Raising the Hard Questions

From Tony Johnson, Chief Executive Officer, Low Volume Vehicle Technical Association (LVVTA)

Times are a-changin' – especially for those who like to ride higher than the rest. Although we don't yet know just how these changes will look when they happen, we can at least share an overview of why the subject of raised four-wheelers has come under the spot-light, explain what the challenges have been during the process of working out how best to deal with them, and offer an insight into the different ideas currently under discussion.

Firstly, what is LVVTA, and what does it do?

An abridged answer to a complex question is that LVVTA is an incorporated society, established over 20 years ago by 10 different hobbyist national bodies, including Motorsport NZ, NZ Hot Rod Association, Sports Car Club of NZ, Motor Caravan Association, and NZ Four Wheel Drive Association (NZFWDA). The principle objective of LVVTA is to advocate the motor vehicle hobby in New Zealand to the Government, specifically in relation to motor vehicle modification and construction.

LVVTA's role, in the simplest of terms, is to sit in-between the Government and all denominations of motor vehicle enthusiasts, and broker - via the development of sensible and practically-oriented technical requirements and a thorough certification inspection system - an environment that both sides can live with. We do this by attempting to find that delicate balance-point between allowing enthusiasts to build and modify cars with sufficient freedom, flexibility, and creativity that they can continue to enjoy their hobby, whilst ensuring that the system is sufficiently robust to be considered reasonable and acceptable to the Government by virtue of minimising any resultant risk to road safety.

The day that the Government loses confidence in LVVTA and the self-governance system that we have (unique in the world) is the day that a Government-run alternative methodology will be applied here in New Zealand, such as that which exists in many states of Australia. We are therefore strongly compelled to protect our privileged position by taking our responsibilities very seriously.

The physics of raised vehicles

Despite differing opinions from some off road enthusiasts, there is a very real safety risk associated with raising the height of a motor vehicle. Whether a vehicle is raised via a body lift, suspension lift, increased tyre circumference, or a combination of two or three of those systems, the bottom line remains that the vehicle has been raised, which increases the vehicle's centre of gravity, which in turn reduces the stability of the vehicle – or more correctly, decreases the speed at which (with any given suspension design or spring rate) the vehicle will roll over.

We've heard it said many times by enthusiastic owners, and even some LVV Certifiers, that the combination of increased height through a lift of some sort, and increased spring rate (stiffer springs) has made a vehicle handle 'much better'. This is true to an extent, insofar as the increased stiffness will decrease the suspension compression and extension during cornering, and therefore

reduce 'body roll', which makes a vehicle tend to sit 'flatter' in corners. However, you can't overcome the simple physics of inertia and gravity. A raised vehicle's reduced stability is still lurking behind the feeling that the vehicle handles better - masked by the flatter cornering experienced during the speeds and cornering forces that the vehicle can cope with during normal driving - but at a certain point the reduced stability created by the higher centre of gravity will still cause the vehicle to roll, where it wouldn't have rolled at its standard height. That window of inertia between the point at which a standard vehicle will roll and a raised vehicle will roll may be minimal, but the point is that – regardless of how well a raised vehicle responds whilst in its operating comfort zone – its stability has been reduced, and it is less safe than a standard vehicle in an emergency response situation.

Associated with this handling issue is that, even amongst experienced drivers – off-roaders and LVV Certifiers alike – there is a wide variance of expertise and competence behind the wheel, and what one person declares to be a good handling vehicle, is declared by another to be rubbish. We've seen this before, where the opinion of an LVV Certifier with 20 years of circuit racing experience on a vehicle's handling characteristics is quite different than another LVV Certifier who doesn't have that background.

Why is LVVTA looking at raised vehicles?

The subject of raised vehicles has made its way to the top of LVVTA's to-do pile (along with many other issues being worked on simultaneously) because of the growing trend in recent years toward people creating road-going 'big-foots' or 'monster trucks'. The issue is exacerbated by the fact that a large proportion of these people are not off-road enthusiasts at all and are only interested in mimicking the rugged off-road 'look' for their urban commuters. With this trend comes increasing concerns about the safety of raised vehicles.

Again, advocates for raised vehicles claim that there are no statistics to support any need to look at them, but there are two counter-points to that position. One is that there have been a number of incidents and accidents where people have been injured or killed as a result of unstable (or less stable) 4WD vehicles, some on-road and some off-road – in fact the only segment of the vehicle modification hobby in which there has been more accidents is the 'boy racer' or 'performance import' sector.

The second counterpoint to the position that we should only look where the dead bodies are stacking up, is that LVVTA's philosophy on such matters has always been to identify, address, and mitigate a potential safety risk *before* a particular modification trend begins to feature disproportionately in accident statistics, rather than reacting to the issue after it has happened. We know from both history and common-sense that being proactive and putting a sensible fix to a potential problem before it gets a chance to become a high-profile incident prevents a media-fuelled knee-jerk over-reaction, so the end outcome is a much better long-term situation for the affected people. And we might save a life or two by taking a safety-based approach.

An additional side-issue with raised vehicles is the extremely adverse effect that a significantly-raised vehicle will have upon any 'normal height' vehicle with which it might collide. Vehicles with extreme lifts in some cases cause the chassis rail height to be up around the windscreen height of a normal

passenger car, and this presents what many people consider to be an unacceptable safety risk for other road users, especially occupants of modern 'normal height' vehicles which are already at a major disadvantage mass-wise in the event of a collision (head-on or side-on) with something like a Nissan Patrol.

How LVV Certifiers see the raised vehicle situation

Many of the people who are calling for technical requirements to be put in place to govern or limit the raising of vehicles are very experienced and competent LVV Certifiers. These are the guys who see them and drive them, but maintain the objectivity about them which can sometimes be lacking amongst those who are passionate about such vehicles. The common view we hear from the LVV Certifiers is that, when presented with a vehicle with an extreme lift, they have major concerns with the way in which the vehicle performs as a result of compromises made in relation to the vehicles' steering geometry and suspension geometry, braking performance, and the overall stability issue discussed earlier.

The LVV Certifiers often say they believe that the vehicles may be safe in the hands of an experienced off roader who understands the characteristics and limitations of the vehicle, but questions the safety of the vehicle in the hands of an inexperienced driver – and we all know how often Joe Average driver gets himself into trouble in a vehicle with a high centre of gravity. These are by far the largest group of vehicles involved in single-vehicle accidents.

There is another problem that keeps on cropping up with raised vehicles, which continually gives LVVTA headaches. Whereas a group of LVV Certifiers around New Zealand will (usually) agree on any given technical subject or vehicle-related technical problem, and carry out their LVV certification inspections with a reasonable degree of consistency from Whangarei to Invercargill, in the case of raised vehicles, LVVTA is constantly experiencing dramatically differing opinions over the same vehicle, or vehicle type, amongst equally experienced and competent LVV Certifiers. This LVV Certifier will say that he is entirely happy with the way that this raised vehicle drives, whereas that LVV Certifier will point-blank refuse to pass the same vehicle on the grounds that it is inherently less safe to drive than what it was when in its original condition. A big part of the reason for this lack of consistency is the simple difficulty in determining what is and isn't 'safe' in terms of handling and stability of a raised vehicle, and the absence of a set of clearly prescribed technical requirements for the LVV Certifiers to apply.

The LVV Authority Card proposal

So, how best to assess such vehicles, and determine what is and isn't safe? The initial thought was, based on a view that the risks associated with raised vehicles are lower whilst driven by off-road enthusiasts, were to create a three-tier system based on: - one; setting a basic 'threshold' that allows a vehicle with a very minor suspension and/or tyre lift to be able to be assessed by a WoF inspector without LVV certification being required, and two; a set of LVV technical requirements that say that any vehicle that is raised beyond that 'threshold', but less than a safe and sensible specified maximum amount, may be approved (for any vehicle owner/operator) by the LVV certification process, and three; any vehicle that is raised to such an extent that it exceeds the maximum specified figure may be approved (up to a higher maximum limit) by the LVV certification process

provided that it can be established that the user is a bonafide enthusiast who understands the limitations and risks associated with a significantly raised vehicle.

The way in which we proposed to identify a distinction between an urban commuter-type operator and a genuine enthusiast is via an existing system that has worked well for the motorsport and hot rodding movements for 20-plus years, which is based around an 'LVV Authority Card' system, which is tied to a certain person who must be a member of a member club of a national association (which must be an LVVTA Member Association) which will monitor and take responsibility for the behaviour of the card-holders via their national club structure so as to prevent the LVV Authority Card system being abused and falling into disrepute.

Unfortunately, this concept – which had been agreed in principle between LVVTA, the New Zealand Transport Agency (NZTA), and NZFWDA after a lot of time and effort was put into the project – met with disapproval by some Canterbury-based off-roading clubs who were not member clubs of NZFWDA. The Canterbury-based clubs had a number of different reasons for working against the idea, and a common theme seemed to be unwillingness to have membership with NZFWD as well as their own club or association. Some members lobbied their concerns about the LVV Authority Card system to NZTA, and this caused NZTA to withdraw their support for the LVV Authority Card concept.

The net result of the affected clubs and associations being unable to work together for the greater good – as the motorsport and hot rodding fraternities have done successfully for over 20 years – is that the LVV Authority Card option is now dead in the water, and will not be re-visited. Many off-road enthusiasts view this outcome as a lost opportunity.

Setting simple maximum height figures

With the LVV Authority Card system no longer an option, the simple solution for providing sound technical requirements to ensure that raised vehicles remain within safe and sensible limits might, on the surface, appear to be setting some maximum figures beyond which a vehicle cannot be raised. Some enthusiasts advocate setting a figure such as vehicles lifted by 50 mm or less can be issued a WoF without LVV certification, and vehicles that are lifted by more than 50 mm being required to undergo LVV certification with the LVV certification process allowing a maximum figure of 100 mm. Or in other words, you can go up to 50 mm above OE without LVV certification, and up to 100 mm above OE with LVV certification. End of story. However, this is not a technically sound way to deal with the problem; - any experienced off-roader who has driven a lot of 4WD vehicles both on-road and off-road will tell you that there are some vehicles which are safe to operate with a 100 mm lift, perhaps more, whereas there are other vehicles, particularly small 4WD vehicles that already have stability problems in as-manufactured condition – to the extent that some would describe them as unsafe to drive – that could become even more unsafe with as little as a 20 mm lift.

The NZ Four Wheel Drive Association (NZFWDA) did some good work many years ago that for various reasons never quite gained traction, that takes this basic notion of setting some figures, but they established a series of figures that vary, dependent on the tare, or 'curb weight' (aka 'kurb weight') of the vehicle being assessed. NZFWDA proposed that the maximum unladen chassis height (measured from ground level to a specified point on the underside of the vehicle's chassis or sub-frame rail) could be, say, 350 mm on vehicles with an OEM curb weight of up to 1400 Kg; 380 mm for

vehicles of 1400 to 1900 Kg; 420 mm on vehicles of 1900 to 2400 Kg; and 460 mm on vehicles of over 2400 Kg. Although the numbers might need to be fiddled with to get the best result, there is obvious merit in the concept. This at least takes into account that it would be reasonable to assume that the greater the vehicle mass the higher it could be safely lifted, but it doesn't make any distinction between expert off-road vehicle users and the urban commuters, nor does it provide a performance-based outcome for vehicles on an individual basis.

If the ideal solution was determined to be a simple numbers-based regime, something like the NZFWDA proposal could be workable, but as time goes by and more ideas surface on ways to carry out a performance-based test – which, it has to be said, would have to be the best way forward if there is a way of doing it that is practical, achievable, safe, and cost-effective – then the less likely it seems that some simple numbers will provide the best safety-based solution.

There's also a strong argument to say that for any increase in centre of gravity there should be a corresponding increase in track to mitigate the effects of the raised centre of gravity. Then of course, if the track is increased by additional wheel offset or wheel-to-hub spacers in order to resolve the stability problem, a whole new set of problems is potentially introduced as a result of the wheel offset or spacers, such as increased loadings on wheel studs, wheel bearings, and the adverse effects of incorrect scrub radius geometry. Nothing's easy, is it!

Alternative performance-based assessment options

So, each vehicle is going to have to be assessed via either a simple measurement-based set of parameters (as outlined above), or a performance-based test.

With a performance-based assessment now seeming like the best way forward (with emphasis on the fact that a measurement-based system hasn't been discounted, and the proviso that a performance-based test will only be the solution if it can be carried out in a practical, achievable, safe, and cost-effective way), LVVTA is now considering a number of different options by which to assess the stability-performance of each raised vehicle. All of these options will incorporate the common theme that the same assessment process, and technical requirements, will be applied to all vehicle owners, whether the owner is an urban commuter or a genuine off-roader. The technical requirements will be based on the simple principle that such vehicles must be safe for all vehicle owners, regardless of driving skill level and experience.

The stability issues that form a big component of LVVTA's concerns could be addressed by any one, or combination of, the following four assessment processes:

Tip-table test

Option one is to assess a vehicle's stability via a physical static roll-over test, sometimes known as a 'tip-table test', which requires a tilting ramp to which a vehicle could be tied. This system doesn't take into account factors such as axle roll stiffness, tyre grip, and dynamic behaviour of the vehicle, so it has its technical shortcomings. More pertinently, this option isn't really viable because of the access to such a ramp (or cost of building a ramp) for each of the 40 or so LVV Certifiers spread around New Zealand, the risk of harm to the LVV Certifier or damage to the vehicle if something goes wrong with the process, and the high certification costs associated with all of the time involved

for the LVV Certifier in carrying out the testing. It would be fine if someone were to build a production run of 20 vehicles and they were all to be assessed in the same way at the same place, but the reality is that in almost all cases, the assessment process will be required on a one-off basis.

Accelerometer-based computer programme

Option 2 is based on Christchurch-based Frank Hassam's idea of assessing a vehicle's stability by carrying out a low-speed slalom driving test over a prescribed course and at a specified speed, using a G-sensor type of accelerometer-based computer programme. This idea might sound a bit far-fetched to some, but initial discussions with computer programmers have determined this could be within the realms of possibility, and it could be as simple as modifying an existing programme or developing a new purpose-built programme, both of which could be used as a smart-phone application. Other experts, however, suggest that there could be complications with this system, as a straight accelerometer set up won't identify the difference between changes in 'roll' and 'direction' during the leaning and turning involved during the slalom test. Having said that, technology is changing rapidly and it could be do-able soon if not already.

Static roll-over threshold

Option 3 is to look at the 'static rollover threshold' (SRT) assessment system that NZTA use for the heavy transport sector. The same issues and concerns exist within the heavy truck fleet, particularly when a heavy load is positioned high within a truck's load area. The SRT system takes into account wheel track, load height and load weight, and a series of mathematical calculations will provide a figure that determines whether or not the vehicle can be legally operated – provided of course that the correct assumptions are made and the correct information is entered to begin with. The advantages with this system is that it is a tried and tested process that is known to work well, and there doesn't seem to be any reason why it couldn't be modified or adapted to suit smaller 4WD type vehicles.

Load-cell test

Option 4 is an idea offered up by Jason Marsden of Christchurch who has a Physics degree to support his thinking on the subject. Jason's idea is another type of static roll-over test which makes use of digital scales or load cells fitted under each wheel. One side of the vehicle is jacked up, and the weight transfer is used to extrapolate a tip angle, which will work for any vehicle regardless of size, weight, or wheel track. This mathematically-based process works on the principle that just before a vehicle tips over there is zero weight on the underside of the 'uphill' wheels, but calculations can be used to add a safety margin so the vehicle doesn't actually go anywhere near the tipping point. The downside of this system is that, while the process would probably be simple, safe, and accurate, there would be costs of somewhere between $1000 and $2000 for the required equipment. LVV Certifiers won't want to be subjected to high expenses unless there is going to be sufficient LVV certification work of this type to make the costs of the equipment economically-viable.

The positive aspect of any of these performance-based stability assessments is that the requirements can be less prescriptive, meaning that there may be no need to limit the amount by which a vehicle is raised, at least in relation to stability. The problems introduced as a result of the raised chassis height however – such as the impact point with other vehicles, and the changes in

relationship between steering and suspension angles - are another separate set of technical challenge which, conversely, might mean that limitations are none-the-less required despite positive results from a stability test process.

The next steps

After talking about the issue on and off for over ten years, LVVTA has made a commitment to deal with the raised vehicle issue as a top priority in 2015.

Each year, in addition to the six regional training sessions for LVV Certifiers held throughout New Zealand in April and October of each year, LVVTA now holds a centralised category-based, or subject-based, mid-year training session at its Wellington offices each year. In 2012 the subject was electric vehicles, in 2013 the topic was trikes, and for 2015 the subject will be raised vehicles - or more specifically, a two-day technical workshop will be held on the subject of safety-related technical requirements and stability assessment for raised 4WDs.

LVVTA will invite selected hobbyist and industry experts in the field of modified 4WD vehicles, who are considered to have particular expertise in the areas of steering and suspension geometry, and stability, to participate in the technical workshop. The participants will be limited to around 15 people from throughout New Zealand, and the criteria LVVTA will be using to determine who will be invited is that the invitees will have a very strong technical knowledge, vast practical experience, can respect the opinion of others, can work well in a group environment, and – most importantly - will not be motivated by any political or commercial agendas.

The objective of the workshop will be to establish the best way forward in terms of dealing with raised 4WDs, and will focus on determining the preferred method of stability assessment including how the preferred assessment process will work at the ground floor from the LVV Certifiers' perspective, and to agree on a series of technical requirements that will ensure a safe inspection process for all of the typical modifications made to these vehicles. The technical decisions made will ultimately form a series of technical requirements that will be incorporated as a separate section in LVV Standard 195 (Suspension Systems), and this in turn will form the basis of the requirements within the inspection form-set that the LVV Certifiers use to assess each raised 4WD that they LVV certify.

In summary

As time goes by and drafts of the new requirements are developed, they will be made available for viewing and downloading free of charge by anyone, on LVVTA's website www.lvvta.org.nz.

This is a complex problem with no simple answers, and LVVTA must, as always, walk that tightrope of trying to provide enthusiasts with as much freedom and flexibility as possible, whilst at the same time ensuring that safety for the vehicle occupants and other road users is not unreasonably reduced or compromised. It's not always an easy balance, but as always, we'll listen to anyone with a constructive opinion, and do our very best to achieve a workable and satisfactory outcome for the hobby, and the associated industry.