# Purpose of the dangerous goods transport hazard overview

For companies in the business of dangerous goods transport, the adoption of practicable risk reduction measures appropriate to their operating environment is important. The starting point to applying rigorous risk management of your dangerous goods transport operations is to identify the inherent hazards.

This overview takes the perspective of a transport operator to prompt the examination of physical, chemical and systems-based hazards that require risk management.

*Note: The treatment of road tank vehicles is intentionally omitted from the scope of this overview.*

## Elements of the overview

This overview highlights the potential issues associated with the transport of dangerous goods in a variety of packaging modes. Analysis of various stages of your consolidation and consignment operations is addressed sequentially.

* Acceptance of package types
* Acceptance of inherent dangerous goods hazards
* Operations within the transport system
	+ Consolidating dangerous goods loads
	+ Loading of dangerous goods
	+ Defective packaging
	+ Load restraint
	+ In transit procedure
	+ Unloading dangerous goods at consignee premises
* Emergency response and planning

## Using the overview

Primarily the template is a prompting mechanism for operators to use in evaluating their control of transport hazards. It could be useful in the following circumstances:

an established prime contractor reviewing or auditing their dangerous goods consignment system

a transporter considering expansion of their range of goods carted – either new container types or Classes or Divisions of dangerous goods

a general freighter deciding upon entry into the dangerous goods transport industry sector.

## Links to other relevant dangerous goods transport documents available on the department web site

* Guidelines, guides and procedure, [www.dmp.wa.gov.au/Safety/Guidelines-guides-and-16209.aspx](http://www.dmp.wa.gov.au/Safety/Guidelines-guides-and-16209.aspx)
	+ *Dangerous goods safety matters – self-audit guide for prime contractors – guide*
* Templates, [www.dmp.wa.gov.au/Safety/Templates-16214.aspx](http://www.dmp.wa.gov.au/Safety/Templates-16214.aspx)
	+ *Documenting a Transport Emergency Response Plan – template*
	+ *Verification of dangerous goods driving procedures – driver interview – template*
* Toolbox presentations, [www.dmp.wa.gov.au/Safety/Toolbox-presentations-16211.aspx](http://www.dmp.wa.gov.au/Safety/Toolbox-presentations-16211.aspx)
	+ *Six pillars of dangerous goods transport series (documentation, packaging, placarding, restraint, segregation, vehicle)*

# Dangerous goods transport hazard overview

## Activity: Acceptance of package types for transport

| **Package type** | **Potential issues to address** | **Controls applied** | **Is the control effective?** |
| --- | --- | --- | --- |
|
| **Limited quantities (LQ)**Shrink wrapped trays < 20 kg each or boxes < 30 kg each[e.g. aerosols, paint tins, mixed goods, typically PGII/III container size < 5 L, retail distribution loads (RDL)] | * Non-approved inner packaging (e.g. jar, sample vial or test-tube has potential to break and leak into adjacent packaging)
* Flimsy wrapping, unrestrained items on trays or inadequately stacked items → physically impacting other goods and causing unintended reactions
* Packages exceeding LQ quantities incorrectly consigned as LQ posing greater fire hazards on mixed loads
* Dangerously incompatible goods in box (e.g. oxidisers with solvents → heating and/or melting containers and rapid escalation of fire incident)
* Co-transporting incompatible goods with RDL at placard load levels → increasing probability of reaction
* Application of LQ placarding to loads in excess of package size limits → acceptance of non-compliant loads
* Legal impacts on segregation requirements when LQ consolidated on load with non-LQ dangerous goods
 |  |  |
| **Pallets of packages**Steel drums, textile bags, fibreboard boxes, jerricans, plywood boxes, articles (e.g. batteries, aerosols, air bags) | * Non-approved packaging exposed to stress failure with normal transport vibration
* Packaging not approved for Packing Group of dangerous goods packed
* Damaged or inferior quality pallets failing → unrestrained load
* Physical impacts of palletising – squash, deform, pressurise or rupture individual packages
* Over-stacking, resulting in damage to packages and loss of containment [i.e. load supported by bottom layer of packages exceeds maximum stacking load (typically packages performance-tested to 3 m stack)]
* Restraint mechanism affects package integrity (e.g. tight steel bands rupturing plastic drums)
* Over-packing technique obscures incompatible goods labelled as mixed class → segregation issues
 |  |  |
| **Segregation devices and segregation packaging**e.g. Type I and II, large packaging, segregation packaging | * Non-approved segregation device allows goods to escape confinement
* Poor stowage and dunnage configuration allows package movement → corrosive goods adversely affecting structure
* Dangerously incompatible goods co-located inside segregation devices
* Mechanical handling of custom-fabricated Type I segregation devices (450 kg limit) compromises integrity (*Note: Type I are non-approved devices that must remain affixed to vehicle)*
* Approved Type II segregation devices not maintained – sides perforated by forklift tynes, panels loosened, closures bent → ineffective segregation
* Large packaging loaded in excess of rated load capacity → failure and leakage of goods
* Segregation packaging not secured (e.g. removable head drums not tightened → goods not contained)
 |  |  |
| **Cylinders < 500 L individually**e.g. 22 L exchange LPG, G-size welding gases | * Non-approved cylinders without burst discs or pressure relief valve (PRV) → rupture hazard
* Cylinders past inspection date (i.e. service interval exceeds AS 2030, AS/NZS 3788 period, or damaged → unknown status of valves, regulators, fixtures)
* Cylinders over-filled: operators exceeding mass-filling ratios → over-pressurised and venting
* Valve protection absent, presents risk of shearing valve → liquid and/or vapour release
* Multiple cylinders shrink-wrapped together but not adequately restrained onto pallets
* Cylinders transported horizontally → increased risk of damage to valves and placing liquid phase in contact with PRV
* Stillage design faults → forklifting grooves absent, creates manual handling hazard

 → large gaps, low rails or inadequate internal restraint allow  cylinder movement* Cylinder becomes projectile as a result of valve failure or burst-disc malfunction
* Temperature effects on cylinders → toxic, flammable or asphyxiating emissions released into cargo transport unit or vehicle cabin
 |  |  |
| **Pressure vessels (PV) > 500 L individually**e.g. chlorine drums, ammonia tanks, insulated helium tanks | * Non-approved pressure vessels (PV) without burst discs or PRV → rupture hazard
* Pressure vessels past inspection date (i.e. service interval exceeds AS 2030/AS 3788 period) or damaged → unknown status of valves, regulators, fixtures
* Pressure vessels over-filled: operators exceeding mass-filling ratios → over-pressurised and venting
* Valve protection absent presents risk of shearing valve → liquid and/or vapour release
* Fusible plugs for toxic goods – visual inspection showing extruded or deformed plug → risk of overpressure ejecting plug
* Refrigeration jacket – insulated jacket with perforations, vacuum loss, insulator compression → heat ingress and over-pressurising contents
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| **Intermediate bulk containers (IBC)**e.g. flexible IBCs (FIBCs) for ammonium nitrate, plastic composite IBCs for corrosives, stainless steel IBCs for solvents (≤ 3 kL) | * FIBCs are perforated on pallets or floor of cargo transport unit → solid spillage of toxic, oxidising or flammable solids
* Bottom outlet valves on liquid goods are vibrated open or sheared off from impact → spillage of goods onto adjacent packages
* Filling lids are cross-threaded → liquid splash or vapour emission under normal transport vibration
* Composite IBCs mechanically damaged – perforated by forklift tynes or squashed by pallets resting directly on plastic inner
* Outer cage of composite IBCs are damaged by mechanical handling → exposing plastic inners to wearing on cargo transport unit floor
* Maximum permitted gross mass exceeded during filling → IBC failure
* Maximum permitted stacking load is exceeded → IBC failure
* Plastic IBCs used past 5 year expiry → UV embrittlement and material failure
* Corrosive product incompatible with internal surface/surface coating → deform or dissolve IBC shell
* High vapour pressure liquids in excess of IBC rating → over-pressurised IBC and release of contents through seams or outlets
* Imported IBCs with globally harmonised system (GHS) markings at exclusion of dangerous goods labelling and marking
* Imported IBCs have no emergency information panels (EIPs) for use in Australian transport system
* IBC not approved for Packing Group of dangerous goods packed
 |  |  |
| **Portable tanks (PT) 1 – 25 kL capacity**e.g. 4 kL off-shore solvent tanks, 20 kL isotainers of corrosives | * Non-approved PT without burst discs or PRV → rupture hazard
* Corrosive product incompatible with internal surface and/or surface coating → deform or dissolve tank shell
* Frame and tank not subjected to dynamic longitudinal impact test → resistance to braking and/or transport collision unknown
* PT being used beyond certified inspection service period → valve or fixture failure
* PT over-filled by operators exceeding mass-filling ratios → over-pressurised and venting
* Contaminated PT (e.g. residue from last chemical fill reacting with contents → heat, gas evolution, precipitation)
* Maximum permitted stacking load is exceeded → PT failure
* Maximum permitted gross mass exceeded during filling → PT failure
* Inadequate twist-lock configuration on PT → alternate anchoring and/or restraint method required
* PT (of compartment capacity >7.5 kL with no surge partitions) filled to more than 20%, but less than 80%
 |  |  |
| **Multiple element gas containers (MEGC)** Used for liquefied or compressed gas transport (e.g. hydrogen, nitrogen, liquefied ethane) | * Non-approved MEGC containing cylinders without burst discs or PRV → rupture hazard
* Frame and tank not subjected to dynamic longitudinal impact test → resistance to braking and/or transport collision unknown
* Burst disc outlet angled to deliver exhausted gas onto tubes above → flame impingement increases boiling liquid expanding vapour explosion (BLEVE) potential for Division 2.1
* MEGC over-filled: operators exceeding mass-filling ratios → over-pressurised and venting
* Maximum permitted stacking load is exceeded → MEGC failure
* Inadequate twist-lock configuration on MEGC → alternate anchoring and/or restraint method required
 |  |  |
| **Freight containers (FC)**e.g. multi-loads of packaged goods on pallets, IBCs or 1 kL portable tanks | * Non-approved FC [i.e. not accepted by International Convention for Safe Containers (CSC) – no CSC approval plate]
* FC not subjected to dynamic longitudinal impact test → resistance to braking and/or transport collision unknown
* Fumigated units not placarded for asphyxiant danger may adversely affect loaders and personnel de-stuffing FC
* Exposure of Division 4.2 or 4.3 IBCs to moisture and/or air, leads to flammable or toxic atmosphere developing in FC
* Leakage of asphyxiant gases of Division 2.2, or toxic gases of Division 2.3 cylinders → elevated unloading hazard for personnel
* Poor stowage and dunnage configuration in FC allows package movement → perforated goods potentially affecting FC structure
* Goods stacked against door, or loosely in second layer, creates pinch and crush hazard for unloader
* Exceed maximum stacking weight → FC frame or panel failure
* Inadequate twist-lock configuration on FC → alternative anchoring and/or restraint method required
 |  |  |
| **Bulk containers (BK1– sheeted, BK2 – closed, BK3 – flexible)**For transport of bulk solids exceeding 1m3 (e.g. FC of ammonium nitrate, bulk bins of sulphur, rotatable containers of heavy mineral concentrates) | * Non-approved FC [i.e. not accepted by International Convention for Safe Containers (CSC) used to transport bulk solids – no CSC approval plate]
* FC not reinforced adequately in end walls → reduced effective longitudinal restraint
* Liner incompatible with goods → corrosive or oxidising goods affecting integrity of bulk container
* BK1 tarpaulin perforated (by goods and/or mechanical handling) or absent → loss of solids in transit due to airflow over surface
* BK3 flexible surface permeable to goods → loss of solids in transit
* BK3 flexible surface perforated by coarse goods → loss of solids in transit
* BK3 exceeding maximum permitted gross mass or maximum product density → loss of containment
* Hinged sides on bulk container or tilting lids on rotatable containers are inadequately locked or hinges damaged → loss of solids in transit
 |  |  |
| **Off-shore containers (OS)**e.g. cylinder manifold packs, IMDG-rated packaged goods containers | * Non-approved OS [i.e. not accepted by CSC or International Maritime Dangerous Goods (IMDG) Code certifiers]
* OS not subjected to dynamic longitudinal impact test → resistance to braking and/or transport collision unknown
* Fumigated units not placarded for asphyxiant danger may adversely affect loaders and personnel de-stuffing OS
* Exposure of Division 4.2 or 4.3 IBCs to moisture and/or air, leads to flammable or toxic atmosphere developing in FC
* Leakage of asphyxiant gases of Division 2.2, or toxic gases of Division 2.3 cylinders → elevated unloading hazard for personnel
* Poor stowage and dunnage configuration in OS allows package movement → perforated goods potentially affecting OS structure
* Goods stacked against door, or not restrained by internal cargo nets, creates pinch and crush hazard for unloader
* Exceed maximum stacking weight → OS frame or panel failure
* Slings, cables, shackles on OS roof not rated or damaged and worn → mechanical handling or lifting failures injuring loader
* Inappropriate slinging resulting in dropped OS
* Inadequate twist-lock configuration on OS → alternate anchoring and/or restraint method required
* Goods inside half-height, open-top OS inadequately restrained → goods projecting out of container
* Goods inside OS inadequately restrained
 |  |  |

## Activity: Acceptance of inherent dangerous goods hazard

| **Class or Division** | **Primary Hazard** | **Inherent chemical hazard** | **Controls applied** | **Is the control effective?** |
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| **Class 1****S:\MIEDGSL\DGStorage\Class Labels\Model No 1.wmf** | **Explosive** | * Co-transport of incompatible explosives → consider Divisions and Compatibility Groups
* Category 1, 2 and 3 loads carted in excess of vehicle aggregate or vehicle licence
* Transport of explosives is incompatible with all other classes and/or division of dangerous goods once placard load thresholds of either are reached

**References*** *Dangerous Goods Safety (Explosives) Regulations 2007, Part 10,* [www.slp.wa.gov.au](http://www.slp.wa.gov.au)
* *Australian Code for the Transport of Explosives by Road and Rail (AEC 3)* for compliance measures, [www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/cp2009actransportofexplosivesbyroadandrail3rdedition](http://www.safeworkaustralia.gov.au/sites/swa/about/publications/pages/cp2009actransportofexplosivesbyroadandrail3rdedition)
* *What is required for the safe transport of explosives?,* [www.dmp.wa.gov.au/Dangerous-Goods/How-should-explosives-be-4677.aspx](http://www.dmp.wa.gov.au/Dangerous-Goods/How-should-explosives-be-4677.aspx)
* *Commercial transport of explosives not requiring an explosives transport licence,* [www.dmp.wa.gov.au/Dangerous-Goods/Commercial-transport-of-20718.aspx](http://www.dmp.wa.gov.au/Dangerous-Goods/Commercial-transport-of-20718.aspx)
 |  |  |
| **Division 2.1**S:\MIEDGSL\DGStorage\Class Labels\Model No 2.1.wmf | **Flammability** | * Leakage of gas into unventilated cargo transport unit forms flammable atmosphere with potential to contact a mobile or fixed ignition source
* Pyrophoric gas release (e.g. phosphine igniting on contact with air → corrosive combustion products)
* Dissolved gases (e.g. acetylene, become unstable due to loss of solvent, vibrational shock or excess heat)
 |  |  |
| **Division 2.2**S:\MIEDGSL\DGStorage\Class Labels\Model No 2.2.wmf | **Compressed gas** **(asphyxiant, cryogenic)** | * Stored potential energy in cylinder → rapid release from valve can injure personnel or puncture adjacent packages
* Leakage of gas into unventilated cargo transport unit forms asphyxiant atmosphere
* Leakage of oxygen gas into unventilated cargo transport unit resulting in oxygen enrichment → elevated combustion risk
* Elevated combustibility of fuels if oxidising gases leak into cargo transport unit (e.g. oxygen or nitrous oxide gases filling a load of organic solvents or fuel)
* Extremely low temperature of cryogenic refrigerated gases (below - 90o C) → risk of cold burns to transferor or unloading workers
 |  |  |
| **Division 2.3**S:\MIEDGSL\DGStorage\Class Labels\Model No 2.3.wmf | **Toxic gas**  | * Leakage of gas into unventilated cargo transport unit forms toxic atmosphere
* Low LC50 values → exceedance of exposure limits (TWA/STEL) and potentially immediately dangerous to life or health (IDLH)
* Leakage of cylinders in public places, assembly areas or depots leads to acute poisoning of workers or public fatalities
 |  |  |
| **Class 3**S:\MIEDGSL\DGStorage\Class Labels\Model No 3a.wmf | **Flammability** | * Leakage of liquid into unventilated cargo transport unit forms flammable atmosphere
* Leakage of liquid onto hot exhaust, or flammable vapour contacts an ignition source → combustion
* Nominally empty containers, often high ignition risk due to flammable solvent/air mixture
 |  |  |
| **Division 4.1**S:\MIEDGSL\DGStorage\Class Labels\Model No 4.1.wmf | **Flammability** | * Heat sources may be sufficient to ignite solids → difficulty extinguishing fire
* Dust explosion by initiation of finely divided metals and organic compounds
* Decomposing self-reactive substance → evolution of toxic gases or vapours
* Self-accelerating decomposition temperature exceeded in cargo transport unit → exothermic reaction
 |  |  |
| **Division 4.2**S:\MIEDGSL\DGStorage\Class Labels\Model No 4.2.wmf | **Spontaneous combustion** | * Self-heating substances absorbing energy from transport conditions → bursting package
* Pyrophoric solids or liquids breaching hermetic sealed package → ignition in air and toxic by-products
* Self-accelerating decomposition temperature exceeded in cargo transport unit → exothermic reaction
 |  |  |
| **Division 4.3**S:\MIEDGSL\DGStorage\Class Labels\Model No 4.3a.wmf | **Flammability if wetted** **(toxic gases possible)** | * Contact of goods with water → releases flammable gas into cargo transport unit
* Moisture trapped internally in package → gas evolution that bursts package
* Evolution of toxic gases upon wetting exposes workers (e.g. solid fumigant aluminium phosphide absorbs water, releasing toxic phosphine gas)
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| **Division 5.1**S:\MIEDGSL\DGStorage\Class Labels\Model No 5.1.wmf | **Oxidizing – oxygen source** | * Combustion of other materials enhanced by release of oxygen during fire
* Leakage onto metal fixtures and reactive surfaces increases decomposition, oxidation and corrosion
* Contamination of oxidising liquids leads to pressurisation of containers (e.g. hydrogen peroxide solutions catalysed by organic residue)
* Excessive temperature may cause decomposition (e.g. hydrogen peroxide releasing oxygen)
* Incompatibility of co-transported oxidizing agents → adverse chemical reactions
 |  |  |
| **Division 5.2**S:\MIEDGSL\DGStorage\Class Labels\Model No 5.2B.wmf | **Organic peroxide** | * Thermally unstable substances → exothermic, self-accelerating decomposition
* Liable to explosive decomposition if contaminated by metal ions or organic residue
* Decomposition hazard where diluent (stabiliser) has been exhausted
* Self-accelerating decomposition temperature exceeded in cargo transport unit → exothermic reaction
 |  |  |
| **Division 6.1**S:\MIEDGSL\DGStorage\Class Labels\Model No 6.1.wmf | **Toxicity** | * Exposure of personnel to LD50 dose (oral or dermal), LC50 (inhalation) or exceedance of exposure standards (TWA/STEL/Ceiling)
* Oral ingestion, dermal contact or inhalation of dusts, mists or vapours
* Failure of cylinder valve for “toxic by inhalation” goods → acute inhalation risk for workers and bystanders in transit
 |  |  |
| **Division 6.2**S:\MIEDGSL\DGStorage\Class Labels\Model No 6.2.wmf | **Infectious** | * **Category A:** An infectious substance which is transported in a form that, when exposure to it occurs, is capable of causing permanent disability, life-threatening or fatal disease in otherwise healthy humans or animals.
* **Category B:** An infectious substance which does not meet the criteria for inclusion in Category A. Infectious substances in Category B must be assigned to UN 3373, except for medical or clinical wastes containing infectious substances in Category B (UN 3291).

**References*** Department of Health, [www.health.wa.gov.au](http://www.health.wa.gov.au)
* *Requirements for the Packaging and Transport of Pathology Specimens and Associated Materials (Fourth Edition)*, [www.health.gov.au/internet/main/publishing.nsf/Content/health-npaac-docs-PackTransPathSpecimens.htm](http://www.health.gov.au/internet/main/publishing.nsf/Content/health-npaac-docs-PackTransPathSpecimens.htm)
 |  |  |
| **Class 7**S:\MIEDGSL\DGStorage\Class Labels\Model No 7B.wmf | **Radioactivity** | * Exposure of personnel to ionising radiation from radionuclide decay (i.e. alpha, beta, gamma evolution→ irradiation of workers and/or public
* Damage to packaging and shielding creates exposure route (e.g. packaged source damaged → radionuclide environmental release → inhalation and/or ingestion)

**References*** Department of Health, Radiation Health Branch services, [ww2.health.wa.gov.au/Articles/N\_R/Radiation-Health-Branch-services](http://ww2.health.wa.gov.au/Articles/N_R/Radiation-Health-Branch-services)
* *Code of practice for the safe transport of radioactive material,* [www.arpansa.gov.au/publications/codes/rps2.cfm](http://www.arpansa.gov.au/publications/codes/rps2.cfm)
 |  |  |
| **Class 8**S:\MIEDGSL\DGStorage\Class Labels\Model No 8.wmf | **Corrosive** | * Chemical action causes severe damage when in contact with living tissue (i.e. corrosion of eyes, skin, mouth, or corrosive vapour inhalation to lungs)
* Chemical reactivity of corrosive substance dissolves metal container → loss of containment and impact upon other goods
* Evolution of flammable gas (e.g. hydrogen, when metals dissolved by acid or alkali; i.e. hydrochloric acid on steel, sodium hydroxide on aluminium)
* Evolution of toxic gases resulting from decomposition (e.g. chlorine from hypochlorite solutions, nitrogen dioxide from nitric acid)
* Incompatibility of co-transported corrosives → adverse chemical reactions (e.g. acid and hypochlorites mixing releases chlorine gas)
* Dangerous reaction from mixing of strong acids and alkalis
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| **Class 9**S:\MIEDGSL\DGStorage\Class Labels\Model No 9.wmf | **Miscellaneous** | **Broad categories** | **Considerations** |  |  |
| Substances which, on inhalation as fine dust, may endanger health | Potential long term health effects |  |  |
| Substances evolving flammable vapour | Flammable atmosphere can be formed in an unventilated cargo transport unit  |  |  |
| Lithium batteries and capacitors | Fire potential if perforated; electrical hazards |  |  |
| Substances and articles which, in the event of fire, may form dioxins | Toxic by-products affecting workers |  |  |
| Substances transported at elevated temperatures | Increased fire hazard to adjacent plant and goods; solidification potential |  |  |
| Life-saving appliances | Air-bags and pneumatic devices – compressed gas and explosive initiator |  |  |
| Environmentally hazardous substances | Transport and unloading around aquatic environments or wetlands |  |  |

## Activity: Operations within the transport system

### Consolidating dangerous goods loads

| **Element** | **Potential issues to address** | **Controls applied** | **Is the control effective?** |
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|
| **Consignment issues** **[including transport documentation (TD)]** | * Transport consignment form does not include dangerous goods (DG) declaration → consignor offering DG mistakenly accepted as general freight
* Transport consignment form does not require full description of DG → acceptance of DG based on brand name, incorrect name or lower hazard packing group
* Consignment system does not recognise DG → manual entry of proper shipping name, UN number and class required onto TD
* Consignment system does not recognise UN number or DG classes → no information for TD, segregation or placarding
* Consignment system not established for nominally empty DG packages → acceptance of variety of partially-filled containers creating an incompatible placard load
* Limited quantity consignment not detailed by consignor with class information on TD → segregation issues for loaders
* Packing group and aggregate quantity not identified on TD → placard load not identified by consolidators, loaders and drivers
* Overall DG manifest (load summary) not generated → difficult for depot supervisor to communicate DG details through logistics chain to loaders and drivers
 |  |  |
| **Overpacking** | * Overpacking technique with opaque shrink-wrap obscures incompatible goods → segregation issues
* Overpacking a loose collection of different-sized containers (e.g. variety of used car and truck batteries → loose packages that can puncture adjacent packages and split in transit)
* Overpacking cylinders (C, D, E, G size) into single stillage → multiple straps required to restrain load
* Load arrangement imparts excess stress (i.e. heavy packages squashing smaller packages)
 |  |  |
| **Labelling** | * The labelling of the overpack does not match the class of dangerous goods stated on the transport document → segregation or ventilation issues
* Labelling is damaged and illegible → identification of goods difficult
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### Loading of dangerous goods

| **Element** | **Potential issues to address** | **Controls applied** | **Is the control effective?** |
| --- | --- | --- | --- |
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| **Loading plan** | * No documented load plan means pallets loaded according to consignee location → poorly planned loads
* Load plan does not indicate position of DG classes on a combination vehicle → poor knowledge of load by company driver or sub-contractor picking up loaded trailers
* Poor load plan → inadequate segregation
* Load arrangement with heavy equipment loaded above DG → imparting excess stress on packages
 |  |  |
| **Achieving effective segregation** | * Segregation practices not adopted formally in transport procedures and training → poor use of segregation devices and preparation of incompatible loads
* Segregation devices and segregation packaging not available → inefficiencies caused by multiple trailers for single consignment
 |  |  |
| **Effective placarding (including IBC emergency information panels)** | * DG transport documents and DG manifest mixed in with general freight details → difficult to establish placard load level
* Vehicles not fitted with DG labels or ‘Hazchem flip folder’ → affixing single labels or hand-drawn labels
* Product specific EIPs and amendable, blank multi-load EIPs are not available → down time spent sourcing correct placarding and hand-drawing in transit
* Tarpaulined loads obscure IBC and portable tank EIPs → extra vehicle placards to be constructed at depot or consignor site
* Vehicle placarding inadequate or incorrect → segregation issues through incompatible goods being accepted
 |  |  |
| **Stacking maximums breached** | * Palletised DG stacked greater than 3 m, or stacked under denser loads → individual packages exceeding stress rating and leaking in transit
* Maximum stacking loads on IBCs ignored → failure of composites, inner bladders, plastic liners and loss of containment
* Maximum stacking loads exceeded → insecure loads
 |  |  |

### Defective packaging

| **Element** | **Potential issues to address** | **Controls applied** | **Is the control effective?** |
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|
| **Identifying non-UN approved packaging** | * Approved packaging marking specifications not audited by competent staff → acceptance of non-approved and non-rated outer packaging
* Placardable units not checked for compliance plate (e.g. IMDG, Bureau Veritas certificate, CSC) → acceptance of non-approved placardable units and freight containers
 |  |  |
| **Identifying defective/damaged/leaking package** | * Examination of package integrity not undertaken by receivals workers → transport of damaged packages
* Quarantine of damaged or leaking containers not actioned → increased likelihood of leakage and dangerous reactions in transit
 |  |  |
| **Managing receivals** | * Overdrums, drum bunds and bunded areas unavailable → isolating defective, damaged and/or leaking packages is difficult
* Procedure for returns to consignors are not documented → confusion over responsibilities and time delays in rectifying unacceptable consignments
* Isolation procedures not in place → escalation of leakage incident
 |  |  |
| **Dealing with handling incidents** | * Mechanical handling incidents create damage or leakage → extra handling work and isolating products
* Unavailability of overdrums or segregation packaging at depots means direct waste management or product return not possible
 |  |  |
| **Responding to leaks or spills in transit** | * Inability to handle damaged large packaging or placardable units at regional depots → costly return journey or costly recovery of controlled waste
* Unavailable overdrums or segregation packaging means leaking packages cannot be legally transported further → depot retains the leaking package problem longer than necessary
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### Load restraint

| **Element** | **Potential issues to address** | **Controls applied** | **Is the control effective?** |
| --- | --- | --- | --- |
|
| **Procedural issues** | * Principles of the *Load Restraint Guide* 2004 are not formally adopted by the company to inform the relevant techniques required to obtain adequate restraint.
* Principles of the ADG Code Chapter 8.1 *Stowage and restraint on or in cargo transport units* or Chapter 8.2 *Restraint of cargo transport units on vehicles* are not in practice

**References*** *Load Restraint Guide: Guidelines and performance standards for the safe carriage of loads on road vehicles*[ntc.gov.au/Media/Reports/(E62BE286-4870-ED95-1914-1A70F3250782).pdf](http://ntc.gov.au/Media/Reports/%28E62BE286-4870-ED95-1914-1A70F3250782%29.pdf)
* *Australian Code for the transport of dangerous goods by road and rail “ Australian Dangerous Goods (ADG) Code”* (Edition 7.4) [www.ntc.gov.au/heavy-vehicles/safety/australian-dangerous-goods-code/](http://www.ntc.gov.au/heavy-vehicles/safety/australian-dangerous-goods-code/)
 |  |  |
| **Generic hazards to address** | * Low friction – sandy, dusty or oily surfaces (e.g. composite IBC with metal tube outer frame on a metal trailer)
* High centre of gravity – especially for portable tanks transported on trailer decks exceeding 1,100 mm height
* Exceeding restraint rating (e.g. using 10 mm nylon rope to secure a 2 tonne IBC)
* Cylindrical objects (e.g. 45 kg LPG cylinders or 200 L plastic drums)
* Lightweight headboards – claiming blocking credits for a thin plywood headboard to reduce tie-down required does not decrease actual forward forces encountered upon braking
* Flimsy sides and gates – minimally-rated side frames used for secondary restraint (as required by ADG Code) are not going to resist sliding IBCs
* Dunnage strength – appropriate material, thickness, shape and orientation
* Inter-layer slippage – consider rubber matting as a means of increasing friction between container and floor, and between freight layers
* Chemically damaged, mechanically damaged or over-stretched straps → failure during normal use
 |  |  |
| **Pallets of packages** | * Adjacent pallets of different heights means lowest pallet only restrained on trailer edge → pallet liable to pivot and shift in transit
* Corner protectors and sleeves are not available to place on pallet top sides to distribute the strap load → operator leaving strap tension below required tie-down force
* Standard 2.5 tonne, 50 mm webbing strap mechanically tensioned to 600 kg perforates fibreboard boxes → loosening of straps in-transit
* Internal restraint of packages on pallet is inadequate → drums being squeezed sideways by horizontal strap tension
 |  |  |
| **IBCs** | * Flexible IBCs are creased significantly due to solids moving internally → gradual loosening of strap in transit
* Steel IBCs and composite metal frames have low surface friction on steel trailer → tie-down force achieved insufficient to stop sliding on acceleration, braking, cornering
 |  |  |
| **Stillages and cylinders** | * Loose vertical cylinders that are horizontally restrained in square matrix move into closer packing arrangement in transit → loosened straps
* Horizontal restraint applied to cylinders over and around standard unreinforced sides → panels bending and restraint loosening
* Insufficient lugs on stillages or sturdy horizontal rails for strapping → compromised restraint
* Stillages without lockdown mechanism on base or vehicle locating pins → unstable loads
* Standard stillage for G-size (50 L) cylinders used for C, D and E sizes → increased chance of ejection of cylinders through rail spaces
 |  |  |
| **Placardable units – twist locks** | * Flimsy or non-rated twist lock housing on freight container (FC) or portable tank (PT) renders twist lock inoperable
* Damaged twist lock mechanism (e.g. worn and/or deformed locking pin on vehicle) does not supply restraining force adequate to immobilise FC or PT
 |  |  |
| **Coaming rails versus rated anchor points** | * Coaming rail not rated to resist multiple straps → rail bending excessively and uncertain tie-down force exerted on pallets
* Suitably rated anchor points for direct restraint method not provided on vehicle → failure in transit of lashings providing direct force restraint of placardable units, FC or PT
 |  |  |

### In transit procedure

| **Element** | **Potential issues to address** | **Controls applied** | **Is the control effective?** |
| --- | --- | --- | --- |
|
| **Breakdowns** | * Driver inability to manoeuvre vehicle fully off carriageway → vulnerable to rear impact or side-swipe collision
* Inexperienced driver unfamiliar with placement of portable warning triangles to highlight immobilised vehicle → increased traffic hazard
* Loads are left unattended → security issues of security sensitive ammonium nitrate (SSAN) and high hazard DG
* Leakage of fuels and hydrocarbons → potential for fire, explosion and mixing with incompatibles
 |  |  |
| **Parking** | * Driver parking in residential area for prolonged period (e.g. overnight or during lunch break→ increased exposure to residents and possible vehicle accidents)
* Parking within 15 m of a commercial building or public assembly area → public has increased exposure, especially to venting vapour or gas release,
* Parking adjacent to another DG vehicle → increased potential for fire propagation or incompatible goods interaction (e.g. fuel truck parked near hot bitumen sprayer)
 |  |  |
| **Rest breaks** | * Vehicle not visible during rest or refreshment break taken at roadhouse → inability to keep load secure
* Parking in areas where there is risk of impact with other vehicles
 |  |  |
| **Road train assembly area (RTAA)** | * Driver doing shuttle runs of single-trailers from depot to RTAA leaving placard loads unsupervised → no load security nor ability to respond to DG incident
* Driver leaves tarpaulined load or locked freight container with mixed class diamond at RTAA → problematic evacuation of trailers with no indication of contents
 |  |  |
| **Journey management plan (JMP)** | * JMP not established → routes chosen by individual drivers and sub-contractors not in accord with permitted routes and risk minimisation principles
* JMP not in place for new recruit → poorly executed delivery and low awareness of permitted routes and unloading procedures
* JMP not executed by inducted driver → fatigue management breaches and unaccounted delays
* JMP not properly conveyed from senior driver trainer or mentor to new inductee, rendering JMP ineffective
* JMP not properly established for remote travel → elevated hazard for individual driver involved in accident, breakdown, bushfire or weather-related incident
 |  |  |

### Unloading dangerous goods at consignee premises

| **Element** | **Potential issues to address** | **Controls applied** | **Is the****control effective?** |
| --- | --- | --- | --- |
|
| **Traffic management** | * Absence of traffic management plan → pedestrian impact, worker injury or goods damage
 |  |  |
| **Multi-modal handling** e.g. forklift, tele-handler, container crane | * Gross mass of container exceeds safe working load rating of mechanical handling machine
 |  |  |
| **Premises configuration** | * Unloading area sloping and unsuitable for parking → load shifting after restraints loosened and problematic unloading of containers
* Haphazard site → poor reversing visibility and congested workspace
* Poor lighting → elevated risk of collisions and forklifting incidents
 |  |  |
| **Transfer of bulk solids** | * Lack of safe work procedures for transfer → loss of containment or contamination of premises
* Perforation of FIBCs or BK3 (flexible bulk container) by forklift tynes
 |  |  |
| **Transfer of liquids** | * Lack of safe work procedures for transfer → loss of containment or contamination of premises
* IBC outlet tap knocked open or filling port loosened → loss of containment
 |  |  |
| **Transfer of gases – portable tank movement** | * Release of vapour if relief valve or burst disc outlet fractured
* Container over-pressure if insulated jacket of cryogenic or refrigerated liquefied gases compromised
 |  |  |
| **Transfer of gases – cylinder and MEGCs** | * Manifolded connections damaged or valves sheared during movement → significant compressed gas release
 |  |  |

## Activity: Emergency response and planning



| **Element** | **Potential issues to address** | **Controls applied** | **Is the control effective?** |
| --- | --- | --- | --- |
|
| **Activating transport emergency response plan (TERP)** | * Driver unaware of TERP → actions undertaken inconsistent with relevant response for specific DG load involved
* Driver does not follow initial response as per emergency procedure guide (EPG) → Elevates the particular hazard (e.g. dousing a fuel pool fire with water)
* Inaccurate identification of containers and goods to emergency services → delays appropriate response
* Communication failure – driver unable to activate TERP → delays in required emergency responder reaching incident site
* TERP responsibilities not understood by responsible officer (e.g. containment strategies, mobilisation of resources → emergency response inadequate and lengthy delay)
* Approved emergency responder not in place → DG recovery action hampered (e.g. road closures lengthened unnecessarily, contaminated soil area expanded, legal responsibilities not met)
 |  |  |
| **Preparedness** | * Lack of security en route and in transit for security risk dangerous goods
* Lack of training and exercises → unfamiliarity with correct mode of response
* Response capabilities untested → poor management of vehicle recovery and protracted clean-up
 |  |  |
| **Resources** | * Lack of emergency response equipment (e.g. response trailer → reduced capability to de-escalate rapidly)
* Insufficient resources for recovery → expensive contracting of incidence site clean-up
 |  |  |
| **Response tasks** | * No mechanism for alerting external agencies [e.g. Department of Environment Regulation (DER), Department of Mines and Petroleum (DMP) → potential culpability]
* Inadequate procedures for bulk product transfer → unsafe work practices
* Insufficient packaging for contaminated materials → non-compliant transport
* Inexperienced staff attempting clean-up → breaching public safety
 |  |  |
| **Continuous improvement of TERP** | * Formal procedures not in place to investigate accidents → potential recurrence and absence of learnings
* No root causes or contributing factors identified → continued acceptance of incident consequence and mediocre response
* Corrective actions not implemented → potential recurrence and repetitive responding mistakes
* TERP modifications not communicated to drivers → status quo of poor situation prevails

**Reference***Guidelines for the preparation of a transport emergency response plan*, [www.infrastructure.gov.au/transport/australia/dangerous/pdf/GuidelineERP.pdf](http://www.infrastructure.gov.au/transport/australia/dangerous/pdf/GuidelineERP.pdf)  |  |  |