Air lifting units - Centre of gravity

A study document – By Len Watson

(Adapted from 'MVA rescue technician *SERIES'* – Safe Tool Operation Part 2 - Air Lifting Units)

The majority of fire departments now carry Air Lifting Units (ALU) of some kind or other. As different as the equipment inventory can be between one fire service and another, their ancillary equipment (cribbing, props and struts etc) is often even more diverse. And it doesn't stop there as the level of training given to operators is predominantly dealership driven and far removed from what is needed in reality.

This situation has been made possible due to the low frequency use of air lifting units. Then all of a sudden, without expectation, a major need for ALU's arises that no one has ever contemplated or prepared for.

As service providers, dealerships are probably the root cause in failing to advise fire departments of the real issues and making a sale irrespective of whether it is sufficient to meet the departments needs. Of course the fire department must shoulder its share of blame which is mainly offloaded with the 'it's impossible to cater for every situation' clause.

In my travels I have come across fire departments that are getting to grips with this area of heavy rescue. In RESCUE news LETTER issue 6, I mentioned that some departments have gone as far as getting their own 'heavy wrecker'. While I feel this is impractical for most departments being well beyond budget constraints, it must be said that improvements in training and essential equipment is not.

In terms of heavy vehicle rescue, the various situations that arise can be categorised.

- Bus/coach
- Truck
- Tanker
- Specialised truck

Rarely encountered by fire departments, when involved in an off-road or roll-over situation, these vehicles present a range of problems all their own. The tow truck operator deals with these situations on a regular basis. It is only where special circumstances or entrapment is involved that fire departments are called out.

Many trucks are equipped with less than adequate under-ride side bars and some have none at all. With some side-on under-rides it mayl be necessary to separate the car from under the truck. This becomes more complicated where the tandem rear wheel rides up onto the car crushing the bulkhead and forcing the steering wheel, column and dash onto the driver.

For the most part training with air-lifting units within fire departments is pretty basic. Outside the larger training establishment with a sufficient budget, smaller departments cannot afford the resource for specialized training of this nature. Even with the necessary resource to mount serviceable ALU training, it will be virtually impossible to meet all the necessary requirements to cater for every eventuality e.g. lifting/ tilting on a hill or gradient with different types of cargo.
Let us first realise the minimum equipment standard that is required to safely lift or tilt a load and the risk assessment criteria that is vitally necessary for safe working practice.

Equipment

High & Low pressure air-bags (HAB/LAB}- Props – Cribbing – Winches, Slings, Tensioners & Ties

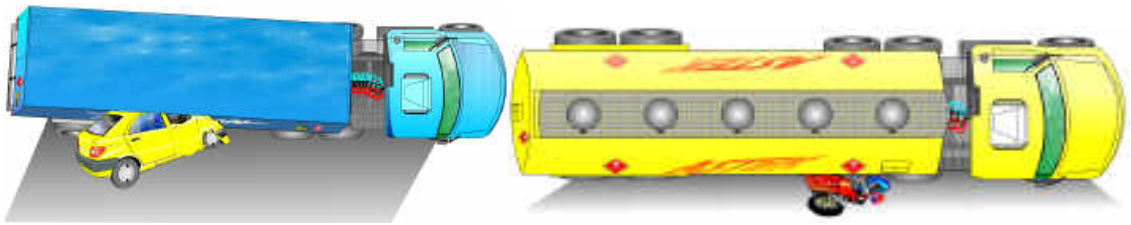
The rescue equipment a fire truck can carry is minimal. Heavy rescue really needs a dedicated rescue vehicle. However, even with a dedicated RV there comes a point where the rescue equipment has to be rationalised otherwise we simply run out of space or overload the vehicle.

To analyse your department's past history of heavy rescue calls is one way forward, but who is required to keep detailed records let alone any records at all. Mostly a department will have to rely on a collective experience-led analysis and then make decisions on that.

It is easy to be sold a pig-in-a-poke. Buying equipment that fails to deliver when the need arises or to undervalue your requirements can initiate the situation where rescuers try to perform the impossible with the resource at hand. This could be seen by some as a situation waiting to happen and a risk in its own right.

When it comes to preparedness training, all that any department seems to do is to base their training on past experience. Unless they enlist some expert help, really that is all they can do.

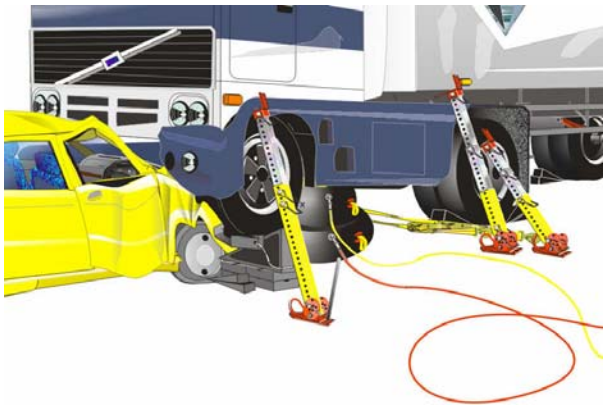
Expert help can be sought from those with a proven track record; those rescuers that have busied themselves in developing appropriate courses and the setting up of real-life exercises at their training venues. As by way of an introduction we can offer the following links which we hope to increase as this series continues –



The most common types of truck versus car/cycle/pedestrian collisions where the truck remains part of the problem are under-rides and capsizes. Where the immediate strategic response is for the use of air lifting units it is essential that the situation is properly risk assessed. This can only be safely arrived at where the Incident Commander knows and appreciates the problems that can exist, and the solutions to remove or reduce the risks to an acceptable level.

Additional to the obvious risks of spills, unstable wreckage and loads he must consider load shift, gradients and slopes, and the centre of gravity of the load to be raised/lifted or moved. When moving a load on soft ground he will have to take rolling resistance into account and, where the rescue is beyond his capability, he must know enough to safe guard the rescuers and casualties when involving other agencies.

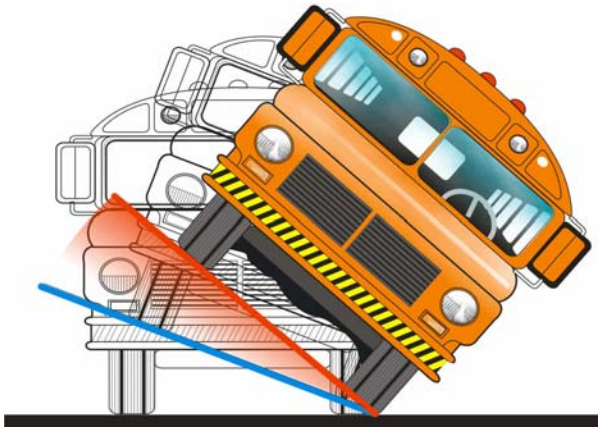
Lifting on gradients and slopes:



When lifting a load on a gradient or slope, even as little as 2%, it is imperative that the risk of lateral movement is controlled. Air lifting bags have the tendency to roll when subjected to lateral force. Again, air lifting bags can easily diminish the advantage of stabilising props; for as the lift progresses props will have little weight to support and purchase to keep them in place. This can allow a 'bouncy' phenomena to occur in gusting or high winds and a risk that must be managed as the lift progresses.

Cribbing, packing or purpose made chocks. Blocks and wedges are essential, not just for supporting the lift, but also in preventing lateral movement. Some chocks offer good support while others are next to useless. It is necessary to use interlocking blocks 'up side down' to use the wedges to best advantage. I still put my trust in good old-fashioned stress graded wood.

Centre of gravity (C of G):



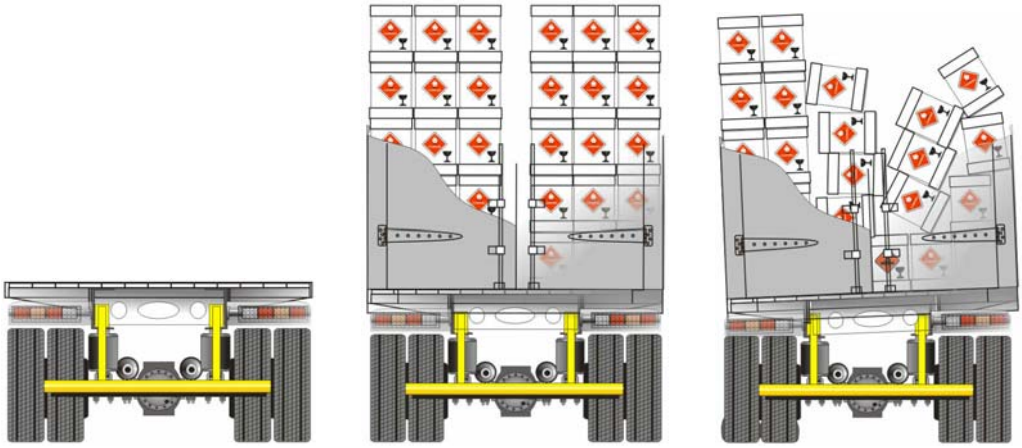
When lifting or tilting a load the 'centre of gravity' must be considered and understood. A simple way to explain its relevance is when tilting a vehicle, as it is raised the actual effort to tilt the vehicle will lessen until at the point of balance, all the weight will concentrate at its centre of gravity; a feather touch is all that is then needed to topple the vehicle.

Of course weight distribution in the vehicle's build and the load it's carrying, and whether its on a gradient or slope, all determine it's centre of gravity

C of E explained

The point of balance is largely dependent on the vehicle type and the cargo it's carrying. Buses and coaches are designed with a lower C of G and can be tilted as much as 30^{o} whereas the double-decker and high sided trucks and trailers can be at risk of toppling as low as 15^{o}.

Load Distribution:

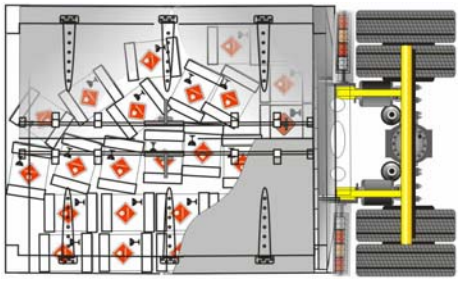


How a truck's cargo is distributed and secured is very important to the centre of gravity of the vehicle. Even where an unladen truck or trailer is positioned on a gradient of 2% or more the centre of gravity alters accordingly and any lifting must take this into account. On some occasions this can

be experienced with the camber in the road.

Every caution must be taken to prevent lateral movement and we must always be vigilant for any shift or pending shifting in the cargo. Wherever possible the cargo should be viewed. Where this is not possible, we can examine the truck's/trailer's tyres for 'bulging' as evidence of significant shift in the load.

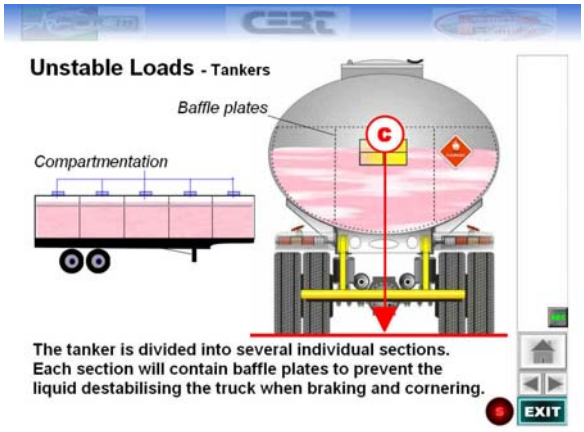
Where the load has shifted it will have altered the vehicle's normal centre of gravity. We must also appreciate that as we lift or tilt the load it can cause further movement in the load which, depending on the cargo, can be sudden with catastrophic effect. It is therefore essential that early in operations that, where necessary, the decision to unload the truck is taken.



Where the truck/trailer has come to rest on its side, movement in the cargo is virtually guaranteed. The coachwork structure will be either prefabricated or framed. Either way it will have little substance and the cargo will have to be unloaded before a lift can be entertained. Hazardous material, leakage or spills must be guarded against and special precautions taken where necessary.

Tankers:

Tankers present problems all their own. The tank is divided up and can have up to five or more compartments. Each compartment will be sub-divided with interconnecting baffle plates to mitigate the movement of fluid when braking and cornering. However these plates only prevent the sudden rush of fluid; they do not prevent the eventual settling and levelling of the fluid. Where the tanker is parked on a camber or incline, the fluid in each compartment will adjust to that level relatively quickly.



The tanker is compartmentised into a series of separate tanks. Again baffle plates are constructed within each tank to minimise movement of fluid during transportation, especially when cornering and braking.

The tanker is most unstable when one or more of its tanks are partially full. This becomes more prevalent when the tanker is involved in a crash and comes to rest on a gradient or hill, or capsizes and needs to be raised or tilted.

Fluid flow can alter the C of E quickly and dramatically and where the load is near its point of balance, it can cause the load to capsize.

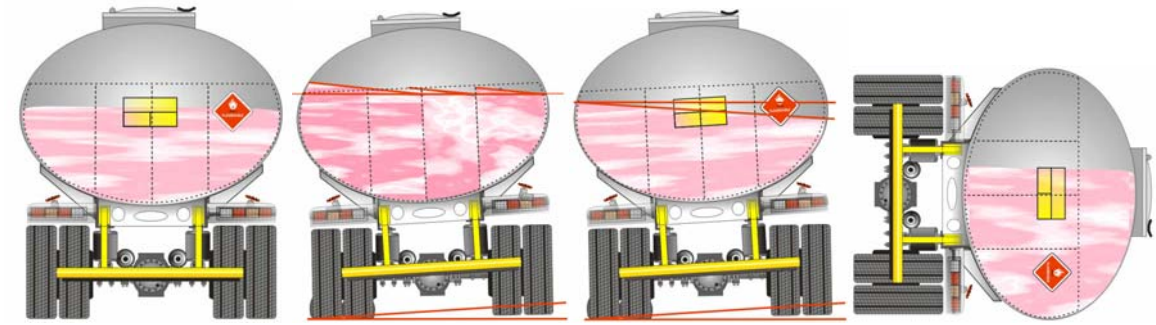


Fig 1 *Fig 2* *Fig 3* *Fig 4*

Initially the fluid will overflow the baffle plates (*Fig 2*) and quickly find its level *(Fig 3)*. As the fluid overcomes the restriction and inertia it will alter the C of G. Unless this has been taken into accounted for it can lead to uncontrolled movement and, with some situations, has been known to topple the load.

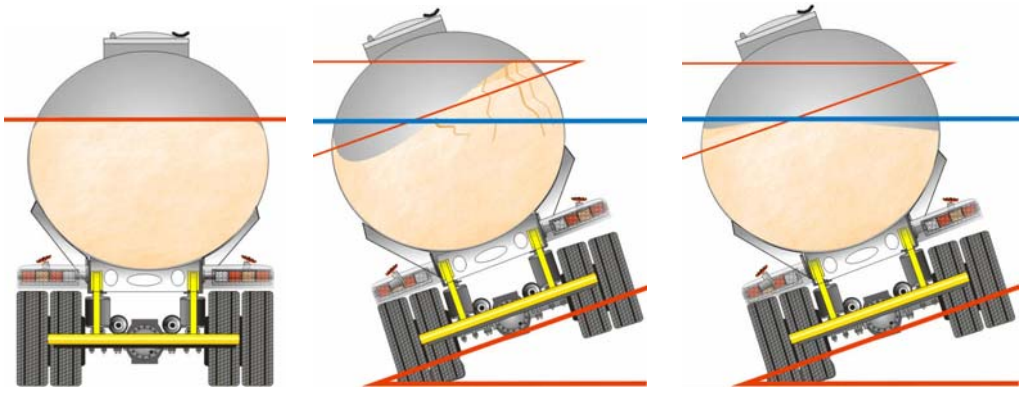
We can examine ‘bulging’ in the tanker’s tyres to determine to some degree the movement of fluid affecting the centre of gravity. This mainly will be dependant on the incline and the amount of fluid in the compartments. As the tanker is tilted the C of G will continue to alter and this must be taken into account and on-going C of G recalculated accordingly.

Where the tanker has come to rest on its side *(Fig 4)* there will be a significant shift in the C of G. Additionally the baffle plates will add to the effort required to tilt the tanker. Initially plates will retain the fluid until the level rises and overflows the individual plates. Where the lift is processed too quickly, it can lead to an imbalance where the flow catches up, alters the C of G and topples the load beyond the point of balance,

With flammable or corrosive fluids there is a greater risk of leaks and, where some compartments are empty, there is a risk of explosion. Water spray must be a prime consideration to disperse vapour and prevent static accumulation. Leaks may require blanketing with foam, bunging and prevented from entering drains.

Unless your fire department has a suitable Heavy Wrecker there will be a need to co-ordinate and co-operate with the tow-truck operator. Tow-truck operators are highly skilled individuals who, due to the volume of their work, become very experienced in recovery in a relatively short space of time. However, it is well worth remembering that no matter how well experienced, they rarely handle a ‘life’ risk in recovery and they are not equipped to handle a haz-mat situation. Likewise, unless formally trained, the Incident Commander will be ‘green behind the ears’. I think that we can all agree that this is not the best of situations to find oneself in!

Bulk Carriers:



Sludge and powder carriers have a set of rules all their own. Powder in transit, when cornering and braking, does not reacts in the same manner as fluid. The tanker does not need to have baffle plates or compartmentation. Powder has a higher degree of inertia than water and the finer the powder the higher the cohesion. This means that the bulk carrier can be tilted to a significant degree before the powder will level. The risk factor associated with powder is that at a crucial time, as the tilted load nears its point of balance, the cohesion will give way and the sudden movement in mass will topple the vehicle.

On occasions when the bulk carrier is being tipped the powder can lodge in the tank. When this happens operators have been known to use the power-take-of to jar the tank using the hydraulic ram to shake the load free. This dislodges the bulk of powder allowing the auger to completely empty the tank. However, sudden movement of the powder has been known to topple the tanker capsizing it onto it’s side.

Specials:

The same condition that exists for bulk carriers, can also be seen as a problem to other special

vehicles. The prime examples are the garbage truck (dust cart), dumpsters (tippers) and cement mixers. Not only is the C of G more difficult to determine, but load shift can present some unique problems all their own.

The garbage truck can suffer from load imbalance, the dumpster from overspill and the cement truck from movement in the mixer drum. Mixer drums have been known to break free as the wrecker rights the capsized truck and, as a runaway, can threaten life and limb especially on a hill or gradient.

These vehicles when they overturn are mainly beyond the capability of a fire department. Even where a fire department has a heavy wrecker, their training may not encompass these vehicles and they must realise that on some occasions more than one wrecker may be required to handle the situation. Boggy or marshy ground can lead to other problems where assistance and advice should be sought. And it is not just with these specials that major problems can arise, it must be appreciated that progression in modes of heavy transport will see more and more tandem configurations that will ultimately cause major headaches.

The Container

When lifting or tilting a container truck with air bags, when risk-assessing, it is imperative that all securing bolts are in contact and engaged in position. Except for nominal lifting or tilting, this scenario is likely to fall outside the scope of the average fire department

Again boggy or marshy ground can lead to other situations where larger bags are required or heavy wrecker assistance or a crane may be necessary.

The capsized tandem unit can lead to untold problems where the trailer cannot be un-hitched. It may even be necessary to use a torch to hot-cut the draw bar to free the trailer.

The structural strength of the typical container will support air lifting units even where the container is full.

When tilting the container, the doors must be monitored for signs of deformity or weakening in the securing bolts or in the brackets that support the latch mechanism. As the doors offer support to the structure; any failing would indicate flexing to the bodywork of the container, which could lead to adverse movement and the container itself bending or breaking up.

The experience of the tow truck operator

The skill and capability of the wrecker operator has grown dimensionally over the years and, time and again, they show the dexterity of their trade at the roadside in terms of vehicle recovery and, sometimes at the scene of crashes, they offer the only solution to an otherwise hopeless situation.

Their knowledge base in relation to C of G, lifting and tilting on a gradient, hill, soft ground or other predicament is second to none and as such, for any officer who is faced with an out of the ordinary difficult rescue situation, a very desirable friend.

Their skill level allows for heavy trucks to be lifted, rotated in any direction and placed inch perfect without occasioning any further damage. For proof and re-proof this can be witnessed as part of their daily workload or set up as an exercise. In place of tunnelling into the trapped driver and compromising their condition by manoeuvrings them out on the long spine board, the whole truck can be lifted/rotated off a crushed car and placed back on its wheels.

The heavy wrecker can work from most positions and operators can offer ingenious solutions. Of course working from off-set angles they will sometimes be dependant on remote anchorages as suitable purchase points to achieve their goals.

How the lifting/rotation/tilting is controlled needs to be witnessed to be believed and certainly needs to be fully evaluated in terms of rescue capability ■

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