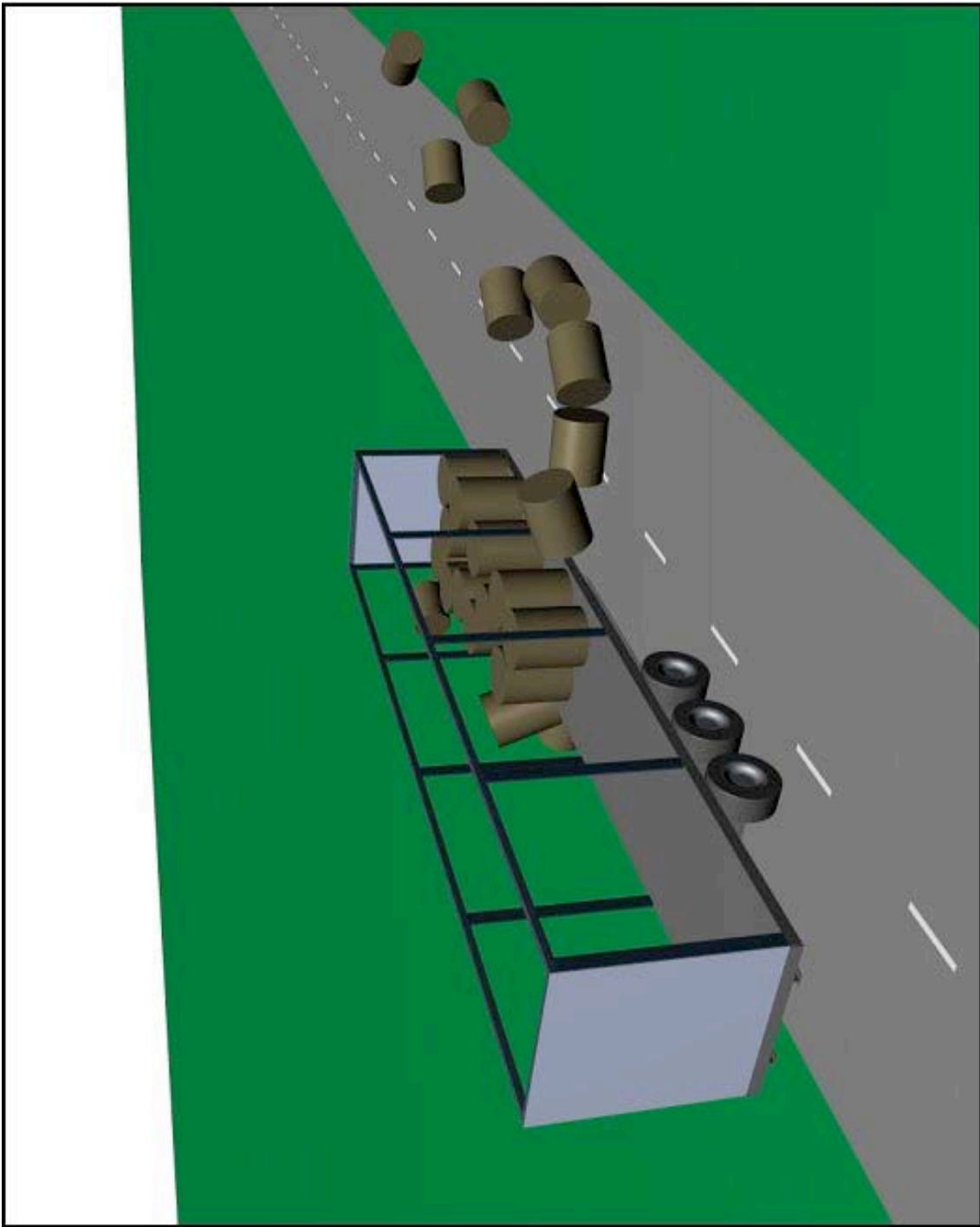
For the straight braking simulations, after a number of failed runs, three successful simulations were run, braking from 30, 50 and 80 kmh⁻¹. For each simulation, the coefficient of friction between the reels and other components was 0.2 .

As expected, braking from increased speeds resulted in greater movement of the reels and more reels falling from the trailer.

In summary: -

- from 30 kmh⁻¹ there was little movement of the reels and no reels lost from the trailer;
- from 50 kmh⁻¹ there was movement of the offside row of reels towards the bulkhead as some of the front reels moved laterally out of line. This ultimately resulted in 3 reels falling from the offside of the trailer;
- from 80 kmh⁻¹ significant reel movements were observed with 14 reels falling from the trailer (6 from the nearside and 8 from the offside).

To illustrate, the diagram on the following page was created from a bitmap image that was exported towards the end of the 80 kmh⁻¹ simulation.



4.1.6.2 *Roundabout simulation results*

Successful simulations were run for a number of roundabout simulations as listed in Table 2. For these simulations, to avoid long run times, the trailer was loaded with 8 reels (2 rows of 4 reels) rather than a fully loaded trailer (2 rows of 13 reels each).

As expected: -

- in simulations with the same constant velocity, but with different coefficients of friction, those with a lower coefficient of friction showed greater movement of the reels;
- in simulations with the same coefficients of friction, but with different constant velocities, those with a higher velocity showed greater movement of the reels.

4.2 PHYSICAL TESTING

4.2.1 Coefficient of friction between a load and a trailer bed

The coefficient of friction between a load and a trailer bed was measured for comparison with values quoted in European Standards.

The measurements were taken both on industrial premises, testing the resistance to movement of a 700kg paper reel on three different trailer beds, and at HSL, testing the resistance to movement of a 370kg palletised load on a trailer bed. The measurements on industrial premises were taken with and without friction matting underneath the reel.

A sideways force was applied to the reel in each condition using a Tirfor hand-operated winch and the force required to initiate movement of the reel measured using a calibrated⁶¹ Dynafor 10-tonne load link.

Table 1 – testing of a paper reel

Test	Force required to initiate movement (tonne f)	Force required to initiate movement (N)	Calculated coefficient of friction
Trailer 1, no friction matting	0.20	1961.33	0.29
Trailer 1, friction matting	0.41 – 0.60	4020.73 – 5883.99	0.59 – 0.86
Trailer 2, no friction matting	0.20	1961.33	0.29
Trailer 2, friction matting	0.42 – 0.55	4118.49 – 5393.66	0.60 – 0.79
Trailer 3, no friction matting	0.22 – 0.25	2157.46 – 2451.66	0.31 – 0.36

Where a range has been given, the first value is the force required to initiate the initial movement of the reel; the second value is the force required where some discontinuity in the trailer bed had provided additional resistance to movement. For the purposes of further calculation, the first value has been used.

Without friction matting underneath the paper reel, the average coefficient of friction of the three trailers was 0.30. With friction matting, the average coefficient of friction was 0.60.

A palletised load was tested on a trailer bed using the same method as above.

⁶¹ Calibration certificate attached

4.2.2 Restraint provided by sidestrapping and overstrapping a load

To test the efficacy of sidestrapping and overstrapping a load, compared to the resistance to movement provided by friction alone, a palletised load weighing 370 kg was placed on the wooden bed of a curtain-sided trailer⁶² and dragged across the bed with a Tirfor hand-operated winch. The force required to initiate movement was again measured with a calibrated Dynafor load link.

The load was initially dragged unstrapped for comparison. The load began to move at an applied force of 110 kgf (1079 N), which approximates to a coefficient of friction between the load and the trailer bed of 0.30.

A sidestrap was then applied to the load, such that the strap was tensioned and in contact with the load. The load began to move at an applied force of 150 kgf (1471 N); its motion was impeded by coming into contact with a load restraint attachment point before the strap came under significant load.

For the third test, the sidestrap was removed and the load was overstrapped instead with a Spanset strap rated for 5000 daN. The secured strap was at an angle of approximately 80° to the trailer bed. The load began to move at an applied force of 320 kgf (3138 N). This is significantly greater than the force required to initiate movement of the sidestrapped load.

To test the effect of the strapping angle on the efficiency of the strapping, the test was repeated with the strap inclined at approximately 35° to the trailer bed. The load began to move at an applied force of 280kgf (2746 N), suggesting that the angle of strapping did have an effect on the degree of restraint provided.

It should be noted that, during testing, it was felt that the tension in the overstrap was not always equal on each side of the load, due to the roughened edges of the packing material. It was considered that edge protectors, as observed during site visits, would help to equalise the tension more effectively.

4.2.3 Side restraint strength of a side strap

The side restraint strength of a strap suspended from the roof of a curtain sider was tested at HSL by applying a sideways force to three straps suspended from the roof, secured to the chassis and tensioned. The strap itself was rated for 700 kgf.

The sideways force was applied using a Tirfor hand-operated winch and, because of this, the loading was applied more progressively than might be seen if a load shifted, for example on a roundabout, and impacted the strap. The force was applied until failure occurred (in each case the strap failed before the roof rail). The results are shown in the table on the following page:

⁶² This curtain-sided trailer is a Montracon trailer owned by HSL

Table 2 – Force required to cause failure of a suspended strap

	Force at failure (kN)	Force at failure (kgf)
Strap 1	7.06	720
Strap 2	7.00	710
Strap 3	7.04	718

The straps failed just below the buckle at an average applied force of 716 kgf. This is almost identical to the rated load of the strap. I would expect a strap used for load restraint to fail at a load at least 150% of the rated load, i.e 1050 kgf or more.

4.3 COMPARISON OF THE TEST RESULTS WITH THE CALCULATIONS

The testing carried out suggested that an unrestrained load or a load placed in contact with a side strap would start to move at a relatively low applied force.

Taking the palletised load with a mass of 370 kg as an example, and assuming that the vehicle the load is resting on is moving with a velocity of 50 mph (22.4 m/s) around a bend with a radius of 100 m:

$$\omega = \frac{v}{r}$$

$$= 0.224$$

The force required to prevent the load moving is found from the equation:

$$F = mr \omega^2$$

$$\text{Hence } F = (370 \times 100 \times 0.224^2) = 1857 \text{ N}$$

This force would be sufficient to cause the unrestrained and sidestrapped load to begin to move.

5 RISK ASSESSMENT

5.1 INTRODUCTION

In general terms, a risk assessment estimates the likelihood of a specific undesirable event occurring as well as the associated harm or damage caused. The significance of the results produced also needs to be taken into consideration. Decision-making can be aided by risk assessment tools, which after application yield information concerning workplace risks as well as suitable risk control and reduction measures.

With goods vehicles, load shift is a common problem that can occasionally lead to serious scenarios such as rollover or more commonly falling loads. The likelihood and consequences associated with these scenarios can be reduced by the introduction of safety measures as illustrated in section 1.2.3. As part of determining whether it is reasonably practicable to implement such measures across industry as a whole, the benefit in terms of the net reduction in risk needs to be compared with the effort (time, trouble and cost) to implement such measures.

The purpose of the risk assessment is to estimate by how much each of the safety measures reduces overall (net) risk, taking account of any new hazards that arise as a result of implementation of the measure; for example, working at height or Musculoskeletal Disorders (MSDs) arising from manual handling procedures. The output from the risk assessment will be an indication of how the level of risk differs for each safety measure relative to the base case (no constraint). This should then enable the containment/restraint options to be ranked that, when used with other factors, will allow judgements to be made on their reasonable practicability.

With curtain sided lorries, load shift is a common feature especially when no restraint or containment methods are used (the base case). When load shift occurs, the consequences can be as minimal as toppled loads within the trailer bed resulting in no accidents, to a multiple car pile up on a motorway due to rollover, resulting in multiple fatalities. There are various restraint and containment methods that could prevent some accidents from occurring. These include side strapping, over strapping, side slats, sliding gates and bungee suspended tarpaulins. Before any assessment can be made the scenarios that can occur based on the safety restraints need to be investigated.

On the whole, the purpose of the risk assessment is to identify the most suitable method for securing loads, from a set of methods that are currently used in industry.

5.2 POSSIBLE SCENARIOS

As with all forms of transport, accidents do occur despite safety precautions. The main accidents that occur involving curtain sided vehicles are as follows:

- Load shifts leading to rollover;

Heavy braking and accelerating as well as cornering sharp bends in the road can cause loads to shift. Therefore load shift is a common occurrence especially if there is no form of restraint available. The load moves against the flexible curtain, which is (usually) not designed to be a restraint method, contributing to vehicle tip over.

- Load ejection during transit;

When sufficient load shift occurs the load can impinge against the curtain, which is not designed as a form of restraint. The load can then burst through the curtain resulting in major accidents.

- Falling objects when the curtain is opened;

Newly formed bulges in the curtain usually indicate load shift. The curtain must not be opened if a bulge is visible, or if it is suspected that the load is pressing against the curtain. Other access routes to the load must be used with caution. Despite these precautions it is still possible for some parts of the load to fall to the ground.

- Personnel falling from trailer bed;

Securing the curtain and fixing straps etc may require personnel to mount the trailer during unloading. Working at height in this manner increases the risk of personnel falling, as much as 2m, from the trailer bed.

- Musculoskeletal injuries (MSDs)

These injuries are associated with personnel when they undertake tasks such as manual handling. Opening curtains, fitting slats and retrieving fallen boxes are all examples of possible causes of musculoskeletal injuries. Furthermore, MSDs are the most common cause of work related injury. Appendix B gives a detailed description of the ergonomic issues that were observed during a site visit to a typical haulage site.

5.3 APPROACH

5.3.1 Quantitative Approach

The initial step of the risk assessment will be to carry out a literature review in order to gain a background understanding of the transport industry as well as exploring the availability and relevance of historical data. Specific and detailed numerical data was required including realistic numbers for accidents such as rollover and load shift, ideally on a per year basis so that frequencies of occurrence could be obtained. For these values to be meaningful, the number of curtain sided vehicles currently in use was also required.

However, comprehensive historical data could not be obtained for major accidents such as rollover because the authorities do not record incidents unless someone is injured. The RIDDOR database could also not be relied upon because it was difficult to assess which transport accidents occurred due to load shift and if they were associated with curtain sided vehicles. Issues also arose with minor accidents because the degree of under reporting increases as the severity of consequences decreases. In the absence of reliable historical accident data it was necessary to adopt a qualitative approach to risk assessment working from first principles.

5.3.2 Qualitative Approach

Due to lack of historical data, the scope of the risk assessment method had to be adjusted to incorporate a qualitative risk assessment. The most effective way of achieving this was through workshop discussions with experienced representatives. To be as thorough as possible two workshops were arranged, one with HSE transport experts and the second with experts from the haulage and logistics industries. The HSE experts were chosen from areas of the organisation that focus on relevant transport issues, while the industry representatives were chosen because they are members of the Transport Working Group and have been involved with other successful transport safety campaigns in the past.

The qualitative approach taken is based on a 6 by 6 risk matrix, shown as Table 3 on the following page. The matrix was populated for each of the safety measure options, with judgement used to assess the collective frequency⁶³ (on a 1 to 6 scale) and consequence (on a 1 to 6 scale) for each of the hazardous event scenarios referred to previously, e.g. load shift leading to rollover. Consequence was assigned on a best-estimate basis, although the range and realistic worst-case consequences were also discussed.

The colours indicate the level of risk, green being the lowest and red being the most severe. The example on the risk matrix (shown by the cross) has been assigned a frequency rating of 2 and a consequence rating of 5, resulting in a risk ranking of 7 (2+5) when added together or 10 (2x5) when multiplied together. Both multiplication and addition are acceptable methods of combining the rating values and will not affect the overall order. The frequency and consequence scales have been set to try and capture the likely ranges.

⁶³ By collective frequency it is the frequency at which the hazardous event (scenario) occurs across the whole industry leading to any level of harm.

Table 3 – Risk matrix example

Consequence	6						
	5		%				
	4						
	3						
	2						
	1						
		1	2	3	4	5	6
		Likelihood					

The approach taken was first to consider the base case (curtain sided vehicle with no restraint/containment). Each scenario was considered in turn and the risk of each estimated using the frequency and consequence scales as illustrated in Tables 4 and 5 below.

Judgements made in making such assignments were recorded as well as other pertinent information. This was then repeated for each constraint option, although a relative assessment of frequency and consequence was then made (relative to the base case), by considering how the frequency and consequence of a specific scenario are likely to be affected by the measure.

Workshop outputs, the ratings assigned and discussion of pertinent factors are used to rank the constraint options in terms of both net overall risk and also in terms of the level of risk of each of the scenarios.

Table 4 – Frequency ranking

Frequency rating	Frequency (mid point)
1	1 in 10 yrs or less
2	1 per year
3	1 per month
4	1 per day
5	1 per hour
6	Many per hour or greater

Table 5 Consequence ranking

Consequence rating	Descriptor	Safety	Health
1	Negligible	Slight, minor injury with no absence	Negligible
2	Low	Requires first aid (< 3day minor injury)	Short term reversible
3	Moderate	>3day minor injury	Long term reversible
4	High	Major injury	Long term irreversible
5	Very High	Single fatality	Permanent severe disability/fatality
6	Severe	Multiple fatality	

5.4 ASSUMPTIONS

A number of assumptions were made to simplify the risk assessment and to make it as accurate as possible. For example the safety measures were assumed to be applied in the manner they are designed across all the accident scenarios under consideration. A full list of the generic assumptions made is included below. The risk assessment results would become skewed if for one accident scenario, it was assumed that the restraints were used incorrectly while another situation uses them in an exemplary fashion. As a result some of the factors involved in transportation and unloading were standardised across all the scenarios.

The following generic assumptions have been made:

- The safety measures are applied correctly;
- The safety measures are in sound condition;
- The safety measures contain and/or restrain the weight of goods they are designed to hold;
- The goods are loaded in a fashion that conforms to Department for Transport Code of Practice Chapter 3, i.e. heavy items are load on the bottom layer near the centre line of the trailer while lighter items are loaded at the top and sides. No gaps should be present. This is important because as the vehicle become more stable, the chances of rollover are reduced;
- The workers involved in unloading are in good health;

- To reiterate it is only accidents that result due to load shift that are to be considered; rollover accidents due to factors such as high wind speeds are not included.

5.5 RESULTS

From the workshop conclusions detailed in appendix D, it is difficult to assign precise frequency and consequence values for some scenarios such as rollover. In addition, with this particular example, it is also very problematic in determining the exact initial cause of the rollover as only a proportion of those that occur will be due to load shift alone. The consequences are slightly easier to determine in the sense that lifting a fallen box is extremely unlikely to result in death, so it is fairly straightforward to eliminate the more serious consequences in this case. However, there are stumbling blocks particularly when trying to assign an exact consequence value, as the consequences that occur will be entirely dependent on the situation that occurs. For example, the consequences for a rollover could range from negligible to a multiple vehicle pile up. The road haulage and distribution industry overview published by HSE in 2007 contains some accident statistics related to the entire haulage industry that is of some use. However, the majority of the analysis is based on the experience of the HSE and industry representatives participating in the workshop.

As there is an extensive range of consequences, two sets of results are discussed, one that is based on the 'most common' consequences that occur and the other that describes the 'worst-case' consequences for each scenario. It is important to clarify what these results actually mean:

In essence, 'most common' indicates what injury is expected in consequence to occur, for example after an accident. For example with rollover, it would be very rare for extreme multiple vehicle pile-ups or negligible injuries, on a regular basis each time there is an accident. It is much more likely for the driver, at least, to suffer from some form of serious injury. This method is representative of typical accidents that could and do occur each year in the transport industry.

'Worst-case' describes the worst possible consequence that could occur following an accident. With the rollover example, a multiple vehicle pile-up would be the worst possible scenario that could occur, as the driver and members of the public would be seriously affected, even before taking into account the costs due to disruption of the road network. However, the results from this method must be treated with extreme caution, as multiple car pile-ups do not occur with every rollover. This method is not representative of typical accidents that occur across the transport industry, it only highlights what could happen in a worst-case scenario.

To reiterate, it is more appropriate to use the 'most common' approach when identifying consequences that are representative of typical industry accidents. The results are broken up into HSE and industry findings, the prior being broken further into 'worst-case' and 'most common' consequences.

5.6 FINDINGS FROM HSE EXPERT FOCUS GROUP

The HSE discussions were particularly detailed, which allowed analysis of both 'worst-case' and 'most common' consequence ratings in addition to the frequency rating. The delegates were keen to capture possible worst-case situations as serious accidents can and do occur with correspondingly serious consequences. To balance this, the 'most common' consequences were also obtained to indicate typical accidents that occur over the transport industry as a whole. Again it is important to note that the ratings obtained are applicable to the entire UK curtain sided vehicle fleet and not to a representative company.

The table below illustrates the rating and ranking values that were obtained. Appendix D should be referred to for the complete HSE discussion on the measures.

Table 6 Rating and ranking values obtained

Safety Measure	Scenario	Frequency Rating	Foreseeable Worst Consequence Rating	Likely Consequence Rating	Ranking
Base case	Rollover	2	6	3	5
	Ejection	2	6	4	
	Falling loads	6	5	2	
	Falls from height	3	5	3	
	MSDs	4	4	2	
Side Strapping	Rollover	2	6	3	6
	Ejection	2	6	4	
	Falling loads	6	5	2	
	Falls from height	4	5	3	
	MSDs	4	4	3	
Over strapping	Rollover	1	1	1	2
	Ejection	1	1	1	
	Falling loads	1	1	1	
	Falls from height	3	5	3	

Safety Measure	Scenario	Frequency Rating	Foreseeable Worst Consequence Rating	Likely Consequence Rating	Ranking
	height				
	MSDs	2	4	2	
Side Slats	Rollover	2	6	3	4
	Ejection	1	1	1	
	Falling loads	1	1	1	
		6	5	2	
	Falls from height	4	5	3	
	MSDs	4	4	3	
Sliding Gates	Rollover	2	6	3	3
	Ejection	1	1	1	
	Falling loads	1	1	1	
		6	5	2	
	Falls from height	3	5	3	
	MSDs	3	4	3	
Bungee Suspended Tarpaulin	Rollover	1	1	1	1
	Ejection	1	1	1	
	Falling loads	1	1	1	
	Falls from height	1	1	1	
	MSDs	2	4	2	

To make the possible risks clearer, the risk matrix as described in section 5.3 has been populated with the ratings for each of the safety measures for each of the described scenarios. The key for the matrix is shown in the table on the following page.

Table 7 Key for ranking matrix

Key	
R	Rollover
LE	Load ejection
FL	Falling loads when the curtain is pulled back
FH	Falls from height
MSD	Musculoskeletal disorders

5.6.1 Base Case

The figure below demonstrates the 'most common' risk associated with the base case scenario for all types of accident investigated. It shows how the risk is determined based on the combination of the likelihood (frequency) and consequence. Load ejection, falls from height and MSDs have the same level of risk, but it is important to note that they are constructed from different likelihood and consequence values. If the purpose of the assessment focuses on reducing the frequency of accidents then the MSD related incidents needs to be tackled more than for load ejection. Conversely, an assessment hoping to reduce consequence should focus on load ejection rather than MSDs. For the base case, the activity with the greatest risk in an every day scenario would be falling loads, so this is an area to concentrate on.

Table 8 Base case - most common outcome

Consequence	6						
	5						
	4	LE					
	3	R	FH				
	2			MSD		FL	
	1						
		1	2	3	4	5	6
		Likelihood					

The Table on the following page shows how the risk ratings change when the 'worst-case' approach is taken. Falling loads have entered into the high-risk category as they occur fairly frequently with potentially severe consequences. Rollover and load ejection also have serious consequences, but because the frequency of these situations is fairly low, combining the two gives a lower risk rating compared to falling loads when the curtain is pulled back. The risk of death from a MSD injury is negligible so the worst possible outcome would be a major injury. Falls from height could potentially result in loss of life.

Table 9 Base case - worst outcome

Consequence	6		R, LE						
	5			FH					FL
	4				MSD				
	3								
	2								
	1								
	Likelihood	1	2	3	4	5	6		

5.6.2 Sidestrapping

The risks associated with sidestrapping are very similar to those of the base case, but with two exceptions; applying the measure has increased the risks from two hazards associated with applying the measure.

The MSD frequency has increased slightly because personnel will be exposed to more situations that could result in MSDs, namely in applying the measure and lifting fallen loads.

The frequency of falls from height has also increased when compared to the base case, mainly because personnel will spend an increased amount of time on the trailer bed when applying the straps.

Falling loads give the highest risk in this scenario, and overall the risk is increased when compared to the base case due to the hazards associated with applying the measure.

Table 10 Side strapping - most common outcome

Consequence	6						
	5						
	4		LE				
	3		R		MSD, FH		
	2					FL	
	1						
		1	2	3	4	5	6
Likelihood							

The 'worst-case' consequence ratings for sidestrapping are the same as the base case 'worst-case' ratings, mainly because the measure does not noticeably reduce the frequency of any of the examined accidents from occurring.

Table 11 Side strapping - worst outcome

Consequence	6		R, LE				
	5				FH		FL
	4				MSD		
	3						
	2						
	1						
		1	2	3	4	5	6
Likelihood							

5.6.3 Overstrapping

The Table below shows that overstrapping is much more effective at reducing risk than sidestrapping. Rollover, load ejection and falling loads when the curtain is pulled back are prevented by this measure so the resultant consequences are negligible.

The frequency of MSDs are also greatly reduced because the method is easy to apply and preventing falling loads means that there will be nothing to lift.

Falls from height will still be an issue as personnel may still climb the trailer bed to apply the measure, hence its rating is the same as the base case.

Table 12 Overstrapping - most common outcome

Consequence	6					
	5					
	4					
	3		FH			
	2	MSD				
		R, LE, FL				
	1	2	3	4	5	6
	Likelihood					

As rollover, load ejection and falling loads when the curtain is pulled back are prevented; the 'worst-case' consequences are the same as the 'most common' consequences. MSDs and falls from height can still occur which can result in serious injury and death respectively, in a worst-case scenario.

Table 13 Overstrapping – worst outcome

Consequence	6					
	5		FH			
	4	MSD				
	3					
	2					
	1	R, LE, FL				
	1	2	3	4	5	6
	Likelihood					

5.6.4 Side Slats

As this measure provides containment, load ejection and falling loads are prevented so there will be negligible consequences. However, rollover can still occur so it has been given the same risk rating as the base case.

MSDs are associated only with applying and removing the measure. Falls from height could be more common with this measure when compared to the base case because personnel could spend more time on the trailer bed applying the measure. However, it is important to note that falling loads can still occur when the measure is removed, as the load has been free to move around within the slats.

Table 14 Side slats - most common outcome

Consequence	6						
	5						
	4						
	3	R		MSD, FH			
	2						
	1	LE, FL					
		1	2	3	4	5	6
		Likelihood					

For the worst-case, only the consequence ratings for rollover, MSDs and falls from height change when compared to the 'most common' values. This is because the frequency of load ejection and falling loads are negligible.

Table 15 Side slats - worst outcome

Consequence	6		R				
	5				FH		
	4				MSD		
	3						
	2						
	1	LE, FL					
		1	2	3	4	5	6
Likelihood							

5.6.5 Sliding Gates

The risks associated with sliding gates are very similar to those of side slats for the more serious accidents such as falling loads when the measure is removed. The frequency of falls from height and MSDs are reduced mainly because gates are easier to apply and operate than the slats, however, the resulting consequences are the same.

Table 16 Sliding gates - most common outcome

Consequence	6						
	5						
	4						
	3	R	FH, MSD				
	2						
	1	LE, FL					
	1	2	3	4	5	6	
		Likelihood					

The 'worst-case' risk ratings obtained for sliding gates are exactly the same as the 'worst-case' ratings for side slats. This is because the gates essentially contain the goods in the same manner, but they are just applied differently.

Table 17 Sliding gates - worst outcome

Consequence	6		R							
	5				FH					
	4				MSD					
	3									
	2									
	1	LE, FL								
		1	2	3	4	5	6			
		Likelihood								

5.6.6 Bungee Suspended Tarpaulin

This method has been assessed based on its potential, as many of the industry and some of the HSE delegates had no working experience with the measure. Appendix D describes fully what the concerns with this method are.

Based on its potential, rollover, load ejection, falling loads when the curtain is pulled back and falls from height are all prevented provided the measure is used in the manner it is meant. The only associated injuries would be through incorrect technique when applying the measure resulting in MSDs.

Table 18 Bungee suspended tarpaulin - most common outcome

Consequence	6					
	5					
	4					
	3					
	2		MSD			
	1	R, LE, FL, FH				
		1	2	3	4	5
Likelihood						

As most of the accident scenarios are prevented, their corresponding consequences are negligible. Only MSDs are likely, which could result in a major irreversible injury.

Table 19 Bungee suspended tarpaulin - worst outcome

Consequence	6						
	5						
	4		MSDs				
	3						
	2						
	1	R, LE, FL, FH					
		1	2	3	4	5	6
Likelihood							

It is worth noting again that the same risk rating can be obtained for multiple incidents, for example, load ejection, falls from height and MSDs have the same risk ratings as an outcome when dealing with the base case analysis, even though they are very different scenarios. It may seem surprising that MSDs and load ejection have the same risk rating but it is because they have been obtained by combining different values of likelihood and consequence. Rollovers do not occur as often as MSDs, which are fairly frequent, but the potential consequences following a rollover are high, while the opposite is true for MSDs. The above risk matrices illustrate how the risk is constructed for each accident scenario.

5.7 FINDINGS OF INDUSTRY EXPERT FOCUS GROUP

The industry findings were obtained in the same manner as the HSE workshops and can be found in Appendix D. Detailed discussions of each safety measure and each of the scenarios took place in order to determine the most appropriate values for the frequency and consequence ratings.

However, the industry volunteers were hesitant in giving exact consequence ratings as they felt that the circumstances of the incident would greatly affect the resultant consequence. As a result, consequence ranges were given. 'Most common' and 'worst-case' consequence ratings were therefore not obtained. Table 20 on the following page summarises the ratings that were generated at the industry workshop and the resultant safety measure ranking.

Table 20 – Summary of ranking

Safety Measure	Scenario	Frequency Rating	Consequence Range Ratings	Ranking
Base Case	Rollover	3	1 - 6	5
	Ejection	3	1 - 6	
	Falling loads	6	1 - 5	
	Falls from height	4	1 - 5	
	MSDs	4	1 - 4	
Side Straps	Rollover	3	1 - 6	6
	Ejection	3	1 - 6	
	Falling loads	6	1 - 5	
	Falls from height	5	1 - 5	
	MSDs	5	1 – 4	
Overstrapping	Rollover	1	1	2
	Ejection	1	1	
	Falling loads	1	1	
	Falls from height	4	1 - 5	
	MSDs	3	1 - 4	
Side Slats	Rollover	3	1 – 6	4
	Ejection	1	1	
	Falling loads	1 6	1 – 5	
	Falls from height	5	1 – 5	
	MSDs	5	1 – 4	
Sliding Gates	Rollover	3	1 – 6	3

Safety Measure	Scenario	Frequency Rating	Consequence Range Ratings	Ranking
	Ejection	1	1	
	Falling loads	1 6	1 – 5	
	Falls from height	4	1 – 5	
	MSDs	4	1 – 4	
Bungee Suspended Tarpaulin	Rollover	1	1	1
	Ejection	1	1	
	Falling loads	1	1	
	Falls from height	1	1	
	MSDs	3	1 - 4	

The industry findings have not been applied to the risk matrix because there are no definite consequence values.

5.8 WORKSHOP COMPARISON

On the whole, the two workshops yielded similar results:

- Base case

The HSE frequency ratings for rollover, ejection and falls from height are slightly lower when compared to industry findings. Ratings for falling loads and MSDs are the same. The HSE foreseeable worst-case consequence ratings are similar to that of the upper end of the industry consequence range.

- Side strapping

The HSE frequency ratings for rollover, ejection, falls from height and MSDs are slightly lower when compared to industry findings. This time the ratings for falling loads are similar between workshops. The consequence ratings obtained by HSE are the same as the upper end of the industry consequence range.

- Overstrapping

Rollover, ejection and falling loads result in the same frequency rating for both HSE and industry workshops. The HSE rating for falls from heights and MSDs, are slightly lower when compared to industry findings. The consequences are again comparable between the two.

- Side slats

Load ejection and falling loads result in ratings that are the same between the two workshops. HSE obtained lower ratings for rollover, falls from height and MSDs. The consequences are again comparable, particularly for ejection.

- Sliding gates

As before, load ejection and falling loads result in the same ratings at each workshop. Again, rollover, falls from height and MSDs result in lower frequencies when comparing the HSE findings to the industry findings. The consequences from the upper end of the industry scale are comparable with that of the foreseeable worst consequences found by HSE.

- Bungee suspended tarpaulin

Discussion at both workshops resulted in the same ratings for rollover, ejection, falling loads and falls from height. HSE findings resulted in a lower MSDs rating than for the industry workshop. The consequences are comparable in value for both workshops.

5.9 OVERALL RESULTS

Table 21 below indicates how each of the safety measures were ranked by the transport experts. It is applicable for both 'worst-case' and 'most common' HSE findings as well as the industry conclusions.

Table 21 – Industry ranking

Safety Measure	Ranking
Base Case (no restraint/containment)	5
Sidestrapping	6
Overstrapping	2
Side Slats	4
Sliding Gates	3
Bungee Suspended Tarpaulin	1

From the table above it appears that the bungee suspended tarpaulin is considered to be the best safety measure for use in restraining and/or containing loads. However, there are many important points to raise with this measure, which could affect its appropriateness for widespread use in industry. The main concern is that only one out of the ten industry representatives have had experience with bungee suspended tarpaulins. As a result, a brief description of how to apply the measure was given at the workshop and any discussions, as detailed in Appendix D, were based on this description alone and not the volunteers' experience. The following cautions with this measure should be highlighted:

- The volunteers discussed concerns about the tarpaulin damaging the edges of products
- They also expressed concern about the durability of the tarpaulin itself; they suggested that there could be a possibility of loads with sharp edges tearing the tarpaulin fabric and poking through.
- Applying the measure raised concerns with both HSE and industry representatives. They felt that the tension applied to each of the straps would have to be in balance to make the restraint effective, which would require specific training for the loading operatives. Unbalanced restraints could make the load unstable.

- The description given indicated that the measure could be applied to mixed loads, but as the representatives had no operational experience of the measure, they could give no opinion on how effective it would be.
- Issues were also raised about forklift trucks becoming entangled in loose straps during the unloading process.
- On the whole, both HSE and industry representatives were concerned about recommending this safety measure when they have no experience of it in operation. They could not discuss the negative and positive aspects of the measure, but based on its potential it was given the best rating. However, all the caveats should be taken into consideration and as a result it would be inappropriate to recommend this method before further trials and testing of the system are undertaken. All volunteers were familiar with the other safety measures and from this, it was determined that overstrapping would be the best current method for use. Again, there were a number of cautions with overstrapping:
 - This is applicable only to certain types of load. Uniform loads are much easier to restrain than loads of different size and weight. Loads of varying height across the width of the trailer, for example, will be difficult to overstrap in a way that ensures that an adequate downward force is applied to every item.
 - The goods must be loaded in the correct manner. For example, heavier items should be placed in the first layer on the trailer bed along the centreline of the vehicle. Lighter items should then be placed either side then on top.
 - The loader should be adequately trained in the proper loading technique as detailed in the previous point. They must be aware of how many straps are required and the proper tension at which to apply them.
 - The straps must be in good condition. Knots, whether to 'add strength' or made as a repair following a previous failure, reduce the strength of the strap under load.

6 DISCUSSION

During the course of the research it became clear that the issue of securing loads on curtain-sided vehicles is far from straightforward, since loads vary considerably in size, mass and composition, trailers vary in design, and loading and unloading sites vary considerably in their physical characteristics and facilities. However, the fundamental physics relating to load shift are considerably more straightforward: a load that is not secured can and will shift if the forces acting on it overcome the friction between the load and the trailer bed. Any loss of contact between the load, however momentary, between the load and the trailer bed removes the effect of friction and therefore friction alone cannot be relied on as a method of load securing.

Vehicles on the road do not travel in a state of equilibrium – they accelerate, brake, turn corners and make emergency manoeuvres, all of which tend to cause the load to shift. Anecdotal evidence suggests that corners, motorway slip roads and roundabouts are the most common sites for rollover and this was borne out by the computer modelling.

Previous research has generally focused on the risk of rollover on the roads, but load shifts also increase the risks when the vehicle reaches its destination. Unstable loads may fall from the trailer when the curtain is pulled back, striking the driver or loader, or causing them to take avoiding action which leads to an accident. Loads that have shifted may be impossible to unload by fork lift truck or clamp truck and require manual unloading, with the attendant risks of manual handling and falls from height. Site visits indicated that injuries, particularly to loaders, could be a problem, as a number of companies operated complicated warehousing arrangements that could not be easily 'picked up' by temporary staff. For self-employed owner drivers, injuries could be particularly devastating as they would have no income if they were unable to drive.

Even without the risks of death and injury, load shifts can have significant financial consequences: vehicular, product and reputation damage due to rollover or other road accidents, or product damage if the load falls from the vehicle during unloading. Delays during unloading due to load shift can have both financial and contractual consequences if the haulier is committed to deliveries to a strict timetable. Many of the companies involved in the site visits and industry consultations cited time as a significant contractual issue, where lost or damaged loads could lead to considerable customer dissatisfaction. The disruption caused by shifted loads was observed at first hand during site visits. Many of the loads at the sites visited had values of many thousands of pounds; damage to these loads was not necessarily covered by insurance and hence the damage was paid for by the haulier.

The requirement to secure loads for road transport in the UK is not a new one; the Department of Transport Code of Practice was originally published in 1972 and is now on its third edition. The more recent European Guidelines for Cargo Securing give detailed examples of how to secure loads. UK guidance is in accordance with EU, North American and Australasian guidance that the curtains of a curtain-sided vehicle should not be used as part of the load security system (with a caveat relating to reinforced curtains, which will be discussed later) and that goods transported on a curtain-sided vehicle should be secured as if they were being transported on a flatbed vehicle.

The site visits and industry consultations identified that there were issues common to many sectors of the haulage industry, such as time pressure, increasing general costs leading to financial pressure on firms and varied and often complicated arrangements between warehousing and haulage operators. This last issue was considered to be significant, as the involvement of a number of parties on a particular site often appeared to lead to confusion over who was responsible for load security and a disinclination for one party to bear the costs. Time pressure was often cited as a reason for not securing loads, as was pressure from customers. Good practice did not appear to be shared between companies and on more than one occasion research had been replicated because a company was not aware of work that had been carried out by other companies.

Industry consultation identified an acceptance that existing load securing practice was often inadequate. Many of those consulted felt that methods of load securing could, and should, be improved. Fear of prosecution under corporate manslaughter legislation was cited as one 'driver' for improvement, however reducing injuries to employees – and hence reducing working days lost – and reducing product and vehicle damage were also cited.

Drivers were often held to be solely responsible for the security of their load, even when they had had no involvement in the loading process and, indeed, had been actively prevented from inspecting the load. Even if they were allowed to inspect the load after it had been secured, some drivers expressed concern at their ability to assess whether a load had been adequately secured when their 'inspection' was limited to a visual check around the curtain. One company that had brought in a reporting system for drivers to report issues with load security had discovered significant dissatisfaction with the loading of their vehicles – and a sense of powerlessness on the part of the drivers to improve matters.

Training appeared to be variable for staff involved in the loading of vehicles. Some companies had very thorough training for both drivers and loaders, with clear, illustrated guidance, training videos and dedicated training staff. At the other end of the scale, some companies appeared to rely on drivers' general experience and/or loaders 'picking up' the correct methods of load securing from their colleagues.

The 'official' statistics for load shifts did not appear to reflect the perception of load shift frequency within industry and it was noted that load shift accidents were often categorised under alternate categories so that they were not identified as such.

Introducing safety measures aims to help protect the general public as well as the employees involved in unloading the cargo. For example, the incidence of rollover could be reduced by simple measures such as:

- Making sure the vehicle is not loaded beyond its capacity;
- Evenly distributing the load across the vehicle;
- Using specifically designed vehicles for carrying loads.
- Securing the load so that its movement does not make the vehicle unstable.

Interventions may introduce additional risks such as working at heights and/or manual handling. Falls from height is a cause of many workplace accidents; these can occur due to factors such as inappropriate footwear, bad weather, lack of proper access

equipment or insufficient training. The incidence of falls could be reduced by measures such as:

- Platforms and/or gantries to be used when personnel need to access the trailer bed of the vehicle;
- Slip resistant walkways
- Fall-arrest harness systems.
- Passive fall-arrest systems, such as airbags

Musculoskeletal injuries can result when personnel pull the curtain across, fit strapping or lift fallen loads. These injuries could be reduced by:

- Ensuring staff are properly trained in manual handling issues
- Providing lifting equipment to eliminate the need for personnel to lift fallen loads.

A risk assessment for the work activity should identify any additional risks introduced by the use of load securing equipment and address them adequately so that the overall level of risk is not increased.

It was noted during the course of the research that there was some confusion regarding the distinction between load restraint and load containment. By consideration of the physics of load shift, it is clear that a load should be prevented from moving relative to the trailer bed, and therefore containment alone is not sufficient – a contained load may still be unstable and fall from the trailer when the method of containment (i.e. side slats) is removed. Many loads may require a combination of load restraint and load containment, particularly if the load is prone to tipping.

There are a number of different methods for achieving both load restraint and load containment and some loads may require a combination of both to transport the load safely. Some companies consulted had attempted to improve their load security by investing in methods of load restraint and/or containment that were insufficient or, indeed, had actually increased the risk of an accident.

Reinforced curtains are allowed for as a method of load securing but their strength relies on the strength of the structure they are attached to, i.e. a reinforced curtain attached to a superstructure constructed for weather-protection only may not be strong enough to withstand the forces exerted on it by a shifting load. Reinforced trailers built to a standard should be tested as a whole and clearly marked; however, even if the curtain can contain the load, an unrestrained load may still become unstable during transit.

The strength of the trailer and the superstructure was identified as an area of concern in the course of the research. The superstructure of a curtain-sided vehicle has the primary function of supporting the weather protection system – the curtain. It was noted that, while reinforced curtains were available, it was not necessarily required to fit them to a reinforced superstructure. There is a European Standard for such a reinforced structure (which must be tested and marked as conforming to that Standard) but there seemed to be some doubt as to how many trailers were built to that standard of construction.

The superstructure also often has the purpose of supporting the rails from which side straps are suspended. These rails do not appear to be load-rated, and the majority of side straps examined during site visits did not appear to be load-rated. Those fitted to a trailer owned by HSL were rated for an applied force of 700 daN, and failed catastrophically at slightly over that. Side straps did not appear to offer much in the way of restraint to a palletised load during testing.

The headboard of a trailer is a vital component of the load securing system, and it must be capable of withstanding the forces exerted on it by the load under braking. Site visits suggested that there was considerable variation in the construction of trailer headboards, and in understanding amongst loaders of why the load should be placed in contact with the headboard. It is important that the load is restrained from moving forward, as large gaps between the load and the headboard can lead to considerable impact forces being exerted on the headboard under heavy braking.

The risk assessment established that overstrapping loads was, overall, the best method of load securing. Testing indicated that overstrapping was highly efficient in preventing load movement and an ergonomic assessment of an overstrapping operation indicated that it posed a low risk of injury to loaders. However, it was noted that overstrapping was not suitable for all loads and that it was not necessarily possible to strap some loads. Straps observed on site and on the public highway were often in poor condition and few companies appeared to be aware of how little damage is required before a strap should be discarded.

At the heart of good load security is the principle of risk assessment. Risk assessment should identify the particular risks of transporting a particular load, the type of vehicle best suited to transport it, any particular issues for the loading and unloading of the load, and hence the most practicable method of securing the load.

UK and international guidance underlines the importance of planning the loading and unloading of a vehicle to take account of issues such as the nature of the site being delivered to, the nature of the load, and the need for load securing. This type of planning does not have to be onerous; indeed, it can often be advantageous in that it allows the operator to identify possible problems in advance.

Securing loads carries a cost in terms of equipment, time and any additional risks such as working at heights. During industry consultation, arguments against securing the load centred around the cost of implementing load security measures and the additional time required to secure the load. However, shifting loads also carry costs in terms of death or injury, product damage, vehicle damage, time lost due to 'clean-up', risks introduced if reactive measures have to be taken, possible fines and/or prosecution if an accident occurs, and damage to a company's reputation caused by repeated and/or serious accidents.

7 CONCLUSIONS

1. Loads should be secured so that they do not move relative to the trailer bed during transport.
2. Load restraint is not the same as load containment. Some loads may require a combination of both.
3. Loads should be placed against the trailer headboard if possible. If this is not possible for reasons of weight distribution, the gap to the headboard should be filled or an intermediate bulkhead could be used.
4. The curtains and the weather-protection structure of a curtain-sided vehicle are generally not suitable for load securing.
5. Friction alone should not be relied on as a method of load securing.
6. Overstrapping the load was identified as the least-risk method for load restraint, however it would not be suitable for all types of load. There is no 'one size fits all' solution to securing a load safely.
7. There are costs involved in securing a load, both in terms of equipment and additional time, however against this must be set the costs of the potential consequences of load shift, such as product damage, vehicle damage, delays, death or injury, and prosecution in the event of an accident.
8. Communication between all parties involved in the loading, transport and unloading may help to avoid or ameliorate problems surrounding load securing.
9. Risk assessment and a loading plan prepared by someone competent to do so is the key to good load security. This does not have to be an onerous process but 'thinking through' the operation in advance may identify potential issues before they become a problem.

8 APPENDICES

8.1 APPENDIX A: BELGIAN REGULATIONS ON LOAD SECURING – ORIGINAL TEXT

CHARGEMENT DES VEHICULES : PRESCRIPTIONS GENERALES⁶⁴.

45.1. Le chargement d'un véhicule doit être disposé (au besoin fixé, recouvert d'une bâche ou d'un filet) de manière qu'il ne puisse :

- 1° nuire à la visibilité du conducteur;*
- 2° constituer un danger pour le conducteur, les personnes transportées et les autres usagers;*
- 3° occasionner des dommages à la voie publique, à ses dépendances, aux ouvrages qui y sont établis ou aux propriétés publiques ou privées;*
- 4° traîner ou tomber sur la voie publique;*
- 5° compromettre la stabilité du véhicule;*
- 6° masquer les feux, les catadioptres et le numéro d'immatriculation.*

45.2. Si le chargement est constitué de céréales, lin, paille ou fourrage, en vrac ou en balles, il doit être recouvert d'une bâche ou d'un filet. Cette disposition n'est toutefois pas applicable si ce transport se fait dans un rayon de 25 km du lieu de chargement et pour autant qu'il ne s'effectue pas sur une autoroute.

45.3. Si le chargement est constitué de pièces de grande longueur, celles-ci doivent être solidement arrimées entre elles et au véhicule, de manière à ne pas déborder le contour latéral extrême de celui-ci dans leurs oscillations.

45.4. Les accessoires servant à arrimer ou à protéger le chargement, tels que chaînes, bâches, filets, etc. doivent entourer étroitement celui-ci.

45.5. Le conducteur du véhicule doit prendre les mesures nécessaires pour que le chargement ainsi que les accessoires servant à arrimer ou à protéger le chargement, ne puissent par leur bruit, gêner le conducteur, incommoder le public ou effrayer les animaux.

45.6. Si, exceptionnellement, des portières latérales ou arrières doivent rester ouvertes, elles doivent être fixées de manière à ne pas dépasser le contour latéral extrême du véhicule.

⁶⁴ AR 1991-09-18/32, art. 19, 006; En vigueur : 01-01-1992

8.2 APPENDIX B: ERGONOMIC ASSESSMENT OF OVERSTRAPPING A LOAD

8.2.1 Purpose

An HSL Ergonomist visited the premises of Company 3 to provide an ergonomics assessment of operators whose task involves fastening load restraint straps. This report documents the risk factors for musculoskeletal disorders involved both generally and specifically to the two methods observed and identifies potential measures to help reduce these risks.

8.2.2 Background Information

The paper mill operated by Company 3 ships out paper in reels varying from approximately 1 meter to 4 meters diameter. Taller reels (more than 2m) are transported in a horizontal orientation (rotational axis horizontal – 'on the roll') while the shorter reels are transported in a vertical orientation (rotational axis vertical – 'on end'). The Company have recently moved to a new system of securing reels transported in the vertical position. After two weeks of using the system to tighten reels vertically, two loaders were reporting back and shoulder pain.

The two methods considered are:

- Strapping rolls transported vertically “on end”,
- Strapping rolls transported horizontally “on the roll”

Information was gathered via a “walk through” of the task with an operator on site providing clarification and insight. Photographs and video were taken to aid in the ergonomics analysis of the tasks. These were considered and compared with HSE guidance in addition to other relevant ergonomics guidance/literature.

8.2.3 Background Information on potential Risk Factors for MSDs

Musculoskeletal disorders (MSDs) can occur in almost any workplace and can usually be prevented. They can affect the muscles, tendons, ligaments, nerves or other soft tissues and joints. Symptoms can include pain, stiffness, soreness, temporary fatigue, numbness, pins and needles, tingling, and a reduction in the ability to use the affected part of the limb. Restriction in the range or speed of movements as well as strength and sensations may occur.

The principal risk factors for upper limb disorders (ULDs) (those which affect the neck, shoulders, arms, wrists, hands and fingers) commonly interact with each other and can be cumulative in nature with risk adding up over a period of time as a result of repeated exposure. These include:

- Repetition

This refers to the same muscle groups being used or frequent movements over prolonged periods. Repeated loading of soft tissues is associated with inflammation, degeneration and microscopic changes. Rapid or prolonged repetition may not allow sufficient time for recovery

and can cause muscle fatigue due to depletion of energy and a build up of metabolic waste materials.

- Working posture

When awkward postures are adopted (i.e. often when joints are close to their extent of motion) additional muscular effort is needed. Resulting friction and compression of soft tissue structures can also lead to injury. Static loading restricts blood flow to the muscles and other structures resulting in less opportunity for recovery and metabolic waste removal. Muscles held in static postures fatigue very quickly.

- Force

A number of factors can interact to affect the level of force including working posture, size and weight of handled objects and speed of movement. Use of excessive force can lead to fatigue, and if sustained, to injury either through a single event or through the cumulative effect. Localised force and stress can also cause direct pressure on the nerves and or blood vessels and increase the risk of discomfort and injury. The effects of wearing gloves can influence the amount of force required to grip.

- Duration of exposure

It is generally accepted that many types of MSDs are cumulative in nature. This is because when parts of the body undertake work for periods without rest there may be insufficient time for recovery.

- Working environment

This includes aspects of the physical work environment that can increase the risk of MSDs.

- Cold; known to decrease dexterity and increase the likelihood of over-exertion injuries.
- Heat; can cause increased sweating which can effect grip, can lead to premature fatigue, and can cause dehydration which can lead to muscle cramps.

- Psychosocial factors

This would include factors such as control over workload and methods, high-level attention, concentration, social support and management “style” factors.

- Individual differences

Differences in competence and skills (training received), different anthropometrics and being in vulnerable groups such as younger/older workers, pregnancy and a previous history of MSD, (especially back pain) can increase the risk.

8.2.4 Task description

8.2.4.1 Vertical Loading

One operator drives an empty trailer, specific for the load, into the warehouse. Two operators are then responsible for securing the load. First, strips of friction matting are laid onto the trailer bed. The driver then sits in the cab while the reels are loaded via clamp truck. The operator then pulls the curtain to allow the last rolls on. The operators each move a gantry to either side of the trailer and working from the front to the back, one operator throws a webbing strap over each pair of reels and the other operator takes the end and allows it to hang down the side of the trailer. There are typically 12 straps and ratchets on a vertical roll loaded trailer to secure.

To secure the load, the operator walks back with the length of webbing, threads it through the ratchet and pulls it through whilst walking to the trailer. This requires about 4 pulls with the right hand. A hook at the bottom of the ratchet is attached to the trailer bed, consequently leaving the ratchet mechanism about 30cm higher than the trailer bed (at around 1.6m above floor level). The ratchet is then held with one hand and the operator tightens the webbing by operating the ratchet lever about 8 times to achieve the required tightness.

Once it is secure the operator drives the trailer on site (about 4 miles a day in total) and then the task is repeated according to how many trailers need to be loaded for that specific shift (typically 8, but may be using different methods i.e. horizontal loading technique).

8.2.4.2 Horizontal Loading

Once the reels have been loaded on, the method of strapping is slightly different. A series of 25kg panels that create the trailer sides are folded up into position manually and then the webbing straps are thrown over by an operator on ground level (rather than from a gantry) with the end hooked onto the bed of trailer. A lever handle is attached to the ratchet mechanism and it is operated a number of times until the webbing is tight. This requires about 6 or 7 repetitions and towards the end it was noted that the operator used both hands and some trunk movement to pull up on the lever to achieve the required force.

8.2.5 Signs and symptoms

Signs that there may be a risk of upper limb disorders in the work place are complaints of aches or pains and any warning signs may be the “tip of the iceberg”. One person with symptoms may mean there are numerous other operators also exposed to the risk factors, and who are in the process of developing a disorder.

During the site visit an operator complained of back, shoulder and feet ache, which can occur as a result of prolonged standing, however there will be whole body movements on a regular basis and the opportunity to sit down in the cab whilst the reels are manoeuvred into position.

Although it is not uncommon for people to experience some discomfort from physical/manual work tasks, this must be balanced against steps to minimise the long-term risks of injury (i.e. reduce the risk to as low a level as reasonably practicable).

8.2.6 System of work

There are 100 drivers working on a shunter system. The working day was reported to include a half hour break after 4.5 hours at work. The operators usually work a five-day week however there are opportunities to do over time i.e. 1 in 3 weekends. There are two 8-hour shifts per day and operators may be permitted to take a double shift if required.

The amount of load fastening work will depend on a number of factors including deliveries per shift, whether any trucks have broken down and how many operators are available. Although the job needs to be done quickly, there is the control and capability to “hand over” to the next shift if necessary. However that would create more work for the following shift. Apart from half an hour for lunch, breaks are not part of the working procedures however whilst the reels are being loaded the operators sit in their cab until indicated by the fork lift driver that loading has finished.

8.2.7 Repetition Rate

The task of securing the load takes 20 – 25 minutes. The operator reported that roughly 8 trailers would be strapped in 8 hours. If it takes 25 minutes per trailer, this would average to just under 3 and a half hours of strapping work a day or just over 2 and a half hours for twenty minutes per truck however this could vary day to day. This is not continuous repetitive work and breaks occur throughout the twenty-five minutes.

Repetition rate in regards to operating the ratchet on the vertical loading method was observed from the video footage to be 8 movements per ratchet in about 5 seconds. About a minute later it would be repeated. There are 12 ratchets however there are two operators so the scenario may be repeated about 6 times. This would then be repeated about 7 more times in a shift. For the horizontal loading, there are about 7 lever movements in 8 seconds and then the operator goes onto the next strap.

It is considered that less than 50% of the overall task cycle involves performing a repetitive sequence of motions therefore it is not considered to increase the risk of musculoskeletal risk.

8.2.8 Working Environment

The operators may at times be working in a cold environment which may decrease the operators dexterity, however all employees are given fleece, and gloves which appear to be suitable.

8.2.9 Observations

1. Force

The tension in the webbing necessary to suitably secure the load appears to be arbitrary. The loading worker appears to input sufficient tension to satisfy themselves that the load is secure. The force input can be considered to be a maximal (reasonable) voluntary exertion. To quantify the forces exerted by the operators, a hand held dynamometer was attached to the ratchet lever and the operator asked to perform the last two force applications on the levers to achieve the required tension in the webbing (the force exertion is greatest at this stage). The dynamometer was attached to the lever by a short thin webbing sling. Given the size of the dynamometer and the nature of attachment, the nature of the measurement scenario is slightly different from normal. The posture of the worker is altered to apply force at a higher level above the ground. Also, both hands can be used to apply force through the dynamometer handles, whereas for the vertical loading method, one hand would typically be used on the ratchet handle. The operator commented that the effort required to operate the ratchet with the dynamometer attached was more than normal.

Method of Loading	Measurement 1 (kgf)	Measurement 2 (kgf)	Average (kgf)
 Vertical Loading	36.7	26.5	32 kgf one handed
 Horizontal Loading	56.8	66.7	62 kgf two handed

As evidenced from the table above, the force exertion involved in the tensioning of the webbing for the horizontally loaded reels involves approximately double the amount of force compared to the vertical loading method. However, the horizontal loading method enables the worker to use both hands on the ratchet lever.

An important aspect of the force requirement is its direction of application. The force application is initially a horizontal pull towards the body (away from the trailer bed), changing to a vertical pull upwards at the mid point, to a horizontal push away from the body (towards the trailer bed) to complete the action. The lever is lowered (without force) to the mid point to repeat the action as necessary to attain the required tension.

Both methods appear to require forces exceeding the risk filter values for normal handling related pushing and pulling. The risk filter values are exceeded by a factor of 3 (for horizontal force application). For information concerning forces applied in a direction more applicable to this operation, the reference source *Adultdata* has been used. There are a number of relevant sources (see Appendix for more detail), which can be applied and these are summarised below.

Vertical Loading (using one hand)

- Mean standing lift strength (male) is 13kgf
- Mean standing dynamic pull (male) is 26kgf
- Mean standing pull (male) is 30kgf
- Mean standing pull (female) is 20kgf

Horizontal Loading (using two hands)

- 5th percentile male standing lift strength is 34kgf (i.e. 5% of the male population would have less strength than this)
- 5th percentile female standing lift strength is 16kgf
- 50th percentile (mean) male standing lift strength is 54kgf
- 50th percentile female standing lift strength is 28kgf
- 95th percentile male standing lift strength is 75kgf (i.e. 5% of the male population would have more strength than this)
- 95th percentile female standing lift strength is 41kgf

The references are intended to serve as a guide only due to limitations in each data set as posture, number of hands used and height, size and shape of handle will all affect the force that can be exerted, as will the type of strength measured i.e. static (no movement) or dynamic (movement involved).

For vertical strapping, the measured force of 32kgf exceeds that of an average male quoted in *Adultdata*. This may be due to the measurements on the dynamometer requiring more force than is usually required and/or that the worker was applying what can be considered to be a maximal (reasonable) voluntary exertion hence he may have been over a 50th percentile male.

The measured force of 62kgf (for horizontal strapping) exceeds the capabilities of 95% of the female population and that of an average male. This could potentially lead to fatigue and increase the risk of injury to the operator. However it would be within the capability of a 95th percentile male according to one data source.

It is not possible to determine whether the forces measured are routinely required or whether the high force is indeed a “self select tension” strategy with the individual working towards the peak of their capability. Further study could explore the forces on the ratchet handle needed to acquire suitable security of the strap.

2. Posture

Vertical Loading

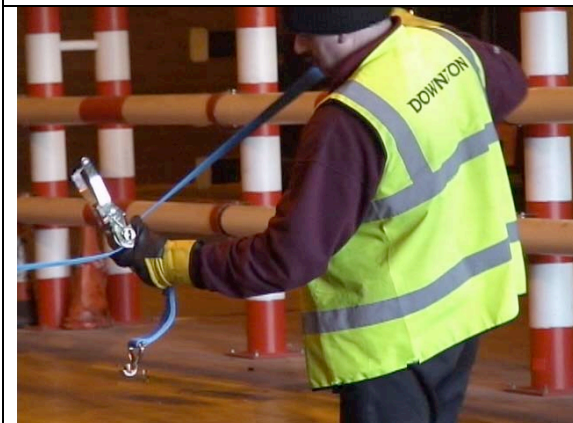
The following photographs are examples of the postures used whilst carrying out the task and will inevitably vary according to the anthropometry of different operators.



Photograph 1: The gantry allows an upright posture when throwing the webbing straps across the reels



Photograph 2: Arms raised away from the body when drawing the curtain



Photograph 3: Elbow raised away from the body when threading the webbing through the ratchet



Photograph 4: Power grip when tightening the ratchet



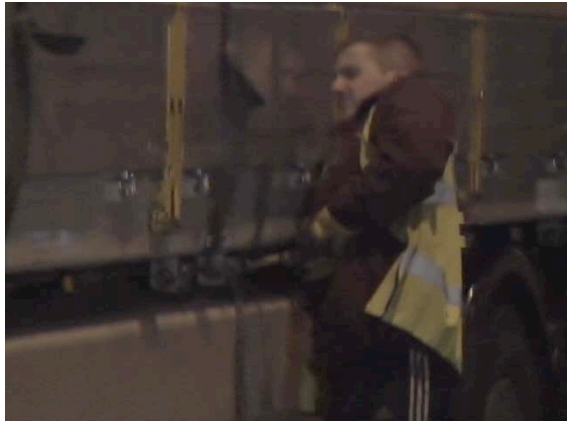
Photograph 5: Neck bent a part of the time whilst securing the load

Throughout the physical part of this task, the operator's back is in an almost neutral position with the elbows raised away from the body for a small part of the time. The operators are not handling a load therefore the Manual Handling Assessment Chart can not be applied to this task.

Overall the postures would appear to be in the low risk category.

Horizontal Loading

The following postures are taken from the video footage and as mentioned previously, will vary according to the differences in height of the operators.

	
Photograph 6: Raising and lowering 25kg weight panels to make up the side of the trailer at around shoulder height	Photograph 7: Using two hands to pull up on the lever. The back is in a neutral position
	
Photograph 8: Use of two hands to pull up on the lever, shoulders are hunched	Photograph 9: Twisting of trunk and shoulders raised to exert the force needed to tighten the strapping

Lifting of the 25kg panels occurs at a moderate distance away from the lower back with the upper arms angled away from the body. It occurs above elbow height but below head height. The trunk is neutral and there are no postural constraints. The load coupled with the repetition rate would be about a medium level of risk.

The worker observed hunching his shoulders and extending and twisting and laterally flexing his trunk is having to extend, what for him is excessive force. He does not have sufficient arm strength alone and is recruiting stronger muscles of the shoulders and trunk while locking or isolating the arms in their strongest posture.

Sometimes Joloda chocks are used to space out the reels. This includes handling 24 weights of about 6.8kg each. This process was not observed so cannot be commented upon but will add to the physical demands of the job.

Due to the force levels needed to tighten the webbing, the consequent postures may increase the risk of MSDs more than the vertical method of loading although the postures are not maintained for long periods of time.

Workstation Design



The height of the trailer bed is 143cm. Elbow height is quoted in *Adultdata* as 950 mm for a 5th percentile female to 1190 mm for a 95th percentile male. Shoulder height is measured at 1230 mm for a 5th percentile female to 1560 mm for a 95th percentile male. Therefore the ratcheting occurs between elbow and shoulder height for most of the population, however 5th percentile females may struggle slightly as the height of ratcheting will take place above shoulder height. Working above shoulder height may increase the risk of MSDs.

8.2.10 Combination of risk factors

Photograph 5 of an operator's posture when using the ratchet (vertical method) was analysed using the Rapid Entire Body Assessment (REBA) (Hignett and McAtamney, 2002) whole body postural analysis tool.

The posture was coded along with aspects of force, hand coupling and activity level to produce a REBA score and an accompanying indication of musculoskeletal risk. No evidence is yet available to validate the REBA scoring system nor the allocation of recommendations for action to particular REBA scores/action levels.

Therefore it is necessary to treat such scoring systems as no more than ordinal scales designed to rank tasks by severity and provide a preliminary guide to the level of remedial action needed. The scoring for this posture indicates a low level of risk with the aspect of force required the main risk factor. REBA is not that sensitive to repetition rates under 4 reps per min. Given the force levels involved lower repetition levels might well be worthy of concern.

Using the REBA system for the posture in Photograph 9 (horizontal loading) scoring would indicate this as a medium level of risk due to the trunk's position and force needed. REBA is also less sensitive to any forces in excess of 20kg so it can be a problem when weighing up the balance of risks and to reduce the scores you'd need to decrease to below 20kg.

The ART (Assessment of Repetitive Tasks) is a new tool (which is still under development) designed to help health and safety inspectors assess repetitive tasks involving the upper limbs. It can assess the most common risk factors that contribute to the development of ULDs. This includes repetition rate, posture and load / force. Green represents a low level of risk, amber a medium and red a high level. Results of the ART assessment for each method of loading are summarised below.

Summary of results for horizontal and vertical loading

Risk Factor	Rationale and Risk Level for vertical loading	Rationale and Risk Level for horizontal loading
Shoulder/upper arm movements	Infrequent (e.g. some intermittent movement) This would be when the ratcheting occurs	Infrequent (e.g. some intermittent movement) This would be when the ratcheting occurs
Repetition	Similar motion pattern repeated 10 times per minute or less	Similar motion patterns repeated 11 –20 times per minute. This is only when the ratcheting occurs and is not representative of the whole task
Force	More than 4kg with one hand) (only when ratcheting occurs)	More than 4kg with one hand) (only when ratcheting occurs)
Head/neck posture	Bent or twisted a part of the time when tightening the strap	Bent or twisted a part of the time when tightening the strap
Back posture	The back is in an almost neutral posture	The back is in an almost neutral posture
Shoulder/arm posture	The elbow is raised away from the body a part of the time	The elbow is raised away from the body a part of the time
Wrist posture	The wrist is bent or deviated more than half the time (when the ratcheting occurs)	The wrist is bent or deviated more than half the time (when the ratcheting occurs)
Hand/finger grip	Power grip or does not grip awkwardly	Power grip or does not grip awkwardly
Breaks	There are frequent short breaks of at least 10 seconds every few minutes over whole work period	There are frequent short breaks of at least 10 seconds every few minutes over whole work period
Work pace	Not difficult to keep up with the work (although could vary from day to day)	Not difficult to keep up with the work (although could vary from day to day)

Other factors	Gloves, operators are exposed to cold sometimes	Gloves, operators are exposed to cold sometimes
Exposure score/level	5.5: Consider individual circumstances	6.5: Consider individual circumstances

Both methods using the ART tool indicate a low level of risk to the operator with consideration to individual circumstances.

8.2.11 Conclusions

The new system of loading the reels vertically appears to present a lower level of risk in comparison to the horizontal loading mainly due to less force being required to operate the ratchets and the consequent postures that this entails. However in each of the force measurements, it is likely to be a function of the operators ability to deploy their body weight onto the handle so it would be useful to ascertain the minimum handle force required to give rise to suitable strap tension and whether the loading method somehow influenced the strap tension and ease of ratchet operation.

The level of risk overall is low for both systems as repetition rate is not high, there are opportunities for rest and the postures are not held statically. There are therefore limited recommendations to follow.

8.2.12 Recommendations

8.2.12.1 *Monitoring of signs and symptoms*

It was noted on the site visit that there have been complaints of aches and pains. A useful system of monitoring could incorporate the application of self-report forms. This might require operators reporting when they experience pain. It could take the form of a log sheet at the end of each shift/month or shading the body parts on a map of the body where discomfort is felt (e.g. Wilson and Corlett, 1990 – see Figure 1 below). This monitoring enables a more complete picture to be built up of where symptoms are occurring and problems exist.

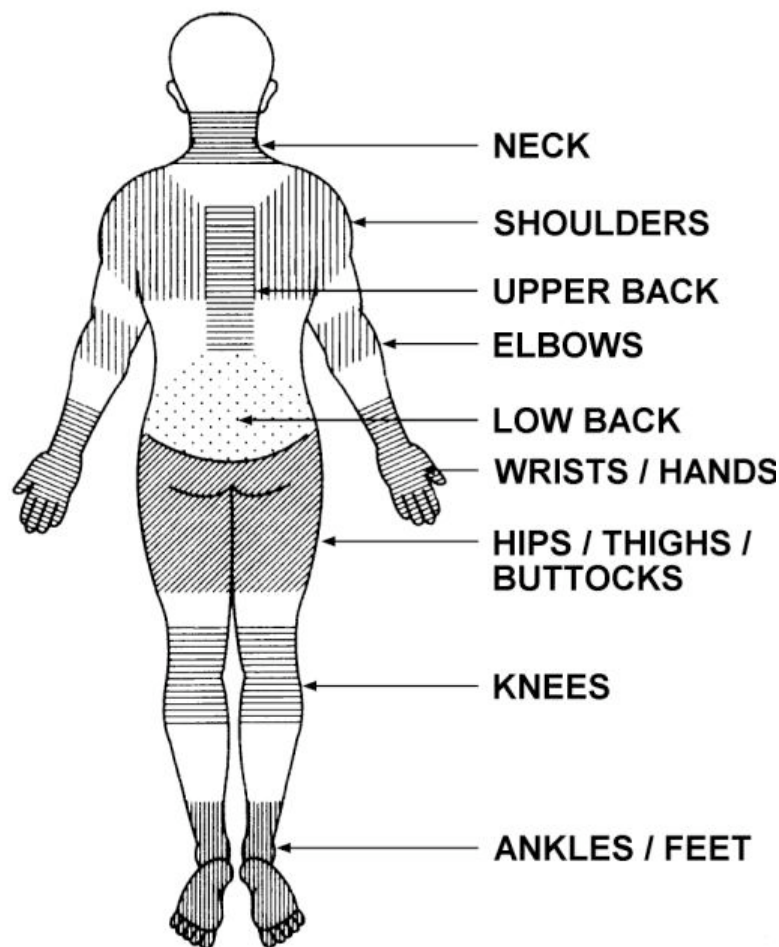


Figure 1 Wilson and Corlett's Body Map

The Trades Union Congress (TUC) has access to the Hazards online guide to body mapping, risk mapping and other tools. HSE guidance “Upper limb disorders in the workplace” (HSG60) also details a number of approaches to monitoring including sickness absence records and staff turnover.

8.2.12.2 Breaks

Consultation with the operators will help to set an adequate work rest ratio although this may already be achieved. It may be that the lunch break could be taken earlier on so that the physical work is split up more equally. 5-minute breaks each half hour in addition to “micro breaks” (e.g. 20-30 seconds break to stretch and flex if muscular discomfort becomes evident at any time) could be recommended especially with the horizontal loading if the operators felt that they needed to.

8.2.12.3 System of Work

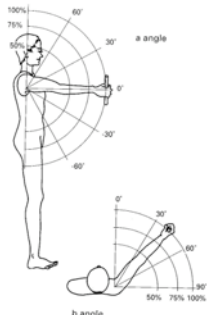
Potentially two hands could be used to operate the ratchets when securing the reels vertically, sharing the level of force between the two hands.

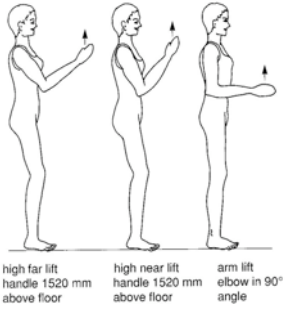
A torque wrench ensures that the desired force is applied to a fixture consistently so it should be possible to use a system like a torque wrench to investigate the minimum levels of force needed to provide a suitable strap tension and so then as part of operator training and awareness help to define and confirm maximum ratchet handle force levels. Depending on the force levels required doing the job it might be that a detachable handle that lengthens the lever arm may be of use during the final tensioning phase.

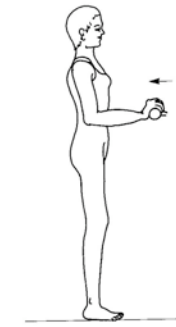
A small stool or platform may help shorter operators acquire a better working posture when using the lever for the horizontal loading. However the effect of reach on shorter operators might be another reason to go vertical.

The new system of vertical loading appears to present a lower level of risk in comparison to the horizontal loading as there is less force required to operate the ratchets (although as discussed previously, the amount of force required may be dictated by operator ability) and the postures are slightly better therefore it is recommended that this method of strapping is more favourable. This method also eliminates the need for operators to handle “joloda” chocks and 25kg trailer panels that were part of the horizontal loading technique.

8.2.12.4 Additional data

Adult Data Reference	Type of Loading	Limitations/ Assumptions of reference	AdultData (kfg)	Comparison to forces measured
 Rohmert and Hettinger 1963 Lifting strength on a cylindrical handle using 1 hand at a variety of arm angles and reach distances feet 30cm apart	Vertical	Estimation of angle	30° a angle, 50% arm reach 30° b angle 13.1	Double the amount of force is needed
	Horizontal	Based only on one hand	–30° a angle 50% arm reach 30° b angle 18.7	More than three times the Adultdata reference however more force can be applied with two hands

 Garg and Beller 1990 Dynamic pull using one hand on a vertical hand grip at a variety of handgrip heights, pull angles and speeds (ms-1)	Vertical	Not sure on the speed	70% shoulder height, pulling speed 1.1 and pulling angle 25 25.6	A little over the adult data reference
	Horizontal	Based only on one hand	70% shoulder height, pulling speed 1.1 and pulling angle 35 33.9	Double the adult data reference although two hands were used
 high far lift handle 1520 mm above floor high near lift handle 1520 mm above floor arm lift elbow in 90° angle Keyserling et al 1978 Lifting strength on a round handle 30mm at various heights from the floor using two hands	Horizontal		Using <i>high near lift</i> Male 95 th percentile 74.5 Male 50 th percentile 53.9 Female 5 th percentile 15.7	Some females may struggle with this as the forces obtained on site exceed a 5 th percentiles capabilities
	Vertical		Using <i>arm lift elbow in 90 degree angle</i> Male 95 th percentile 54.9	Data obtained is over that of the capability of a 95 th percentile male

			Male 50 th percentile 38.2 Female 5 th percentile 8.8	
 standard posture - handle at shoulder height Daams 1993 Pull on a horizontal bar (32mm) with 1 hand at a variety of handle heights. Two postures were tested a) free posture no restrictions and b) standard posture; one foot 30cm in front of the other, elbow in 90degree flexion	Vertical	Handle in horizontal position	Using shoulder height, free and mean Male 30.1 Female 20.1	Some females and some males may struggle with this
Daams 1993  standard posture - handle at elbow height Pull on a horizontal bar (32mm) with 1 hand at a variety of handle heights. Two postures were tested a) free posture no restrictions and b) standard posture; one foot 30cm in front of the other, elbow in 90degree flexion	Horizontal	Only 1 hand Handle in horizontal position	Handle height at 1.3m, free posture Male 34.7 Female 22.3	Over double the amount of force was measured however two hands were used

8.3 APPENDIX C: COST BENEFIT ANALYSIS

1. The following calculations are based on information so far available. At present some key data is missing, including the proportion of lorries currently using the various different securing methods (this is assumed to be very low and figures presented below assume no compliance at current), the number of people who would be affected by additional loading time, the costs that would be incurred through a reduction in lorry loads (as explained in paragraph 15) and the benefits in a reduction in congestion caused by accidents on public roads (this is currently being calculated). Costs of training are also not included at this stage and the benefits of a reduction in injuries in the workplace could be affected by the risk assessment. Impacts on firm's reputation and productivity are also not included.

2. For each different restraint method a number of factors contribute to the costs and benefits associated with that method. The main factors are:

- additional time needed to load or unload a lorry caused by the new restraint method
- cost of buying the restraint equipment, whether that be caused through having to retro-fit the lorry or buying additional equipment such as straps
- a reduction in injuries caused by load-shift
- a reduction in road traffic accidents caused by load-shift

3. This analysis considers the two main alternatives to what shall be considered the status-quo - relying on friction to prevent load-shift. These methods are fitting side slats to lorries and over-strapping loads to prevent movement.

Data Sources and Assumptions

4. The primary data sources for this analysis are Department for Transport (DfT) statistics. Figures on the number of heavy goods vehicles and curtain-sided lorries, average haul length, vehicle kilometres travelled, the number of traffic accidents and the cost of those accidents are all available through the DfT's Road Freight Statistics and Transport Statistics for Great Britain .

5. Data on injuries caused by load-shift are taken from the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR) database, using the average over the four year period from 2001/02, adjusted for under-reporting. As there seems to be no reporting among the self-employed, the same injury rate has been assumed for employees and the self-employed and adjustments made to RIDDOR figures based on the proportion of employees in freight transport by road that are self-employed.

6. Further data is drawn from Network Rail, for the bridge strike information, and industry estimates, supplied to the Health and Safety Laboratory (HSL), on the additional loading time required for each method and the cost of restraint equipment and fitting.

7. In the absence of data outlined in paragraph one, it is currently assumed that all curtain-sided lorries in the UK currently rely on friction to restrain loads, all lorries shall adopt the new restraint method under consideration and that this will eliminate all injuries caused by load-shift.

8. A reduction in road traffic accidents (RTAs) caused by load-shift is also included for each option. Although there is no specific information on the number of RTAs caused by load-shift on curtain-sided lorries, reasonable assumptions can be made from what data is available and, in the calculations below, all of these RTAs are eliminated.

9. Both costs and benefits have been discounted in line with Treasury guidance. Discounting is a method used to convert future costs and benefits to present values using a 'discount rate'. Costs have been discounted at a rate of 3.5%, meaning the present value of a future pound is assumed to decrease by 3.5% per year. Health and safety benefits have been discounted by 1.5% per year. Costs and benefits are calculated over an appraisal period of ten years and expressed in present value terms so that future costs and benefits can be compared.

10. Where data is unavailable on the precise number of incidents involving curtain-sided lorries (CSLs), the proportion of CSLs to heavy-goods vehicles (HGVs) is used. This is the case for all RTAs.

11. Averages from the three year period starting in 2004 are used for the number of hauls per year and the total annual cost of RTAs involving CSLs.

Option 1 – fit side slats to the lorries

Costs

12. The Company estimates the cost of modifying their trailers with side slates to be £2K per trailer. Using this figure, the one-off cost of modifying all curtain-sided trailers would be £42m.

13. St Regis estimates that the time required for side strapping is 20-40 minutes. Using the mid-point of this range, thirty minutes, and assuming that it is only the lorry driver who is unable to complete other work during this period, the costs incurred through additional loading time are £100m per annum or £890m over the ten year appraisal period.

14. These figures do not account for the likelihood that less loads would be able to be completed, as there is only a limited amount of space available for loading or unloading. The only way to allow for the same amount of haulage would be either to expand the space available for these activities or to pay workers for longer hours. Either of these options would incur large additional costs which have not currently been estimated. If less loads were completed there would also be large additional costs incurred.

Option 2 – secure loads by over-strapping

15. Eight Spanset five tonne straps cost around £50; this is the figure used here for the cost of over-strapping equipment. There may be additional costs through modifying trailers to fit attachment points but these are not estimated here (it is likely that most trailers would not require this). Assuming that one set of straps is bought per trailer per year, the annual cost of over straps would be £5.3m, or £45.4m over the ten year appraisal period.

16. St Regis estimate that it would take them two hours to overstrap their paper reels, UPM-Kymmene, a company transporting similar loads, estimate an additional twenty minutes. If a thirty minute estimate is used the costs would be the same as for option one; £100m p.a. or £890m over the ten year appraisal period if only one worker's time is taken up by the additional requirements.

17. As with option one, these figures do not account for the costs of a decrease in loads completed or the costs that would be incurred preventing that decrease.

Benefits

18. Assuming that either method of load restraint eliminates all injuries caused by load-shift in the workplace, annual benefits of £1.4m or £12.9m over a ten year appraisal period would be realised.

19. There are around 2000 'bridge strikes' in the UK each year costing the economy £50m. Three per cent of these are caused by load shift. If we assume that more effective load-restraint on curtain-sided lorries will reduce the number of load-shift related bridge strikes by one quarter (although only 5% of HGVs are CSLs) then an annual benefit of £375K would be realised. This equates to £3.2m over the ten year appraisal period.

20. Whilst there is no specific information available on the number of incidents on public roads caused by load shift on curtain-sided lorries, the following information does add to the overall picture.

21. Police records on road accidents include details on vehicles involved and contributory factors. The most relevant classification of vehicle is HGV. As we know what proportion of HGVs are CSLs, assumptions can be made on the proportion of these accidents that involve CSLs. Of 77 specific contributory factors listed only four have the potential to include load shift. These are;

- Overloaded vehicle (160/9720 accidents)
- Swerved (167)
- Loss of control (394)
- Distraction in vehicle (84)

In total these add up to 8% of all accidents reported. These four categories clearly have a lot of scope to include other types of accidents too. With this in consideration, the following figures are the benefits realised if enhanced restraint methods led to a 5%

reduction in accidents involving CSLs. The total number of CSL accidents is deduced from DfT statistics for injury accidents, adjusted for under-reporting. Non-injury accidents are calculated using the DfT's standard figure of 11 non-injury accidents for each injury accidents. DfT appraisal values for preventing incidents are used to calculate the monetary benefit.

22. Using the above figures, the annual benefit from a reduction in accidents on public roads is £4.6m or £43m over the ten year appraisal period. These figures do not include the benefit from a reduction in congestion caused by RTAs.

23. Using DfT and Highways Agency figures for vehicle flow, time taken to clear accidents and the cost of vehicle delay on the UK road network, an maximum annual benefit of £31.4m is realised through a reduction in congestion caused by RTAs involving load shift on CSLs. This equates to £271m over the ten year appraisal period. It must be noted that these figures are also calculated using the contributory factors explained in paragraph 21 and that it is likely that many of those accidents were not caused by load shift on CSLs. The figure presented is a maximum designed to illustrate the scope of the benefits in light of the costs.

24. Combining all the above benefits gives an annual total of £37.8m or a total over the ten year appraisal period of £329.9m

8.4 APPENDIX D: DETAILED HSE WORKSHOP FINDINGS

Note that the statistics detailed below come from The road haulage and distribution industry – overview [1].

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
Base case	Rollover	Exceeding the speed at which the load shifts can cause rollover, especially on roundabouts/slip roads. Bumpy road surface can also increase likelihood. Loading the vehicle incorrectly could also increase the chances of toppled loads. Justification Rollovers probably occur fairly often, but are not attributed solely to load shift. Over industry as a whole, it is hard to determine how often rollover due to load shift occurs. Ranking: 2	Consequences depend on what type of road the accident happens on e.g. motorway, and how many people are in the vicinity. Disruption and cost to the road network is more severe than any injuries/fatalities that could occur. Note this case assumes that the load is contained within the curtain. Justification Injuries will involve pedestrians or other vehicle users, the driver will be protected by the cab so will most likely escape with minor injuries. However, most cases of rollover will not impact on anybody else. Worst case would be a multi-vehicle pile-up. Range: 1 to 6 Ranking: 3
Base case	Ejection	More likely to occur on fast corners as load presses against curtain, usually on roundabouts and slip roads. Bumpy roads could also result in load shift leading to	Could depend on what is being ejected as heavy paper reels could crush nearby vehicles while lighter objects may have no direct consequences, but there may

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		ejection. Justification Likelihood of ejection is assumed to be slightly higher than the likelihood of rollover but not enough to move it into a higher frequency category.. Ranking: 2 <i>Need more evidence from other sources</i>	be delayed effects caused by vehicles swerving. Ejected loads may scatter over a large area of the road, potentially affecting many road users. Justification The consequences could be more severe than that of rollover. Drivers are more likely to swerve, avoiding the falling cargo rather than being fatally injured. Lorry drivers are less likely to be injured than the public if load falls from side/back. Worst case would be a multi-vehicle pile-up. Loss of control due to swerving will most likely result in a major injury. Range: 1 to 6 Ranking: 4
Base case	Falling loads when curtain is pulled back	More likely to happen with curtain siders than flat bed/rigid vehicles as the load is hidden by the curtain and shifting may not be noticed until too late. Justification In 05-06, there were 1165 injuries from people being hit by falling loads covering all types of injury e.g. major, minor for all types of vehicle. However as stated before this scenario occurs most frequently with curtain siders so value will account mainly for these vehicles. This value includes all scenarios	In most cases the load misses drivers possibly due to quick reaction times as well as an element of luck. However, moving out of the way quickly can cause new risks e.g. falls. Of the 1165 injuries in 05-06, there were 3 fatalities, 215 major and 947 over 3 day injuries. Justification Worst case would result in a person being crushed under heavy items, but is unlikely to result in multiple fatalities. On occasions the person unloading will completely escape injury.

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		leading to falling objects, but most injuries are assumed to occur when the curtain is pulled back. 1165 equates to approximately 3 injuries per day over the entire industry. However, under-reporting of lesser events e.g. near misses could skew the figures leading to a lower frequency. These values only account for injuries meaning that falling loads resulting in no injuries are a common occurrence. As a result many falling loads per hour is a reasonable assumption. Ranking: 6	Most injuries fall within the over 3 day injury bracket but as many incidents go unreported there will be more short term reversible injuries occurring that require first aid. As a result, underreporting of near misses results in bumps and bruises being the most common injury due to personnel jumping out the way suddenly and stumbling to the ground. Range: 1 to 5 Ranking: 2 <i>Check RIDDOR for more evidence.</i>
Base case	Falls from height	This scenario is concerned with falls resulting from climbing onto the trailer bed to sort shifted cargo. Note that the shifted loads are more likely to be sorted away from depots where there is less control in terms of protecting from falls i.e. gantries and other measures. Justification Of the 6 out of 8 load shifts Nina witnessed, personnel climbed onto trailer bed to sort the load in all 6 cases. Over industry as a whole there is the potential for numerous falls. 702 falls from height occurred in 05-06 from various different heights. This value will also	During 05-06, there were 702 reported falls from height in the road haulage and distribution industry: this is broken down into 1 fatality, 299 major and 402 over 3 day injuries. This can again be broken into: High fall – 30 major and 19 over 3 day injuries; Low fall – 1 fatality, 245 major and 319 over 3 day injuries; Unknown height – 24 major and 64 over 3 day injuries. Justification Personnel falling from the trailer bed could be lucky and escape with few injuries or they could fall awkwardly

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		include falls from height that are not due to load shift. If 1% of these incidents result from falls due to load shift, then this equates to 7 per year, or slightly less than 1 per month. Underreporting of minor injuries is also an issue so the actual number of falls will be much higher. The value below feels the most appropriate. Ranking: 3	resulting in a fatality. Despite the fact that over 3 day injuries are the most common depending on the height of the fall, the consequences due to falls from the trailer bed are assumed more likely to result in a major injury such as broken bones. Range: 1 to 5 Ranking: 4
Base case	MSDs	MSDs can be reduced using specialised unloading machines. When loads shift and equipment is not used, personnel can pull muscles when lifting fallen loads. This will depend on the heaviness of the load, as employees are more likely to try and lift cargo they think they are able to lift. Justification MSDs are the most common work related injuries, with almost 4000 (3941 to be exact) cases reported under RIDDOR in 05-06 (for the road haulage and distribution industry) so the frequency will not be at the lower end of the scale. Underreporting is common especially with minor injuries so the real frequency is probably much higher than the above value. However, this number includes other vehicles besides curtain siders as well as for incidents other than load shift, so a proportion of	Generally, the consequences will not be severe enough to result in single or multiple fatalities. Of the 3941 handling injuries, there were no fatalities, 281 major and 3660 over 3 day injuries. In addition MSDs account for a third of all absences from work. Justification Underreporting of MSDs such as muscle twinges are assumed to be fairly common; in fact it is probable that employees will work 'through the pain'. As a result there are likely to be more of these types of 'injuries' occurring than reportable over 3 day injuries. As a result the consequences will favour the lesser injuries, ranking towards the bottom of the scale. Range: 1 to 4 Ranking: 2

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		this value, say 1%, (why “say 1%” I can see no justification at all for selecting 1%– there is no justification, Shane recommended this to be done due to lack of data) needs to be taken. This equates to 40 actual incidents over 1 year for the entire industry, or just over 3 per month. Underreporting means there will be more minor incidents occurring, leading to the below frequency rating. Ranking: 4	
Side-strapping	Rollover	The straps are not designed to restrain the load and are only applied periodically along the vehicle. There is containment to a certain extent generally when the load is light as the overhead pole usually fails with heavier cargo, rather than individual straps snapping. This method will not prevent rollover, as the load is still able to move around in all directions in the same way as the base case. Ranking: 2	Side strapping has no effect on the consequences when compared to the base case. Same as the base case. Range: 1 to 6 Ranking: 4
	Load ejection	The restraint may prevent the ejection of light material that is wider than the spacing of the straps. However, the most common loads consist of heavy building materials and minerals (28%) 65 so load shift would result in the cargo pressing against the straps and snapping the	Again side strapping has no effect on the consequences when compared to the base case. Same as the base case. Range: 1 to 6 Ranking: 4

⁶⁵ The road haulage and distribution industry – overview, SIM 5/2007/02

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Falling loads when curtain is pulled back overhead pole. The restraint is not effective so the same frequency as the base case is assumed. Ranking: 2 As the straps are placed at large intervals along the side of the trailer there is still the possibility that some of the load will be completely unprotected by the straps, leading to falling loads. The safety measure is useful for light loads as there could be an increase in warning time before the load falls through the straps. However, heavy cargo will most likely detach the overhead rail en route, which means that falling loads when the curtain is pulled back are still likely. As before heavy building materials and minerals are the most commonly transported items. However, there will be cases where the load is completely contained so overall there will be a slight reduction in frequency of falls, but not enough to significantly change the frequency from that of the base case. Same as base case. Ranking: 6 Falls from height Personnel usually climb on the trailer bed to fit the straps so are more likely to be exposed to falls from height than the base case. The load can also still shift due to lack of restraint so personnel may climb onto trailer bed to	As falling loads are not prevented the consequences are unchanged from that of the base case. Same as the base case. Range: 1 to 5 Ranking: 2 The consequences resulting from a fall are unchanged from the base case. Range: 1 to 5	

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		lift fallen items. As a result there is an increase in the frequency of falls from height to that of the base case.	Ranking: 4
	MSDs	Ranking: 4 Drivers usually pull the straps downwards with one hand and use the other to prevent falls from the trailer bed. Force to pull strap is $\geq 100\text{N}$. Overall, MSDs are judged to occur slightly more often than with the base case. More input from Ergonomics would be useful. Ranking: 4	Injuries sustained from lifting fallen loads may affect different parts of the body to that of injuries obtained when applying the safety measure. However, the injury consequences are assumed to be of the same magnitude as the base case. Range: 1 to 4
	Other issues	Straps can get caught up in forklifts during unloading. Fingers can be severed when applying and removing the straps.	Ranking: 3
	Overall	Measure does not prevent major accidents. It is only useful at containment if the loads are relatively light and large in size. It increases the chances of falls from height and MSDs as applying the measure increases exposure to working at height and manual handling. The overall likelihood of accidents is slightly increased using this measure when compared to the base case.	Even though the restraint changes the likelihood of accidents occurring, it does not affect the resulting consequences as compared to the base case.
Over-strapping		Load shift in all directions is prevented provided measure is used correctly and there are no gaps in the load. Containment is also provided. However, drivers can underestimate the	

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Rollover	number of straps required. This assessment assumes that the straps are applied in the correct manner, i.e., number of straps, adequate strap points, goods size (palletised) and properly loaded goods, i.e. no gaps as per relevant standards.	
	Load ejection	The load is unable to move so rollover due to load shift is prevented. Ranking: 1	Rollover does not occur so the consequences are negligible. Ranking: 1
	Falling loads when curtain is pulled back	The load is completely contained so load ejection is prevented. Ranking: 1	The load cannot be ejected through the restraint so the consequences are negligible. Ranking: 1
	Falls from height	The load will not fall when the curtain is pulled back as the cargo is completely restrained. As the cargo has been loaded correctly there will also be no chance of falling loads due to internal load shift when the measure is removed. Ranking: 1	As the measure has been used appropriately there will be no possibility of falling loads. Consequences are negligible. Ranking: 1
		Personnel usually have to climb onto trailer bed to feed straps over the load as curtain siders generally have high loads. However, this will be done in a controlled environment before transit so the load will be properly stacked with no spillages and will be more planned and safe as a result. Strap could be unhooked on one side and pulled over the top of the load before unloading so	Falling from the trailer bed in this manner will result in the same level of consequence as the base case. Range: 1 to 5 Ranking: 4

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	MSDs	personnel would only be on the bed if it became tangled. However, this could occur fairly often especially with oddly shaped loads. Pulling the straps in this manner could cause the top of the load to fall so the restraint may not be moved in this way very often. More likely for employees to climb onto the trailer to remove the restraint. Overall frequency of exposure to falls is considered to be no different to the base case but for different reasons. Personnel will be exposed to falls by climbing onto the bed to apply the restraint (unlike the base case) but will not have the possibility of falling due to lifting shifted loads (like in the base case). Ranking: 3 Introduces injuries from pulling straps when applying and removing the restraint. If the employee's body weight is used to pull the strap down, the likelihood of MSDs can be reduced. However, unlike sidestrapping, there is no need to lift fallen loads as the cargo is completely restrained. Likelihood of MSDs is therefore less than for sidestrapping. Comes out as the same as the base case but for different reasons. Ranking: 2	Consequences depend on what occurs as illustrated for the base case. Range: 1 to 4 Ranking: 3
	Other	Sometimes the strap is flung	Could range from negligible to

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Overall	over the load when it isn't too high; this could hit someone. Edge protectors can also hit people when the restraint is removed. Measure prevents major accidents and falling loads when used correctly. Falls from height and MSDs are introduced when applying the measure but MSDs associated with load shift are removed. Can be reduced further by combining measure with bulkheads. <i>Overall likelihood of accidents is reduced when compared to the base case.</i>	a fatality if someone is hit on the head. Most likely to result in a minor injury. Range: 1 to 5 Ranking: 3 The consequences are greatly reduced in terms of removing the possibility of major accidents such as rollover. However, there is a slight increase in the consequences associated with applying the measure, which can result in MSDs etc.
Side slats	Rollover	The load is not restrained and is free to move around within the confinement of the slats. There is load containment, provided the slats are designed to the correct standard and are appropriately placed. Assume that the cargo fills the curtain sider and that there are no gaps in the load. Increasing in popularity in the EU so could become a common feature in the UK. Rollover due to load shift is a possibility, although the likelihood may be slightly reduced as slats prevent bulging of the curtain. However, this reduction is not sufficient to move the likelihood to a lower ranking so same as the base case. Ranking: 2	The consequences will be the same as the base case. Range: 1 to 5 Ranking: 3

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Load ejection	The slats are assumed to be strong enough to hold the load and prevent ejection. As a result, the likelihood of rollover due to load shift is negligible. Ranking: 1	No load ejection so the consequences are negligible. Ranking: 1
	Falling loads when curtain is pulled back	As the slats are assumed strong enough, the load will not fall when the curtain is pulled back. It is also assumed that if the load was strong enough to break through the slats, the cargo would continue on through the curtain, most likely in transit. The load could fall as the measure is removed but the operative will be able to see any shifted loads before the restraint is removed. In addition, the cargo pressing against the slats means that it would be extremely difficult to remove them. As a result the likelihood of falling loads when the curtain is pulled back is negligible. Ranking: 1 When removing the measure the likelihood of falling loads is increased. Assumed to be the same as the base case. Ranking: 6	Assume here that the cargo is contained so the consequences when the curtain is pulled back are negligible. Ranking: 1 However, when the measure is removed there is a chance of falling loads, so the consequence would be the same as the base case. Range: 1 to 5 Ranking: 2
	Falls from height	Personnel will have to climb the trailer bed to apply the slats unless there are gantries etc available. There is also the possibility of toppled loads that need to be	The consequences of a fall will be the same as the base case. Range: 1 to 5

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		lifted that could result in a fall. Applying the measure places the operative at a similar location along the length of the trailer bed as when side strapping is fitted. As a result, the rating is assumed to be the same as side strapping. Rating: 4	Ranking: 4
	MSDs	Slats are very heavy and awkward for the operative to apply so injuries of this kind are likely to be common. Sometimes the measure is applied with one hand as the other is used to prevent falls from height. If the load shifts against the slats, it is very difficult to open them, so again injuries are likely to be common. Once the slats have been removed, there is again the possibility of MSDs occurring when lifting shifted loads manually. Slightly more likely to cause injury than sidestrapping or overstrapping, although not sufficiently more to increase the frequency rating. Ranking: 4	Despite the fact that applying slats is cumbersome, the injuries that could be sustained are not expected to be severe. They are likely to be the same magnitude as sidestrapping or overstrapping. Possibly need more information from ergonomics on this. Range: 1 to 4 Ranking: 3
	Other	As the slats are heavy it is possible that personnel could drop the measure from the trailer bed. It could either miss operatives on the ground or hit them head on.	
	Overall	Measure reduces likelihood of major accidents such as load ejection but they can still occur. Should prevent falling loads when curtain is pulled	The consequences in terms of falling loads and ejection are negligible, but there are still some issues concerning rollover, falls from height and

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		back but does not prevent falls from height. MSDs are more common with this measure than any other due to their cumbersome nature. <i>Slight reduction in likelihood of accidents when compared to the base case.</i>	MSDs.
Sliding gates		It is assumed that the sliding gates are strong enough to contain the load. This measure is unable to restrain the load so the cargo is free to move in any direction. Only drawback with this measure is the structure to which the gates are attached to also needs to be stronger than normal, otherwise there is a possibility that the gates could cause part of the trailer to bend or detach. However, once in place the measure is easy to operate and could be ideal for containing smaller items. It is also assumed that the cargo is packed to the height of the gate and not above.	
	Rollover	Rollover can still occur in a similar way to side slats. Overall, same rating as slats is assumed. Ranking: 2	As rollover can still occur the consequences will be the same as the base case. Range: 1 to 6 Ranking: 3
	Load ejection	Better than slats at preventing load ejection of smaller items. Items loaded above height of gate can still be ejected although this is assumed not to occur. As a result load ejection is negligible. Ranking: 1	The consequences are negligible as load ejection assumed not to occur with this measure. Ranking: 1

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Falling loads when the curtain is pulled back	The gates should prevent falling loads when the curtain is pulled back, however, the load may fall when removing the safety measure if it has shifted against the gates during transit. Before the measure is removed the operatives will easily be able to see if the load has shifted within the confines of the gates, so they will take care when removing the measure. As the same situation occurs with side slats, when the curtain is pulled back, the same frequency rating is assumed. Ranking: 1 When the measure is removed falling loads are assumed to have a similar frequency to that of the base case. Ranking: 6	As it is assumed that the load does not fall when the curtain is pulled back, the consequences are negligible. Ranking: 1 However, when the measure is removed falling loads can still occur in a similar manner to the base case. Range: 1 to 5 Ranking: 2
	Falls from height	Gate can be applied from the ground so the need to climb the trailer bed is removed. However, personnel will still be required on the trailer bed if the load shifts. As a result the likelihood is the same as the base case. Ranking: 3	The consequences of a fall from height is unchanged when compared to the base case. Range: 1 to 5 Ranking: 4
	MSDs	Injuries could be sustained when opening the gates outwards(Sliding gates slide open . They do not open outwards). As the load is free to move, personnel may be required to climb onto the	The consequences are similar to that of sidestrapping. Range: 1 to 5 Ranking: 4

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Others Overall	trailer bed to lift fallen loads. These scenarios are similar to that of sidestrapping so the same ranking is assumed. Ranking: 3 Easy to apply measure, however, it couldn't be easily retrofitted on current curtain sided vehicles. Major accidents can still occur. Falling loads and falls from height are prevented if proper procedures are followed. MSDs can still occur. <i>Risk ranking is slightly reduced when compared to the base case. Measure is more effective than slats due to the slight reduction in frequency of falls from height and MSDs.</i>	Consequence rankings for major accidents are slightly reduced and are removed for falling loads and falls from height. MSDs are also slightly reduced.
Walki Wisa tarpaulin		This safety measure provides containment and restraint. Similar to overstrapping though there are no edge protectors or working at height hazards involved. However, there are some important issues that <i>must</i> be addressed. The tarp used is dependent on the type of load. If the load isn't matched to the tarpaulin it can shift. The tension in the straps must be exactly balanced over the entire load. Measure is not suitable for mixed loads. More effective when load is of a similar type that is uniform in size. For this case it is assumed that the tarpaulin is applied in	Assume tarpaulin is used correctly.

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Rollover	an appropriate fashion. Rollover is prevented, as the load is unable to shift. Ranking: 1	As the tarpaulin has assumed to be used correctly the consequences are negligible. Ranking: 1
	Load ejection	The load is contained so ejection is prevented. Ranking: 1	Consequences are negligible. Ranking: 1
	Falling loads when the curtain is pulled back.	Falling loads should be prevented if tarpaulin is used correctly. Loads will not move as the measure is removed as the load is restrained during transit. Frequency rating is negligible for both. Ranking: 1	Consequences are negligible for both pulling back the curtain and removing the measure. Ranking: 1
	Falls from height	Tarpaulin is operated from the ground so there should be no need to climb onto the trailer bed. Ranking: 1	Consequences are negligible. Ranking: 1
	MSDs	MSDs are introduced when pulling the tarpaulin straps into place. Slightly more force may be required to pull against the bungee cord but should still have similar frequencies to overstrapping. Ranking: 2	Injuries sustained will be similar to that of side strapping as both methods involve pulling straps from the ceiling of the trailer. Range: 1 to 4 Ranking: 3
	Other	The straps could become entangled in the forklift trucks during unloading. Need clarification as to whether or not the driver would have to mount the trailer bed to hold	

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Overall	the straps out the way during unloading. If this is required it hazards such as falls from height will be reintroduced. Likelihood of all accidents is greatly reduced by this method but there are some major concerns about applying the measure correctly. <i>The likelihood ranking is reduced when compared to the base case.</i>	The consequences are greatly reduced if the tarpaulin is used correctly.

Detailed industry workshop findings

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
Base Case	Load Shift	Load shift occurs when the load has moved in relation to the position it began its journey at. This can range from as little as one box being moved to the majority of the load being affected. The majority of curtain sided vehicles use no form of load restraint and/or containment and if they do, the measures are generally in poor condition. Mixed loads are also common which can lead to pack instability when the vehicle begins to move. Load shift is therefore a common problem. However, minor occurrences are unlikely to be reported unless the load falls to the ground. Bulging curtains indicate load shift so drivers will be more aware of the risks involved. In general, the police	Shifted loads will have consequences for both the personnel involved in unloading as well as the company who owns the goods; some of which will undoubtedly be damaged if the load topples. It is not unusual for forklift drivers to try nudging the load upright when a bulge in the curtain is noticed. The dangers involved are serious, as the curtain is not designed to be part of the load restraint system. It is also not uncommon for drivers to climb the load to try and rearrange fallen goods, which introduces falls from height issues. In addition,

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		attribute load shift, when it is detected on roads, to driver error i.e. speeding. Load security is more of a priority in Europe but this does not mean to say the safety measures are being used in an appropriate fashion. Issues: It is extremely difficult to pin point the exact reasons as to why a load shifts and if it is the sole reason for the accident. Drivers are commonly blamed despite the fact that no or little investigation is carried out into the root causes. Travelling at a speed which causes the load to shift as well as issues such as curb clipping and the camber of the road have all been raised as possible causes. However, a change in culture is required to prevent drivers being needlessly blamed.	as drivers can be away from their vehicle at the time of loading, they may not know the type of cargo they are carrying and therefore how dangerous it could be if it topples off the trailer bed. Double decked curtain sided vehicles are much more dangerous than single decked because load shift can cause items to fall and get wedged between the curtain and the side of the vehicle. It is important to note that what is perceived as a minor load shift can instigate a much more serious accident. Issues: Point was raised that if the unloading of a trailer with a bulging curtain is rejected on account of safety reasons, what happens? Is the vehicle sent back onto the road? Or is it put to the side and unloaded when there is time to deal with it? Industry does not want to reject customers in this way. Better guidance detailing specific actions is required.
Base case	Rollover	The most serious cases of load shift will result in rollover. It is unlikely that, for example, one shifted box will result in rollover. Justification	The consequences to industry could be catastrophic depending on the situation that occurs. In addition to the consequences of injuries to employees and

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		The condition and camber of the road can have an effect on the likelihood of load shift leading to rollover. One company experienced 5 or 6 rollovers over the last 5 years, although this may not be representative of every company. When applying to industry as a whole this would result in a frequency ranking between 2 and 3. Ranking: 3	members of the public, there are also cost issues of goods damaged as a result of rollover that the company will be liable for. However, these cost issues will not be raised here. Justification There is a vast range of possible consequences that can occur. This all depends on what occurs during the accident, e.g. the proximity of members of the public and the type of goods that are involved. It is not uncommon for shrink-wrapped fridges to be on the same load as machinery weighing several tonnes. As a result, best case would be negligible injuries to worst case involving a multiple vehicle pile up. It was determined to be inappropriate to suggest a typical consequence rating, as the situations that can arise are too variable. Range: 1 to 6
Base case	Ejection	As for rollover, the more serious instances of load shift will result in cases of load ejection. There is also the general belief in industry that the curtain itself can act as a form of load containment. Containment can occur on the	As with rollover, the consequences to industry could be potentially catastrophic. There are again cost issues involved that will not be discussed here. The consequences are

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		odd occasion but cannot be guaranteed. Justification Load shift due to tight bends seem to be a possible cause of load ejection. This is more likely to occur from the side of the vehicle but ejection is also possible from the back of the vehicle particularly when climbing steep hills etc. The frequency is assumed to be similar to that of rollover. Ranking: 3	greatly affected by the different variables that could arise during and after ejection. Justification As an example, load ejection occurring at night on sparsely populated roads will have far less consequences than on a road during rush hour. The cargo itself will be an issue with heavier goods more likely to do damage than lighter goods. On the whole any load ejection scenario has the potential to cause considerable harm. Again the situation depends on the resulting consequences so only a range can be identified. Range: 1 to 6
Base case	Falling loads when curtain is pulled back	If the load has shifted, falling loads are almost certain to occur when the curtain is pulled back. Justification The possibility of this occurring will be fairly obvious if the curtain is bulging, but falling loads (when the curtain is pulled back) can happen even if there are no apparent signs. This scenario encompasses a range of possibilities from a single fallen object on the trailer bed to numerous items scattered on the depot floor. As a result, this scenario is a	Once more the consequences depend on the situation as it unfolds. Justification Light objects such as pillows or polystyrene will probably not produce any significant consequences to contend with, perhaps requiring first aid if the operative is taken by surprise. However, the consequences associated with cargo such as machinery are much more severe. A

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		fairly common occurrence. Ranking: 6	fatality in such cases would not be unrealistic. It is therefore difficult to pinpoint a particular consequence without knowing the full extent of the accident. Range: 1 to 5
Base case	Falls from height	Personnel are not supposed to climb onto the trailer bed for any reason but most are unaware of this. Justification Safety representatives are most likely to be absent during night shifts so can't enforce procedures that prevent falls from height. Drivers are known to not only climb onto the trailer bed, but also onto the goods themselves, usually when correcting a shifted load. Falls were determined to occur frequently. One company experienced 15 staff suffering falls from height. Over industry as a whole this will add up to a significant amount. Ranking: 4	Again, could depend on the extent of the fall and what contributed to it. Justification Falls can occur from various heights: the height of the trailer bed to that of the roof of the trailer itself. As a result the consequences will range from minimal to very severe. Multiple fatalities are not likely. Range: 1 to 5
Base case	MSDs	With the base case there are only MSDs associated with personnel lifting shifted loads. Justification Falling loads are a common occurrence so each time a load is manually lifted there is a chance that an MSD will result. Personnel should have received some form of manual handling training, which should reduce the number of MSDs.	The consequences associated with MSDs will not result in fatal or multiple fatalities. Justification There will be a range of consequences depending on the situation as it occurs. Injuries can range from negligible to a major injury.

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		Ranking: 4	Range: 1 to 4
Side- strapping		The roof and curtain of the trailer is designed purely for weather protection and offers no enhancement to the load restraint/containment system. The overhead rail that sidestrapping relies on is not extra strengthened. The number of straps can be underestimated because a lot of drivers are untrained in how many are adequate. The straps themselves can also be in poor condition.	
	Rollover	The load is not restrained so the free movement can still cause the load to shift so rollovers are still possible with this measure. There is a small amount of containment, which could reduce the amount of bulging and therefore slightly reduce the number of rollovers. Overall the reduction is not sufficient to move it to a new ranking level, when compared to the base case. Ranking: 3	Rollovers can still occur so the consequences are exactly the same as the base case. Range: 1 to 6
	Load ejection	There is some level of containment provided, however the individual goods must be of a size that is not small enough to fall through the straps. Lighter items should be fully contained. However, as before, heavier goods will detach the overhead rail and continue through the curtain. As a result the base case ranking is assumed. Ranking: 3	Minor as well as serious accidents can still occur so the same range of consequences as the base case is assumed. Range: 1 to 6

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Falling loads when curtain is pulled back	As before with load ejection, the load should be contained provided the individual goods size is large compared to the spacing of the straps. Lighter items are more likely to be contained. Therefore, the measure may prevent falling loads when the curtain is pulled back so there is a slight reduction in risk when compared to the base case. However, the load can still fall when the measure is removed. The frequency is not significantly reduced to give the measure a different ranking. Ranking: 6	The load still has a possibility of falling so the consequences are on the same level as the base case. Range: 1 to 5
	Falls from height	Falling from height is an issue that becomes more important with the introduction of this measure. Personnel may climb onto the trailer bed to apply it if there are no safe means such as gantries available, though it should be possible to slacken the straps from the ground. In some instances operatives climb onto the trailer to remove the measure by cutting through the straps; falls can also occur here. If the straps become tangled in forklift trucks, untangling may involve mounting the trailer. As a result the frequency is greater than that of the base case so the frequency ranking is set at the next most frequent level. Ranking: 5	The consequences that result from a fall from height are the same as the base case. Ranking: 1 to 5
	MSDs	MSDs in terms of applying the measure are introduced. The	As with the base case, the consequences are

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Other issues Overall	type associated with lifting fallen loads is also still an issue so overall, the frequency of MSDs is slightly increased when compare to the base case. Ranking: 5 When the straps are ratcheted tight, the employee will be in close proximity to the load, which could be potentially dangerous. Workers may experience false confidence by assuming the load is completely secured. The risk in terms of preventing accidents is slightly reduced by using the measure. However, physically applying the measure introduces more hazards such as falls from height and additional MSDs. As a result this measure is slightly worse than having nothing at all.	not likely to be severe. They will range from negligible to major. Ranking: 1 to 4 The consequences are unchanged from that of the base case because the measure does not prevent any accidents from occurring.
Over-strapping	Rollover	With this measure there is an increase in force on the trailer bed, keeping the load in place. This method provides load restraint and containment. However, there are issues associated with how the measure is positioned over the load. Load type will affect the applicability of this measure. Assume here that the load is an appropriate size in relation to the strap spacing. The load is unable to shift when the straps are used in the correct manner; therefore, this scenario is prevented. Ranking: 1	As rollover is prevented the consequences are negligible. Ranking: 1

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Load ejection	The load is fully restrained so load shift and therefore load ejection is prevented, provided there are no small packages that can fall through the straps. Ranking: 1	Load ejection is prevented so the consequences are negligible. Ranking: 1
	Falling loads when curtain is pulled back	The load is fully restrained and contained so falling loads when the measure is pulled back are prevented. Ranking: 1	The consequences are again negligible as falling loads are prevented. Ranking: 1
	Falls from height	This measure introduces falls from height associated with applying the measure. However, climbing the trailer to retrieve fallen loads is not required as the load is fully restrained. As with other safety measures, gantries may be available but depending on how many trailers are in the unloading bay, there may not be enough room to use them. The frequencies involved will be slightly less to that of side strapping as the amount of time on the trailer bed applying the load will be similar, but the need for lifting fallen loads is eliminated. Ranking: 4	The consequences that occur from a fall are unchanged to that of the base case. Range: 1 to 5
	MSDs	As with falls from height, the main causes of injury deal with applying the measure, however this time there are no issues concerning retrieving fallen loads as the pack is restrained. As a result MSDs will be less frequent when compared to the base case.	The consequences are similar to that of the base case. MSDs will always result in the same range of consequences. Range: 1 to 4

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Other Overall	Ranking: 3 There are issues associated with throwing the overstrapping over the load. This could easily hit other employees on neighbouring bays or possibly hidden forklift truck drivers. Edge protectors and ratchets can fly off and hit people. Overall major accidents are reduced but issues involving the increase in falls from height and MSDs when compared to the base case are introduced.	Overall the consequences range between negligible to a single fatality. Rollover and load ejection are prevented so multiple fatalities are improbable.
Side slats	Rollover	This measure is not commonly used in the UK. It is mainly present on EU tilts where the roof of the trailer can be removed. The measure can be made of wood or aluminium. A strong structure is required to attach the measure to. It is assumed that the structure and slats are of appropriate strength. The measure provides containment but not restraint. Can be thought of as being used as an additional support to the trailer structure. The method is fairly impractical. There is no form of restraint so the load is still free to move around within the confines of the slats so rollover is still a possibility. There may be a very slight reduction in frequency because the load does not press directly against the curtain, but not enough to change the frequency from that of the base case.	Rollover can occur so the consequences are the same as the base case. Range: 1 to 6

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Load ejection	Ranking: 3 Load ejection is prevented provided the cargo is not small enough to poke through the spacing between the slats and provided the slats themselves are strong enough.	The consequences are the same as overstrapping, which is a measure that also prevents load ejection.
	Falling loads when curtain is pulled back	Ranking: 1 Items poking through the slats will be visible by bulges in the curtain at the corresponding places. Assuming that the goods are of an appropriate size, load falls will be prevented when the curtain is pulled back. However, because the load is able to shift freely, there is a chance that the goods can fall when the measure is removed, in a manner similar to the base case. This can still occur if one slat is removed and there are still some in place. When curtain is pulled back: Ranking: 1 When measure is removed: Ranking: 6	Ranking: 1 The consequences are the same as the base case as loads are still able to fall. There will be negligible consequences when the curtain is pulled back. Range: 1 to 5
	Falls from height	Personnel will risk falls from height when applying the measure as well as when lifting fallen loads. The slats are heavy which could cause the operative to become unbalanced. The frequency would be on a similar scale to sidestrapping.	The consequences are the same as the base case because falls are still possible. Range: 1 to 5
	MSDs	Ranking: 5 The slats are heavy and awkward to apply which could	The injuries that result will be of the same

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Other	result in the possibility of an increase in the frequency of MSDs when compared to sidestrapping. However, the increase is probably not sufficient to raise it to a higher frequency ranking. The employee will have to deal with issues such as lifting falling loads too. Ranking: 5 Where are the slats stored during loading and unloading? Premises must be fairly large to allow slats to be applied, removed and stored. The use of forklifts in fixing the measure has been known to occur.	magnitude as the base case. It not likely that the cumbersome nature of the slats will increase the severity of injuries dramatically. Range: 1 to 4
	Overall	Overall the measure is slightly better at preventing accidents than sidestrapping, mainly because more containment is provided, thus preventing load ejection.	Accidents such as load ejection and falling loads when the curtain is pulled back are in essence eliminated. However, falls from height, rollover and MSDs are still an issue.
Sliding gates	Rollover	As with side slats, the strength of the trailer structure is an issue as heavy loads pressing on the measure could cause the trailer to buckle. This measure is very similar to slats. Assume the size of the load is large enough to be fully contained because smaller objects will poke through. The load is still free to move around so rollover due to load shift is still possible. As with side slats, the measure may slightly reduce curtain bulging. The ranking is the same as side slats.	The consequences are the same as the base case as the load is still free to move. Range: 1 to 6

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Load ejection	Ranking: 3 As it is assumed that the load is of an appropriate size, load ejection is prevented. Ranking is similar to that of side slats.	The consequences are the same as side slats as load ejection is prevented.
	Falling loads when the curtain is pulled back	Ranking: 1 When the curtain is pulled back the load is fully contained so there will be no falling loads. However, when the restraint itself is removed there is a chance of falling loads because the load could have shifted within the confines of the gates, which is then released by removing the measure. Frequency of falls when removing the measure will be the same as side slats. When curtain is pulled back: Ranking: 1 When measure is removed: Ranking: 6	Ranking: 1 There will be negligible consequences when the curtain is pulled back as the load is contained. When the measure is removed the consequences are the same as side slats. Range: 1 to 5
	Falls from height	Falls from height will result mainly from retrieving fallen loads. The measure can be applied from the ground, which removes the possibility of working at height issues, except when the personnel are on the trailer to lift the fallen loads. The ranking will be the same as the base case. Ranking: 4	The consequences of a fall are unchanged from that of the base case, as personnel may be working at height. Ranking: 1 to 5
	MSDs	MSDs will result mainly from lifting fallen loads as a result of load shift. The gates themselves are not too awkward to apply so the ranking will be slightly less	Again the consequences are unchanged when compared to the base case. Range: 1 to 4

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
	Others	than that for side slats. Ranking: 4 There could be loading problems depending on how the gates are attached to the structure. If there are posts placed at intervals along the edge of the trailer bed, spaces will arise around the post where goods cannot be loaded.	
	Overall	This measure is very similar to that of side slats. The only major difference is that the frequency of MSDs are less for sliding gates than side slats as the measure is easier to apply.	The consequences that could possibly result are on the same scale as side slats.
Bungee Suspended Tarpaulin	Rollover	Most of the volunteers were not acquainted with this measure, so a brief description was given. The tarpaulin fully restrains the load and therefore prevents load shift. Ranking: 1	The consequences are negligible as load shift is prevented. Ranking: 1
	Load ejection	The load is fully contained so load ejection is prevented. Ranking: 1	The consequences are negligible as the load is contained. Ranking: 1
	Falling loads when the curtain is pulled back.	Again the load is restrained and contained so loads will not fall when the curtain is pulled back. Removing the restraint in the correct manner will also not result in fallen loads. Ranking: 1	The consequences are negligible as falling loads are prevented. Ranking: 1
	Falls from height	The measure is fully operable from the ground so there is no	The consequences are negligible as personnel

Hazard		Likelihood	Consequence
Safety Measure	Scenario		
		need to climb the trailer bed. Falls are therefore prevented. Ranking: 1 In this instance, MSDs will only be associated with applying the measure as load shift is eliminated. The straps are on a bungee cord so simple to enforce. A ranking similar to overstrapping is assumed. Ranking: 3	are not required on the trailer bed. Ranking: 1
	MSDs	The MSDs associated with this scenario are based on injuries sustained during applying the measure. The range will be similar to that of the base case and the other scenarios.	
	Other	Despite the promising rankings, there are numerous significant issues that need to be addressed. Tarp can damage the edges of the product; There are durability issues concerning the tarp, steel loads could poke through; Tension in the straps needs to be applied correctly so training would be required otherwise the load could become unstable; Snagging could occur with forklifts; Preferable with uniform loads rather than mixed.	
	Overall	Overall this method has potential to be the most appropriate. However, there are many drawbacks as detailed above that need to be resolved. The frequency of major accidents such as rollover is greatly reduced, as is the possibility of falls from height.	Multiple fatalities are essentially eliminated as rollover and load ejection is prevented. Only consequences related to MSDs are an issue.

8.5 APPENDIX E – LOAD SECURITY PROSECUTIONS

Man who brought misery to motorway users convicted of dangerous driving

A man responsible for endangering motorists on the M25 last May has been disqualified from driving for a year.

Graham Thomas, 55, of Dartford Place, Bonymaen, Swansea, pleaded guilty at Guildford Crown Court to dangerous driving. He admitted being in charge of a Renault articulated curtainsider goods vehicle which was tilting dangerously due to an unsecured load inside.

He was driving along the westbound carriageway of the M25 from Reigate towards Leatherhead around 9.45 am on 28th May 2003, when he was seen by police from the opposite carriageway. The vehicle was being driven with the semi-trailer leaning over at an alarming angle. It looked as if the vehicle was so precarious that it would topple over.

Motorway Control Room staff, utilising the motorway camera system, continually monitored the progress of the Renault goods vehicle. Whilst police units responded the driver was seen to stop momentarily in a coned off area before continuing to drive out from that safe area and rejoin the main carriageway. He travelled a distance of 4 kilometres before being stopped by a Strategic Roads Police Patrol.

It was obvious that there was a serious problem with the load that had shifted. Officers saw that the nearside trailer wheels had lifted off the road surface by up to 6 inches and the load was leaning to the offside and into the next carriageway. The load weighed 19 tonnes and consisted of two pallets each loaded with a reel of tinplate coil. Neither of these pallets was secured in any way to the trailer bed, thus relying upon their own weight to retain them. The only item retaining the load within the vehicle was the fabric of the trailer curtain.

The load was redistributed before the lorry could be moved again. This involved the closure of three lanes while work was undertaken to move the two pallets.

The M25 motorway had various lane closures in place from 10am to 3pm as a result of this incident. At the time restricted running lanes were also in operation nearby following separate damage to Oaklawn Bridge at Leatherhead. Congestion and long delays ensued.

The driver and operator Graham Thomas appeared at Guildford Crown Court on Friday 18th June 2004. He pleaded guilty to dangerous driving and was sentenced to £1000 fine, £235 costs, a 12-month disqualification and was ordered to take a retest before renewing his licence.

Source: http://www.surrey.police.uk/news_item.asp?artid=4575

Company and sole trader fined £37,500 after steel beam falls from vehicle and fatally injures the driver

The Health and Safety Executive (HSE) has today warned road haulage and steel fabrication companies of the importance of having properly secured heavy loads, following the death of a driver in Leith.

Steel fabrication company, McDonald and Ross Ltd, and a road haulage sole trader, Ron Boyd Trading, were today fined a total of £37,500 at Edinburgh Sheriff Court. Mr Nicholas McKellar age 45, died after a steel beam weighing almost 1000kg fell from a vehicle as it was being unloaded, on 10 October 2005.

McDonald and Ross Ltd of Mayfield Industrial Estate, Dalkeith were fined £30,000; having pleaded guilty to a breach of Section 3(1) of the Health and Safety at Work etc Act 1974 (HSW Act), and Ron Boyd Trading, also of Mayfield Industrial Estate, was fined £7,500 after pleading guilty to a breach of Section 2(1) of HSW Act..

HSE Inspector Isabelle Martin commented after the case:

'It is entirely foreseeable that a load on a vehicle will move during transit on the road. It is therefore important that the load is placed onto the vehicle in its most stable orientation and that appropriate measures are taken to ensure that it cannot fall from the vehicle at any time. It is also important that the stability of the load is assessed prior to beginning to unload it.

"This incident could, therefore, easily have been prevented. The beam that fell from the vehicle was one of three identical beams placed on the vehicle. Each of these beams could have been placed on their side therefore making it very unlikely that they could fall."

NOTES TO NEWS EDITORS

1. Section 2(1) of HSW Act states, "It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees."

2. Section 3(1) of HSW states, "It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety."

3. The Maximum fine for breaches of Section 2(1) and Section 3(1) of HSW Act on indictment in the Sheriff Court is an unlimited fine for each offence.

4. McDonald and Ross Ltd were contracted by a residential developer to fabricate, deliver and erect a steel framed building in Arthur Street, Leith. However they were unable to deliver the steel to the construction site themselves and therefore subcontracted delivery to The Ron Boyd Group.

5. On 8 October 2005, McDonald and Ross, partially assisted by Nicholas McKellar, employed as a driver by Ron Boyd, loaded the steel for the 4th floor of the building onto

one of Ron Boyd's vehicles. The vehicle containing the steel was then driven from Mayfield to the site in Arthur Street, Leith on the morning of 10 October 2005 by Mr McKellar. Mr McKellar arrived at the site and was met by two of McDonald and Ross Ltd's employees and directed to park next to the pavement across the road from the construction site, where the steel was to be unloaded. Mr McKellar began to remove the straps that retained the load on the vehicle, however the load had become unstable and a steel beam fell to the ground striking Mr McKellar.

6. The HSE investigation revealed that McDonald and Ross Ltd had failed to assess the risks involved in loading and unloading steel. They also failed to ensure that the steel was correctly placed upon the timber bearers on the vehicle. Ron Boyd had failed to ensure that his employees involved in loading, unloading and transporting steel to site had been properly trained.

7. Contractors should have made arrangements for the safe delivery and unloading of materials to their sites. A number of simple steps can prevent this type of accident occurring. Guidance has recently been published by the British Constructional Steel Association.

Source: <http://www.gnn.gov.uk/Content/Detail.asp?ReleaseID=283867&NewsAreaID=2>

8.6 APPENDIX F – EXAMPLES OF LOAD SHIFTS IN MAINLAND EUROPE

1. Load shift during cornering



This German trailer was transporting empty beer bottles and kegs when the load shifted in a low-speed corner. The roof was ripped open and the superstructure damaged.

Traffic was disrupted for three hours and the superstructure was a write-off. The driver, owner and loader were prosecuted.

2. Load shift during cornering



This incident happened in Norway when a Lithuanian trailer transporting a 21-tonne unsecured palletised load went out of control due to load shift while cornering.



The load was valued at approximately 45,000 euros.

3. Load shift during cornering



This German trailer was transporting a 10-tonne piece of machinery to a trade fair when the load shifted. The load came through the curtain and fell onto the highway.

Damage was estimated at 22,000 euros.

4. Load shift during transport



These coils, being transported on a trailer designed to transport air freight pallets, shifted during normal driving, destroying the front bulkhead and curtain. The coils, which weighed between 8 and 12 tonnes, were secured with two webbings straps apiece.

5. Load shift under braking



This load, weighing approximately 22 tonnes, shifted under braking from 50 kph (30mph), striking the front bulkhead.

The load had been loaded approximately 3 metres back from the bulkhead and secured with three webbing straps.

6. Unsecured load shift in roadworks



This unsecured load shifted as the lorry was negotiating roadworks. The company had assumed that the curtain would contain the load.

7. Unsecured load shift during emergency braking



This trailer was transporting steel in Germany in 2002 when the vehicle braked heavily on the motorway. The steel had not been loaded against the headboard.

The incident caused significant disruption (a crane had to be brought in to remove the load) and damage totalling nearly 50,000 euros.

8 Load containment failed to prevent load shift



This load was being transported with no load restraint – the only methods of preventing load movement were the bulkhead and the side slats. However, the shrinkwrapped load was unstable and the stacks toppled as the vehicle braked.

Difficulties in unloading caused significant delays.



Zertifikat zur Ladungssicherung durch den Fahrzeugaufbau Anforderungsprofil und Ladevoraussetzungen

1. Angaben zum Fahrzeug

Fahrzeughersteller:

Mustermann

Industriestr. 111

12345 Musterstadt

Motorwagen und Sattelanhänger

Fahrzeugtyp:

Fahrzeug-Identifizierungsnummer:

Aufbaunummer:

max. technische Nutzlast :

13.000 kg

lichte Abmessungen innen L / B / H:

13.600 / 2.450 / 2.640 mm

Fahrzeugaufbau:

Curtainsider

Der Fahrzeugaufbau erfüllt die Anforderungen der DIN EN 12642 Code XL

2. Angaben zur Ausstattung des Fahrzeugs

Der Fahrzeugaufbau ist dann in der Lage, die unter Punkt 4 genannten Ladegüter bei Einhaltung der unter Punkt 3 genannten Ladebedingungen zu sichern, wenn folgende Ausstattungskomponenten vorhanden sind:

Stirnwand

- Aluklickprofil
- 2 verschweißte Stahleckenungen 80 x 40 x 4mm
- 2 Stirnwandstützen aus Hutprofil 100 x 40 x 4mm im Bereich der Alufüllung genietet

13.500 daN

Seitenwände

- 2 paar XXXL Klapprungen
- jeweils 4 Reihen Aluminiumeinsteckbratler
- **Seitenplane** Hersteller XXXL, Panamaqualität
- 14 Gurte Abstand vertikal 400 mm, horizontal 450 mm
- Planenverschlüsse mit zusätzlicher Sicherung

10.800 daN

Rückwand Heckportal

- Stahleckenungen 130 x 40mm mit einer Sicke für das Planenrohr
- XXXXL Sandwichtüren mit 4 Scharnieren und 2 Dachstangenverschlüssen je Türflügel

8.100 daN

Dach

- Außenbaum 80 x 40 mm und einem Querspiegel mittig
- Mind. 3 Reihen Planenrohre, zur Unterstützung der Dachplane

Der Zustand des Fahrzeugaufbaus ist gem. VDI 2700 regelmäßig zu überprüfen.

Dieses Zertifikat umfasst 2 Seiten und hat nur in vollständiger Form Gültigkeit.

8.8

APPENDIX H – COMPUTER SIMULATION RESULTS

Table 1 – Summary of straight-line braking simulations

Model (.wm3)	No. Reels	Reel material properties		Motion (s) s = stationary a = acceleration c = coasting b = braking	Description
		Coef. of restitution	Coef. of friction		
30kmhstreels1q 8reels	8	“	“	a(5.33) c(2.0) b(2.33)	Reels slide towards the rear of the trailer during the acceleration period, then forward under braking, with the front two impacting with the bulkhead. No reels fell from the trailer.
30kmhstreels1q	26	“	“	“ “	Similar results to the above, although there was more visible movement of the reels.
80kmhstreels1q	“	“	“	a(13.0) - c(1.0) - b(6.22)	Significant movement of reels both under acceleration and when braking, with 6 reels falling from the nearside and 3 from the offside.
30kmhstreels1q withstartvelocity	“	“	“	c (0.5) – b (2.33)	Reels impact with the bulkhead under braking, but little out of line movement with no reels falling from the trailer.
50kmhstreels1q withstartvelocity	“	“	“	c (0.5) – b (3.89)	Significant movement of reels with 3 falling from the offside.
80kmhstreels1q withstartvelocity	“	“	“	c (0.5) – b (6.22)	Significant movement of the reels, with 8 falling from the offside and 6 from the nearside.
80kmhst2mreel	1	“	“	c (0.5) – b (6.22)	Reel impacts with the bulkhead under braking, no

(reel against bulkhead)					significant movement.
80kmhst2mreela (reel 1m back from bulkhead)	1	“	“	c (0.5) – b (6.22)	Reel end is initially 1 m from the bulkhead. Under braking, the reel slides forward and impacts with the bulkhead.

Table 2 – Summary of roundabout simulations

Model (.wm3)	No. Reels	Reel material properties		Motion (s) s = stationary a = acceleration c = coasting b = braking	Description
		Coef. of restitution	Coef. of friction		
30kmhra8reels (8 m entry radius)	8	0.1	0.2	“ “	6 reels fell from the offside of the trailer on the entry radius to the roundabout with 1 reel falling from the nearside on the way round the roundabout.
30kmhra8reelsa (16 m entry radius)	8	0.1	0.2	“ “	5 reels fell from the offside of the trailer on the entry radius to the roundabout with 2 reels falling from the nearside on the way round the roundabout
30kmhra8reelsb (16 m entry radius)	8	0.1	0.5	“ “	Slight movement of reels with none falling from the trailer.
20kmhra8reels	8	0.1	0.2	“ “	Some movement of reels, with none falling from the trailer.
20kmhra8reelsa	8	0.1	0.5	“ “	No noticeable movement of reels.

The final column in each Table gives a brief summary of the results obtained from each simulation.

In Table 1 a number of simulations are summarised in which the trailer was accelerated from rest up to a coasting speed and then braked, as specified in Section 3.3.1 of this report.

8.9 APPENDIX I – ARTSA TEST METHOD FOR CURTAIN-SIDED VEHICLES

Testing a Curtain-Sided Vehicle Body - Laterally

The Load Restraint Guide sets out in section I “How to certify a load restraint system” that only a person with appropriate skills and experience should assess and certify a load restraint system. Such a person should have an understanding of vehicle design and load restraint issues. Normally a mechanical engineer with these types of skills and experience would be chosen.

Road transport authorities in each State and Territory have a list of qualified persons who can carry out engineering work of this type. Persons designing curtain-sided systems as a load restraint/containment system should also check with their State or Territory for any special requirements including other regulations such as dangerous goods and occupational health and safety.

Key Performance Measurement Results – Curtain Deflection

The key measure following a curtain side “containment test” will be how much deflection occurred when the typical or sample load in a frictionless state was pushed into the curtain.

The load restraint guidelines state that the maximum sideways deflection of a curtain-sided vehicle should be limited to 100mm. This is considered to be the maximum amount of lateral load movement that should occur before there is a serious loss of vehicle stability.

The applied load causing 100mm or less of curtain deflection determines the maximum mass of the pallets or other load units that may be contained by the curtain-side system.

What type and weight of load can a curtain-sided vehicle “contain”?

The vehicle body builder, who has designed, rated and tested not only each component, but also the completed vehicle with the intended type of load or commodity to be carried, should determine this.

Methods for Static Testing Curtains

Static test methods using air or hydraulics are cost effective, repeatable and comparable while not being dependent on a particular load. Static testing is more economic to set up than “on-road” dynamic testing, which delivers accurate results for specific loads but carries higher costs and certain risks. In addition to these physical test methods, computer simulations and calculations can generate valid information for new variants of vehicle body design without the need for practical tests.



1. Place the load on rollers or a similar system of eliminating friction between the load and the vehicle floor.
Force is supplied by hydraulic jack in this example.



2. Apply an even horizontal force to the side curtain by pushing the proposed load type into the curtain. The pushing force can be applied via mechanical, hydraulic or pneumatic (cylinder or air-bag) methods.

Measure the lateral deflection

(This particular test was measuring deflection for a solid unit load pallet cage at floor level, not stacked.)



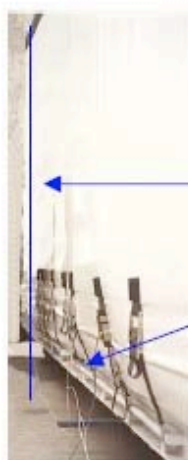
3. This example involves tilting the vehicle sideways to 30° with the load free of any friction or vibrated to simulate road shocks and travel movement.

Note the load (although not curtains) is on rollers for zero friction.



4. A test setup showing an air operated test rig pushing evenly against 4 rigid pallet cages into a curtain-side. (far side) The required test force depends on the mass of the pallets or load units.

Note the cages on rollers for zero friction.



5. Measuring deflection on the closed side of the curtain. The test rig is wired up to an electronic data logger and a string line is used for accurate measurement of maximum deflection.

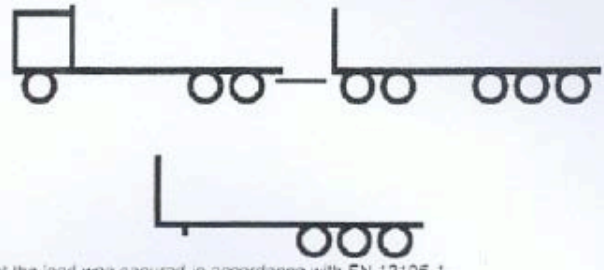
EN 12195-1:2003 (E)

Annex D
(informative)

Table D.1 - Example for a load securing docket (no copyright)

If one needs a load securing docket, the following example may be used:

Table D.1 — Example for a load securing docket (no copyright)

Company: Address:						
Telephone: Fax:		Road only	Road and Sea — A	Road and Sea — B	Road and Sea — C	Combined traffic
Place of loading: Date of loading:		Freight papers No.:				
Description of loads	Mass in t	Packing			Centre of gravity in relation to front	
Lashing equipment on the road vehicle	☐ Front wall ☐ Side walls	☐ Front stakes ☐ Side stakes ☐ Trough wagon			☐ Lashing points ☐ Lashing winch ☐ Other	
Characteristics of the load ☐ Metal ☐ Concrete ☐ Wood ☐ Other ☐ dry ☐ wet ☐ greasy	Characteristics of the loading surface ☐ Metal ☐ Concrete ☐ Wood ☐ Other ☐ dry ☐ wet ☐ greasy	Resultant friction factor (see table on the back side) $\mu =$ Load covered by a tarpaulin? ☐ YES ☐ NO			Do sharp edges affect the safety adversely? ☐ YES ☐ NO Edge protectors in use? ☐ YES ☐ NO	
Description of the used load restraint assembly		☐ Web lashing ☐ Wire lashing rope ☐ Lashing chain ☐ Fixing bar ☐ Stowing pad ☐ Side wall anchor ☐ Other				
Labelling of the load securing by label(s) on ☐ vehicle ☐ load ☐ CTU (body) ☐ tarpaulin		Type	Number	LC in straight pull or SIF		
1						
2						
3						
4						
Description of the securing procedure		☐ Over top lashing ☐ Direct lashing ☐ Blocking ☐ Combination of crossed in methods				
Description of the lashing angles		Angle of over top lashing $\alpha =$ °		Angle of direct lashing $\alpha =$ ° Angle of direct lashing $\beta =$ °		
Sketch 						
We herewith certify that the load was secured in accordance with EN 12195-1. Date: _____ Name of responsible person: _____ Signature: _____						

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Load security on curtain sided lorries

This report seeks to establish good practice for securing loads on curtain sided lorries across various industry sectors and direct the reader to practical, robust guidance on load restraint to enable them to minimise the risks to health and safety of all those working on and around curtain-sided vehicles. Good practice in this case is defined as those systems of work that are the most practical, involve the least risk of loads becoming unstable or falling, least risk to the operator/driver, and are practicable.

The report reviews existing legislation and guidance in the UK, Europe, and in North America and Australasia and current practice across a cross-section of UK industry, and assesses the mechanics of load shift and what systems of load securing are most effective in restraining loads.

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