INFORMATION SHEET
03 - 2017 December 2017

LOW VOLUME VEHICLE TECHNICAL ASSOCIATION Inc

Total Cost Involved (TCI) Independent Front Suspension System Failure

Introduction

The purpose of this LVVTA Information Sheet is to advise LVV certifiers and potentially-affected vehicle owners, suppliers, and distributors of a safety risk associated with a range of Total Cost Involved (TCI) independent front suspension (IFS) systems.

Background

During 2017 there was a catastrophic failure of a welded upper coil-over shock absorber mount on a newly installed and LVV certified TCI IFS. That failure directly resulted in a serious motor vehicle accident due to the complete collapse of one side of the front suspension, and the integral bump-stop which also became disconnected as a result of the failure. Fortunately, no-one was injured.

TCI make several styles of IFS. The design which is affected is the coil-over IFS which has an upper coil-over mount welded to the upper a-arm pivot tube, as shown — along with the area of failure — below. A similar design is offered by TCI for a variety of IFS systems which utilise coil-over shocks.

Investigation Process

The cause of the failure was investigated by the LVVTA's Technical Advisory Committee (TAC), with the assistance of the vehicle owner. TAC members found that, based on detailed visual inspection of the upper shock absorber mounting bracket, and 'macro' photographs of the associated pivot tube, that the failure was directly related to poor fit-up and assembly of the sections of the IFS beam, along with multiple welding defects on the upper shock mount.

The owner of the vehicle further assisted TAC members by having a non-destructive test carried out on the remaining (opposite side) coil-over mount. This inspection, carried out by a certified weld-testing laboratory, identified serious cracking at the weld, and the same poor fit-up issues as the failed mount. With continued use, failure of this same area on the opposite side of the IFS beam would have been inevitable.

To follow is a summary of the key issues associated with the failed TCI IFS, as identified by the TAC members, who, between them, have significant design, fabrication, and welding skills and experience.

All of the issues listed are easily visible to the naked eye.

Welding:

The following welding defects were identified:

- the throat thickness of the weld is insufficient; and
- the weld is concave, not convex, which results in a reduction in weld strength; and
- it appears that the angle of the welding tip had been aimed more toward the coil-over mounting bracket, and not the pivot tube. The bracket — which was made from thinner material than the tube — received the bulk of the heat, which had the effect of providing insufficient penetration of the weld to the much thicker pivot tube. Being thicker material, the pivot tube should have received a higher proportion of the heat to enable correct fusion, but in fact the opposite occurred.

The resultant weld was not sufficiently strong to support the weight and bump-loads of the corner of the vehicle, and the coil-over mounting bracket tore away in three stages, twisting and distorting the bracket as it broke away from the beam.

Fit-up:

The coil-over mounting bracket was poorly fitted-up to the tube prior to welding, which left a gap of up to 3 mm between the underside of the bracket and the tube to which it is welded.

This resulted in a lack of fusion, and in the weld essentially becoming a 'bridge' between the two parts, which provided inadequate strength.

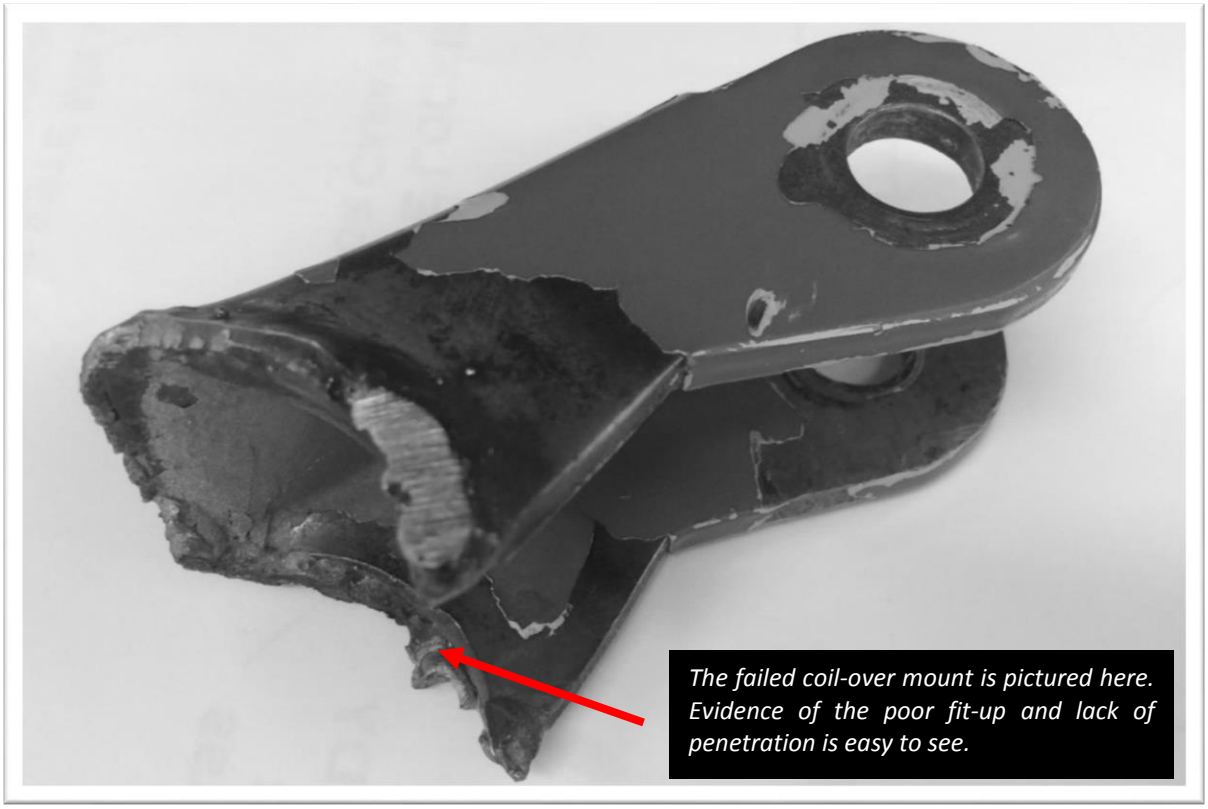
Cracking, poor fit-up and incomplete welds are all evident in this picture, as is the fact that the bracket has not been welded on the inside.

P. O. Box 50 600, Porirua, Wellington, New Zealand
Phone: (04) 238 4343 Fax: (04) 238 4383 E-mail: tech@lvvta.org.nz

Bracket design:

TAC members are of the opinion that with only (approximately) 90 mm of weld area in total, the design of the coil-over mounting bracket does not allow sufficient weld area to provide an adequate safety factor. Additionally, the highest loads are applied to the very end of the weld, at the edge of the bracket. That means the main load-bearing welds (on each side of the bracket) are only around 60 mm in total.

To achieve an increase in weld area, the bracket should extend further down the outside of the 'beam', which has the added advantage of adding material and weld area in tension; — the direction of highest loading. There are numerous other ways that weld area can also be achieved whilst maintaining aesthetic appearances. TAC members have recommended to TCI that the bracket is redesigned to provide an increased safety factor.



The failed coil-over mount is pictured here. Evidence of the poor fit-up and lack of penetration is easy to see.

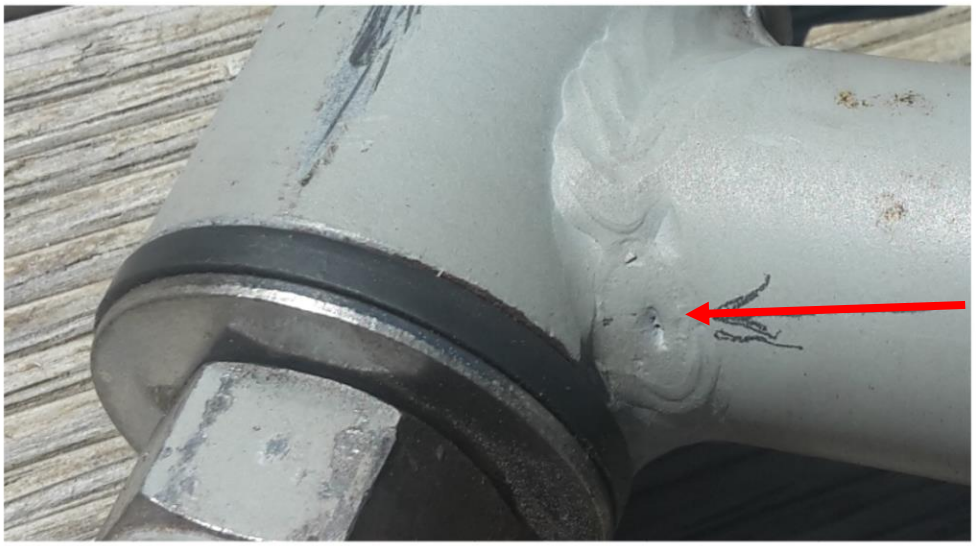
Additional concerns about welding and construction of TCI suspension

During the investigation process into the coil-over mounting bracket failure, a local modifier notified LVVTA of his concerns about another TCI front suspension assembly that he had become involved with. This example had poor welds with visible defects on the suspension A-arms that would not meet the non-destructive testing required by LVVTA's 'critical function welding' requirements. A TAC member viewed the welding and confirmed that the welding quality was inadequate.

A-arm welds are under extremely high loads, and it has always been the expectation of the TAC that these welds must be carried out to a very high standard. With only a visual inspection by an experienced welder multiple defects were identified, including undercut and craters.

Photographs of the suspension A-arm welding of concern (on the second TCI IFS) are shown below:

A weld defect called 'undercut' is visible in this picture. Undercut can result in a significant reduction in weld strength, and also reduction in the material cross-sectional area of the parent metal. This is usually a result of poor fit-up of sections, excessive gaps, and lack of sufficient filler metal in the weld. These issues combine to indicate poor operator technique.



An undesirable 'crater' can be clearly seen in this photograph. Such an imperfection can cause weakness in the weld, and is caused by poor operator techniques in the start/stop regions of weld.

This welding issue, combined with the coil-over mounting bracket failure, has caused LVVTA to form an opinion that potential safety concerns exist with TCI IFS assemblies in a broader context, rather than the assembly that failed being an isolated incident.

Communications with TCI

LVVTA has alerted TCI management to the failure, and our resultant concerns, and are currently in communications with the company's VP/GM. LVVTA is hoping to achieve an acceptable outcome

where all of the known issues are properly addressed, and where we are able to develop a high level of confidence in TCI as a component manufacturer.

At this stage, no specific conclusion has been reached, however the expectation of the TAC members is that the issues that have been raised all need to have remedies put in place as quickly as possible in order to reduce the risk of further failures to both new and existing suspension assemblies.

TCI have however acknowledged to LVVTA that they accept that the problem exists, and have confirmed in writing to LVVTA that they will contribute $150.00 per vehicle towards the non-destructive testing inspection costs. This is a recent development, and more details will be available from LVVTA in early 2018 as we learn more about TCI's involvement in the resolution of this problem.

LVVTA Recognised IFS/IRS Manufacturer Status

A manufacturer of custom IFS and IRS (independent rear suspension) assemblies can be given 'LVVTA Recognised IFS & IRS Manufacturer' status by the TAC. This removes the requirement for individual TAC approval of the suspension assembly, and also removes the need for individual non-destructive testing of critical function welds within the suspension assembly. This Recognised Manufacturer status can be issued after the TAC has, over a period of time, developed a high level of confidence in a specific aftermarket suspension assembly manufacturer – usually through a combination of having reviewed a number of applications for approval, and also through having confidence that the manufacturer maintains a high level of quality control within their design and manufacturing processes.

TCI were issued with this status many years ago, when LVVTA had confidence in the design and manufacturing quality control processes of TCI.

In the interim period, given the issues detailed within this Information Sheet, the TAC has had to reconsider its position in relation to TCI's status as an 'LVVTA Recognised IFS & IRS Manufacturer'. As part of the review of TCI's recognised manufacturer status, TAC members discussed and considered the issues that had been identified both with the component failure and the poor A-arm welds, and the safety concerns raised by these issues.

The TAC has determined that due to the current direct safety concerns raised with the two different IFS assemblies, they have no alternative but to suspend TCI's status as an LVV Recognised Manufacturer. This status will be reviewed again in the future and may be reinstated if TCI are able to regain the confidence of TAC members.

Next steps for affected owners

<u>If you have a TCI IFS in your vehicle, and it's already been LVV certified:</u>

If your vehicle is fitted with this style of TCI IFS we strongly urge you to have this specific area visually-inspected by a Category 1D LVV certifier at your earliest convenience. Contact information for all LVV certifiers can be found on the contact us page of www.lvvta.org.nz.

Depending on the outcome of the LVV certifier's inspection, repair work may be required, or if no visible defects are found all that will be required is for the affected area to undergo non-destructive testing (NDT).

In some instances, the type of NDT recommended, usually Magnetic Particle Inspection, may require paint removal in the area immediately adjacent to the coil-over mount. However, we suggest you confirm this with the specialist testing business you choose to have assess the vehicle, as an alternative process may not require the removal of paint.

Non-destructive testing must be carried out as required by the NZ Car Construction Manual in section 18.9.2(a), which states that (the component must): *"…be non-destructively tested, and comply with, as a minimum, Tables 6.1 or 6.2 of the AS/NZS 1554.1:2004 Standard, or an equivalent standard, as applicable to the method of weld examination undertaken, by a person holding not less than a current NDT Level 2 qualification in CBIP, ASNT, AINDT, or other equivalent certification…"*

Non-destructive testing can be carried out by any individual who is qualified as above. There are a number of companies across New Zealand who can carry out this work including the following:

- SGS (branches nationwide) www.sgs.co.nz
- Southern QA (Christchurch, Invercargill and Hamilton) www.sqal.co.nz
- Xray Labs (Auckland) www.xraylabs.co.nz
- Materials & Testing (Auckland) http://mtlabs.co.nz/
- Sentinel Inspection Services (New Plymouth) www.sentinelltd.co.nz
- e-Quality (Wellington) 0274 434 513
- Stork Technical Services (Whangarei, New Plymouth) www.stork.com

If you're outside of these areas, a quick Google or phonebook search for Non-Destructive Testing followed by your location should bring up a business able to offer the service in your region, or you can contact the LVVTA Technical Team on (04) 238-4343 for assistance.

LVVTA urges all owners of vehicles equipped with a TCI IFS to cease driving the vehicle, and have the vehicle inspected by an LVV certifier as soon as possible, and not to drive the vehicle again until such time as an LVV certifier has determined that the vehicle is safe.

For more details of the process required for LVV Certifiers inspecting an IFS in a vehicle that's already been certified, see the 'Inspection Process for existing IFS' further on in this Information Sheet.

<u>If you have a TCI IFS in your vehicle, and it has NOT been LVV certified:</u>

As the 'Recognised Manufacturer' status for TCI has been suspended, an IFS approval (an approval process carried out by the TAC) is required for any IFS manufactured by TCI, irrespective of the date of purchase or installation. This approval process will allow TAC members to assess and advise applicants on the suitability of the upper coil-over mounting bracket design and A-arm suitability.

However, at this time, working geometry drawings are NOT required to be submitted. Any person who needs to go through this process can contact the LVVTA office and speak to one of the LVVTA Technical Team members for assistance. Vehicle owners can also download the 'IFS Approval Application Guide' Infosheet, which provides full instructions for submitting an application.

The LVV 'Recognised Manufacturer' status will be updated on the 'Recognised Manufacturers' section of the 'Approvals' page, on www.lvvta.org.nz should the status change in the future.

Inspection Process for existing IFS (for LVV Certifiers):

LVVTA has notified all owners of vehicles (that we are aware of) which have been LVV certified and fitted with TCI front suspension assemblies of the potential safety risk. These vehicle owners have been advised to contact their nearest 1D-category LVV certifier as soon as possible, and to cease driving their vehicles until such time as the inspection has taken place.

Once a vehicle owner makes contact and the LVV Certifier is able to inspect the vehicle, the LVV Certifier will need to take the following steps:

1. Disassembly:

   Remove upper coil-over mounting hardware, and either remove the coil-over from the vehicle or lower it away from the coil-over mount, to allow for thorough visual inspection both inside and outside of the upper coil-over mounting bracket.

2. Fit-up Inspection:

   The area inside the coil-over mount must be carefully inspected for any signs of a poor fit-up* between the bracket and the pivot-tube it is welded to. If any evidence of poor fit-up is evident, the vehicle owner should be advised in writing, on an F004 - LVVTA Rectification Sheet, with a copy retained by the LVV certifier.

   * Poor fit-up in this context is defined as *any gap which exists between the two welded sections*. When inspecting a vehicle, an LVV Certifier must look for is how well the shock absorber mounting bracket attaches. While the front suspension assembly in most of these vehicles are likely painted, an LVV Certifier should still be able to get an indication of the quality of the fit up of components.

   If any poor fit-up between the upper coil-over and the upper A-arm pivot tube is identified, refer to paragraph # 4. The vehicle owner must be advised that rectification work is required, and they should not operate the vehicle until such time as the rectifications have taken place.

   If the fit-up is satisfactory, refer to paragraph # 3.

P. O. Box 50 600, Porirua, Wellington, New Zealand
Phone: (04) 238 4343 Fax: (04) 238 4383 E-mail: tech@lvvta.org.nz

3. Welding Inspection:

If *any* visible cracking or other significant weld defects are evident, the vehicle owner must be advised that rectification work is required, and they should not continue to operate the vehicle until such time as the rectifications have taken place.

If the welding (and fit-up) is good, refer to paragraph # 5.

4. Rectification:

If rectifications are required due to poor fit-up or visible weld defects, the LVV Certifier should, in the first instance, communicate the findings to the LVVTA Technical Team with photos for reference. The Technical Team members will then provide guidance for rectifications depending on the issue/s identified. For example, if the upper coil-over mount has poor fit-up, then it will need to be removed to rectify this fault – at this point however it is the opinion of the TAC that the bracket design should be improved, and a new bracket with increased weld area should be fabricated. If the LVV Certifier or the vehicle owner would like information on how to improve the design of the bracket, LVVTA technical staff will communicate with the TAC and provide the vehicle owner with this information free of charge and as quickly as possible.

If cracking is identified, but fit-up is acceptable, then welding may be able to be brought up to the required standard without the removal of the mount. However, this is not recommended; — an improved bracket is a preferred option.

5. Where no fit-up or welding problems are evident:

If no fit-up or cracking is evident, then a non-destructive test (NDT)* of the weld is required in order to confirm that no underlying cracking or weld defects which are not visible to the naked eye are present. Cracks can be disguised or hidden by paint, powder-coating or other surface coverings, so this step is critical. The vehicle owner should arrange for the vehicle to be delivered to a non-destructive testing specialist for this inspection process.

As this is a serious safety risk, the inspection should be performed to a recognised standard, such as that specified by the NZ Car Construction Manual, to confirm suitability of the welds, which states: "…*The NDT process must be carried out by an NDT operator certified to NDT Level 2 by CBIP,*

ASNT, AINDT, or other entirely equivalent certification, and will be assessed to, as a minimum, Table 6.2.2 of the current version of AS/NZS 1554.1 Standard, SP category…"

* The inspection process above usually involves a magnetic particle or X-ray inspection, and may involve removal of paint to allow for the inspection. The NDT operator will make that determination. The cost of such a weld examination should be somewhere in the region of $100 to $250 NZD (depending on the process used and time taken), excluding disassembly, and paint removal. The cost will vary between individual NDT inspectors.

6. Re-inspection:

Once a vehicle has had any required rectifications completed, the LVV Certifier should ensure that all work has been completed to a tradesman-like standard, that all welds have been tested, and comply with LVVTA Critical Function welding requirements. The LVV Certifier should communicate this information, along with supporting photographs and copies of NDT reports, through to the LVVTA Technical Team for filing.

Additional comments:

Costs Incurred:

There will be a cost incurred to the vehicle owner during this process for the LVV Certifiers time, any required non-destructive testing, and any required rectification work. TCI have agreed to cover a portion of the costs and it is the responsibility of the owner to recover these costs from TCI. It is not LVVTA's responsibility to meet any costs, nor is it LVVTA's responsibility to deal with TCI in the recovery of costs for vehicle owners.

Notification and records:

As part of the inspection process, we ask that LVV Certifiers inform the LVVTA Technical Team about which owners have been dealt with so that LVVTA can keep a record of this, and follow up with any owners who have not had their vehicles inspected.

If LVV Certifiers have any further questions, they should contact Justin at LVVTA who will liaise with the TAC to provide feedback on any proposed design changes.

Justin Hansen
Technical Team (Mechanical)
Low Volume Vehicle Technical Association, Inc