HIGH-SIDED RACE SEATS AND THREE-POINT SEATBELTS

Issues with the fitment of high-sided race seats to passenger vehicles are being noted with increasing frequency on some vehicles going through LVV certification, particularly regarding the routing of a vehicle's OEM three-point (lap and diagonal) seatbelts with high-sided race seats *(see Image 1)*. Historically, this is an issue which may not have had due attention paid to it - there is a perception that three-point seatbelts and high-sided race seats will usually be a compromise, and depending on the type of seat (and the vehicle it is fitted to), requirements may not always have been applied consistently.

For clarification, this Information Sheet is focused on the fixed-back, high-sided race seats normally found in motorsport vehicles, which are designed to be used with a full harness. Information Sheet *# 02 - 2012 Aftermarket Sports Seats - General Information* further details issues around fitting high-sided race seats into a vehicle, and should be read in conjunction with this Information Sheet.

Applicable Requirements

There are two pertinent requirements relating to seatbelt routing over high-sided race seats. LVV Standard 175-00 *Seatbelt Anchorages* requires that:

> ***2.10(7)*** *The seatbelt buckle of a seatbelt fitted to a low volume vehicle must be located so as to be able to be readily reached by the wearer, so that the seatbelt can be easily fastened or released, and on a lap and diagonal seatbelt, the buckle must be situated on or just below the hip area.*
>
> ***2.10(8)*** *A seatbelt must maintain full contact with the occupant and must not be held away from the occupant by interior trim or the seat structure, such as the deep sides of a sports seat.*

2.10(7) also has a note box, which states:

> ***NOTE:*** *A seat designed for use with a full harness has higher side bolsters that can impede fastening or releasing of a seatbelt, or prevent proper fit of the seatbelt to the occupant, and as such may not be suitable for use with a lap and diagonal seatbelt.*

Image 1: *This fixed-back race seat shows some of the issues with mounting a three-point seatbelt across a sports seat.*

While it is not possible to cater to every scenario, and to a point the suitability of a seat to a particular occupant becomes a user/vehicle owner issue, the purpose of this Information Sheet is to provide clarity on the expectations regarding high-sided race seats and LVV requirements. Note that for a seat that is on adjustable runners, all seatbelt positioning requirements specified within this Information Sheet (like those in LVV Standard 175-00 *Seatbelt Anchorages*) are specified with the seat at the mid-point of its fore-aft extension.

Defining 'High-sided'

A race seat can be considered 'high-sided' if the side bolsters are higher than the seat's H-point. For reference, the H-point is defined in LVV Standard 175-00 *Seatbelt Anchorages*, and is reproduced in the diagram below *(see Image 2)*. The H-point is intended to approximate the pivot point of the human torso at the hip joint, and originates from UN/ECE Regulation 14 *'Uniform provisions concerning the approval of vehicles with regard to safety-belt anchorages'.*

The H-point *(see Image 2)* is translated into a vehicle by this tool *(see Image 3)*, used by LVV Certifiers. As shown, the sides of this race seat (like most) are much higher than the H-point.

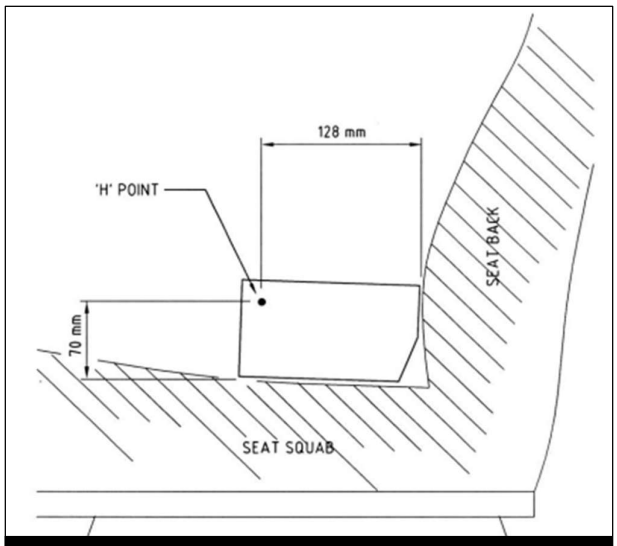

Image 2: *LVVTA H-point template diagram, LVV Standard 175-00 Seatbelt Anchorages, section 2.3(1)(b)(ii).*

Image 3: *The H-frame tool.*

Note that in most cases, the H-point will be forward of (and somewhere near) the holes in the sides of the seat bolsters. Because most race seats are designed (if not necessarily always tested or homologated) to meet FIA or SFI harness belt routing angle requirements, these regulations determine where the holes in the side of the seat bolsters need to be located. These routing angles can be used as a guide for where the seatbelt path should be across the seat occupant, and therefore where the seat needs to be positioned in relation to the lower seatbelt anchorages.

Issues

The main points of concern relate to the positioning of (and ease of access to) the seatbelt buckle, and the seatbelt being held away from the seat occupant by the bolsters or other structure. Most FIA or SFI-approved fixed-back race seats are intended by their manufacturer to be fitted in one position, and be used with a full harness belt, specifically in a motorsport application.

These seats often have very high side bolsters, and wings around the head and shoulder area (particularly those seats designed for use with a HANS device), which are intended to provide as much support and protection to the occupant as possible. There are, however, cheaper fixed-back race seats available that are not manufactured to meet an FIA/SFI standard, and because they are ineligible for use in most motorsport applications, they are usually destined for use in road-going vehicles. Not all of these seats are suitable for use with a three-point seatbelt however, and LVV requirements preclude the use of full harnesses unless the vehicle has an LVV Authority Card. Variations in both the design of aftermarket seats, and the vehicle manufacturer's positioning of seatbelt anchorages, means there is no single definitive answer that can be given as to whether race seats are acceptable - to an extent, every fitment is different.

The FIA requirements for full harnesses state the following:

> *'The lap straps must fit tightly into the bend between the pelvic crest and the upper thigh. Under no conditions may they be worn over the region of the abdomen. The lap and crotch straps must hold the pelvic region over the greatest possible surface.'*
>
> *'All the straps must pass freely through the seat slots in order to prevent the webbing from stressing the seat slot edge. Care must be taken that the straps cannot be damaged through chafing against sharp edges. Regarding the pelvic/lap straps, they must not pass over the sides of the seat but through the seat, in order to wrap and hold the pelvic region over the greatest possible surface. They must fit tightly into the bend between the pelvic crest and the upper thigh, and they must not be worn over the region of the abdomen'.*

As illustrated in Images 4 and 5, routing the seatbelt over the seat bolsters does not allow the belt to maintain full contact with the occupant, or sit on or just below the seat occupant's hips, so this belt will not properly restrain the seat occupant in a crash, and may allow them to 'submarine' (to slide forward in the seat, under the belt).

If the occupant doesn't submarine under the seatbelt, because it sits across their midriff (rather than anywhere bony), the occupant will also be allowed to move forward in a crash (as their internal organs squish) before being restrained by the belt, which greatly increases loads on the belt (and the wearer). LVVTA have seen cases where a seatbelt has failed in a crash (with fatal consequences), because the seat occupant was allowed to build forward momentum before being restrained by the belt.

Images 4 and 5: *Routing a seatbelt over the seat bolster.*

This improper belt routing will also transmit loads into the seat frame that it was not intended to withstand - particularly where seatbelt pretensioners are fitted. Over time, there is also the possibility of the belt rubbing through the seat padding and chafing on the hard fibreglass seat body.

The other issue is the routing of the upper part of the seatbelt over the head and shoulder restraint 'wings' in the seatback. Depending on the height of the seat occupant and the relationship of the seatback to the upper seatbelt anchorage, these 'wings' may not allow the seatbelt to sit correctly across the occupant's shoulders *(see Image 6)*, and may instead sit on the seat back *(see Image 7)*.

In short, none of this is good practice, and is not acceptable for LVV certification.

Images 6 and 7: *Routing a seatbelt over the head and shoulder restraint 'wing'.*

Although the FIA requirements relate to full harness belts, the logic behind this supports the view taken by LVVTA that routing a seatbelt over the sides of a high-sided race seat is unsafe, and the lap section of a seatbelt must be routed over the occupant's hip and pelvis area, rather than their abdomen. In terms of the placement of the seatbelt over the occupant's shoulder, this depends largely on the location of the upper seatbelt anchorage in relation to the seat, and the design of the seat's shoulder support bolsters. Because the upper anchorage location influences the angle of the belt, a seat that is suitable in one vehicle may not be suitable in another. For instance, an early Mazda MX-5 has an upper anchorage that is mounted low-down and to the rear of the seat occupant *(see image 8)*, so the upper portion of the seatbelt is very likely to sit on the shoulder support bolster area of any retrofitted race seat, rather than the shoulder of the occupant.

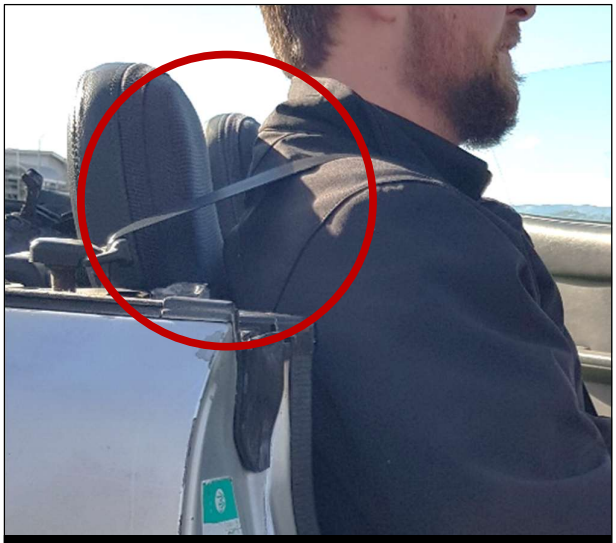

Image 8: *Low seatbelt anchorage position in a Mazda MX-5.*

If the same seat was fitted to a vehicle with an anchorage that is positioned further forward, and higher up the B-pillar in relation to the seat (like a BA Falcon ute, for example), this change in upper anchorage position may mean the belt sits over the occupant's shoulder rather than the shoulder support bolster, and could therefore be acceptable.

There are other factors to consider too - the seat can (in most cases) be moved forward and rearward on runners, which changes the relationship between the seat and seatbelt anchorages. A seat can also be used by people over a range of different sizes - for instance, in a two-seater vehicle (because there are no rear seats available) the passenger's seat could legally be occupied by an eight-year-old child without any sort of booster seat arrangement being needed. For contrast, Motorsport NZ regulations specify a minimum age for a competitor of 12 years old. One reason for this is that a 12-year-old is normally much closer to adult proportions than an eight-year-old, who would be very unlikely to be properly restrained by a three-point seatbelt in a high-sided race seat, and would have a much higher chance of submarining under the seatbelt in a crash.

Image 9: *The position of the upper seatbelt anchorage in relation to the seat can be crucial when determining whether a seat is acceptable or not. A low seatbelt anchorage (see Image 8) is very unlikely to work correctly with a seat with large shoulder supports (like the one shown in Image 9), as the seatbelt will sit over the seat, rather than the occupant's shoulder.*

Meeting LVV Requirements with a High-sided Race Seat

The key to meeting LVV requirements with a high-sided race seat is to ensure the seatbelt routing is correct. The seatbelt needs to be routed through the holes in the side of the seat bolsters, not over the top, and must sit over the occupant's shoulder, not on the shoulder support bolster. There is the possibility that due to their design, that some high-sided fixed-back race seats simply cannot be used in a vehicle fitted with a three-point seatbelt, as they cannot be made to meet LVV requirements for seatbelt location and routing. In such cases, reclining sports seats or fixed-back seats with a different bolster design could be employed, or full harness belts could be fitted if the vehicle is eligible for an LVV Authority Card (and the design of the seats permit this).

Normally, for a high-sided race seat to be acceptable, this will require the replacement of the OEM inner anchorage point (the buckle, or seatbelt receiver) with a fabric webbing-type seatbelt that can pass through the aperture in the side of the bolster. A stalk-type inner anchorage is not normally acceptable, as it will not allow correct placement of the seatbelt. If fitted to sliding runners, a webbing-type buckle could incorporate an adjustment of the webbing length, in order to keep it in the ideal position regardless of the seat's forward or rearward position.

Where there are OE seatbelt anchorages mounted to the seat runners, a fabric webbing-type buckle may be used to replace the fixed buckle, where possible *(see image 11).* This means that the buckle can be tailored to sit in the right position relative to the H-point no matter where the seat is positioned in its fore and aft range.

Note, however, that replacement of the seatbelt buckle will normally necessitate replacement of the complete belt unit (as seatbelts are sold as a complete kit, including reel and webbing), which if the vehicle is fitted with seatbelt pretensioners, will mean these must be removed (which must also be covered by the LVV certification). For vehicles that are not eligible to have frontal impact SRS components removed (because they do not meet the age criteria in LVV Standard 155-30 *Frontal Impact*), this may mean sports seats simply cannot be used.

If a seatbelt anchorage needs to be moved from a seat rail to the floor or transmission tunnel, the routing of the seatbelt needs to be carefully taken into account when choosing the placement of the anchorage. FIA/SFI harness anchorage and belt routing angles can be used as a guide to determine the correct anchorage placement. Again, this will almost always result in the removal of a seatbelt pretensioner, so the same LVV Frontal Impact Standard 14-year vehicle age clause applies.

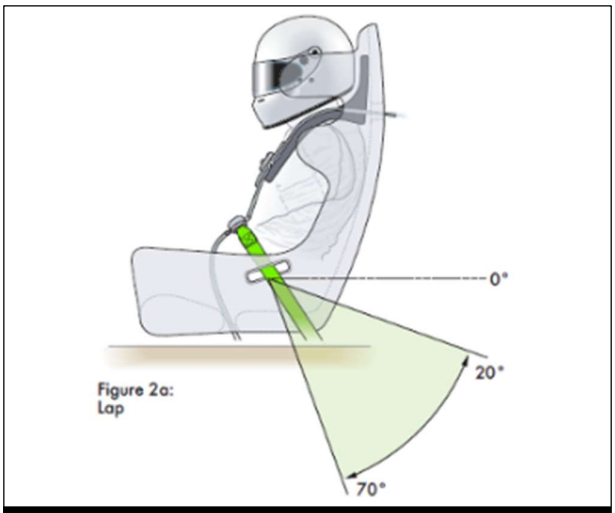

Image 10: *This diagram has been taken from FIA Appendix J Regulations, and shows acceptable lower harness belt routing angles for FIA competition vehicles.*

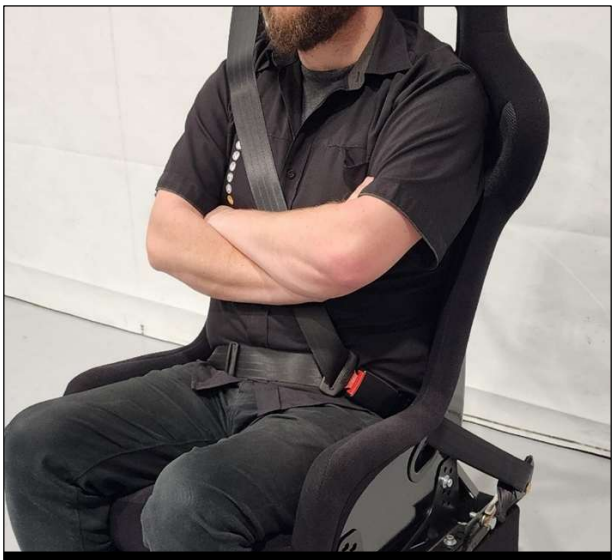

Image 11: *Using a 'floppy' fabric webbing-type buckle gives the best chance of positioning the seatbelt correctly on the seat occupant. On this occupant, the buckle sits over the hip, however on a smaller occupant the buckle may sit too high, or too far forward.*
Note that this fitment is on the borderline of acceptability - the ideal position for the buckle would be lower on the hip, closer to the side of the seat.

Finally

Where a high-sided, fixed-back race seat is being fitted to a vehicle, it will normally require LVV certification, which means the routing of its OE three-point seatbelt must meet LVV requirements. In some applications, this is simply not possible. When fitting high-sided, fixed-back race seats to a vehicle undergoing LVV certification, the following points need to be noted:

- The seatbelt must be routed over the seat occupant correctly - this means the upper (diagonal) section of the seatbelt must sit across the occupant's shoulder, rather than across the seat shoulder bolster section. This does not mean the belt needs to pass through one of the harness holes in the seatback, as this will not normally allow correct belt routing with a three-point seatbelt.

- The lower (lap) portion of the seatbelt must sit low across the occupant's hip and pelvis region.
- No part of the seatbelt may sit across the top of the side bolsters in the seat.
- The lap portion of the seatbelt must be routed through the holes or cutouts in the seat side bolsters, and these holes or cutouts must be in the correct location to allow proper belt path routing over the occupant. Where the side bolsters are higher than the H-point and there are no holes or cutouts provided in the seat for the seatbelt, it is almost impossible for the seatbelt routing to meet LVV requirements, and it is highly unlikely that seats of this type could be LVV certified.
- A flexible fabric webbing-type ('floppy') lower inner anchorage provides the best chance of achieving correct seatbelt routing and buckle location for the seat occupant, as this allows the buckle to pass through the hole or cutout in the seat bolster *(see Image 11)*. It is almost impossible to achieve correct belt routing with a flexible stalk or fixed buckle.

Image 12: *Some high-sided seats have cutouts in the bolsters specifically to enable use of an OEM three-point seatbelt.*

- Where the inner seatbelt anchorage mounts to the vehicle (rather than the seat rails), and the seat features adjustment fore and aft, an adjustable length strap could be used to keep the buckle in the correct location relative to the seat occupant. Note that replacement of the seatbelt buckle will normally necessitate replacement of the complete belt unit (as seatbelts are sold as a complete kit, including reel and webbing).
- If the OE inner seatbelt anchorage attaches to the OE seat runners, where possible the fixed buckle may be replaced with a flexible fabric webbing-type buckle, routed through the hole in the side of the seat bolster.
- Where a seatbelt anchorage has been moved (for instance, where the OE buckle was mounted to the seat runners, but has moved to the transmission tunnel), the placement of the anchorage needs to be carefully considered to provide the best seatbelt routing possible. As a modification to a seatbelt anchorage, this will always require LVV certification, and where this involves modification to parts of the frontal impact SRS, this will also need to meet the requirements of LVV Standard 155-30 *Frontal Impact*. For some vehicles, this may not be possible due to SRS-related vehicle age restrictions.
- There is currently no requirement for a seat to incorporate forward or rearward adjustability, provided that it is positioned in such a way as to enable the vehicle to be safely operated by a person within the average range of height and stature. For a vehicle with high-sided race seats, achieving the correct seatbelt routing and keeping the buckle in the correct location may mean that the seat cannot be allowed to move forward or rearward.

FOR FURTHER INFORMATION PLEASE CONTACT YOUR LVV CERTIFIER, OR LVVTA.