Ministry of Defence

Defence Equipment and Support
Secretariat
#2043 Maple 0a
Ministry of Defence
Abbey Wood
Bristol BS34 8JH

Email: DES SEC-PolSec LE-JSC-WPNS@mod.uk

de&s

[redacted]

Our Reference:
FOI2022/07075
Date:
4 August 2022

Dear [redacted]

I am writing about your email of 13 June 2022 requesting the following information:

'Thank you for your recent emails to me regarding MAN Support Vehicle Roll Over Protection system. (ROPS)

I am adding to the list of reports, to include photos and DVD's that you sent me to include the most important namely that of the rollover test that the minister stated had been conducted.

This is when the vehicle would have been turned through 180º to finish up with the cab on the ground and the ROPS system fully stressed.

• copies of the MOD's Serious Equipment Failure Investigation Team reports
• copies of the safety tests carried out by an independent contractor (All)
• copies of the improvements and modifications to the TCVES ROPS that were implemented Copies and DVD of Rollover Test reports.

I would be happy to clarify any points arising but look forward to receiving all the information requested.'

Your request has been handled in accordance with the Freedom of Information (FOI) Act 2000.

A search has been carried out of Ministry of Defence (MOD) records and it is confirmed that some information related to your request is held. This is attached as follows:

Annex A		
Serious Equipment Failure Investigation Team Reports	**Ref:**	**Date:**
1. Support Vehicle (SV) Cargo Light 6 Tonne 4x4 Euro 4 Man, Full Bowman Fit VRN – HK76AB Front Left Hand Wheel Station Failure	SEFIT 11-0133-SI	29 June 2011
2. Engineering Officer's Executive Summary of SEFIT 11-0133-SI	0408_SEFIT /40/11_0133_SEF	30 June 2011
3. Troop Carrying Vehicle Enhanced Seating System MK2	SEFIT 11-0108-SEF	10 June 2011

SER NO – ESK02243 Clamp Assembly Failure		
4. Engineering Officer's Executive Summary of SEFIT 11-0108	0408_SEFIT/40 11_0108_SEF	10 June 2011
5. Troop Carrying Vehicles Enhanced Seating System Mk2 ERM – MT0148 Seating Pod Detachment	SEFIT 12-051-SI	17 March 2012
Annex B		
Independent Contractor Safety Reports		
6. Cranfield Impact Centre Rollover of Troop Carrying Seat	SV 10579 Microsoft Word -Revolve doc 08-0098	20 June 2008
7. Roush Europe TCV ROPS Roll Over Test Review-Attendance Register	SV 10578 – Rollover test Assessment 240608 pdf	13 November 2008
8. Revolve/Vecatyn TCVES Mk2 Computer Aided Engineering Assessment of Seating System Structural Integrity under ECE Reg66 Truck Tilt Testing with 95%tike Occupant Mass	Report 15013.012	7 June 2016
9. Revolve/Vecatyn TCVES Mk1 Computer Aided Engineering Assessment of Seating System Structural Integrity under ECE Reg66 Truck Tilt Testing with 95%tike Occupant Mass	Report 15013.011	25 May 2016
Annex C		
Defence Equipment & Support Safety Notice		
10. Supplementary Instruction – TCVES Mk2-Secondary Tie-Down	SLV/SV/LC/TCV/SAF/12-0151 V3	17 May 2012
Annex D		
Cranfield Impact Centre Video		24 June 2008
11. (Link provided in email)		

Some of the information you have requested falls within the scope of the absolute exemption provided for in Section 40 (personal data) and qualified exemptions Section 26 (Defence) and Section 38 (Health and Safety) of the FOI Act and has been withheld.

Section 40(2) has been applied to personal information as governed by the General Data Protection Regulations (GDPR). Section 40 is an absolute exemption and there is therefore no requirement to consider the public interest in making a decision to withhold the information.

Sections 26 and 38 are qualified exemptions and subject to public interest testing which means that the information requested can only be withheld if the public interest in doing so outweighs the public interest in disclosure.

Section 26(1)(b) and Section 38(1) have been applied to some of the information because it contains details which are operationally sensitive and would prejudice the capability and effectiveness of the Armed Forces, prejudice the relations between the United Kingdom and other states, and compromise the health and safety of Armed Forces personnel. The balance of public interest was found to be in favour of withholding the information under these exemptions. Therefore, I have set the level of prejudice against release of the exempted information at the higher level of 'would' rather than 'would be likely to'.

If you have any queries regarding the content of this letter, please contact this office in the first instance. If you wish to complain about the handling of your request, or the content of this response, you can request an independent internal review by contacting the Information Rights Compliance team, Ground Floor, MOD Main Building, Whitehall, SW1A 2HB (e-mail CIO-FOI-IR@mod.gov.uk). Please note that any request for an internal review should be made within 40 working days of the date of this response.

If you remain dissatisfied following an internal review, you may raise your complaint directly to the Information Commissioner under the provisions of Section 50 of the Freedom of Information Act. Please note that the Information Commissioner will not normally investigate your case until the MOD internal review process has been completed. The Information Commissioner can be contacted at: Information Commissioner's Office, Wycliffe House, Water Lane, Wilmslow, Cheshire, SK9 5AF. Further details of the role and powers of the Information Commissioner can be found on the Commissioner's website at https://ico.org.uk/.

Yours sincerely,

DE&S Secretariat

[redacted]
Officer Commanding
SEFIT
[redacted]
MINISTRY OF DEFENCE DE&S Abbeywood
Bristol
BS34 8JH
Email: [redacted]
T [redacted]
Tel: [redacted]

de&s
SAFETY & ENGINEERING

Distribution as per attached report

Reference: 0408_SEFIT/40/11_0133_SEF

Date: 30 June 2011

ENGINEERING OFFICER'S EXECUTIVE SUMMARY - SEFIT 11-0133-SI SUPPORT VEHICLE (SV) CARGO LIGHT 6 TONNE 4X4 EURO 4 MAN, FULL BOWMAN FIT VRN – HK76AB FRONT LEFT HAND WHEEL STATION FAILURE

1. The attached report details an investigation following a reported incident in which 14 people were injured as the vehicle was travelling on the BATUS training area.

2. During the course of the investigation it was established that the LH wheel station had become detached from the vehicle when it drove into a water filled, 60cm deep pothole. Further, the troop carrying vehicle enhanced seating system modules lifted from the cargo bed resulting in injury to those travelling. The Investigating Officer concludes that it is probable that the seat system mounting clamps were either not fitted or not tightened correctly.

3. The Investigating Officer makes a number of recommendations which are detailed within the report. Notably, GSG-GSV Project Team should further raise awareness of the TCV ES clamping system procedure and that the holding unit immediately instigate a training programme to ensure that users are aware of the need to ensure that the seating modules clamp assemblies are fitted correctly and checked in accordance with the relevant AESPs.

4. All addressees are to be aware that SEFIT recommendations are by no means exhaustive; further action may be required to prevent a reoccurrence of this incident. Action addressees are encouraged to fully implement the recommendations and complete the Report Response Form (RRF) giving details of their action/plan, within 30 days of the date of the report. The RRF is held by SEFIT for 6 years in case of litigation.

Original Signed

[redacted]

Attachment:

1. SEFIT 11-0133-SEF dated 29 Jun 11.

LAND SYSTEMS
SAFETY & ENGINEERING

DEPLOYABLE SUPPORT

de&S

SAFETY & ENGINEERING

SERIOUS EQUIPMENT FAILURE INVESTIGATION TEAM

SERIOUS INCIDENT

Title: SUPPORT VEHICLE (SV) CARGO LIGHT 6 TONNE 4X4 EURO 4 MAN, FULL BOWMAN FIT

VRN – HK76AB

FRONT LEFT HAND WHEEL STATION FAILURE

Reference No: SEFIT 11-0133-SI

SEFIT 11-0133-SI

SUPPORT VEHICLE (SV) CARGO LIGHT 6 TONNE 4X4 EURO 4 MAN, FULL BOWMAN FIT

VRN – HK76AB

FRONT LEFT HAND WHEEL STATION FAILURE

Author: Original Signed

Name: [redacted]

Rank: [redacted]

Tel: [redacted]

Date: 29 Jun 11

Please direct any queries/comments on this document to:

By Mail:

SEFIT (G)
DE&S SE Land
Rochdale Barracks
BFPO 39

By Email:

DES SE Land-SEFIT-G-Mailbox(Multiuser)

Enclosures:

1. Statement of Events – [redacted]
2. Statement of Events –
3. Statement of Events –
4. MAN SV First & Last Parade Sheet - [redacted] dated 11 May 11.
5. Army Form G1084A dated 6 Jun 11.
6. Journey Summary Report – HK76AB dated 17 Jun 11.

Distribution:

GSG GSV (COS)*
COEFOR (2IC)*

Copy to:

HQ LF (Eqpt Dir & ECIT)*
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12 Mech Bde (ES Br)*
BATUS ES Br (SO2 ES)*
DGS&E Science Technical Integrator*
Eng Pol Div (for [redacted]
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CONTENTS

SEFIT 11-0133-SI

SUPPORT VEHICLE (SV) CARGO LIGHT 6 TONNE 4X4 EURO 4 MAN, FULL BOWMAN FIT

VRN – HK76AB

FRONT LEFT HAND WHEEL STATION FAILURE

References:

A. Telecon [redacted] BATUS Ops Rm/[redacted] SEFIT (B) dated 171605S Jun 11.
B. Joint Service Publication (JSP) 886 (Ver 1.1, dated 4 Mar 11), Vol 5, Pt 2, Chap 3.
C. BATUS Equipment Management Directive (Edn 1, Amdt 11, dated May 11) Chap 1, Annex G – BATUS SEF/SI Reporting.
D. MAN Commercial Repair Manual, MAN 161 (Edn 1) – Drawings UK60YGAAA 001/002
E. AESP 2320-G-300-411 (Edn 2, Amdt 2, dated Jun 09) – Installation Instruction No 6, Pages 5-8 – Installation Instructions and Index.
F. SEFIT Report 2011-0108-SEF dated 10 Jun.
G. AESP 2320-G-300-111 (Edn 2, Amdt 1, dated Jun 09) – Page 6 – Equipment Support Policy Directive.

Figure 1 – SV Cargo 6T, VRN – HK76AB

INTRODUCTION

1. In response to Reference A and in accordance with References B & C, [redacted] from the Serious Equipment Failure Investigation Team (SEFIT) British Army Training Unit Suffield (BATUS) (SEFIT (B)), deployed to Bingville Road, Grid Reference VA135898 on BATUS Military Training Area (MTA). The purpose of the deployment was to conduct an engineering investigation of the subject vehicle, held by Contemporary Operating Environment Force (COEFOR) (Figure 1).

DATA

2.	Date of Incident:	17 Jun 11
	Date of Investigation:	17 Jun 11
	Owning Unit:	BATUS
	Holding Unit:	COEFOR
	Div/Bde:	HQ LWC
	Equipment Type:	SV CARGO 6T 4X4 FB
	Asset Code:	DB 1428 3100
	VRN:	HK76AB
	Usage:	11514 km
	Main Assembly Type:	Front axle
	Sub Assembly Type:	LH wheel station
	Date/Type of Last Service:	14 Jan 11 / 6 monthly
	Usage Since Last Service:	7367 km
	Date/Type of Last REME Inspection:	14 Jan 11 / MEI
	Usage since last Inspection:	7367 km
	Date into Service:	3 Apr 08
	BOWMAN Fitted:	No
	PT Informed:	GSG-GSV
	PT Contact Details:	DES LE GSG-SLV-SV-MAN-ESM [redacted]

BACKGROUND

3. The following has been extracted from Enclosures 1 - 3 and information gained throughout the course of the investigation:

a. On 17 June 2011 the subject vehicle was travelling South on Bingville Road. Driving through a puddle, at approximately 20 kmph, a double impact was experienced causing the subject vehicle to bounce into the air and subsequently slide to the right.

b. Consequently the Troop Carrying Vehicle Enhance Seating (TCV ES) system 6 and 8 seat modules were lifted off the cargo bed of the subject vehicle; struck the overhead canopy and then impacted with the drop down side panels on the Right-Hand (RH) side of the vehicle. The second impact returned the TCV ES system back to the centre of the cargo bed. The vehicle was halted.

c. The vehicle commander exited the vehicle and noted that the front Left-Hand (LH) wheel station had folded underneath the vehicle. The incident was reported through the Chain of Command (CoC) to the SEFIT. There were 14 casualties as a result of this incident, all of whom were seated in the TCV ES system.

TECHNICAL DESCRIPTION

4. A full technical description of the subject vehicle is currently unavailable. The following has been extracted from Reference D and the investigators knowledge of the equipment which is pertinent to this investigation:

a. The front steering planetary axle is a cast steel alloy construction consisting of the LH and RH wheel stations, the axle drive, steering and braking components. Steering is achieved via a steering arm which is connected to the RH wheel station. A steering tie rod transfers the steering motion to the LH wheel station. Each wheel station is connected to the main axle body by means of cast upper and lower swivel housings. These fit over upper and lower trunnions housed in the axle body allowing the wheel stations to pivot (Figure 2).

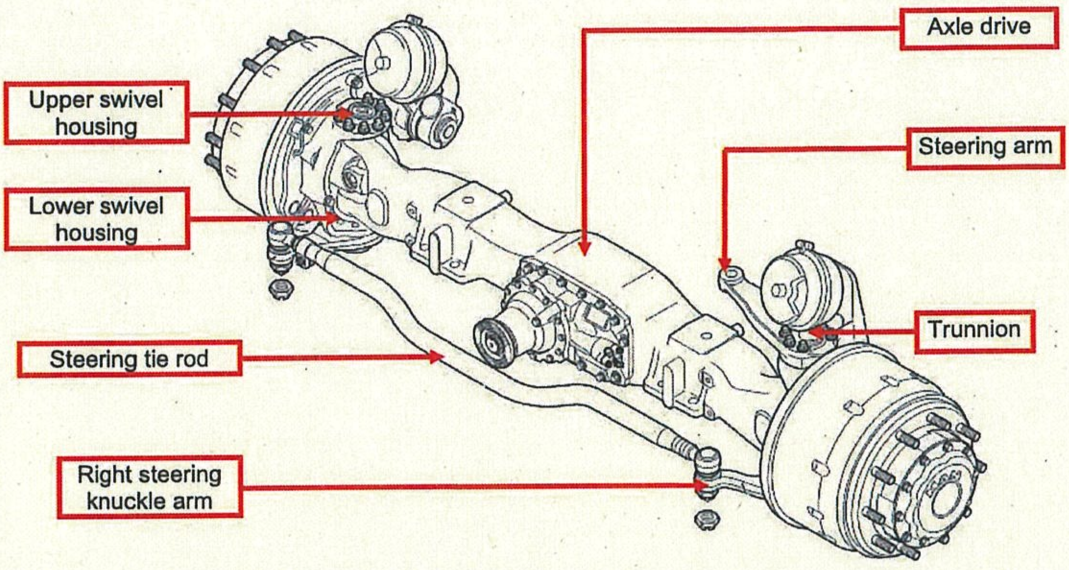


Figure 2 – Front axle, view from RH rear

b. The axle assembly is attached to the leaf spring by means of 2 spring clips. The leaf springs are connected to the main chassis member by means of leaf spring hangers. A shock absorber is connected at its lower end to the axle assembly and to the main chassis member via a shock absorber housing and mount at its upper end. Each wheel station is fitted with a diaphragm brake cylinder, compressed air feed and return pipes, and electrical cabling (inside a shroud) for brake signal and error information (Figure 3).

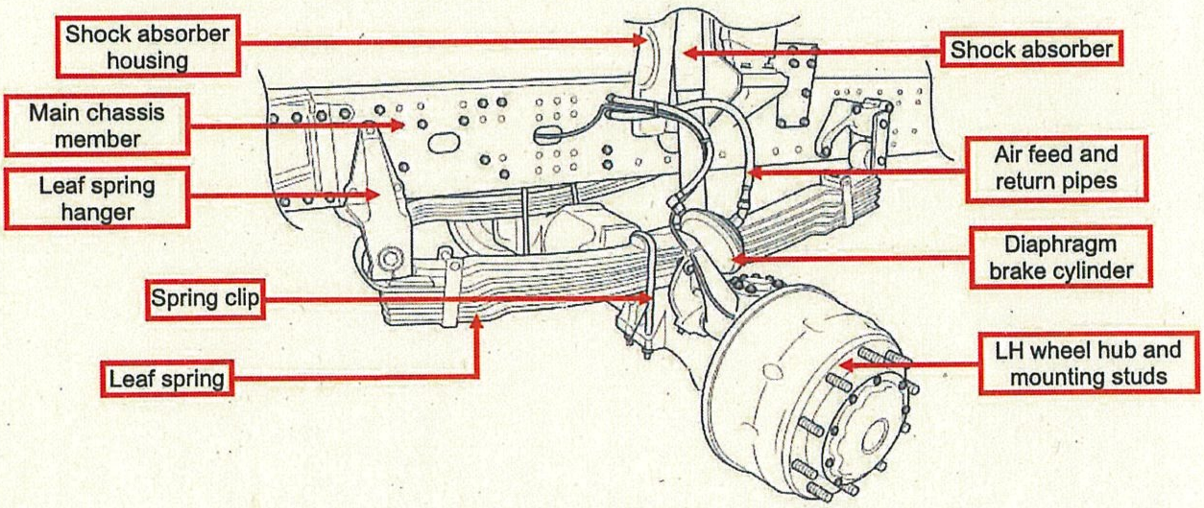


Figure 3 – Front LH wheel station

INITIAL INVESTIGATION

5. The Investigating Officer carried out an initial investigation of the subject vehicle. The following was noted:

a. The front LH wheel station complete with hub, mounting studs and wheel nuts was located inside of the LH wheel arch with its outer hub facing upwards position and was pushed up against the LH mudguard (Figure 4).

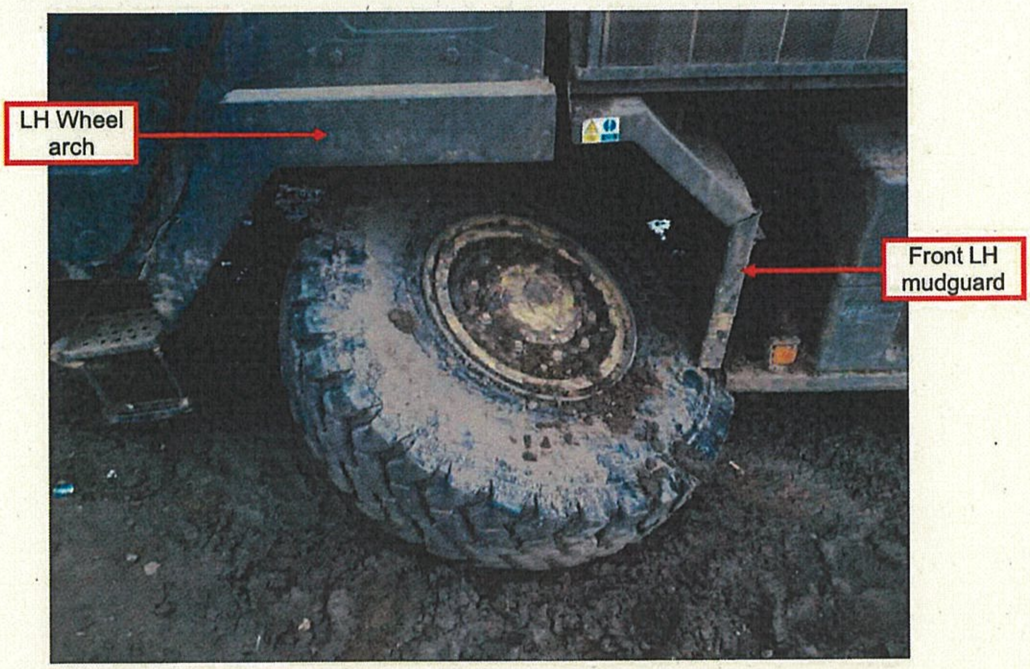


Figure 4 – LH wheel and hub

b. The front LH side of the axle and the rear of the hub assembly were entrenched in the dirt. The air feed pipe, air return pipe, electrical cables and shroud had severed. The steering tie rod had disconnected at the knuckle joint on the damaged wheel station (Figure 5).

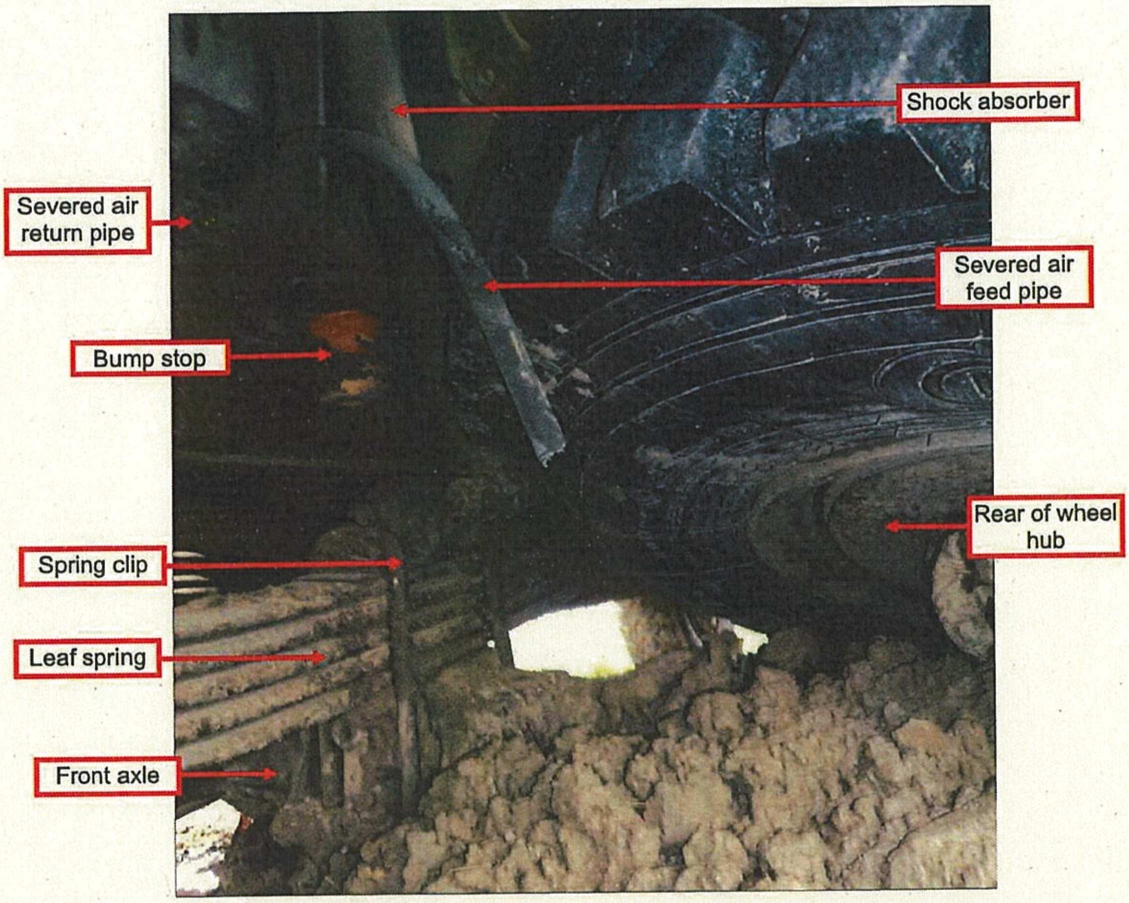


Figure 5 – Area of front LH wheel station

c. An area of stripped paint, consistent with contact with the tyre was noted on the leaf spring forward of the rearmost leaf spring hanger (Figure 6).

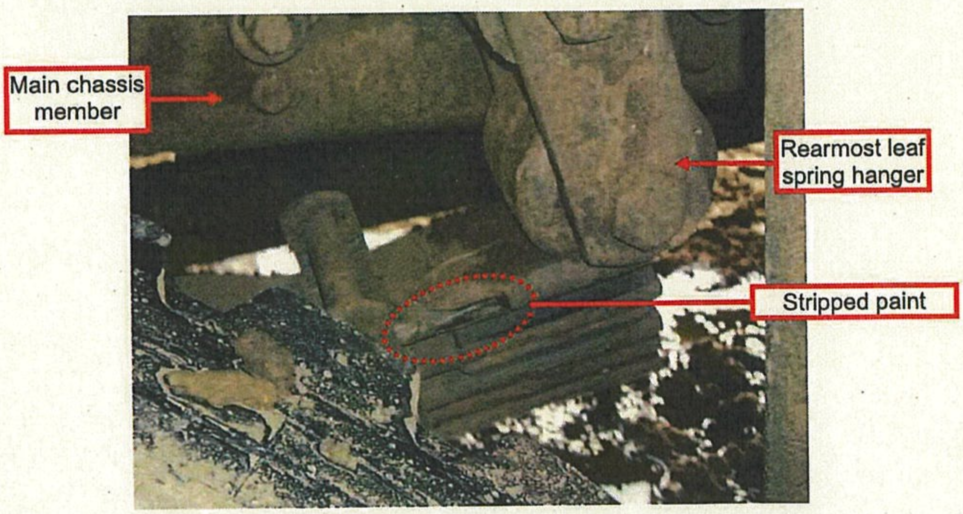


Figure 6 – Stripped paint on leaf spring

d. A further area of stripped paint was noted on the shock absorber directly in line with the upper, outer circumference of the front LH tyre (Figure 7).

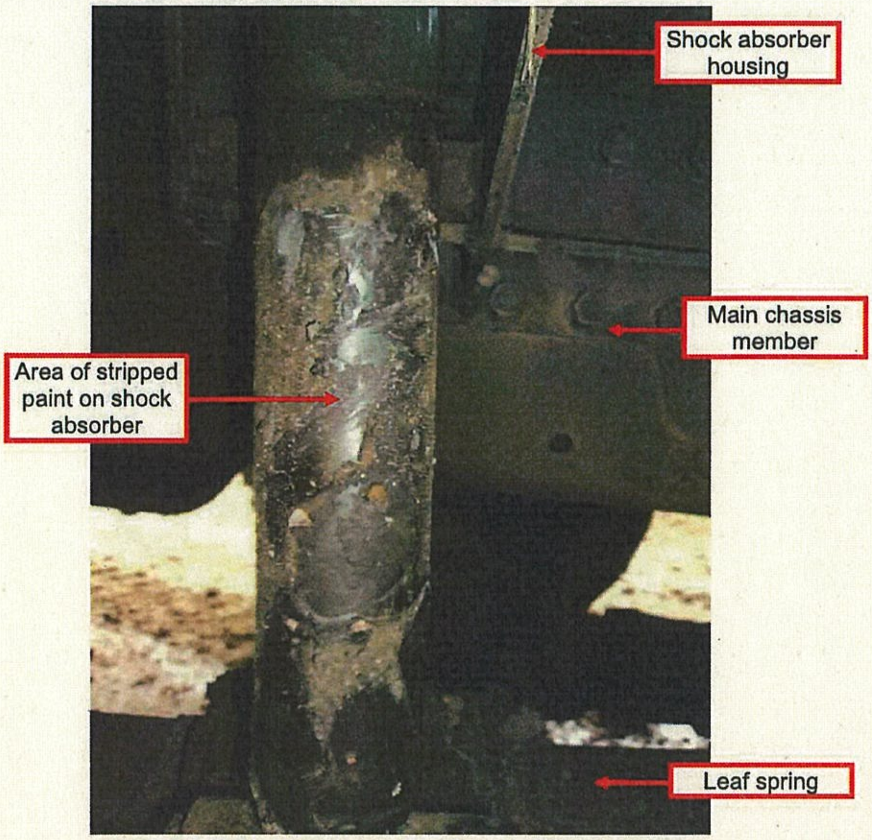


Figure 7 – Stripped paint on shock absorber

e. The front LH mudguard had suffered damage consistent with impact from the tyre and was deformed outwards (Figure 8).

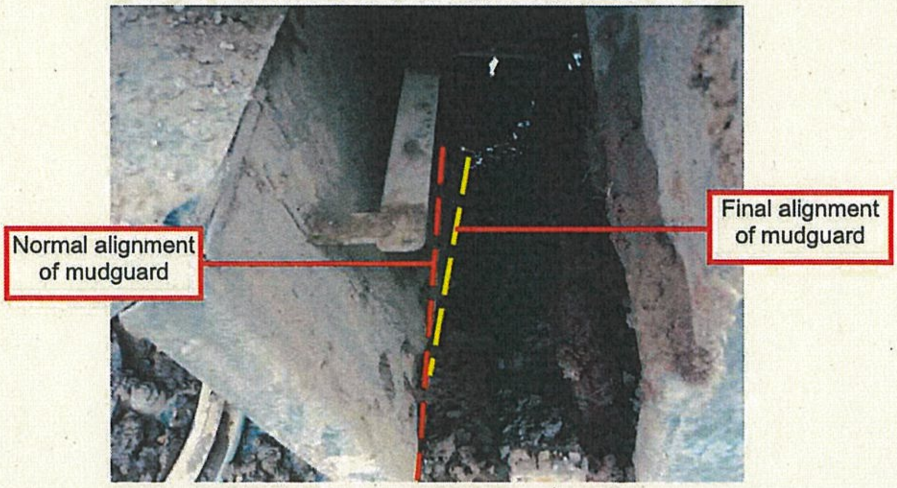


Figure 8 – Deformed front LH mudguard

f. The LH windscreen was not fitted. 3 sheets of opaque plastic had been taped over the windscreen cavity (Figure 9).

Figure 9 – Plastic sheets taped over windscreen cavity

g. The RH windscreen had 2 distinct star shaped cracks in the area towards the central windscreen pillar. Both of these cracks had joined at various locations and radiated across the windscreen (Figure 10).

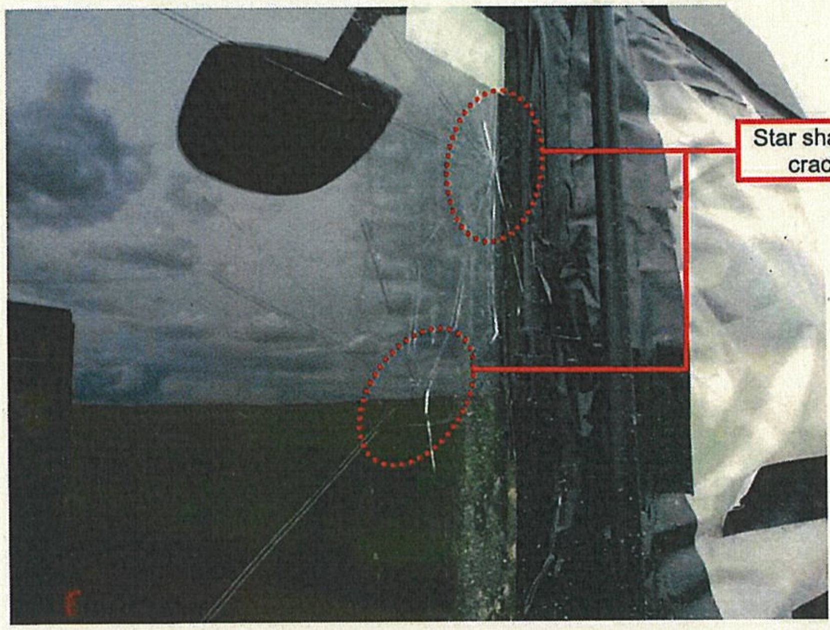


Figure 10 – Damage to RH windscreen

6. The subject vehicle was raised by the Recovery Call Sign (C/S) attending the incident. The following was noted:

a. The front LH drive shaft had slid out of the cavity in the front axle and was bent upwards at the hub end. The sealing gasket at the axle end of the driveshaft had unseated and slid partially down the driveshaft allowing oil to leak (Figure 11).

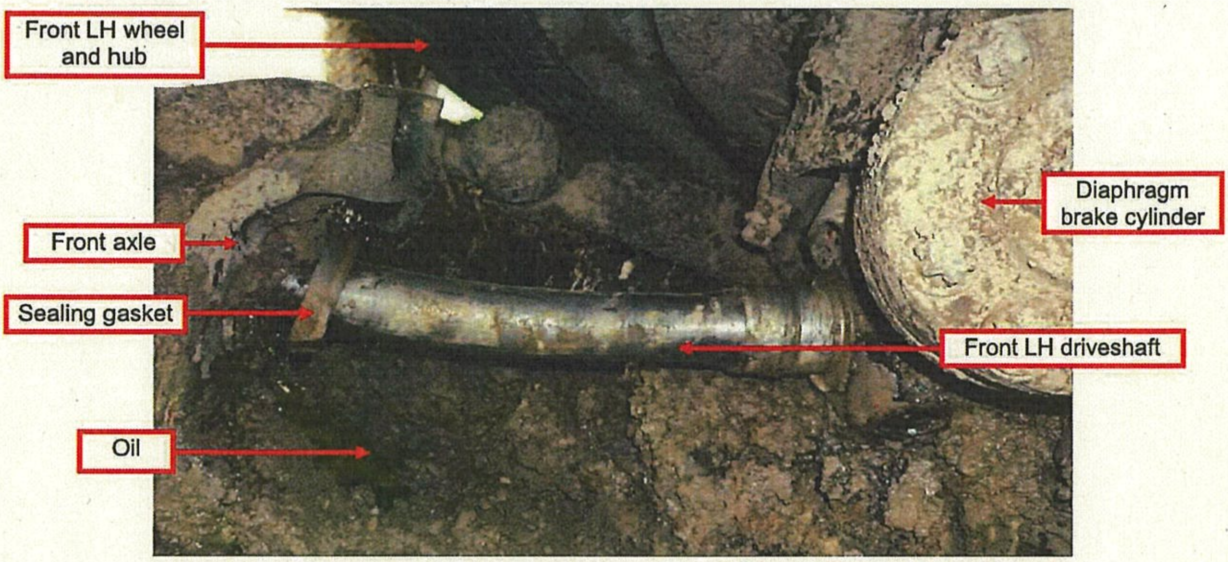


Figure 11 – Front LH driveshaft damage

b. The upper swivel housing had sheared at both its upper and lower edges at the approximate 11 and 2 o' clock positions from where the housing arm extends from the main body of the axle (Figure 12).

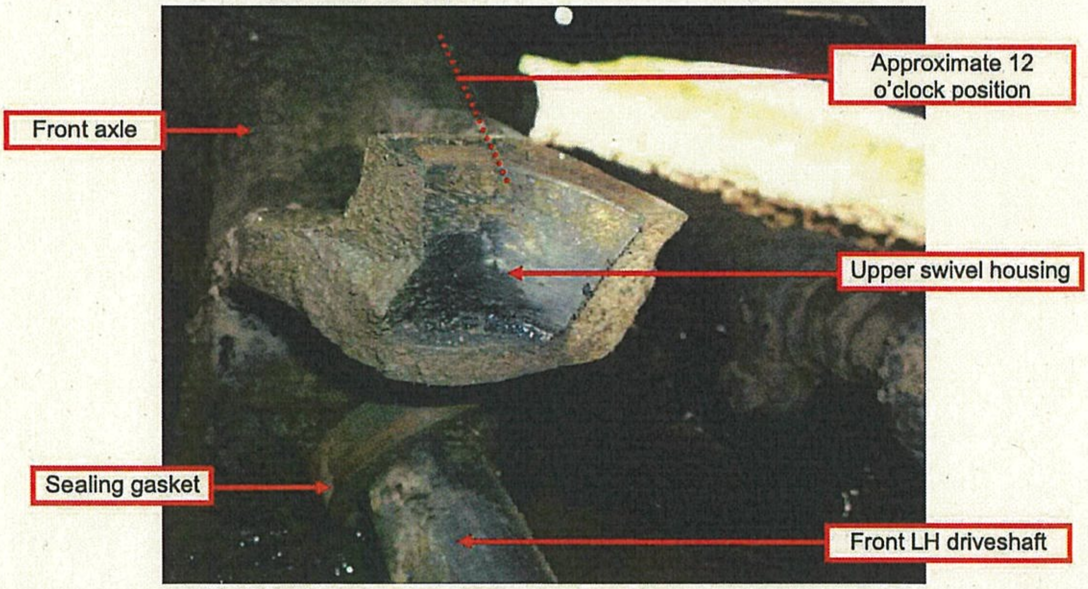


Figure 12 – Sheared upper swivel housing

c. The lower swivel housing had sheared at the approximate 8 and 2 o'clock positions in the area where the lower trunnion locates (Figure 13).

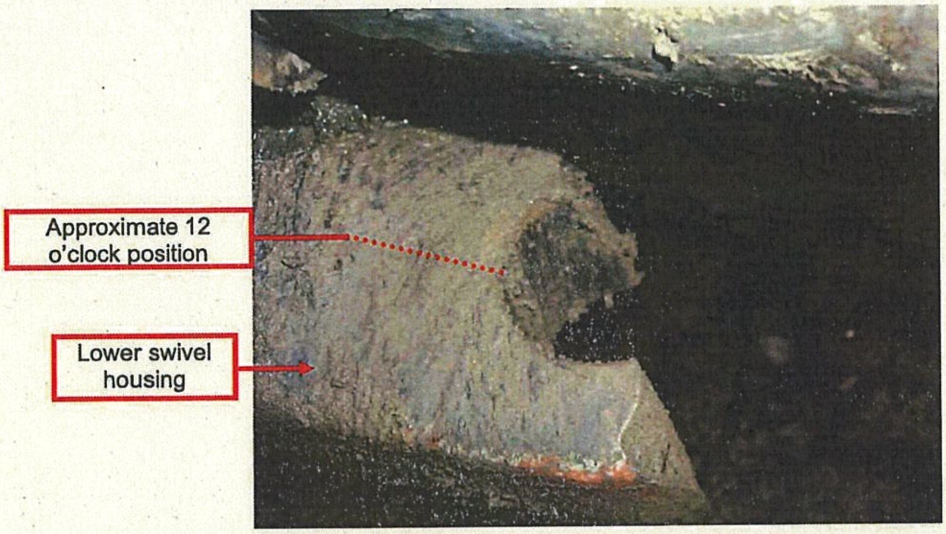


Figure 13 – Sheared lower swivel housing

d. The connecting sheared section of the upper swivel housing was attached to the upper trunnion on the detached LH wheel hub. The upper and lower trunnions were also attached to the wheel hub. The sealing gasket on the lower trunnion had dismounted from its seat (Figure 14)

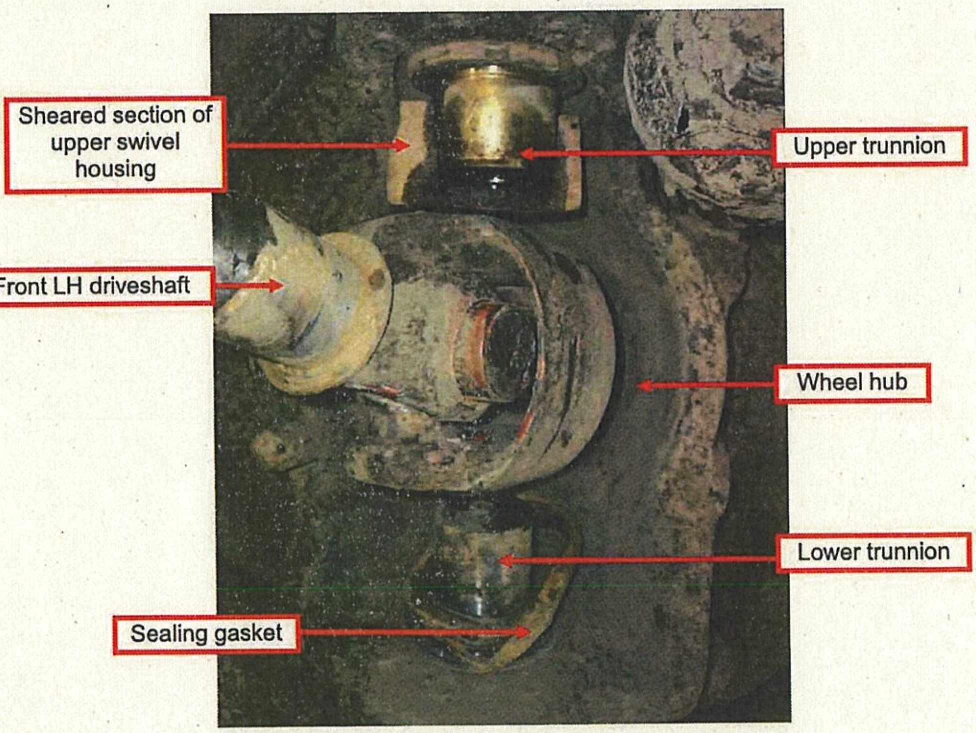
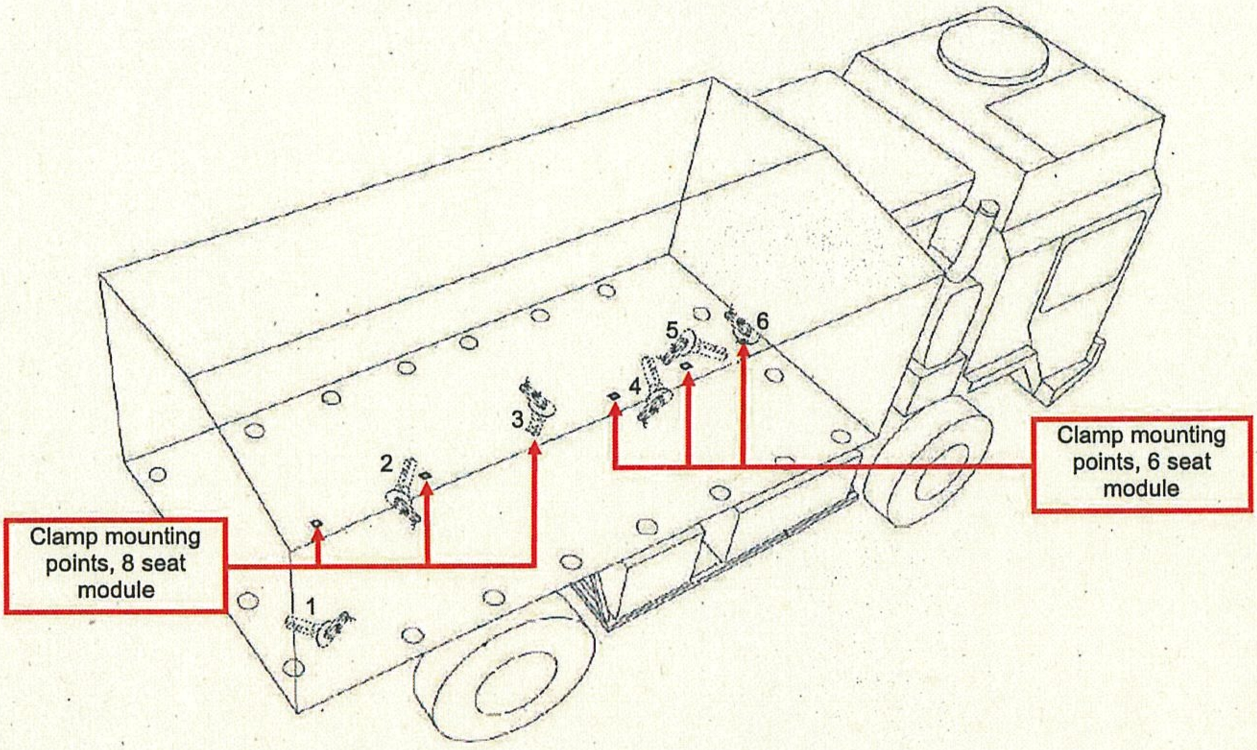


Figure 14 – Rear of LH wheel hub

FURTHER INVESTIGATION

7. The cargo bed was investigated for the fitting and security of the TCV ES system. The following was noted:

a. Of the 6 clamps normally fitted to secure the seating modules to the cargo bed one clamp remained fully fitted in its mounting hole and one remained partially fitted (Reference E describes the operation and fitment of the clamps). Figure 15, labels 1-6 show the final positions and details the condition of the clamps at the time of investigation (For clarity the TCV ES modules are not shown).



Clamp No	Position
1	Located rear right of the cargo bed. Upper collar had detached from top plate and slid down the body of the clamp. Clamp unlocked and handle partially open.
2	Located across the central frame of the seating module. The clamp was undamaged and in the unlocked position.
3	Located partially seated in the mounting hole up to the upper collar of the clamp. The clamp was undamaged and in the locked position.
4	Located inside of the central frame of the seating module. The clamp was undamaged and in the locked position.
5	Located inside of the central frame seating module. The clamp was undamaged and in the unlocked position with the handle fully open.
6	Located within the mounting hole, fully fitted. The clamp was undamaged and in the locked position.

Figure 15 – Final positions and condition of TCV ES clamps

b. The rearmost clamps upper collar had slid down the body of the clamp. This collar is normally connected to the top plate of the clamp (Figure 16) (Reference F details a similar occurrence of a failed clamp).

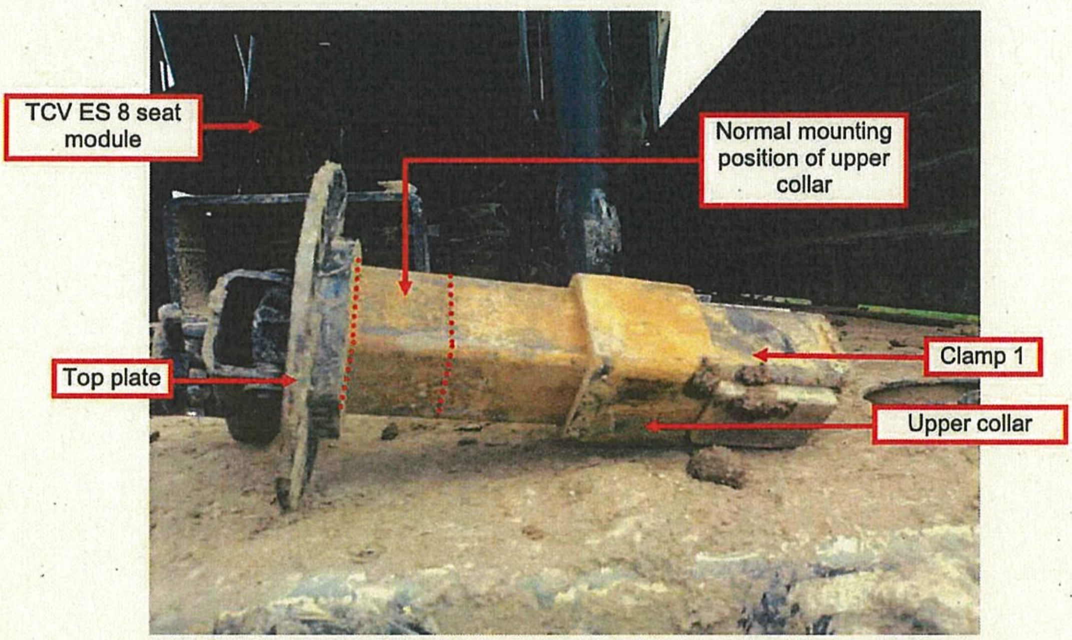


Figure 16 – Clamp 1 showing upper collar disconnected from top plate

8. The Subject vehicle was recovered to the Force Maintenance Area (FMA) to allow further inspections. The following was noted:

a. The driveshaft had sheared approximately 30 cm along its length away from the hub. The left steering knuckle arm and diaphragm brake cylinder were still attached to the hub. The air return pipe was severed approximately 30 cm from the connection at the hub end. The electrical cable was severed approximately 40 cm from the hub end; both the air return pipe and electrical cable were attached to the diaphragm brake cylinder. The air feed pipe had severed flush with its inlet on the diaphragm brake cylinder (Figure 17).

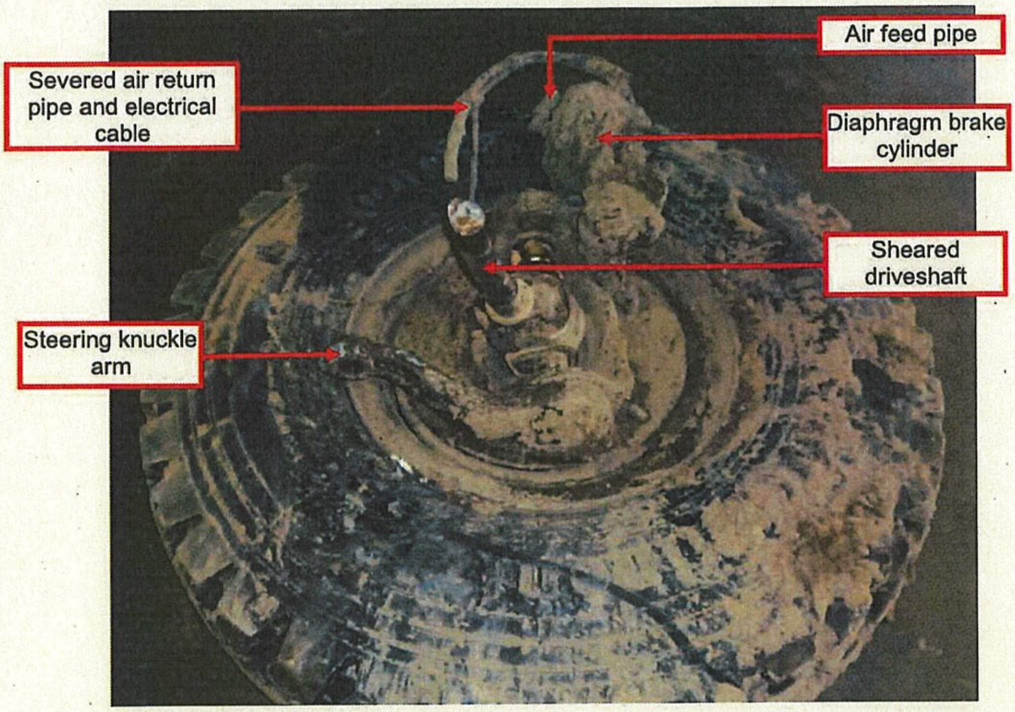


Figure 17 – Rear of LH wheel hub

b. The front chassis protection bar had been pushed backwards and was deformed upwards on its RH side and had impacted with the leaf spring on the LH side (Figures 18 & 19).

Figure 18 – Deformed front chassis protection bar

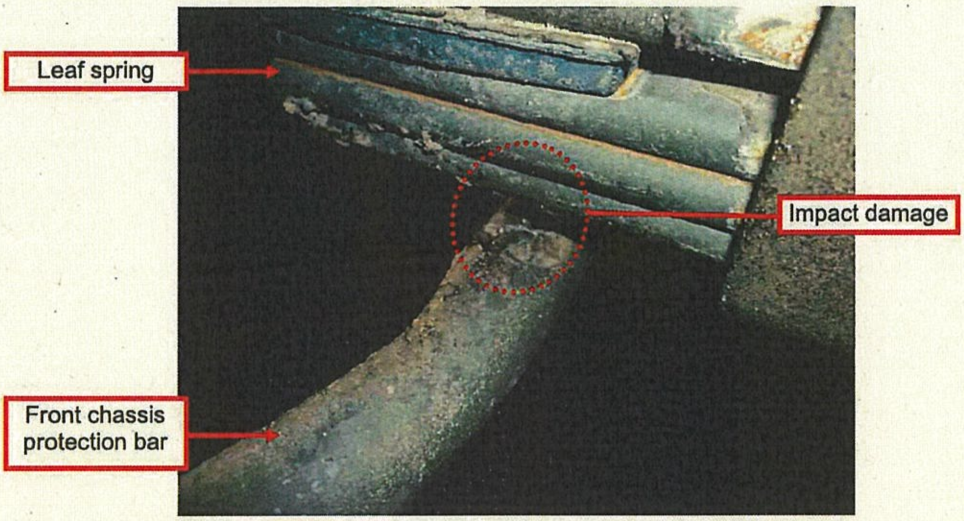


Figure 19 – Area of impact with leaf spring

OBSERVATIONS

9. Reference G, table 4 details scheduled maintenance and inspections to be carried out on the TCV ES system. With reference to daily before use checks on the clamps (mounting latches) it states:

> Check security of mounting latches through TCV ES frame and check for any signs of distortion around the bottom mounting rail/cargo bed interface and cracking of the welds at welded joints.

10. There was no Authority To Use Document (ATUD) or work ticket available for inspection. The most recent first parade sheet found was dated 11 May 11 (Enclosure 4).

11. The replacement windscreen was demanded on 6 Jun 11 and received on 7 Jun 11. The sealing frame and filler strip were not ordered until 13 Jun 11 and had not been received at the time of the incident (Enclosure 5 (front)). From Enclosure 5 (rear) it can be seen that the vehicle had been sentenced 'fit to drive on exercise area only', and the driver advised to wear goggles.

12. Enclosure 6 details the Journey Summary Report information obtained through MAN trucks, which shows that at the time of the incident the subject vehicle was travelling at 17 mph (27.2 kmph).

13. The course of travel of the LH side of the subject vehicle was in line with the deepest area of the puddle; a depth of approximately 60 cm.

CONCLUSIONS

14. The failure to the front LH wheel station was a direct result of the subject vehicle impacting with the uneven road surface concealed by the puddle. It is probable that the given speed of the subject vehicle was excessive for the conditions experienced at the time of the incident.

15. The damage witnessed at the upper and lower swivel housings and driveshaft is consistent with the wheel station suffering an impact from below. This was further compounded by the effect of harsh braking placing excessive weight on the front end of the vehicle. The impact would have

forced the lower trunnion outwards and the upper trunnion inwards shearing both from their respective housings.

16. The damage to the drive shaft is congruent with impact damage, harsh braking and subsequent failure of the upper and lower swivel housings, causing the driveshaft to hyper-extend and shear. At this point the air feed pipe, air return pipe and electrical cable have also been severed. Once disconnected from the axle the upper half of the tyre has made contact with the shock absorber, stripping the paint from its surface.

17. On impact it is probable that the front chassis protection bar has struck the underwater surface of the track causing the bar to deform and impact on the leaf spring.

18. The TCV ES system moved as a result of the impact sustained to the subject vehicle. It is probable that the TCV ES mounting clamps were either not fitted or not tightened in accordance with Reference E which resulted in the 14 injuries. If the clamps had been fitted correctly and locked in place then similar damage witnessed in Reference F, would have been sustained to the clamps as they would have been forced from their mounting holes.

19. It is possible that the lack of a LH windscreen contributed to the incident. Had the commander been able to see the track conditions ahead he would have been able to advise the driver accordingly.

RECOMMENDATIONS

20. The engineering authority for this equipment lies with the General Support Group - General Support Vehicles (GSG-GSV). The conclusions and recommendations made by the Investigating Officer are fully endorsed by the Engineering Officer. It is recommended that:

a. **GSG-GSV:**

(1) In accordance with the recommendations made in Reference F, further raise awareness of the TCV ES clamping system procedure.

(2) Record the incident and monitor future trends.

(3) Complete the attached Report Response Form (RRF) and return it to SEFIT (G) within 30 days of the date of the report.

b. **COEFOR:**

(1) Immediately instigate a programme of further training aimed at drivers and commanders of MAN SV emphasising the need to ensure that TSV ES clamp assemblies are fitted correctly and frequently checked in accordance with Reference E.

(2) Inspect the subject vehicle and make a repair decision.

(3) Complete the attached RRF and return it to SEFIT (B) within 30 days of the date of the report.

21. The recommendations contained within this report may not be exhaustive; addressees should review this incident to determine if further action within any Defence Lines of Development (DLoD) is required to prevent a reoccurrence.

22. In accordance with Reference B, all action addressees are mandated to complete the attached RRF and return them to SEFIT (B/G) within 30 days of the date of the report. These RRFs are held by SEFIT for 6 years in case of litigation.

ACKNOWLEDGEMENTS

23. [redacted] (GSG-SLV PT) is thanked for his assistance throughout the investigation.

Enclosure 1 to
SEFIT 11-0133-SI
Dated 29 Jun 11

STATEMENT OF EVENTS – [redacted] DATED 17 JUN 11

①

Annex F to Chapter 2

ENGINEERING INVESTIGATION ONLY

~~SEF~~/SI/~~OT~~*/ 2011 /133 - STATEMENT OF EVENTS

Number: [redacted] Rank: [redacted] Name: [redacted]

Unit: Welsh Guards Coy/Sqn: 2 Coy Sect/Tp:

We were approaching the puddle at about 20kph. We may of slowed down prior to the puddle. We went through the puddle which was much ~~deeper~~ deeper than I had anticipated. There was a loud bump. We stopped immediately.

Jumped out of the vehicle to see that the wheel was at a strange angle.

We then started dealing with the casualties.

*delete as applicable

Signature [redacted]

Date 17/06/2011

Sheet 1 of 1

ENGINEERING INVESTIGATION ONLY

Enclosure 2 to
SEFIT 11-0133-SI
Dated 29 Jun 11

STATEMENT OF EVENTS – [redacted] DATED 17 JUN 11

②

Annex F to Chapter 2

ENGINEERING INVESTIGATION ONLY

~~SEF~~/SI/~~CF~~*/2011 /133 - STATEMENT OF EVENTS

Number: [redacted] Rank: [redacted] Name: [redacted]
Unit: 1WG Coy/Sqn: 2 COY Sect/Tp:

First parade in the morning checked on dash board for any faults in ~~the~~ technical faults. There was a windscreen whiper fault due to no passanger front window. Did a visual check of the vehice light, wheels, or any sort of visual damage. Failed to check the seats to be screwed in prier to moving off ~~the~~ checked everyone was wearing a seat belt and wearing there helmets then closed the tailgate. Set off ~~the~~ comander got out when came to going round a lake obstical, ~~a~~ mounted drove down for a further couple of hundred meters seen an obstical ahead slowed down to around 20 kph maintaining that speed, ~~we~~ have gone down into the puddle being deper first expected to gone down into the puddle with the momentum of the vehice were ~~[illegible]~~ shot back up with the back of the vhice following and has started to slide to the right with the vhice with full locke left has sort the ~~[illegible]~~ front left hand wheel has snaped into place. heard a hising sound turned the egnition off and got out.

*Delete as applicable

Signature [redacted]

Date 17/06/11

Sheet ____ of ____

ENGINEERING INVESTIGATION ONLY

STATEMENT OF EVENTS – [redacted] DATED 17 JUN 11

(3)

ENGINEERING INVESTIGATION ONLY

~~SEF~~/SI/~~OF~~*/ 2011 /133 - STATEMENT OF EVENTS

Number: [redacted] **Rank:** [redacted] **Name:** [redacted]
Unit: 1 WG **Coy/Sqn:** **Sect/Tp:**

On The 17th of June 2011 Approx 14:30 I was travelling down a Track in The back of a TCV When We hit a ditch in the road. I was sitting 5th from Rear. When We hit the bump the frame jumped to side trapping my leg to the side of the Wagon then ~~&~~ The second bump the frame jumped back releasing us Then We came to a halt

*delete as applicable

Signature [redacted]

Date 17/6/11

Sheet ____ of ____

ENGINEERING INVESTIGATION ONLY

Enclosure 4 to
SEFIT 11-0133-SI
Dated 29 Jun 11

MAN SV FIRST & LAST PARADE SHEET, [redacted] DATED 11 MAY 11

④

MAN SV FIRST & LAST PARADE SHEET

VRN..HK76AB.... C/S...Z37A.. GROUP...3....... DATE.11/05/11......

NUMBER..[redacted].... RANK.[redacted]... NAME..[redacted]..................

SER	TASK	FIRST PARADE	LAST PARADE	REMARKS
01	Examine vehicle for any obvious faults and damage, and report it to the MT	✓		
02	Check batteries	✓		
03	Check engine oil level	✓		
04	Check brake fluid level	✓		
05	Check coolant level	✓		
06	Check transmission fluid level	✓		
07	Check windscreen washer fluid level	✓		
08	Check fan belt condition	✓		
09	Check battery box cover for security.	✓		
10	Check all wheels and tyres for serviceability & security (Including Spare wheel winch and strap)	✓		
11	Check Tyre pressures are correct.	✓		
12	Check tightness of wheel nuts	✓		
13	Examine and check operation of seat's and seat belts	✓		
14	Examine and operate windscreen wipers and washers	✓		
15	Examine all mirrors for serviceability and correct adjustment	✓		
16	Check all lights, horn, hazard warning lamps, heaters, instruments and gauges	✓		
17	Check ladder for serviceability	✓		

FUEL 1/4 TANK.

ARMY FORM G1084A DATED 6 JUN 11 (FRONT)

Job Report

Sheet of

Army Form G1084A (Revised 2/88) (Pads of 50)

Special Code

Data Centre Use -

Estimated Cost: Lab / Spares

FWD Category A B C

Job Number

Repair Unit: COFOR. Code

Holding Unit: COFOR (MT). Code

Equipment: MAN SV. Code

Contract No. — Regn. Mark/Serial No. HK76AB.

Days held up for: Spares / Labour / Authority / Facilities

B / Q / R

Job Dates	Day	Mth.	Year
Work demand	06	06	11
Eqpt. received			
Completed			

Reason for Work

Defect Report Reference

Single Item Disposal

Category A Eqpt. Usage: Miles / Kms / Hr/Rv / EFC

Multi-Item Di: Qty. Rec'd / Qty. Rep'd / Qty. BLR / Qty. B/SL / Qty. BR

Power Pack Serial No.

New Power Pack Meter Reading

Work To Be Done	No. of Items	Operation/Modification Codes	Man-hours Hrs.	Man-hours 1/10th	Catalogue Number: COSA Section / NATO Stock Number	Qty.
RENEW WINDSCREEN.						
FIT TO DRIVE ON EXERCISE AREA						
ONLY. DRIVER INFORMED ON USE						
OF EYE PROTECTION						
REAR MOST SEAT BASE CLAMP REPLACED WITH SPARE			0	5	[redacted]	
			0	5		VM

AF G890 (ADP)/AFG8304 Attached .... S

Job Report Checked.................... Sig

ARMY FORM G1084A DATED 6 JUN 11 (REAR)

For Workshop Use

AF G890 Serial Number	Date of Demand	Date Received	Stores Required	COSA Section	NATO Stock Number	Qty.	Code Fault	Routed Items		
								Item	Despatched	Re
004.	06/06/11	07/06/11	WINDSCREEN.		2510-12-346-2778	ONE		[redacted]		
59/1	13/06/11		SEALING FRAME.		5330-12-346-3676	ONE				
59/2.	13/06/11		FILLER STRIP		9390 12 168 6513	TWO				

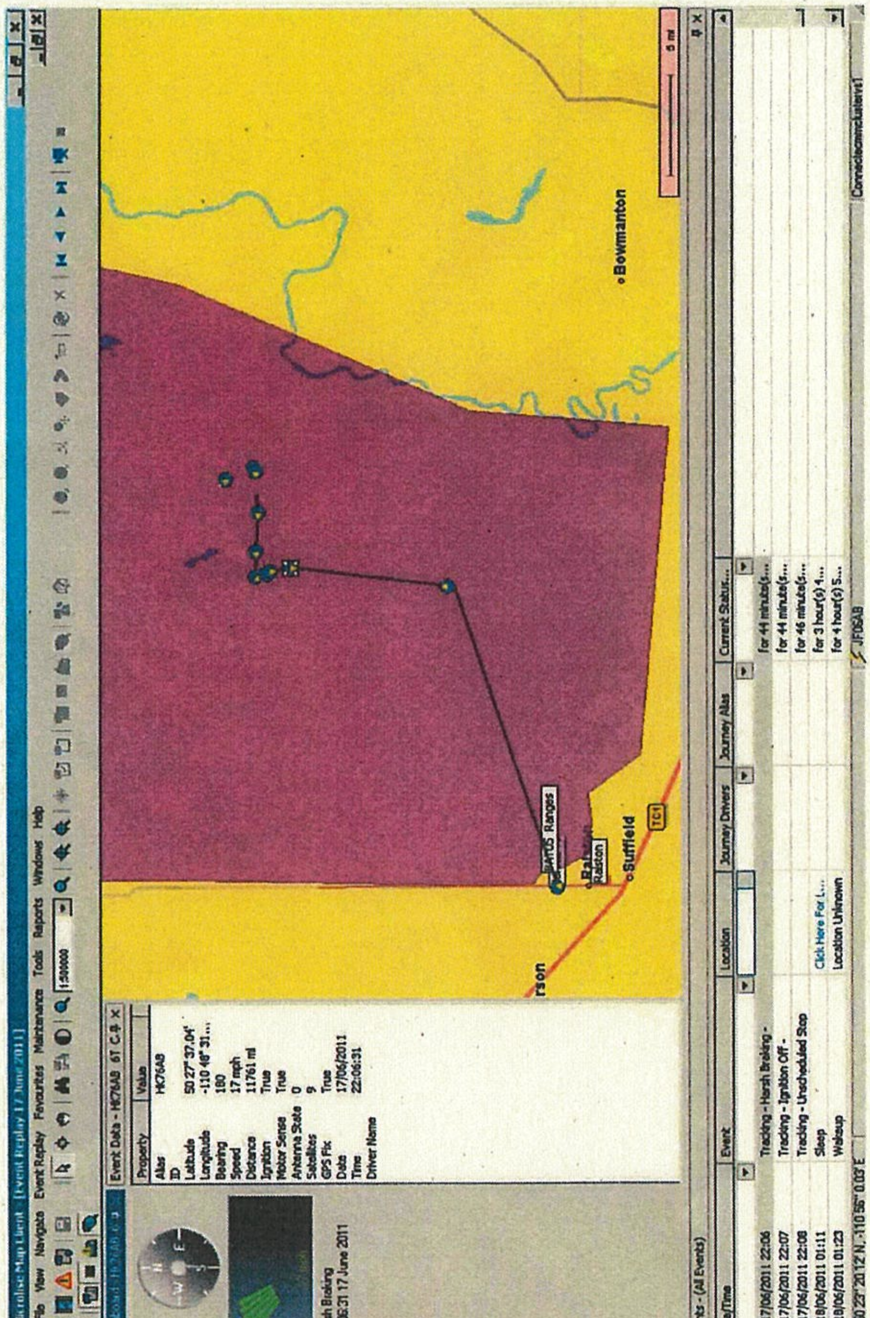
For RAF Use

Road Test. Authorised By:	Rank Name	Certified Carried Out		Rank Name
Special Requirements		Mileage Out		Mileage In
Approved	In Inspected	Estimated Date of Completion: Day / Month / Year	Repairs Completed	Out Inspected

							Co-ordination Signature
Op. Code							
Name							
Trade							
Signature							
Counter Signature							
Rank							
Name							
Start							
Stop							
Total Time		Hrs. Mins	Hrs. Mins	Hrs. Mins	Hrs. Mins	Hrs. Mins	Hrs. Mins	Rank Name

Enclosure 6 to
SEFIT 11-0133-SI
Dated 29 Jun 11

JOURNEY SUMMARY REPORT – HK76AB DATED 17 JUN 11



LAND SYSTEMS
SAFETY & ENGINEERING

DEPLOYABLE SUPPORT

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SAFETY & ENGINEERING

SERIOUS EQUIPMENT FAILURE INVESTIGATION TEAM

SERIOUS EQUIPMENT FAILURE

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Title: TROOP CARRYING VEHICLE ENHANCED SEATING SYSTEM MK2

SER NO – ESK02243

CLAMP ASSEMBLY FAILURE

Reference No: SEFIT 11-0108-SEF

Defence Equipment & Support

~~RESTRICTED~~

SEFIT 11-0108-SEF

TROOP CARRYING VEHICLE ENHANCED SEATING SYSTEM MK2

SER NO – ESK02243

CLAMP ASSEMBLY FAILURE

Author: Original Signed

Name: [redacted]

Rank: [redacted]

Tel: Civ: [redacted]
Mil: [redacted]

Date: 10 Jun 11

Please direct any queries/comments on this document to:

By Mail:

SEFIT (G)
DE&S SE Land
Rochdale Barracks
BFPO 39

By Email:

DES SE Land-SEFIT-G-Mailbox(Multiuser)

Enclosure:

1. Statement of Events – [redacted] dated 26 May 11.

Distribution:

GSG SLV (Out Sp Safety Mgr)*
BATUS ES Br (SO2 ES)*

Copy to:

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CONTENTS

SEFIT 11-0108-SEF

TROOP CARRYING VEHICLE ENHANCED SEATING SYSTEM MK2

SER NO – ESK02243

CLAMP ASSEMBLY FAILURE

References:

A. Conversation [redacted] SEFIT (B) dated 250930L May 11.
B. Joint Service Publication (JSP) 886 (Version 1.1, dated 4 Mar 11), Vol 5, Pt 2, Chap 3.
C. BATUS Equipment Management Directive (Edn 1, Amdt 11, dated May 11) Chap 1, Annex G – BATUS SEF/SI Reporting.
D. AESP 2320-G-300-411 (Edn 2, dated Jun 09) – Installation Instruction No 6.
E. AESP 2320-G-300-111 (Edn 2, dated Jun 09), Page 1, Para 4 – Equipment Support Policy Directive.

Figure 1 – Troop Carrying Vehicle Enhanced Seating (TCV ES) system, Mk 2, Ser No – ESK02243

INTRODUCTION

1. In response to Reference A and in accordance with References B & C, [redacted] from the Serious Equipment Failure Investigation Team (SEFIT) British Army Training Unit Suffield (BATUS) (SEFIT (B)), deployed to the Range Safety Control Group (RSCG), Force Maintenance Area (FMA), Suffield. The purpose of the deployment was to conduct an engineering investigation of the subject equipment (Figure 1). The unit representative, [redacted] (Artificer Vehicles) was present throughout the investigation.

DATA

2.	Date of Incident:	25 May 11
	Date SEFIT Informed:	25 May 11
	Date of Investigation:	26 May 11
	Owning Unit:	BATUS
	Holding Unit:	RSCG
	Div/Bde:	HQ LWC
	Equipment Type:	TCV ES System Mk2
	NATO Stock No:	7SV 2540 99 602 7565
	Ser No:	ESK02243
	Main Assembly Type:	TCV ES System Mk2
	Sub Assembly Type:	Clamp assembly
	Date/Type of Last REME Inspection:	16 May 11/MEI
	Date of Last First Parade:	25 May 11
	Date into Service:	Feb 10
	PT Informed:	GSG-GSV-SLV
	PT Contact Details:	[redacted]

BACKGROUND

3. The following has been extracted from Enclosure 1 and information gained throughout the course of the investigation:

a. On 25 May 2011 the subject equipment, fitted to a MAN Support Vehicle (SV) 6 Tonne, was being used to move troops across the undulating terrain of BATUS Military Training Area (MTA). The vehicle was travelling at approximately 15 mph when the driver unexpectedly drove into a ditch which caused a sudden impact to the vehicle. The passengers in the rear of the vehicle brought it to the driver's attention that one of the clamp assemblies securing theTCV ES system had become loose.

b. The vehicle was halted and upon inspection it was found that the rearmost clamp assembly, securing the TCV ES system had failed. All passengers dismounted the vehicle and the driver returned the vehicle to the FMA for inspection where it was quarantined pending a SEFIT investigation

TECHNICAL DESCRIPTION

4. The following key features have been extracted from References D and E and the investigators knowledge of the equipment, which are pertinent to this investigation:

a. The Roush Technologies (MK2) TCV ES system is fitted to provide seating combined with suitable safety restraints for passengers being transported in the rear of MAN SV 6 Tonne and MAN SV 9 Tonne variants.

b. Each TCV ES system Mk 2 comprises 14 seats, broken down into modules of 6 and 8 seats, both of which can be fitted independent of the other. Each seat offers a four point seatbelt, back protection, stowage under each seat for individual bergens and an individual rifle stowage point; it does not offer overhead stowage. The system is designed specifically for MAN SV (Figure 2).

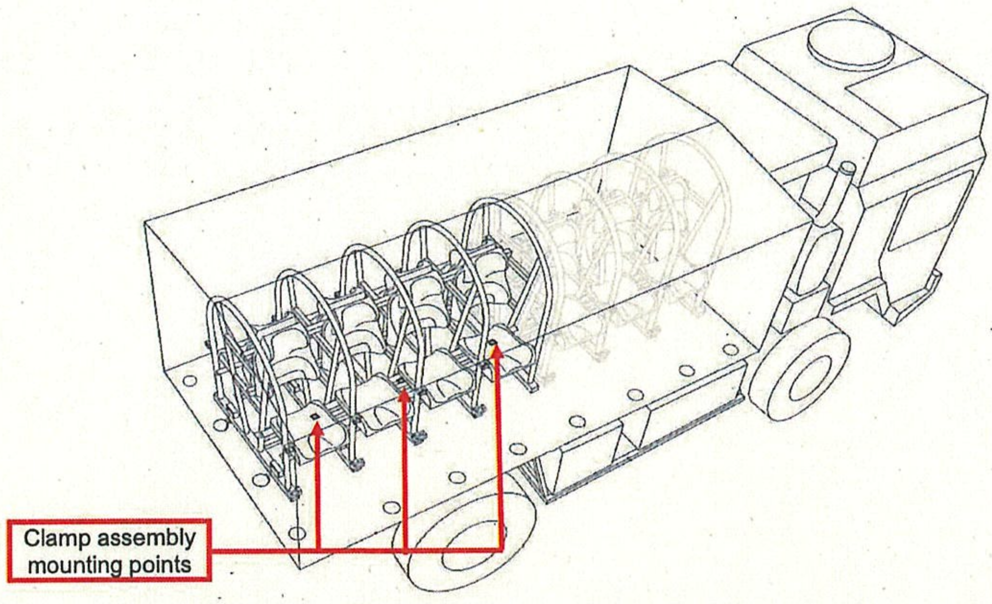


Figure 2 – TCV ES system Mk 2 fitted to MAN SV 6T

c. Prior to fitting, the seats are first strapped down using ratchet tie-down straps to ensure a secure fit (Figure 3). These straps are removed prior to use.

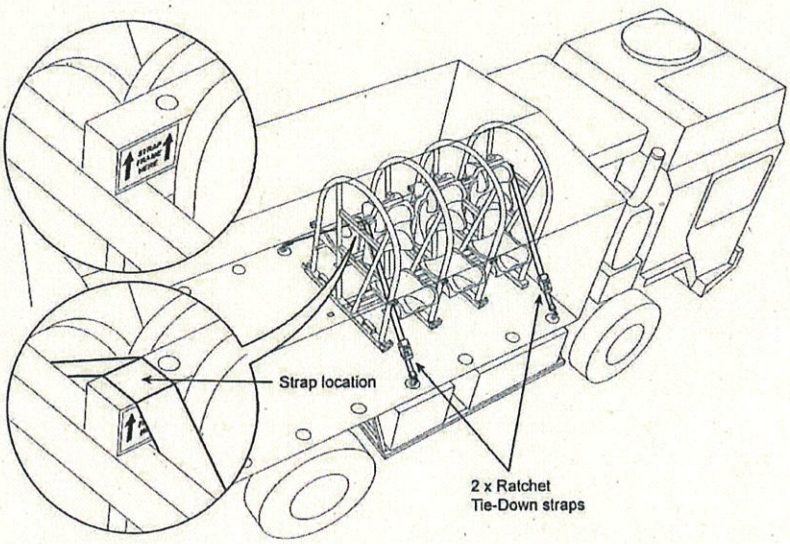


Figure 3 – Ratchet tie-down straps fitted to the TCV ES system 6 seat module

d. Both the 6 and 8 TCV ES modules are fitted to the cargo bed of the MAN SV using 3 clamp assemblies on each module frame. The clamp assembly fits through slots in the frame and locks in to fitted holes in the cargo bed of the MAN SV (Figure 4).

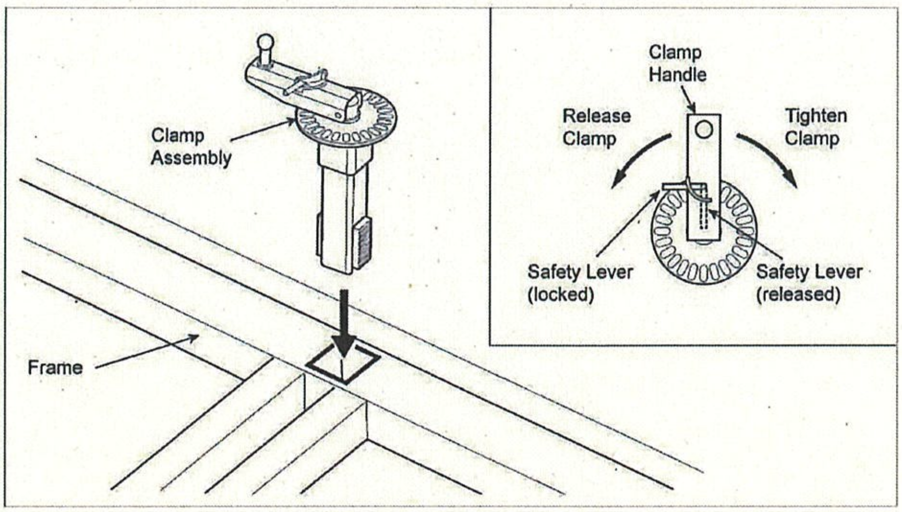
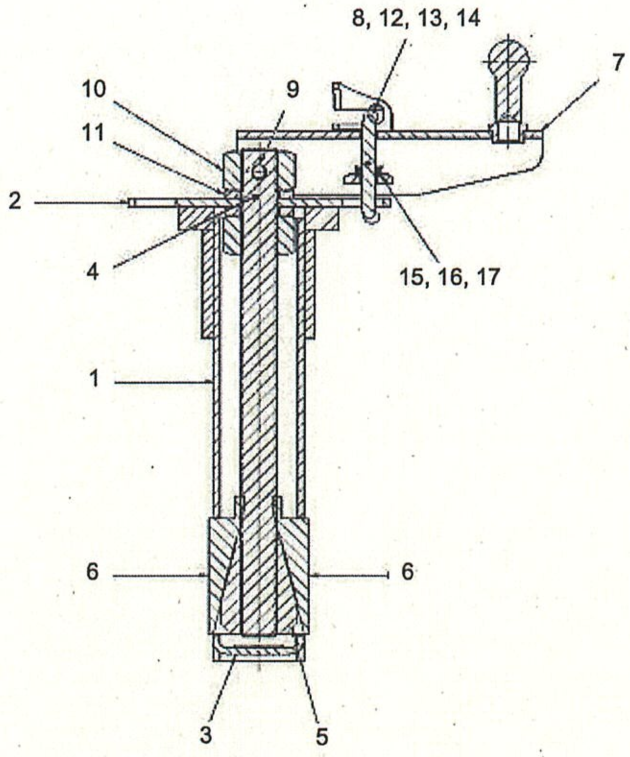


Figure 4 – Clamp assembly

e. The clamp assembly is tightened by turning the clamp handle in a clockwise direction. The clamp handle is connected through a hinged joint and M16 X 2 hex nut to an M16 screw shaft. The action of turning the handle clockwise winds a single sided wedge up the screw shaft pushing 2 sliding shoes outwards, securing the clamp assembly inside its mounting hole. To prevent damage and over tightening the sliding shoe comes into contact with the lip of the sliding shoe aperture stopping any further tightening. Once the clamp assembly is locked in place a safety lever on the handle is turned through 90° to secure the handle (Figure 5).



1	Casing tube assembly	10	M16 X 2 hex nut
2	Casing top assembly	11	M16 washer
3	Casing base cap	12	Spring washer
4	Screw shaft M16	13	Washer
5	Wedge single sided	14	'C' clip
6	Sliding shoe	15	Spring
7	Handle	16	Washer
8	Safety lever	17	Cotter pin
9	Roller pin		

Figure 5 – Clamp assembly components

INITIAL INVESTIGATION

5. The Investigating Officer carried out an initial investigation of the subject equipment. The following was noted:

a. Both the 6 and 8 seat TCV ES modules were still connected to the cargo bed of the subject vehicle (Figure 6). The 6 seat module had all 3 clamp assemblies fitted. The 8 seat module had the centre and foremost clamp assembly fitted.

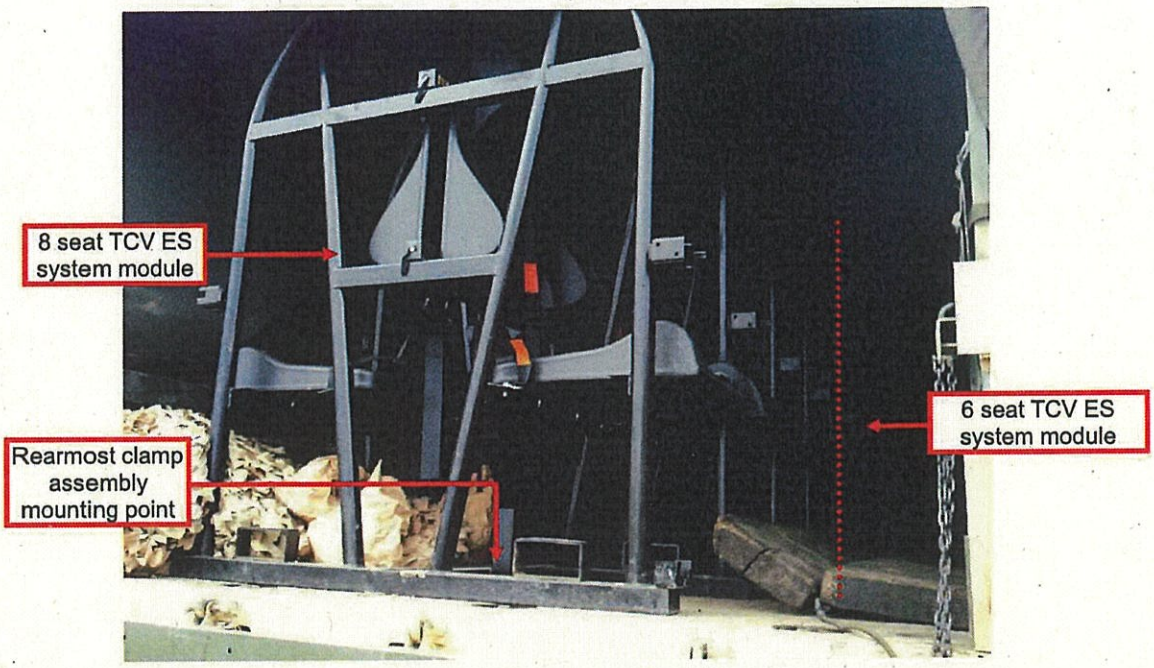


Figure 6 – TCV ES system fitted to subject vehicle

b. The rearmost clamp assembly of the 8 seat TCV ES module had been removed from its mounting hole by the driver at the scene of the incident. When manipulated by hand there was limited lateral movement of the seating frame. Figure 7 illustrates the failed clamp assembly mounting hole.

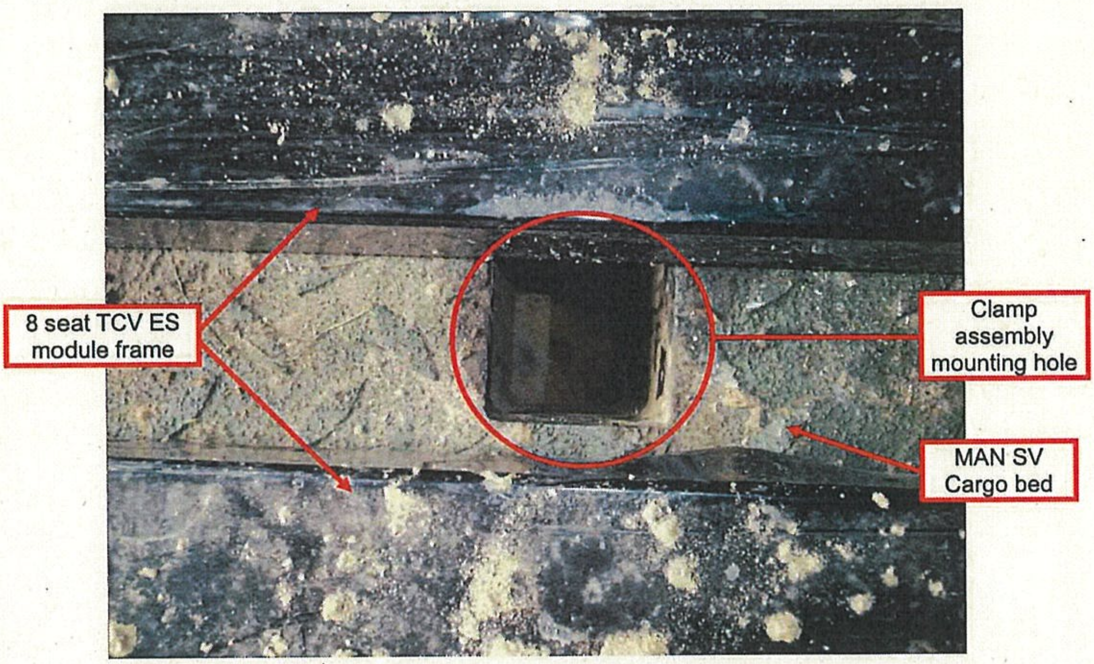


Figure 7 – Failed clamp assembly mounting hole

c. The base cap of the clamp assembly and both sliding shoes were detached, these were not recovered from the scene. The lower portion of the outer casing was distorted and the fitting points for the base cap had both fractured. The M16 screw shaft had sheared approximately 1 cm from its lower end (Figures 8 & 9).. The upper portion of the clamp assembly, handle and safety lever remained complete and operated as designed when tested.

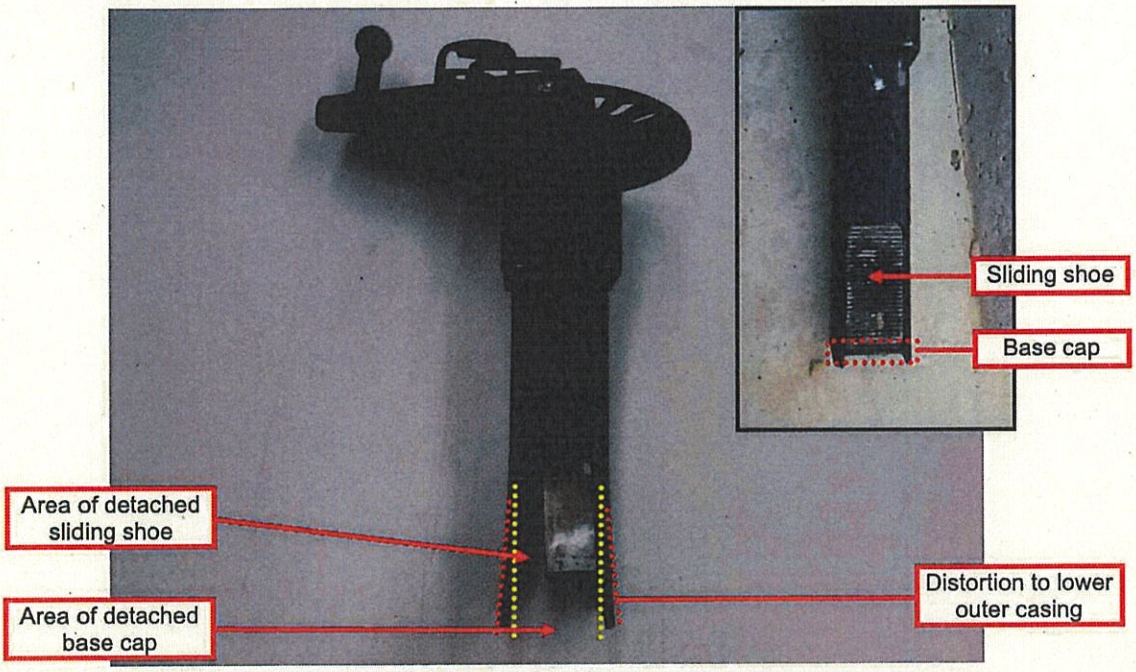


Figure 8 – Failed clamp assembly showing distorted outer casing[1]

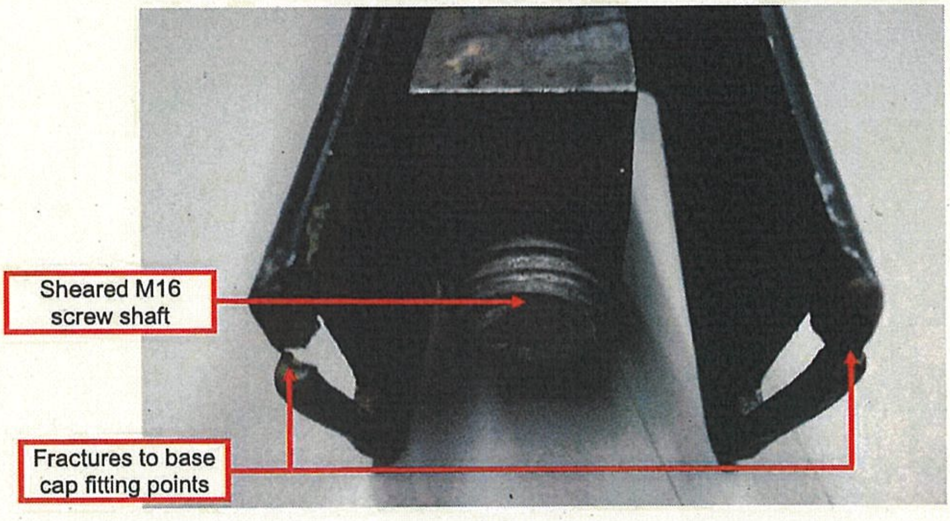


Figure 9 – Fractures to base cap fitting points and sheared M16 screw shaft

[1] Inset picture is for reference only

FURTHER INVESTIGATION

6. The TCV ES system on 4 further MAN SV 6T vehicles from the BATUS fleet were checked for serviceability, during which a second failed clamp assembly was found fitted to TCV ES Ser No – ESK02442. This clamp assembly had failed in a similar mode as the subject equipment. The base cap and one of the sliding shoes were detached from the clamp assembly and the base cap fitting points had sheared from the outer casing (Figure 10).

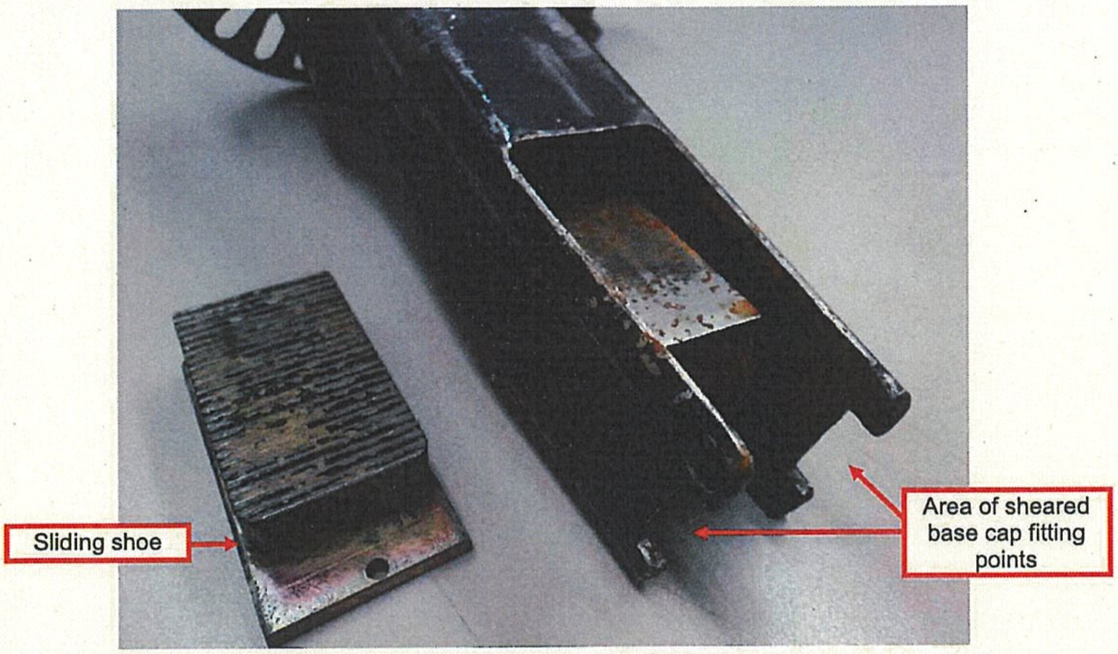


Figure 10 – Failed clamp assembly, Ser No - ESK02442

OBSERVATIONS

7. It is extremely difficult to over tighten the clamp assembly. To do so the user would have to either kick the handle or use a tool, inevitably leading to damage or failure of the handle before damage could be done to the more substantial sliding shoes or outer casing.

8. The clamp assembly will only fit into the hole in the MAN SV cargo bed when aligned correctly. Once aligned the weight of the clamp assembly ensures that it drops fully into the hole up to the casing top assembly as designed. Once fitted the clamp assembly fits loosely in the hole until tightened.

CONCLUSIONS

9. It is concluded that the failure of the TCV ES clamp assembly was probably caused by a combination of the MAN SV 6T being subjected to a sudden impact combined with a weakness in the design of the clamp assembly.

10. As the rearmost clamp assembly was the only clamp assembly to fail, it is possible that it may have been unserviceable prior to the incident; however, from Enclosure 1, a first parade inspection of the TCV ES system was carried out satisfactorily to ensure that it was correctly fitted.

11. It would be extremely difficult to fit the clamp assembly incorrectly, as once aligned gravity ensures that the clamp assembly drops fully into the hole on the cargo bed of the MAN SV. The passengers in the cargo area did not notice the failed clamp assembly until immediately after the impact of crossing the ditch, indicating that it was correctly fitted and serviceable prior to this point.

12. It is likely that at the instance of the impact the eight seat TCV ES module frame moved up and down, subjecting the rearmost clamp assembly to substantial tensile stress. This tensile stress has forced the rearmost clamp assembly upwards out of its mounting hole whilst the sliding shoes have remained locked inside the mounting hole. Assuming that the clamp assembly was in a serviceable state, the upwards motion of the clamp assembly body combined with the locked sliding shoes pushing onto the base cap and base cap mounting lugs, has caused the base cap fitting points to fracture. This has allowed the base cap and sliding shoes to fall out of the bottom of the open mounting hole at the scene.

13. The damage to the outer casing could not have been caused by over tightening. If over tightened the outer casing would have exhibited damage around the area of the cut outs for the sliding shoes, where the sliding shoes push up against the lip on the outer casing. In this mode of failure, the damage would be on the outer casing perpendicular to the damage seen in this incident.

14. When subjected to tensile stress, the design of the bracket assembly forces the sliding shoes downwards onto the base cap, placing excessive strain on the base cap mounting lugs and thus the lower portion of the outer casing and base cap fitting points. From the evidence seen, this causes the outer casing to fail at the weakest point; that of the base cap fitting points.

RECOMMENDATIONS

15. The engineering authority for this equipment lies with the General Support Group Specialist and Logistic Vehicles Project Team (GSG SLV PT). The conclusions and recommendations made by the Investigating Officer are fully endorsed by the Engineering Officer. It is recommended that:

a. **GSG SLV PT:**

(1) Inform all users of the requirement to check the serviceability of the clamp assemblies as fitted to the TCV ES system before, during and after use. Failures are to be reported to the PT via Equipment Failure Reports EFRs .

(2) Record the incident and monitor future trends.

(3) Complete the attached Report Response Form (RRF) and return it to SEFIT (G) within 30 days of the date of the report.

b. **BATUS ES Br:**

(1) Carry out a 100% check of the BATUS TCV ES system clamp assemblies for serviceability. EFRs should be raised for all failures.

(2) Complete the attached RRF and return it to SEFIT (B) within 30 days of the date of the report.

16. The recommendations contained within this report may not be exhaustive; addressees should review this incident to determine if further action within any Defence Lines of Development (DLoD) is required to prevent a reoccurrence.

17. In accordance with Reference B, all action addressees are mandated to complete the attached RRF and return them to SEFIT (G) within 30 days of the date of the report. These RRFs are held by SEFIT for 6 years in case of litigation.

ACKNOWLEDGEMENTS

18. [redacted] is thanked for his assistance throughout the investigation.

Enclosure 1 to
SEFIT 11-0108-SEF
Dated 10 Jun 11

STATEMENT OF EVENTS – [redacted] DATED 26 MAY 11

Sir

I 25193598 [redacted] WAS DRIVING CROSS COUNTRY ON THE TRAINING AREA, ON THE 25th MAY 2011, THE VEHICLE (HV 32 AB, MAN TRUCK) HIT A SMALL DITCH. WE WENT FIRM AND ON INSPECTION OF THE WAGON I NOTICED THAT THE ROLL CAGE HAD CAME APART FROM THE FLOOR. BEFORE LEAVING FOR THE AREA ALL FIRST PARADE CHECKS WHERE DONE AND THE VEHICLE WAS POL.

[redacted]

26/05/11

MINISTRY OF DEFENCE

[redacted]
Senior Investigator

SEFIT (G)
DE&S SE Land
Rochdale Bks
BFPO 39

Tel: [redacted]
Tel Mil: [redacted]
Fax: [redacted]
Fax Mil: [redacted]

Email: DES SE Land-SEFIT-G-FI2

de&s
SAFETY & ENGINEERING

Distribution as per attached report

Reference: 0408_SEFIT/40/11_0108_SEF

Date: 10 Jun 11

ENGINEERING OFFICER'S EXECUTIVE SUMMARY – SEFIT 11-0108-SEF, TROOP CARRYING VEHICLE ENHANCED SEATING SYSTEM MK2, SER NO – ESK02243, CLAMP ASSEMBLY FAILURE

1. The attached report details an investigation into a Serious Equipment Failure (SEF) where the rearmost clamp assembly used on the Troop Carrying Vehicle Enhanced Seating (TCV ES) system MK2 failed. On 25 May 2011 the subject equipment, fitted to a MAN Support Vehicle (SV) 6 Tonne was being used to move troops across the BATUS Military Training Area (MTA). The vehicle was travelling at approximately 15 mph when the driver unexpectedly drove into a ditch, which caused a sudden impact to the vehicle. The vehicle was halted and upon inspection, it was found that the rearmost clamp assembly, securing the TCV ES system had failed

2. The base cap of the clamp assembly and both sliding shoes were not recovered from the scene. The lower portion of the outer casing was distorted and the fitting points for the base cap had both fractured. The M16 screw shaft had sheared approximately 1 cm from its lower end. The upper portion of the clamp assembly, handle and safety lever remained complete and operated as designed when tested.

3. Comprehensive checks were carried out to an additional 4 MAN SV 6T variants held by BATUS. A second clamp assembly failure was found fitted to TCV ES Ser No – ESK02442. The clamp assembly had failed in a similar manner, whereby, the base cap and one of the sliding shoes had become detached from the clamp assembly and the base cap fitting points had sheared from the outer casing.

4. It is concluded that the failure of the TCV ES clamp assembly was probably caused by a combination of the MAN SV 6T being subjected to a sudden impact, combined with a weakness in the design of the clamp assembly.

5. The Investigating Officer makes a number of recommendations, which are detailed within the report. Notably, General Support Group Specialist and Logistic Vehicles Project Team (GSG SLV PT) should inform all users of the requirement to check the serviceability of the clamp assemblies as fitted to the TCV ES system before, during and after use. Failures are to be reported to the PT via Equipment Failure Reports EFRs. BATUS should carry out a 100% check of the BATUS TCV ES system clamp assemblies for serviceability. EFRs should be raised for all failures.

6. Action addressees are encouraged to fully implement the recommendations and complete the Report Response Form (RRF) giving details of their action/plan, within 30 days of the date of the report. These RRFs are mandatory and are held by SEFIT for 6 years in case of litigation.

Original Signed

[redacted]

For Land Systems Team Leader

Attachment:

1. SEFIT 11-0108-SEF dated 10 Jun 11.

Cranfield Impact Centre
Cranfield Impact Centre (CIM Ltd)
Building 56,
Central Avenue
Cranfield University
Bedfordshire, MK43 0AL

Tel: 01234 754149
Fax: 01234 754280

[redacted]

20th June 2008

Re:- Rollover of Troop Carrying Seat

This short report confirms that the Cranfield Impact Centre have performed a series of physical tests on a set of Troop Carrying Seats attached to a truck for Roush Technologies Limited on 20th June 2008. In all cases, the rollcage structure did not deform into the survival space occupied by the mannequins. The attachment mechanism of the rollcage to the floor of the truck maintained integrity throughout the testing programme. The three tests are itemised below.

1 Rollover test

A dynamic rollover test was performed with a six seat troop carrying assembly mounted onto a Bedford truck. The rig was capable of performing an ECE R66 rollover test. The vehicle was mounted onto the platform 800mm from the ground and tilted until it initiated into a roll at [redacted] The vehicle struck the ground and damage occurred to the rollcage and cab structures. The mannequin cut-outs included in the seats were un-damaged by the test. 440kg of ballast was attached to the floor of the truck and 60kg of ballast was attached to each seat.

2 Static Roof Crush

Using the same vehicle and configuration as used in the rollover test, the vehicle was upturned and lowered statically onto the ground. The vehicle was loaded via the top of the rollcage and the cabin. The rollcage was able to support the rear axle mass of the vehicle, without damage to the mannequins.

3 Dynamic Roof Crush

A new set of six seats was mounted onto the back of the truck in the same location as for the rollover and static tests. The ballast on the floor of the truck was maintained, but there was no ballast associated with the dummies included. The cab was upturned and suspended by two cranes. The rear section of the truck was allowed to drop towards the ground, whilst the cabin was held off the ground. First contact was made with the rearmost rollcage and subsequently all rollcages were loaded. Deformation of the rollcages was observed, although it did not damage the survival space vacated by the mannequins.

[redacted]
Senior Project Engineer,
Cranfield Impact Centre,

Tel: +44 (0) 1234 754149
Fax: +44 (0) 1234 754280

Email: [redacted]

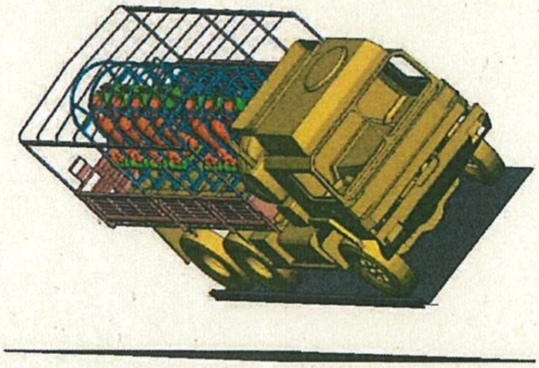
Report 15013.012

TCVES Mk2

Computer Aided Engineering Assessment of Seating System Structural Integrity under ECE Reg66 Truck Tilt Testing with 95%tile Occupant Mass

Date 07/06/2016

Author [redacted] Vectayn Ltd



Executive Summary :

Report 15013.012 TCVES Mk2, Computer Aided Engineering Assessment of Seating System Structural Integrity under ECE Reg66 Truck Tilt Testing with 95%tile Occupant Mass

Objective

The objective of this study was to assess the structural strength of the MK2 TCVES system mounted on an HX58 truck, undergoing ECE reg66 type tilt testing loaded with the mass of 14 95%tile occupants.

Results & Conclusions

- The Mk2 TCVES frame is predicted to provide a survival space greater than the volume of a 95%tile occupant at all seat positions under ECE66 Tilt testing with a full compliment of 14 95%tile occupant masses.

- The occupant restraint anchorages are predicted to remain sound.

- The rear of the rearward (8 seat) frame suffers the most distortion due to the twist of the truck chassis. At the worst point, the upper beam of the load bed frame comes within 36mm of the 95%tile occupant helmet volume.

- The kerb weight of the HX58 truck, plus equipment mass, results in a rear axle load of [redacted] This, together with the 1330kg weight of occupants could be approximated as applying [redacted] through the load bed and TCVES frame on roll over.

- The peak force acting through the worst case TCVES floor fixing, along the length of the fixing (normal to the floor) is predicted to be approximately 22kN.

- ECE regulation 66 is a test of structural strength and survival space around the occupants. It is not a test of occupant injury. However, for reference in any potential future development work, lateral accelerations of the frame at occupant shoulder height are presented within this report.

Recommendations

- The conclusions gained from this study should be considered along side those of parallel studies investigating the seating system and vehicle combined structural performance, occupant restraint strength and front impact protection.

1.0 Introduction

The objective of this study was to predict, through Computer Aided Engineering (CAE) calculation, the structural strength of the MK2 TCVES seating system mounted on an HX58 truck, undergoing ECE reg66 type tilt testing.

Models of the seating system with a full compliment of 95kg occupants (representing 95%tiles) and HX58 truck at [redacted], were combined and tipped from a platform into an 800mm deep gully as defined by the test. The use of 95%tile mass goes beyond the requirement of ECE66. The interpretation of results also differs for the seating system as the regulation defines a survival space a certain distance inside the roll over protection which does not equate to the occupant space in TCVES. Instead, structural, or ground intrusion into the 95%tile occupant volume will be considered as the failure criteria.

2.0 Method

2.1 Summary

An HX58 truck model, with Mk2 8 and 6 seat TCVES systems mounted on the load bed, including 14 x 95kg occupant mass, was placed on the tilt table. The whole assembly was pre-tilted to the point at which the vehicle centre of gravity just passed the tile table lip. Finite element analysis was initiated allowing the vehicle to tip and drop under gravity, to the rigid floor 800mm below.

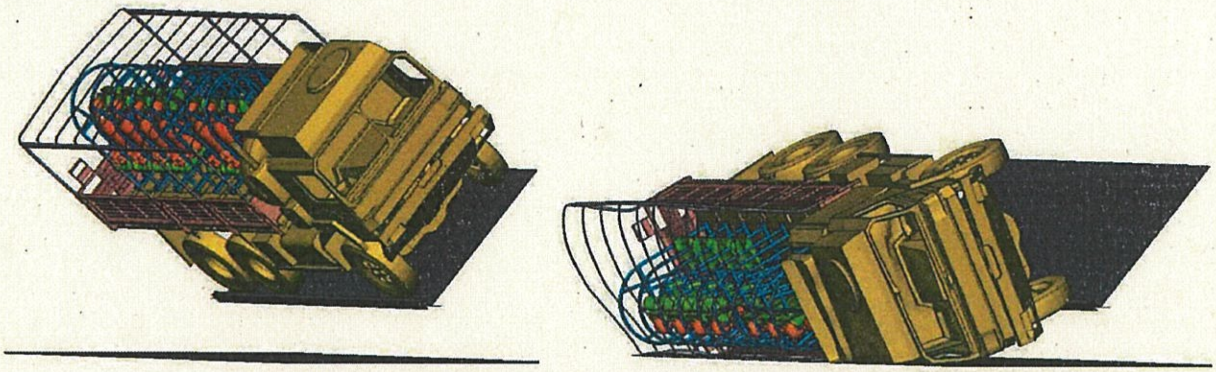


Fig 2.1 : Truck Tilt Images

Non-linear, dynamic finite element analysis was conducted using LS-DYNA code.

Results were recorded to measure, amongst other details;

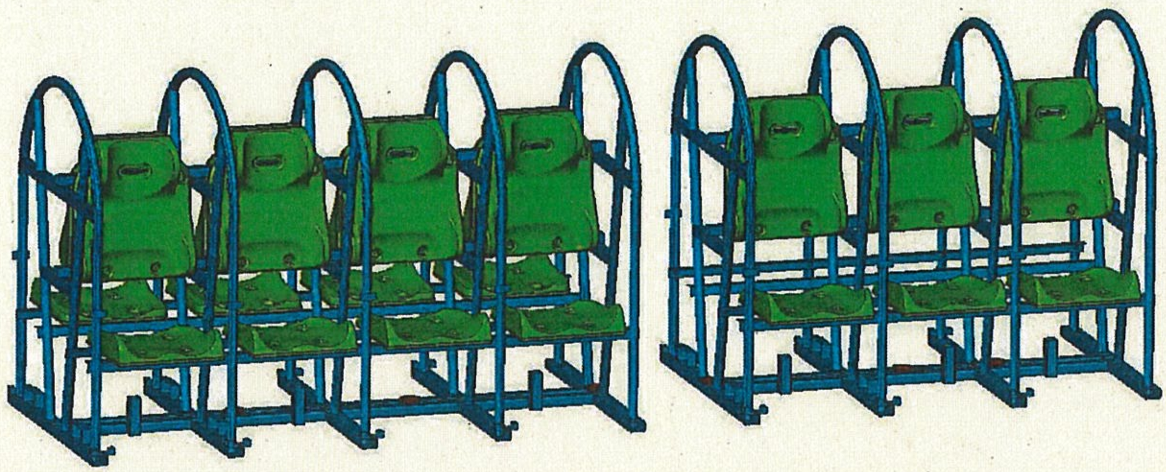
- Frame deformation
- Frame acceleration
- Forces acting through the floor fixings in X,Y,Z cords.

2.2 Seat Frame Model

The TCVES frame CAE model source data, finite element detail and material data is presented in Appendix B of this report.

CAE simulation was carried out on the full 14seat twin frame combination

Fig 2.2 : TCVES Mk2 Seating Frame CAE model



Three floor clamps per frame connected the TCVES systems to the load bed floor. Clamps were modelled as rigid with rigid connection to the load bed sockets i.e. no slippage possible.

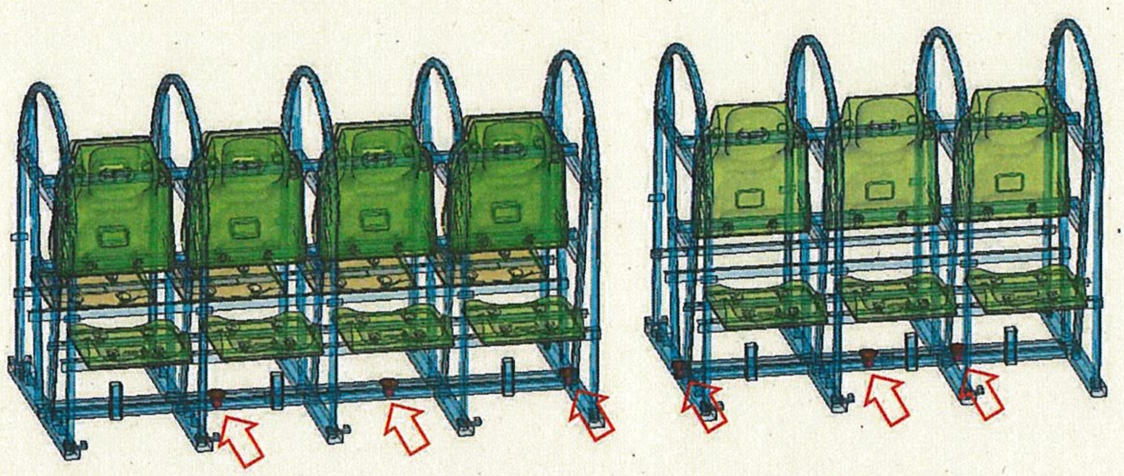
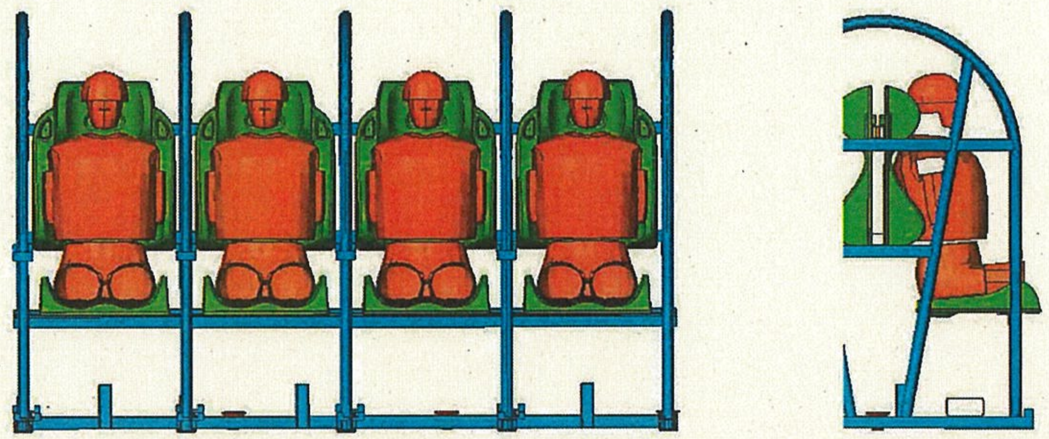


Fig 2.3 : Floor clamp locations

Surfaces of manikins were attached to the seats of the frame impact side to give a reference of the survival space, during and after the impact. The surfaces were created from a 95th percentile dummy and positioned visually against the seat. The torso of the manikin was expanded +50mm outwards to represent body armour on the occupant and the upper head surface was expanded +20mm outward to represent the helmet. The surfaces were created as a visual aid only. They provide no stiffening affect to the frame and impart no mass or contact to frame, truck or ground

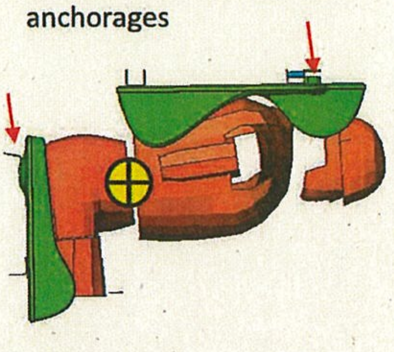
Figure 2.4 Occupant Manikins



2.1.1 Occupant Mass

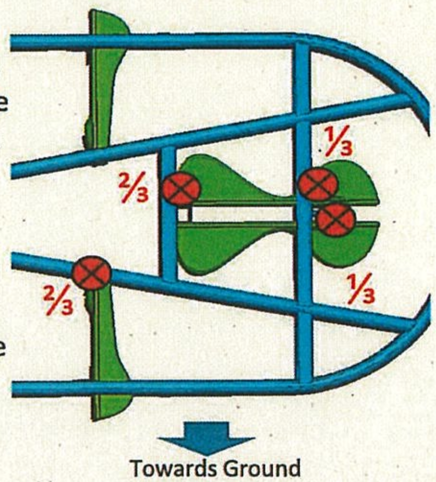
A mass of 95kg (95%tile) was included for the occupant at each seat. This applied a total of 1330kg for the 14 seats. Occupant masses were modelled as point mass elements distributed over 4 points per occupant.

The C. of G. of an occupant facing towards the ground is distributed approximately ⅔ - ⅓ in favour of the lower belt anchorages



For the occupants on the upper side during roll over, masses were applied to the 4 mount fixings of the seat back

For the occupants on the lower side during roll over, masses were applied to the 4 seat belt anchorage points

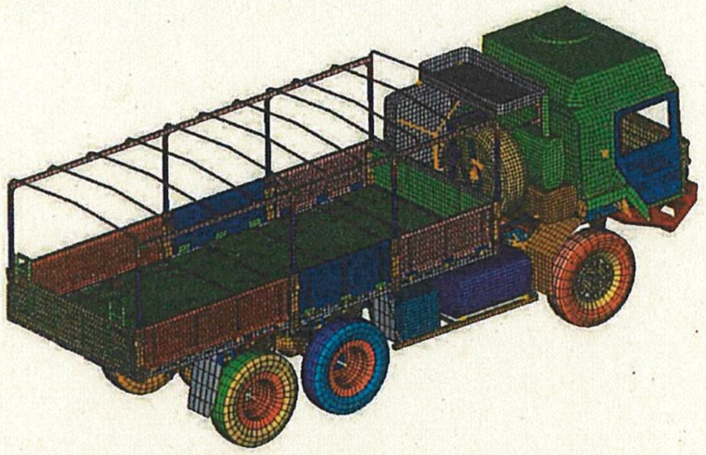


2.3 HX58 Truck Model

The manufacturer's design data was not available for the HX58 truck. Hence, the model was built from limited design information. The HX58 truck model produced is considered to be representative in exterior geometry, wheel track and wheel base, mass distribution, load bed stiffness and main chassis rail stiffness. It is not accurate in cab stiffness, chassis cross member detail, suspension, wheel/tyre or drive train detail.

The construction of the HX58 truck model is described in Appendix 1

Fig. 2.5 : HX58 Truck & Load bed Model

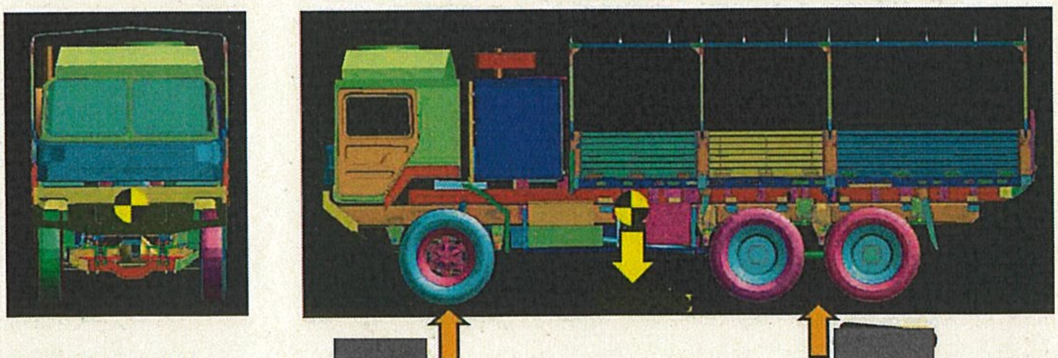


HX58 Truck Mass

Additional masses were added to the CAE model components for each of the sub assemblies defined in the spreadsheet *HX58 CoG & weight Data.xlsx*, supplied on 21/01/2016. The breakdown of this is shown in Appendix D. Cab armour as defined in the spread sheet was not added.

The total HX58 truck mass attained was [redacted]

The centre of gravity was located, 2394mm from the front axle,
45mm below the top of the main chassis rail
80mm offset from centre line (towards offside)



[redacted] [redacted]

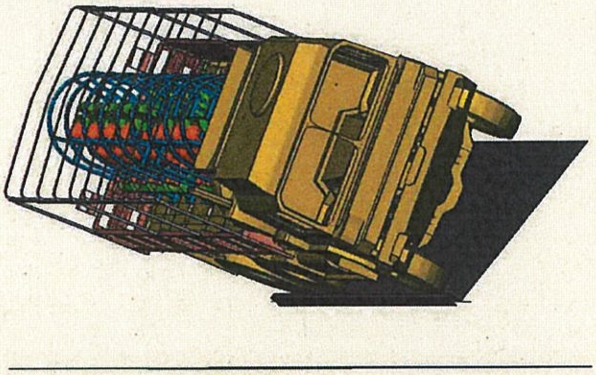
Fig. 2.6 : HX58 CAE model Centre of Gravity plots

It could be approximated that [redacted] truck mass acts on the TCVES frame during roll over

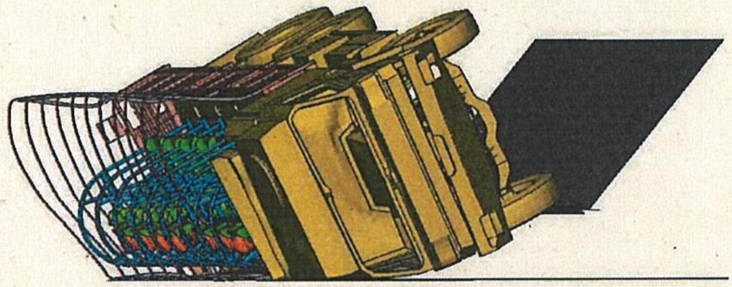
3.0 Results

Refer to animation files *TCVES_Mk2_HX60_truck_ECE66_Tilt_1view.avi* & *TCVES_Mk2_HX60_truck_ECE66_Tilt_2views.avi*

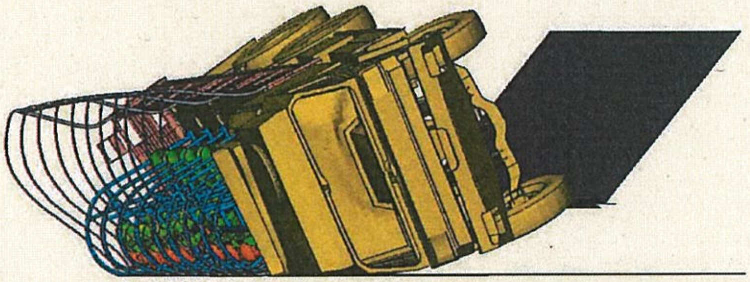
3.1 Tilt Event Kinematics



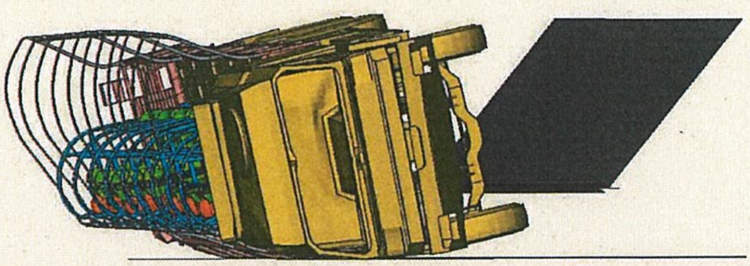
The truck begins to tip



The load bed frame and cab impact the ground



The TCVES frame impacts the ground

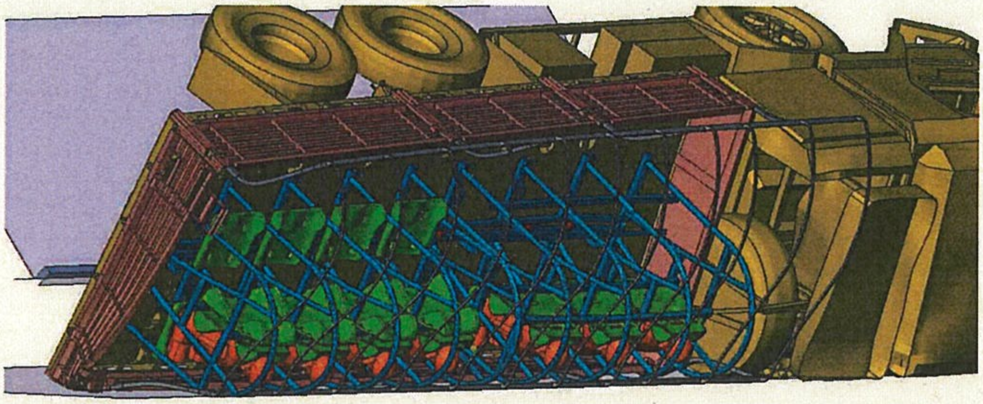


The truck slides outwards and rolls back onto it's side

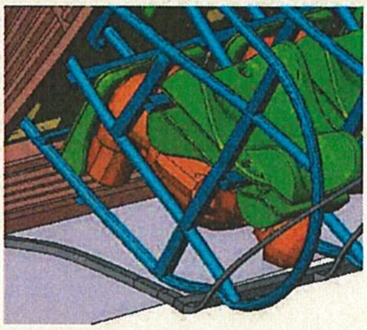
3.2 Structural Behaviour of TCVES

Mid Impact

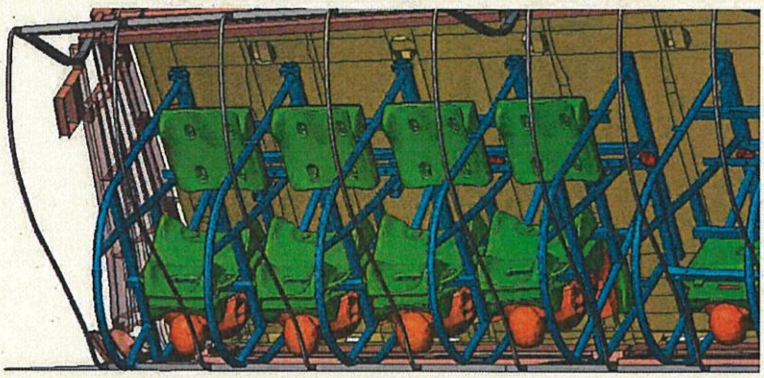
The load bed & chassis twists, causing greater deformation towards the rear of the frames.



The rear roll hoops distort around the load bed frame

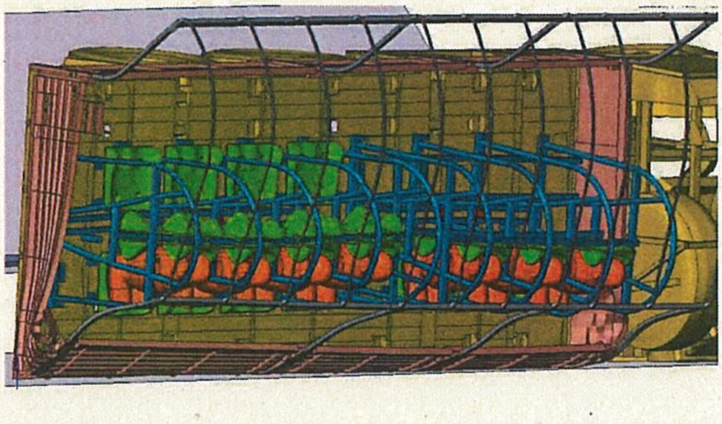


The central seat spine and roll hoops bow slightly under the weight of the occupants

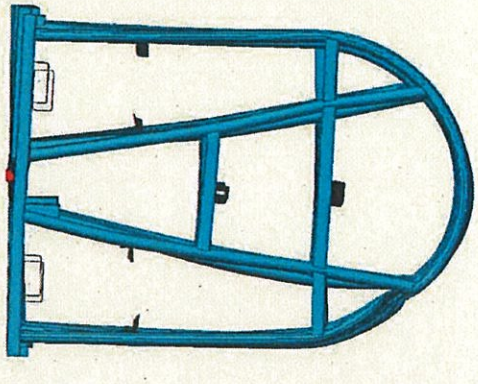


Post Impact

The frames are predicted to remain intact and suffer generally low levels of distortion



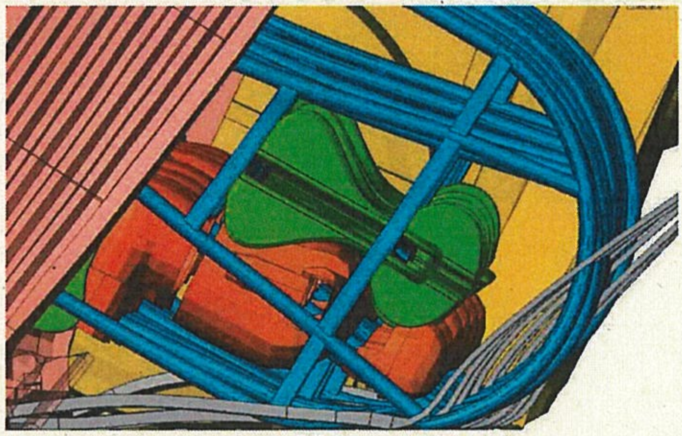
End view, rearward 8 seat frame

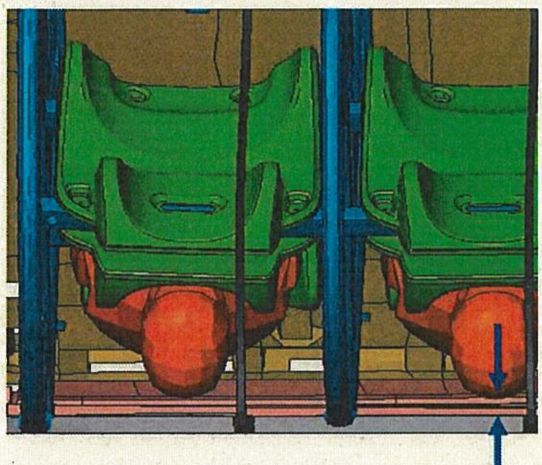


3.3 Effect on Survival Space Around the Occupants

As the structure remains intact, the occupant restraint anchorages are predicted to remain sound.

The roll frames prevent the ground from encroaching into the occupant volume for all seating positions.



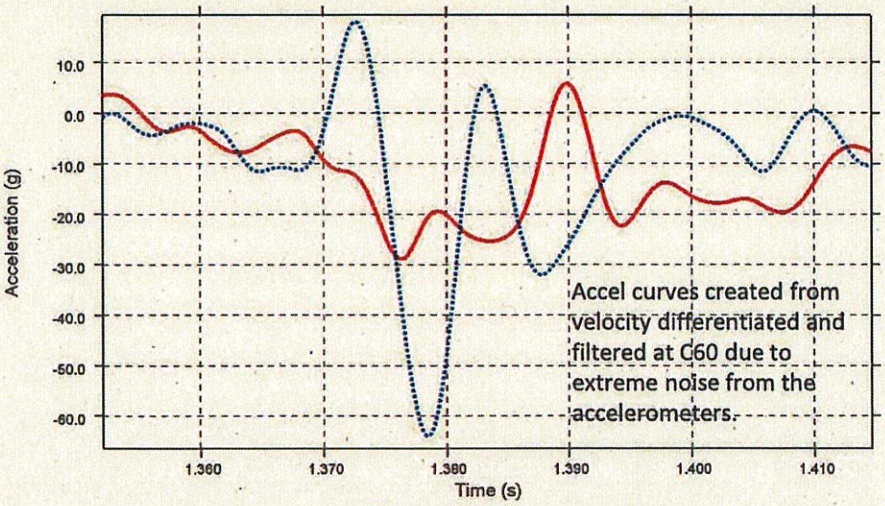


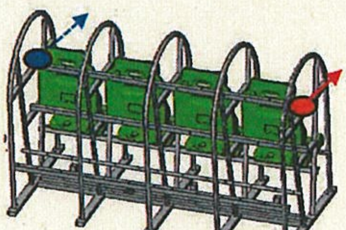
The load bed frame upper beam comes within 36mm of the occupant helmet volume

36mm

3.4 Impact Accelerations

ECE regulation 66 is a test of structural strength and survival space around the occupants. It is not a test of occupant injury. However, for reference in any potential future development work, lateral accelerations of the frame at occupant shoulder height are presented below for the instant of frame to ground impact. These could potentially be used to assess the actions of the occupants.

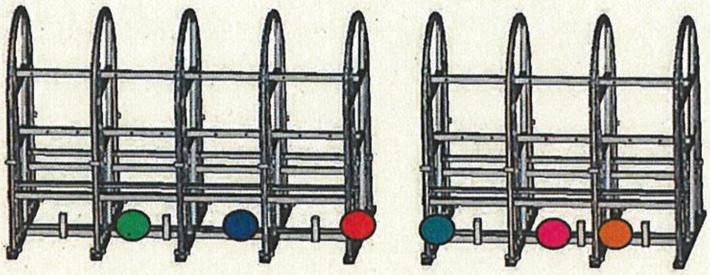




Graph 3.1 : **Acceleration of 8 seat TCVES frame in local lateral axis during initial ground impact**

3.5 Force Acting Through the Floor Fixings

The peak force, acting normal to the floor predicted through the worst case fixing under ECE66 Tilt impact was approximately **22kN.**



4.0 Conclusions

- The Mk2 TCVES frame is predicted to provide a survival space greater than the volume of a 95%tile occupant at all seat positions under ECE66 Tilt testing with a full compliment of 14 95%tile occupant masses.

- The occupant restraint anchorages are predicted to remain sound.

- The rear of the rearward (8 seat) frame suffers the most distortion due to the twist of the truck chassis. At the worst point, the upper beam of the load bed frame comes within 36mm of the 95%tile occupant helmet volume.

- The kerb weight of the HX58 truck, plus equipment mass, results in a rear axle load of [redacted] This, together with the 1330kg weight of occupants could be approximated as applying [redacted] through the load bed and TCVES frame on roll over.

- The peak force acting through the worst case TCVES floor fixing, along the length of the fixing (normal to the floor) is predicted to be approximately 22kN.

- ECE regulation 66 is a test of structural strength and survival space around the occupants. It is not a test of occupant injury. However, for reference in any potential future development work, lateral accelerations of the frame at occupant shoulder height are presented within this report.

5.0 Recommendations

- The conclusions gained from this study should be considered along side those of parallel studies investigating the seating system and vehicle combined structural performance, occupant restraint strength and front impact protection.

Appendix A

HX58 Truck Model Construction

Appendix A HX58 Truck Model

Load Bed

The load bed was modelled from manufacturers CAD and is considered to be an accurate representation of the structure in terms of geometry and stiffness for this level of structural prediction.

Load Bed CAD file Supplied on 14/12/2015 :
HX58 Non-Winch.stp

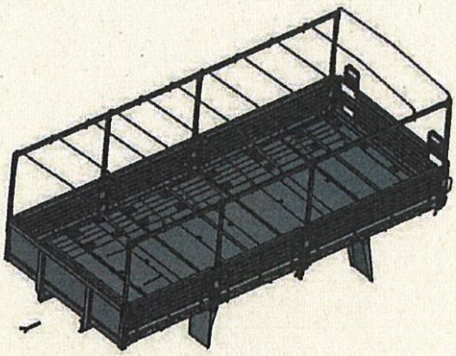


Fig. A1.1 : HX58 Load Bed CAE model

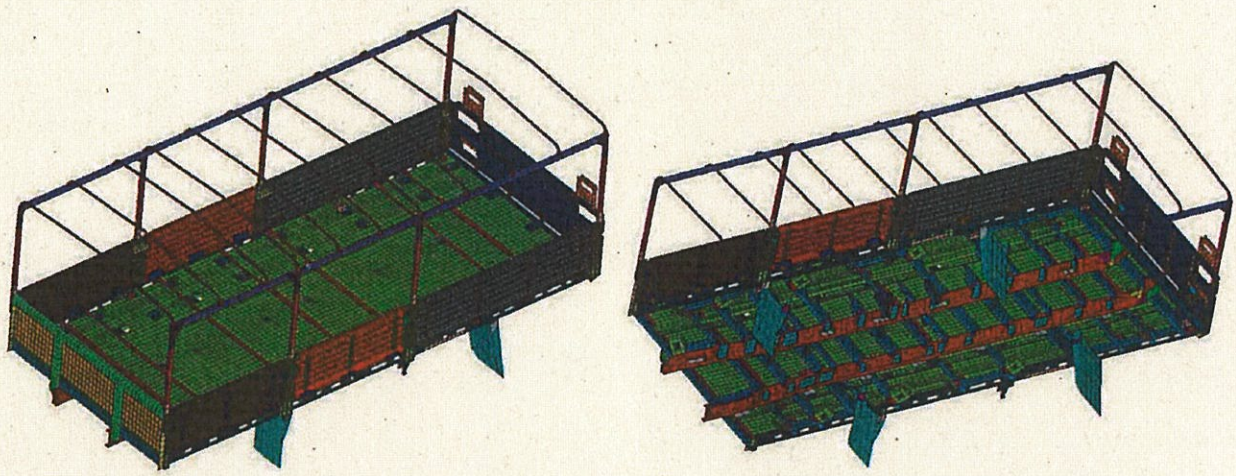
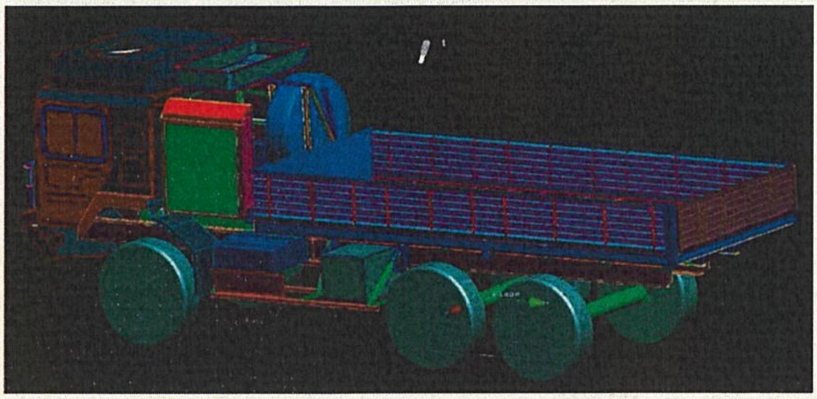


Fig. A1.2 : HX58 Truck Exterior scan



Truck Model

Manufacturers CAD data could not be supplied for the truck. Instead, CAD was created from a scan of the exterior surfaces of the truck chassis and cab.

Chassis Model

Due to the lack of definition in suspension, wheel/tyre and chassis data, these parts were obtained from an open source truck model, described in Appendix C of this report,. The parts were scaled, translated and duplicated then combined with the scanned chassis rail CAD to create the HX58 Truck chassis model of representative chassis size, ride height, wheel base & track and tyre size.

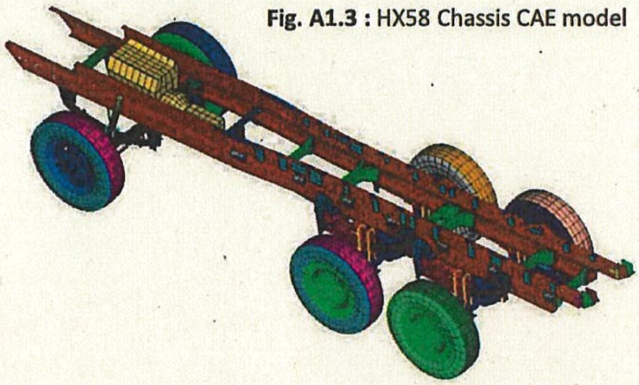


Fig. A1.3 : HX58 Chassis CAE model

Cab Model

The cab model contained geometrically correct representations of main inner & outer panels, frt bumper, frt panel, IP beam and door inner & outer panels. The lack of design info relating to reinforcement panels and gauges meant that the cab stiffness was not accurate. The overall roll impact stiffness of the cab was tuned (through panel gauge adjustment) to match the levels of deflection observed in roll testing of a Bedford truck of similar size but of older design

Fig. A1.4 : HX58 Cab Model

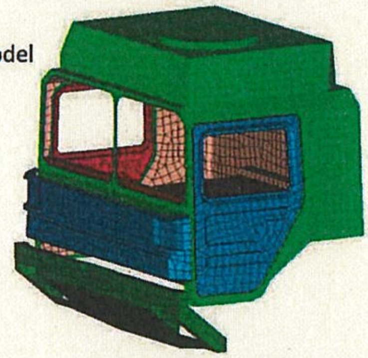
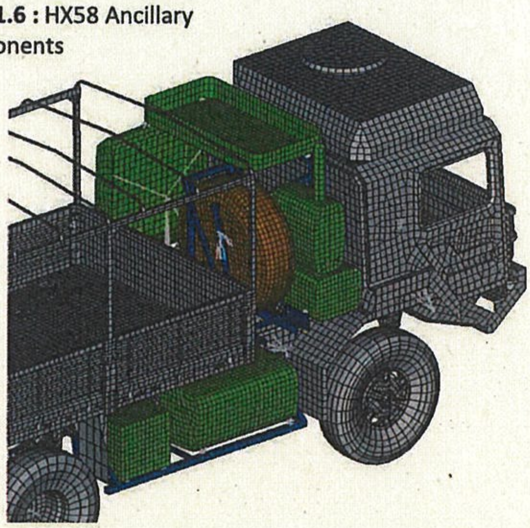


Fig. A1.5 : Comparison, tilt test cab deformation - HX58 CAE Model vs Bedford truck test

Fig. A1.6 : HX58 Ancillary components



Ancillary components were modelled from the surface scan CAD. The spare wheel is considered representative as it has the rubber and inflation characteristics of the mains wheels. Other components however are accurate in geometry but not necessarily stiffness.

Full Truck CAE Model

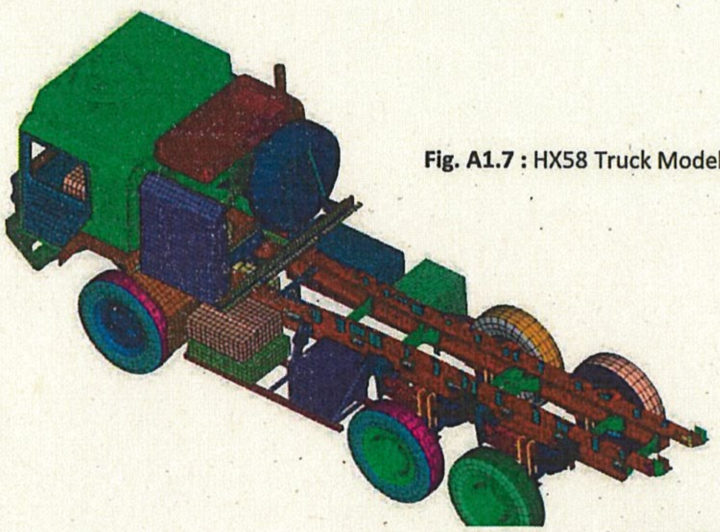
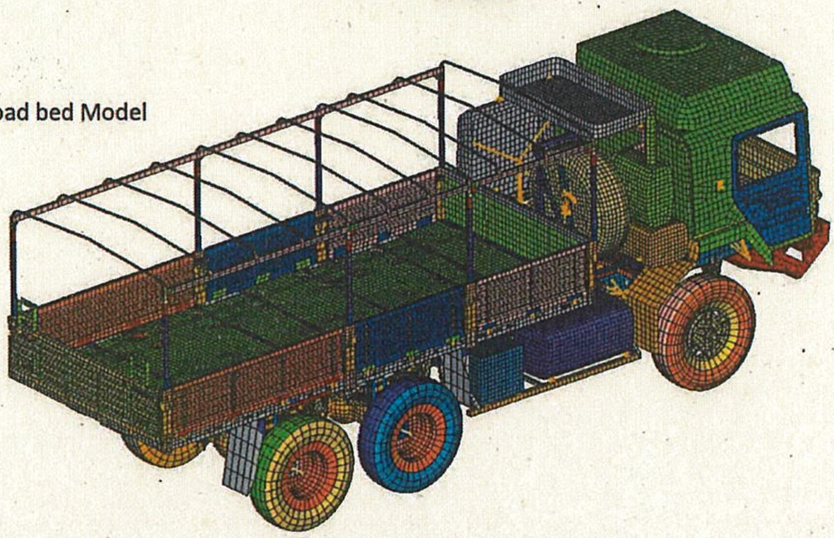


Fig. A1.7 : HX58 Truck Model

Fig. A1.8 : HX58 Truck & Load bed Model



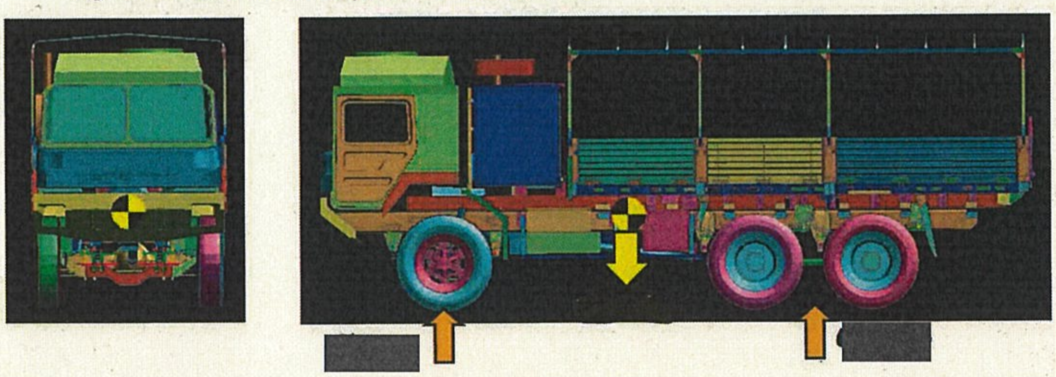
HX58 Truck Mass

Additional masses were added to the CAE model components for each of the sub assemblies defined in the spreadsheet *HX58 CoG & weight Data.xlsx*, supplied on 21/01/2016. The breakdown of this is shown in Appendix D. Cab armour as defined in the spread sheet was not added.

The total HX58 truck mass attained was [redacted]

The centre of gravity was located, 2394mm from the front axle,
45mm below the top of the main chassis rail
80mm offset from centre line (towards offside)

Fig. A1.9 : HX58 CAE model Centre of Gravity plots



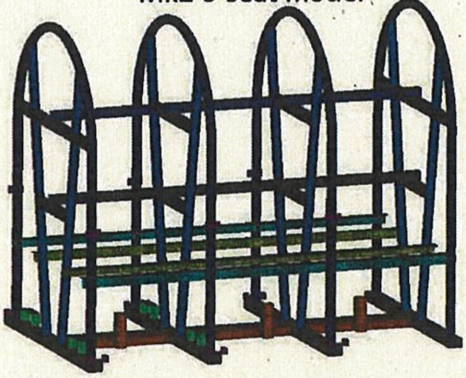
Appendix B

Finite Element Model Detail
Mk2 TCVES Frame

CAE Model Summary

Finite element (FE) models of the Mk2 frame structure and floor constraint matching HX58 installation, for both 6 seat and 8 seat variants were created in LS DYNA code format.

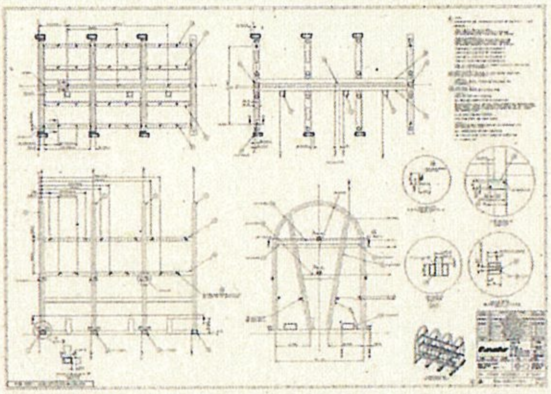
Mk2 6-seat model

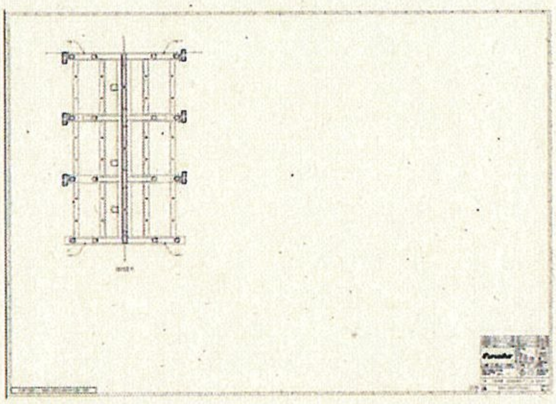


Mk2 8-seat model

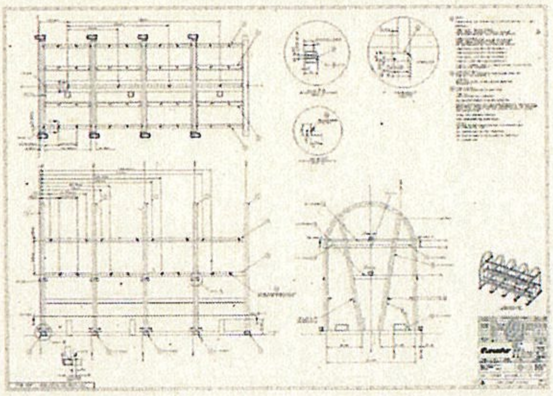
Design Data

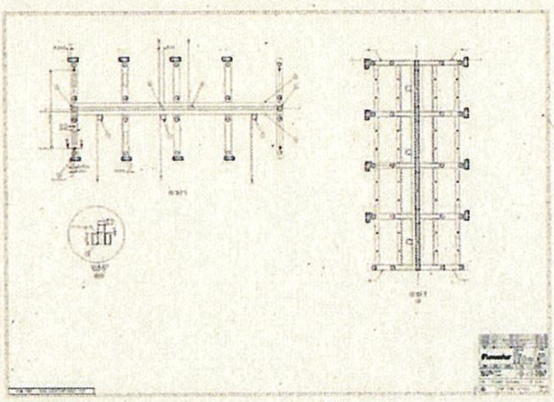
The 6 seat frame FE model was constructed from drawing files
RSK-2061-01001-E_SHT-1.pdf & RSK-2061-01001-E_SHT-2.pdf





The 8 seat frame FE model was constructed from drawing files
RSK-2061-01002-E_SHT-1.pdf & RSK-2061-01002-E_SHT-2.pdf

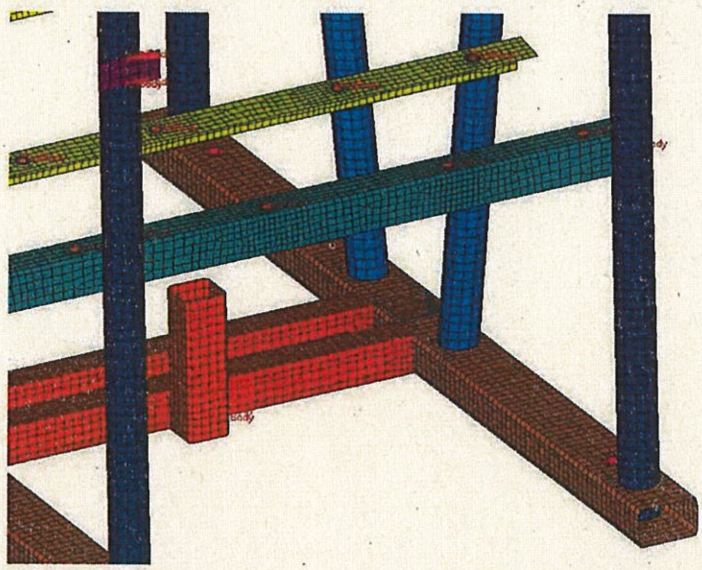




Finite Element Model Detail

The frame models were constructed in Thin-Shell elements, predominantly 4-node QUADs and some 3-node TRIAs. Average element size was 12mm with refinement around some details. Thickness was assigned as defined on the drawing pdf files.

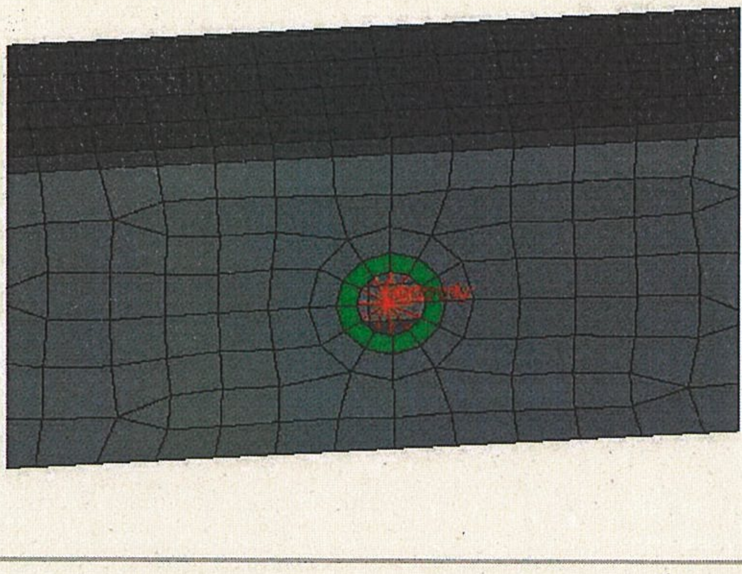
Example of Finite Element Mesh



Parts were modelled to mid-surface. At welded joints, parts were connected by shared nodes, or, where this was infeasible without mesh distortion, through the use of singular node to node rigid links.

Bolt points and rivnuts were modelled as a thickened region of 5mm under the area of the washer/rivnut with a rigid link connecting the centroid to the perimeter of the hole. A ring of equi-spaced QUAD elements was placed around the washer/nut for consistent stress calculation

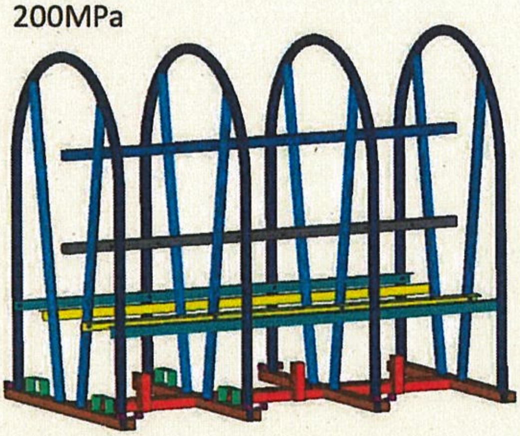
Example of Rivnut model detail



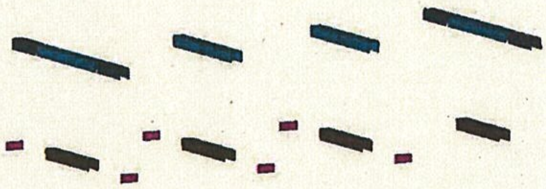
Material Data

Material allocation represents the minimum grades specified in the frame drawings.

The majority of the members are specified with minimum yield 200MPa



Hoop cross members and minor plates are specified as BS1449 HR4. This steel has yield in the region 170-340. For this study the minimum yield of 170MPa has been modelled



Properties Applied :

Density	7.85e-9 Mg/mm³
Elastic Modulus	210,000MPa
Poissons Ratio	0.3
Yield Stress	203MPa
Failure Strain	25%

Strain Rate Hardening Coefficients

C=1300.0 P=5.0

Properties Applied :

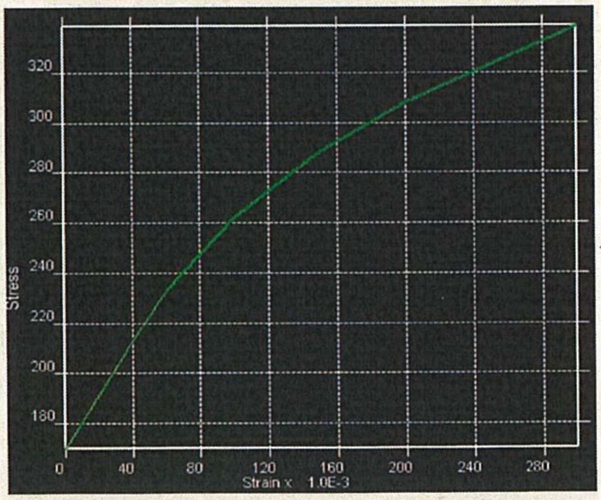
Density	7.85e-9 Mg/mm³
Elastic Modulus	210,000MPa
Poissons Ratio	0.3
Yield Stress	170MPa
Failure Strain	25%

Strain Rate Hardening Coefficients

C=710.0 P=5.88

Stress-strain Plot

Post Yield Stress-strain Plot : 170 Yield

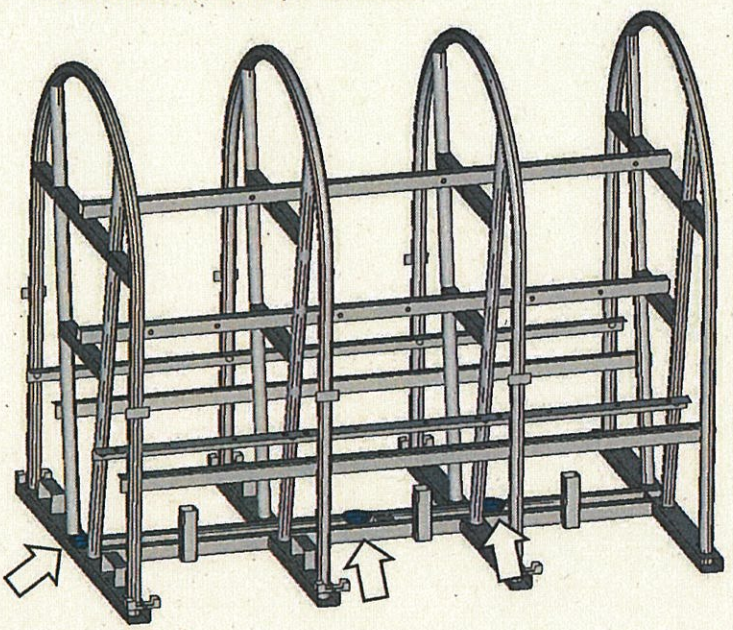


Constraints

A rigid floor was placed under the frames. The frames were attached to the floor by three clamps positioned at seat mounting points as directed in document *Support Vehicle Cargo Light (SVCL) 9 Tonne 6x6 Installation Instruction No. 6* and dimensioned from document *TD-MSV- 3123-Load Interfaces Safe Designers Guide Iss 3.*

The clamps were modelled as fully fixed rigid surfaces and constrained the frame via a surface to surface contact. No preload (clamping force) was modelled. Note that this study assesses the strength of the frame and not the strength of the clamping mechanism. Forces between clamps and frame can be extracted to facilitate a future clamp strength assessment.

6 seat frame Clamp Positions

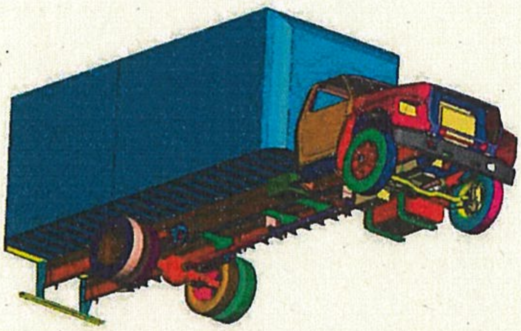


Clamp to frame example condition

This method of constraint allows the frame to separate from the clamp to facilitate accurate representation of frame distortion.

Appendix C

Donor Finite Element Model from which, Suspension, Drive train and Chassis Components were obtained



Filename : F800.k

$--
$- This model has been developed by the National Crash Analysis Center at The
$- George Washington University. The FE model is based on a 1995 Ford F800
$- Single unit truck. The model has been validated to an oblique impact test
$- into an F-shape barrier (test conducted at FOIL). The results are published
$- in the International Journal of Vehicle Systems Modeling and Testing
$- http://www.inderscience.com/search/index.php?action=record&rec_id=11423
$-
$- The model was further improved by Battelle Memorial Institute.
$- http://thyme.ornl.gov/FHWA/F800WebPage/partSets/partSets.html
$-
$- The model is continuously updated to improve its capabilities in
$- predicting responses in various impact scenarios. However, the user must
$- verify his own results. Neither NCAC, GWU, FHWA or NHTSA assume any
$- responsibility for the validity, accuracy, or applicability of any results
$- obtained from this model.
$-
$- Please feel free to contact us with any suggestions, comments, or
$- questions.
$- [redacted]
$-
$-
$-
$-

Appendix D

Mass Breakdown for Man HX58 Truck

Appendix C : Mass Breakdown for Man HX58 Truck

[redacted]

Appendix C Continued.... Mass Breakdown for Man HX58 Truck

[redacted]

Vectayn Data Reference

Analysis Code : LS-Dyna **Analyst :** [redacted]

CAD :
P:\W15013-Revolve_ROPS\Data_In\15_12_14_Load_Bed\MARSHALL DOWN LOAD\HX58 Non-Winch.stp
P:\W15013-Revolve_ROPS\Data_In\16_11_03_Truck_CAD
Original Frame CAD:
P:\W15013-Revolve_ROPS\Model_Build\Revolve_ROPS_Frame
ROPS_FRAME_6_SEATS_071127.stp
ROPS_FRAME_8_SEATS_071127.stp

Latest Drawings
P:\W15013-Revolve_ROPS\Data_In\Revolve_ROPS_Frames_Drawings

Load Bed Constraint Dimensions
P:\W15013-Revolve_ROPS\Data_In\15_09_10_designers_guides
TD-MSV- 3123-Load Interfaces Safe Designers Guide Iss 3.pdf

Material Curves
P:\W15013-Revolve_ROPS\Reports\Steel_curves_used.xlsx

Analyses
P:\W15013-Revolve_ROPS\Analysis\Mk_2\Truck_runs\Tilt
TCVES_14seat_assembly_22042016_ECE66_OccMass95d_47483
Include Files
P:\W15013-Revolve_ROPS\Analysis\Mk_2\Truck_runs\Include

Supporting Animation Files
P:\W15013-Revolve_ROPS\Reports\Animations
TCVES_Mk2_HX58_truck_ECE66_Tilt_1view.avi
TCVES_Mk2_HX58_truck_ECE66_Tilt_2views.avi

This Report :
W15013_012_TCVES_Mk2_Reg66_Truck_Tilt_CAE_simulation_07052016.pptx

RESTRICTED

DEFENCE LAND SAFETY REGULATOR

DSEA

Defence Safety and Environment Authority

SERIOUS EQUIPMENT FAILURE INVESTIGATION TEAM

SERIOUS INCIDENT

TITLE: TROOP CARRYING VEHICLES ENHANCED SEATING SYSTEM MK2

ERM – MT0148

SEATING POD DETACHMENT

REFERENCE NO: SEFIT 12-051-SI

SEFIT 12-051-SI

TROOP CARRYING VEHICLES ENHANCED SEATING SYSTEM MK2

ERM – MT0148

SEATING POD DETACHMENT

Investigating Officer	
Name:	[redacted]
Rank / Appt:	[redacted]
Signature	Original Signed
Tel:	[redacted]
Date:	17 Mar 12

Engineering Officer	
Name:	[redacted]
Rank / Appt:	[redacted]
Signature	Original Signed
Tel:	[redacted]
Date:	17 Mar 12

Please direct any queries/comments on this document to:

By Mail:

SEFIT (UK)
Defence Land Safety Regulator
ELM 1C
#4136
MOD Abbey Wood
Bristol
BS34 8JH

By Email:

DSEA-DLSR-SEFIT-UK-Mailbox

Action:

DES LE GSG-SLV-OutSp-SafetyMgr [redacted]
1RIFLES-BHQ-2IC[redacted]

Copy to:

LF-Eqpt Dir (Mailbox) (MULTIUSER)
LF-Cap-Cbt-0Group Mailbox (MULTIUSER)
DEME-HQ-MAILBOX (MULTIUSER)
LF-CESO(A)-&LAIT-Mailbox (MULTIUSER)
LF-CESO(A)-&AINC-mailbox (MULTIUSER)
3UKXX-G4-ES-AVAILMNGT-SO2
1UKXX-ES-GROUP-ACCT (MULTIUSER)
THTPS-SO2 ES Mech [redacted]
3CDOX-HQ-BART[redacted]
1RIFLES-LAD-AQMS [redacted]
DES LE GSG-SLV-SV-Cargo-ESM [redacted]
DSEA-DLSR-POLPLANS-VP
DSEA-DLSR-Sys-Perf1
DSEA-DLSR-SEFIT-SO2
DES LE COS-Group Mailbox (MULTIUSER)
DSEA-DLSR-SEFIT-UK-Mailbox (MULTIUSER)
DSEA- DLSR-SEFIT-G-Mailbox(MULTIUSER)

CONTENTS

SEFIT 12-051-SI

TROOP CARRYING VEHICLES ENHANCED SEATING SYSTEM MK2

ERM – MT0148

SEATING POD DETACHMENT

References:

A. Telecon [redacted] dated 28 Feb 12.
B. Joint Service Publication (JSP) 886 (Ver 1.5, dated 14 Nov 11), Vol 5, Part 2, Chap 4.
C. Army Equipment Support Publication (AESP) 2320-G-300-111, Edn 2, Amdt 1, dated Jan 11 - Equipment Support Policy Directive.
D. AESP 2320-G-300-411, Edn 2, Amdt 2, dated Oct 10 - Installation Instructions and Index.
E. Troop Carrying Vehicles Enhanced Seating (TCV ES MK2) – Safety & Engineering Issues Update, letter dated 14 Dec 11 (attached).

ENGINEERING OFFICER'S EXECUTIVE SUMMARY

1. This report details an investigation into the detachment from the cargo platform of a Troop Carrying Vehicle Enhanced Seating System Mark 2 (TCV ESS Mk2) as a result of a Road Traffic Incident.

2. It was discovered that clamps used to secure the seating system were not fitted correctly and that mandated maintenance and inspection details were not being recorded.

3. The investigating officer's key recommendations to prevent a recurrence are that the Project Team instigate an inspection programme to ensure the correct fitment of all seating systems and reiterates the correct procedure for fitting the seating arrangement to all users; particularly the enhanced securing arrangements recently promulgated in a Safety & Engineering Issues update.

INVESTIGATING OFFICER'S RECOMMENDATIONS

4. The conclusions and recommendations made by the Investigating Officer are fully endorsed by the Engineering Officer. The engineering authority for this equipment lies with the General Support Group Specialist Logistic Vehicles Project Team (GSG SLV PT). It is recommended that:

a. **GSG SLV PT:**

(1) Instigates an inspection programme to ensure the correct fitment of all currently installed seating systems and reiterates to users of TCV ES the correct procedure for fitting the seating arrangement in accordance with Reference D and the enhanced measures for securing it as detailed in Reference E.

(2) Ensure all holding units are aware of the requirement to keep TCV ES records as detailed in Reference C.

(3) Update relevant AESP's in accordance with Reference E.

(4) Enter this incident into the Equipment Hazard Log and monitor for future trends.

b. **1st Battalion The Rifles:**

(1) Immediately instigate the recording of fitting, maintenance and inspection of TCV ES in accordance with Reference C.

(2) Carry out a learning account into the incident to identify and resolve any competency or training currency issues with unit personnel who operate TCV ES.

5. The recommendations contained within this report may not be exhaustive; addressees should review this incident to determine if further action, within any of the Defence Lines of Development (DLoD), is required to prevent a reoccurrence.

6. In accordance with Reference B, all action addressees are mandated to complete the Report Response Form (RRF) contained at Annex A and return it to SEFIT UK within 30 days of the date of the report. RRFs are held by SEFIT for 6 years in case of litigation.

INTRODUCTION

7. In response to Reference A and in accordance with Reference B, SSgt Shepherd from the Serious Equipment Failure Investigation Team (United Kingdom) (SEFIT (UK)), deployed to Beachley Barracks, Chepstow. The purpose of the deployment was to conduct an engineering investigation into the detachment of the TCV ESS Mk 2 ERM MT0148 (Figure 1), from a MAN Support Vehicle Cargo 6 Ton 4X4 (MAN SV Cargo 6T 4X4). The equipment is on charge to 1st Battalion The Rifles (1 Rifles), the unit representative, [redacted] was present throughout the investigation.

Figure 1 – Troop Carrying Vehicles Enhanced Seating System (TCV ES)[1]

---

[1] Proxy vehicle, with Enhanced Seating System fitted.

DATA

8. Date of Incident: 28 Feb 12
Date SEFIT Informed: 28 Feb 12
Date of Investigation: 1 Mar 12
Owning Unit: 1 Rifles
Bde: 3 Cdo Bde
Equipment Type: Troop Carrying Vehicles Enhanced Seating System Mk2
ERM: MT0148
Date/Type of Last REME Inspection: 18 Oct 11, MEI (VRN KY11AB), ERM MT0148 not known
PT/DT Informed: [redacted] by email – 7 Mar 12
PT/DT Contact Details: DES LE GSG-SLV-SV-Cargo-ESM

BACKGROUND

9. The background of events has been taken from information gained by the Investigating Officer throughout the course of the investigation:

a. The subject equipment was fitted to MAN SV Cargo 6T 4X4 VRN KY11AB. The vehicle was involved in a Road Traffic Incident (RTI) during which it rolled 90 degrees onto its left side.

b. As a consequence of the RTI the TCV ES Mk 2 seating pods became detached from the cargo platform; no personnel were travelling in the seating at the time of the incident.

TECHNICAL DESCRIPTION

10. Full technical descriptions can be found at References C and D. The following details have been extracted directly from these References and are pertinent to this investigation (*the indexing has been formatted for consistency*):

a. The Troop Carrying Vehicles Enhanced Seating has been developed to provide as low as reasonably practical risk of injury or death to personnel travelling on the cargo platform of the authorised cargo vehicles in the event of a crash or rollover.

b. Reference C refers to the both the original ACS International Ltd Troop Carrying Vehicle (TCV) and Enhanced Seating (TCV (ES)) systems, and the Roush Technologies Ltd TCV ES (MK 2) system as fitted to the incident vehicle. Both types of TCV (ES) are manufactured from steel and have an integral Roll Over Protection System (ROPS) incorporated, affording a high level of troop protection.

c. Each Roush system comprises 14 seats, broken down into a set of 6 and a set of 8, both of which can be fitted independent of the other. The system is designed specifically for SV, although it can be fitted to 4T DAF/Bedford but only as a single 6 or 8 seat module; the full 14 seats will not fit.

d. The installation layout of the clamps for the TCV ES Mk 2 pods when fitted to MAN SV Cargo 6T 4X4 is detailed in Reference D, Installation Instruction Number 6 (Inst Instr No 6) (Figure 2). It further details the need to lock the locking handle down post tightening procedure.

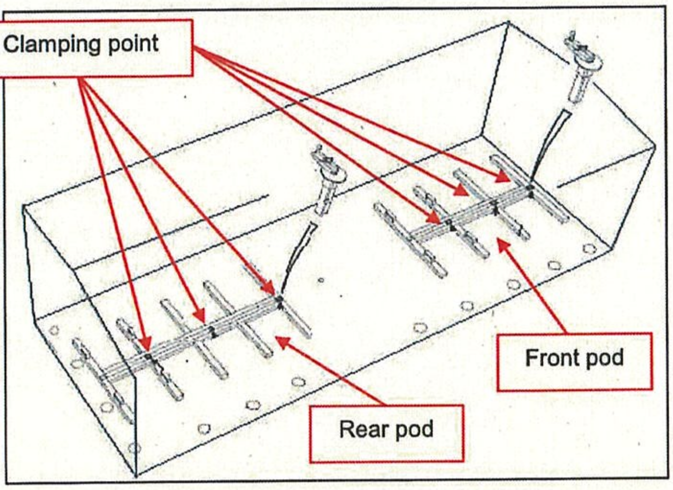


Figure 2 – Clamp assembly layout

INITIAL INVESTIGATION

11. The Investigating Officer spoke to [redacted] and the following points were noted:

a. The Investigating Officer was handed photos of the scene of the RTI taken by [redacted] (1 Rifles LAD). These were examined and it was observed that the vehicle was orientated on its left side and both front and rear TCV ES Mk 2 pods had detached from the cargo platform (Figure 3).

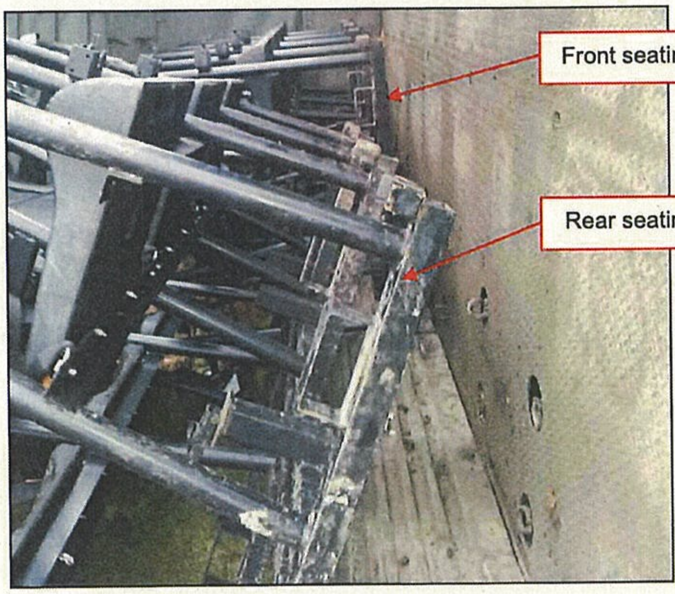


Figure 3 – Detached TCV ES Mk2 pods[2]

[2] Photo taken prior to vehicle recovery.

b. Further examination of the pictures identified that a clamp still located in the TCV ES Mk 2 rear pod was incorrectly positioned (Figure 4). No other clamps were visible on the rear pod.

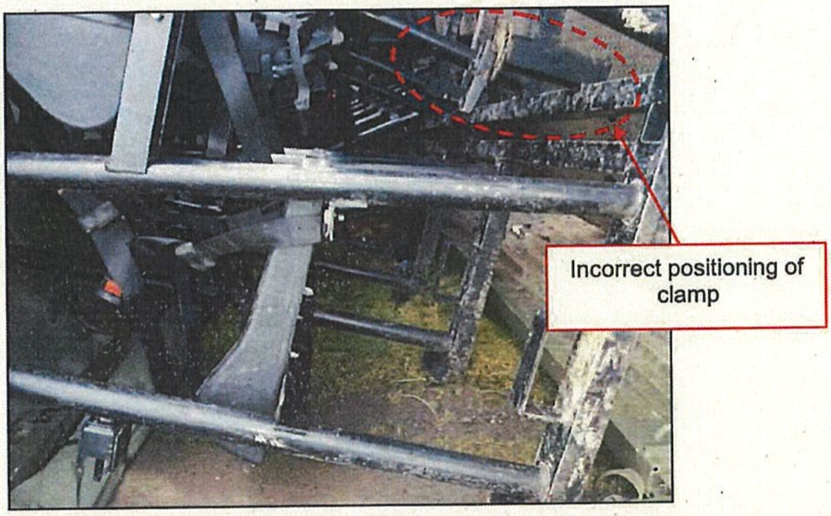


Figure 4 – Incorrectly positioned rear pod clamp

c. Examining the photos taken of the front pod showed that one clamp had been correctly positioned however the clamp handle was not in the locked position, indicating that it had been incorrectly secured to the cargo platform (Figure 5). No other clamps were visible on the front pod.

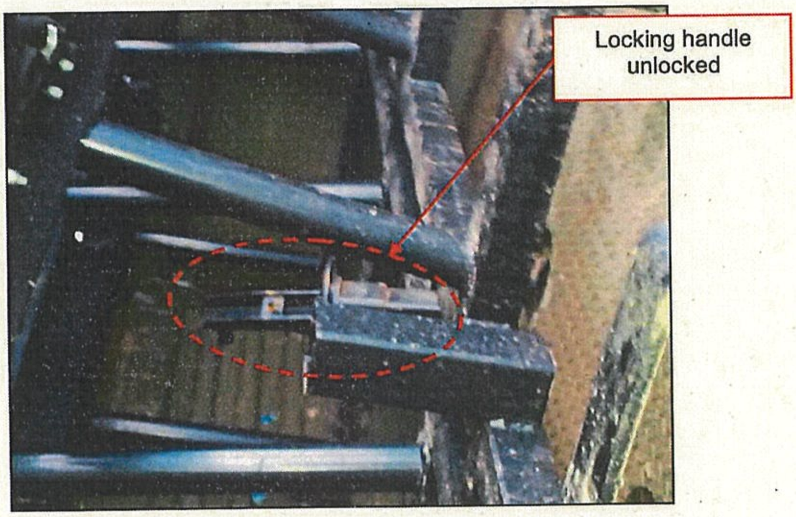


Figure 5 – Incorrectly secured front pod clamp

FURTHER INVESTIGATION

12. The Investigating Officer inspected a MAN SV Cargo 6T 4X4 vehicle located in Beachley Barracks which was also fitted with TCV ES Mk 2. There were 3 locking clamps fitted to each of the TCV ES Mk 2 pods in the correct position. The rear clamp on the front pod was found to be insecure and the locking handle unlocked (Figure 6).

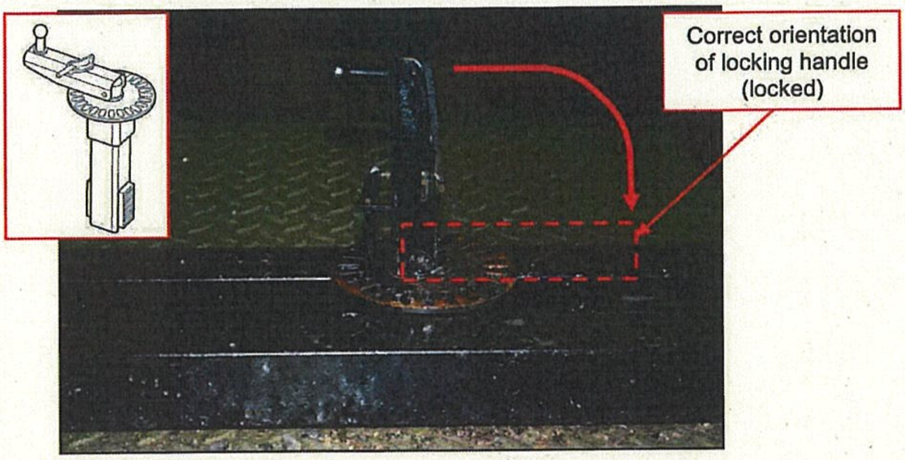


Figure 6 – Incorrectly fitted clamp[3]

13. The Investigating Officer was made aware of Reference E which mandates that the ratchets straps (used to tension the TCV ES pods to the cargo platform) are not to be removed post tensioning. No ratchet straps were visible on any of the pictures supplied by the unit. It further details the use of cable ties to ensure that the locking handle remains in the locked position; no evidence of their use could be identified.

OBSERVATIONS

14. Reference C[4] mandates that Inspection Maintenance Records must be kept for TCV ES; the unit was unable to produce this documentation to the Investigating Officer as they were unaware of the requirement.

15. References C & D have not yet been amended to reflect the information promulgated in Reference E.

16. The RTI which was the catalyst for this incident was outside the scope of this investigation.

17. The unit is currently carrying out an investigation into the fitting and maintenance of the TCV ES involved in the incident.

18. The driver of VRN KY11AB was not available for interview or to give a statement due to being on sick leave.

INVESTIGATING OFFICER'S CONCLUSIONS

19. It is concluded that the seating pods were not fitted in accordance with Reference D Inst Instr No 6. As a direct result of the vehicle rolling onto its side during the RTI, the pods detached from the cargo platform. This was due to the clamp assemblies which were present being incorrectly fitted therefore, not securing the TCV ES pods to the cargo platform.

ACKNOWLEDGEMENTS

20. [redacted] is thanked for his assistance throughout the investigation.

[3] Inset picture shows clamp in locked position.

[4] Page 6, Para 10.

Annex:

A. Report Response Form (RRF) SEFIT 12-051-SI, Troop Carrying Vehicles Enhanced Seating System Mark 2, ERM – MT0148, Seating Pod Detachment.

Enclosure:

1. Equipment Failure Report (EFR) Serial No. 0070 dated 29 Feb 12.

Annex A to
SEFIT 12-051-SI
Dated 17 Mar 12

REPORT RESPONSE FORM (RRF)

SEFIT 12-051-SI, TROOP CARRYING VEHICLES ENHANCED SEATING SYSTEM MARK 2, ERM – MT0148 SEATING POD DETACHMENT

1. After consideration of the enclosed report, this form is to be completed and returned to the address on page (i) of the above report within 30 days of the date of the report.

2. The subject ~~SEF~~/SI/~~GT~~* Report is acknowledged as being received on ___________(Date).

Our reference is ____.

3. This DT/PT/Organisation/Unit* have the following comments on each pertinent recommendation.

(NB – if a recommendation is not fully accepted then details of the risk management action must be included below):

Recommendation(s) accepted Yes/No Comments (including mitigation action where necessary):

Rank/Grade: ....

Name: ....

Appt: ....

Unit: ....

Tel No: ....

Date: ....

UNIT STAMP

* Delete as appropriate.

Enclosure 1 to
SEFIT 12-051-SI
Dated 17 Mar 12

EQUIPMENT FAILURE REPORT (EFR) SERIAL NO. 0070 DATED 29 FEB 12

12/03/2012 15:26 943575285 1 RIFLES PAGE 01/01

AF G8267A/B - EQUIPMENT FAILURE REPORT NSR

UIN	DATE	Serial No
A0563A	29022012	X 0070

Originating Unit: 1 RIFLES LAD

	Description	VRN/ESN/EAC (As Applicable)	NSN/Part No			Usage Units
End Item	TVCES	MT0148	25409947137B7			KM
Mj/Assy ID						
Assy						
Sub Assy						
Component						

No. of items: 1 — Failed in (Country): UK

ON POST RTI IT WAS FOUND THAT THE SEATING SYSTEM HAD BEEN DISLODGED FROM ITS MOUNTING HOLES. ON INSPECTION OF THE MOUNTING BRACKET IT WAS FOUND THAT THE LOCATING PIN HAD FAILED.

Completed By: [redacted] Name: [redacted]

CHEPSTOW 94357 5228

Signature: [redacted]

12 MAR 2012 15:36 943575285 PAGE.01

ROUSH
EUROPE

From :
[redacted]
Project Manager

Roush Technologies Ltd
Propect Way
Hutton
Brentwood
Essex CM13 1XA

Tel: + 44 (0) 1277 261400
Direct: [redacted]
e-mail: [redacted]

Subject	TCV ROPS Roll Over Test Review
Venue	Roush Europe, Hutton
Date	24/06/08
Attendees	See attached list

Agenda

1) Presentation video of Rollover and Roof crush tests carried out by Cranfield Impact Centre
2) Comparison of CAE predictions versus actual results
3) Assessment of results and discussion of modifications should they be required
4) Conclusions

Item no	Description	Originator	Action owner
1	Video footage of the tests shows that the safety zone within the frame retains its integrity through out the tests. See attached short report from Cranfield Impact Centre P:\26-2061\Testing\ Physical Testing\Cran		
2	The video shows that the mannequins stay within the safety zone of the seating unit frame throughout the rollover test.		
3	The video shows that the greatest deformation to the frame is seen on the opposite side to the point of contact. The occupants of this side of the frame will remain within the safety zone.		
4	The CAE simulation represents agricultural testing to 77/536/EEC which is a pendulum type test, as opposed to the physical rollover test which was carried out.		
5	The deformation seen on the physical testing was predicted by CAE, the main difference seen was that the point of impact deformed considerably less on the actual test compared with the prediction. P:\26-2061\Testing\ Physical Testing\Cran		
6	CAE to be re-run with new point of impact to reflect actual testing	[redacted]	[redacted]
7	Roush to supply dimensions and angle for actual impact point	[redacted]	[redacted]
8	Should any modifications be made to improve the performance of the frame, some fracturing of the metal was seen around the heat affected areas (welds)		

ROUSH
EUROPE

From :
[redacted]
Project Manager

Roush Technologies Ltd
Propect Way
Hutton
Brentwood
Essex CM13 1XA

Tel: + 44 (0) 1277 261400
Direct: [redacted]
e-mail: [redacted]

9	It may be possible to improve performance by extending the upper x-member the whole way across the hoop as this location would be coincidental with material failure being seen. P:\26-2061\Testing\ Physical Testing\Cran		
10	CAE to be re-run with extended x-members as shown above. Any improvements found would need to be assessed against the increase in weight and cost that would be associated with this modification.	[redacted]	[redacted]
11	The results of the test show that the occupants remain within the safety zone, and actual results correlate to the simulations by CAE. This should be classified as a pass and production should proceed with current design, unless further CAE investigation suggests a substantial improvement in frame integrity with minimum impact on weight.		
12			
13			
14			
15			
16			
17			
18			
19			
20			

From : [redacted]
Project Manager

Roush Technologies Ltd
Propect Way
Hutton
Brentwood
Essex CM13 1XA
Tel: + 44 (0) 1277 261400
Direct: [redacted]
e-mail: [redacted]

TCV ROP Roll Over Test Review Minutes Sign Off

The undersigned agree the attached minutes represent an accurate reflection of the decisions and actions arising from the TCV ROPS Roll Over Test review at Roush Hutton on 24/06/08

ORGANISATION	NAME & POSITION	SIGNATURE
For Roush Europe Ltd		
For MAN Truck & Bus UK Ltd		
For The MOD GSV IPT		
For Vectayn Ltd		

ROUSH
EUROPE

From :
[redacted]
Project Manager

Roush Technologies Ltd
Propect Way
Hutton
Brentwood
Essex CM13 1XA

Tel: + 44 (0) 1277 261400
Direct: [redacted]
e-mail: [redacted]

TCV ROPS Roll Over Test Review – Attendance Register

This is a generic list of attendees – those present at the meeting are shown highlighted

Name	Organisation	Position	Email address
[redacted]	Roush Europe	Project Manager	[redacted]
[redacted]	Roush Europe	Technical Director	[redacted]
[redacted]	Roush Europe	Business Development Manager	[redacted]
John Mitchell	Roush Europe	Director	[redacted]
Andy Williams	Roush Europe	Director	[redacted]
[redacted]	Roush Europe	Design / Stress SME	[redacted]
[redacted]	Roush Europe	Metallurgy SME	[redacted]
[redacted]	Vectayn	Manager CAE	[redacted]
[redacted]	Vectayn	CAE SME	[redacted]
[redacted]	MAN Truck & Bus UK Ltd	Head of Government Sales	[redacted]
[redacted]	MAN Truck & Bus UK Ltd	Commercial Manager	[redacted]
[redacted]	MOD GSV IPT	Support Vehicles Programme Manager	[redacted]
[redacted]	MOD GSV IPT	Support Vehicles Commercial Manager	[redacted]
[redacted]	MOD GSV IPT	SO2 Engineering	[redacted]
[redacted]	MOD GSV IPT	Engineering Officer	[redacted]

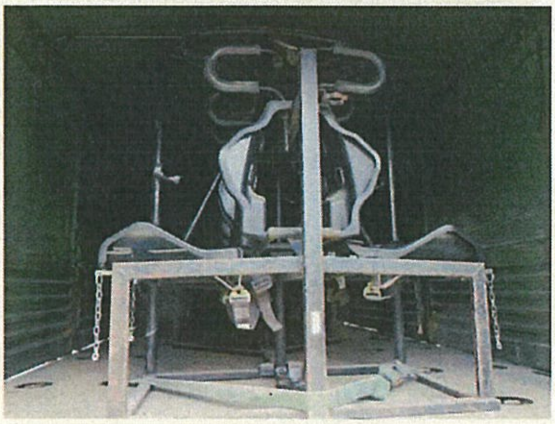
Report 15013.011

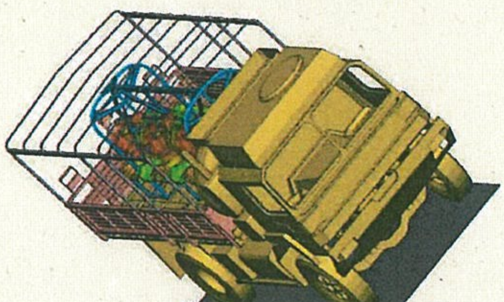
TCVES Mk1

Computer Aided Engineering Assessment of Seating System Structural Integrity under ECE Reg66 Truck Tilt Testing with 95%tile Occupant Mass

Date 25/05/2016

Author : [redacted]





Executive Summary :

Report 15013.011 TCVES Mk1, Computer Aided Engineering Assessment of Seating System Structural Integrity under ECE Reg66 Truck Tilt Testing with 95%tile Occupant Mass

Objective

The objective of this study was to assess the structural strength of the MK1 TCVES system mounted on an HX60 truck, undergoing ECE reg66 type tilt testing loaded with the mass of 14 95%tile occupants.

Results & Conclusions

- The Mk1 TCVES frame is predicted to provide a survival space at least as large as the volume of a 95%tile occupant at all seat positions under ECE66 Tilt testing with a full compliment of 14 95%tile occupants.

- Upon impact of frame to ground, deformation of the roll over hoops is relatively low but the sudden deceleration combined with 1.1Tonnes weight of 12 occupants acting on central longitudinal beams, results in deformation to the central beams and joints. Some 'clasp' joints deform and open up and high strain is applied through the pins of the central uprights, however, enough connectivity is predicted to remain in the frame to retain the system integrity. Occupant restraint anchorages are predicted to remain sound.

- For the central seats, impact side, the bending of the central seating beams result in the ground just touching, but not compromising the 95%tile occupant volume.

- The kerb weight of the HX60 truck, plus equipment mass, results in a rear axle load o[redacted] This, together with the 1330kg weight of occupants could be approximated as applying[redacted] through the TCVES frame on roll over.

- The peak force acting through the worst case TCVES floor fixing, along the length of the fixing (normal to the floor) is predicted to be 47kN.

- ECE regulation 66 is a test of structural strength and survival space around the occupants. It is not a test of occupant injury. However, for reference in any potential future development work, lateral accelerations of the frame at occupant shoulder height are presented within this report.

Recommendations

- The conclusions gained from this study should be considered along side those of parallel studies investigating the seating system and vehicle combined structural performance, occupant restraint strength and front impact protection.

1.0 Introduction

The objective of this study was to predict, through Computer Aided Engineering (CAE) calculation, the structural strength of the MK1 TCVES seating system mounted on an HX60 truck, undergoing ECE reg66 type tilt testing.

Models of the seating system with a full compliment of 95kg occupants (representing 95%tiles) and HX60 truck at [redacted] were combined and tipped from a platform into an 800mm deep gully as defined by the test. The use of 95%tile mass goes beyond the requirement of ECE66. The interpretation of results also differs for the seating system as the regulation defines a survival space a certain distance inside the roll over protection which does not equate to the occupant space in TCVES. Instead, structural, or ground intrusion into the 95%tile occupant volume will be considered as the failure criteria.

2.0 Method

2.1 Summary

An HX60 truck model, with the Mk1 TCVES system mounted on the load bed, including 14 x 95kg occupant mass, was placed on the tilt table. The whole assembly was pre-tilted to the point at which the vehicle centre of gravity just passed the tile table lip. Finite element analysis was initiated allowing the vehicle to tip and drop under gravity, to the rigid floor 800mm below.

Fig 2.1 : Truck Tilt Images

Non-linear, dynamic finite element analysis was conducted using LS-DYNA code.

Results were recorded to measure, amongst other details;

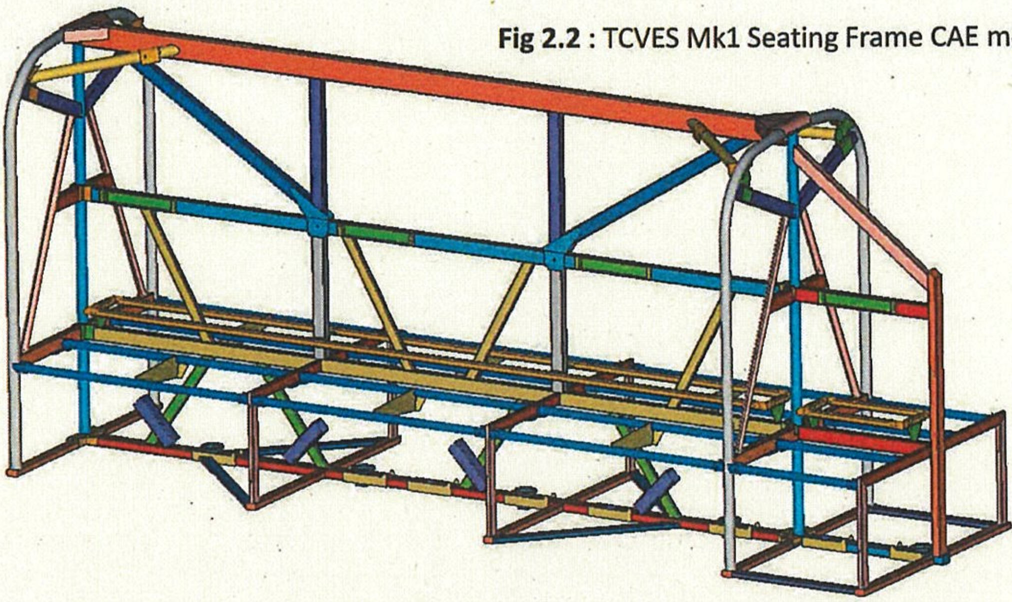
- Frame deformation
- Frame acceleration
- Forces acting through the floor fixings in X,Y,Z cords.

2.2 Seat Frame Model

The TCVES frame CAE model source data, finite element detail and material data is presented in Appendix B of this report.

CAE simulation was carried out on the full 14seat frame with modified floor fixing layout for installation in the Man HX60 truck. This applies 5 clamp fixings between the frame central beam and load bed floor.

Fig 2.2 : TCVES Mk1 Seating Frame CAE model



Floor clamps were modelled as rigid, i.e. no slippage possible. Floor to frame straps, as evident in some in-service photos, were not modelled.

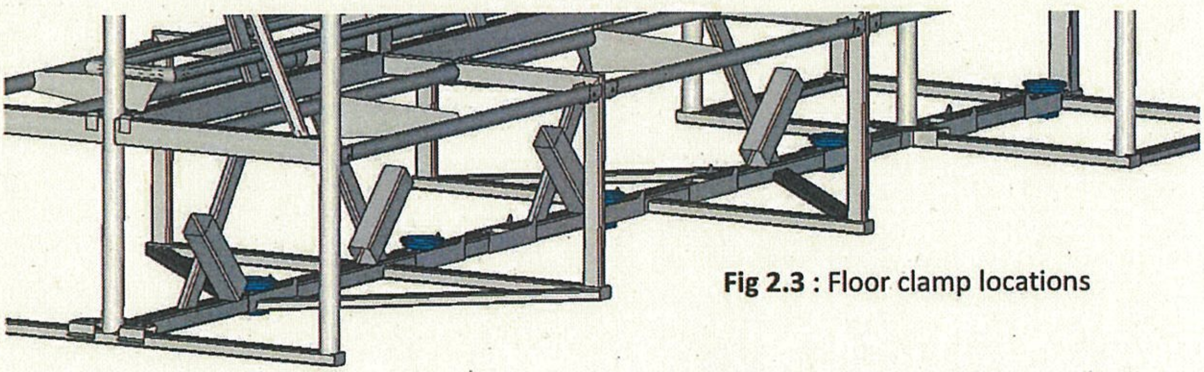
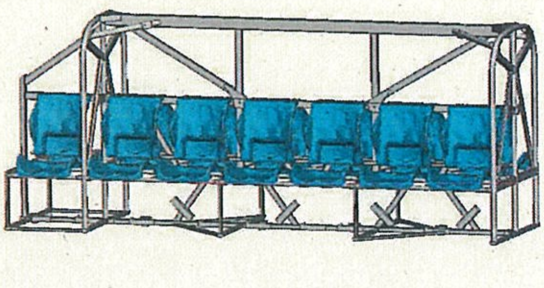


Fig 2.3 : Floor clamp locations

Seats were added where necessary to stabilise the frame work



Surfaces of manikins were attached to the seats of the frame to give a reference of the survival space, during and after the impact, at four positions along the impact side of the frame. The surfaces were created from a 95th percentile dummy and positioned visually against the seat. The torso of the manikin was expanded +50mm outwards to represent body armour on the occupant and the upper head surface was expanded +20mm outward to represent the helmet. The surfaces were created as a visual aid only. They provide no stiffening affect to the frame and impart no mass or contact to frame, truck or ground

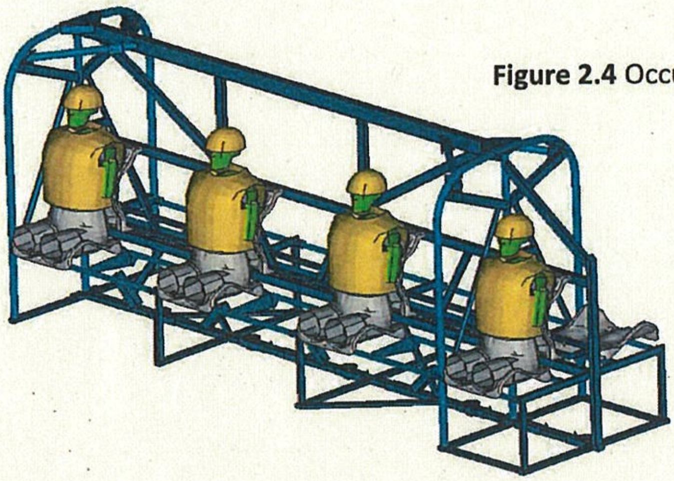
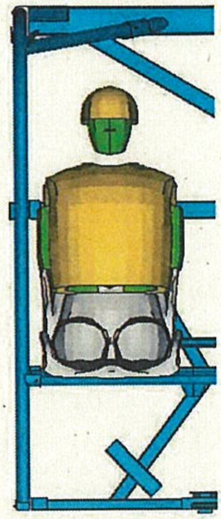


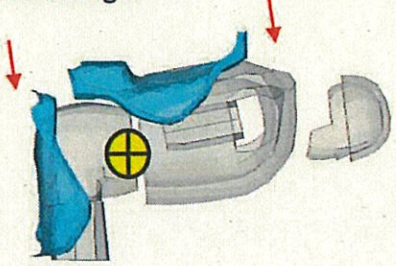
Figure 2.4 Occupant Manikins



2.1.1 Occupant Mass

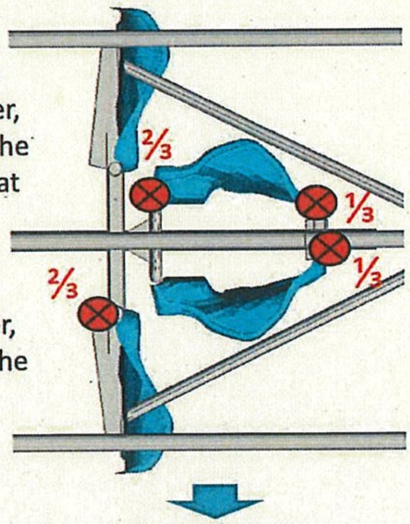
A mass of 95kg (95%tile) was included for the occupant at each seat. This applied a total of 1330kg for the 14 seats. Occupant masses were modelled as point mass elements distributed over 4 points per occupant.

The C. of G. of an occupant facing towards the ground is distributed approximately ⅔ - ⅓ in favour of the lower belt anchorages



For the occupants on the upper side during roll over, masses were applied to the 4 mount fixings of the seat back

For the occupants on the lower side during roll over, masses were applied to the 4 seat belt anchorage points



Towards Ground

2.3 HX60 Truck Model

The manufacturer's design data and detailed mass breakdown was not available for the HX60 truck. Hence, the model created was a shortened version of the HX58 truck, which in turn was built from limited design information. The HX58 truck model from which the HX60 was produced is considered to be representative in exterior geometry, wheel track and wheel base, mass distribution, load bed stiffness and main chassis rail stiffness. It is not accurate in cab stiffness, chassis cross member detail, suspension, wheel/tyre or drive train detail.

The construction of the donor HX58 truck model and the subsequent conversion to HX60 is described in Appendix 1

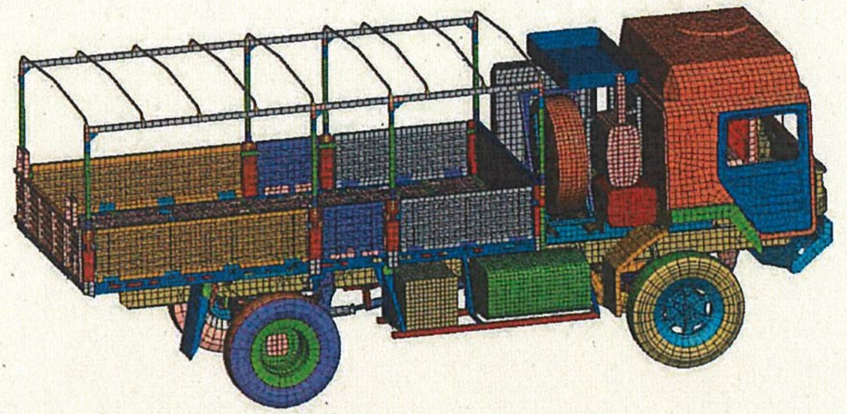


Fig. 2.5 : HX60 Truck & Load bed Model

<u>HX60 Truck Mass</u>

The total mass of the HX60 truck model was [redacted]. This is [redacted] lighter than HX58. Refer to Appendix D for a mass breakdown for the HX58 donor vehicle

The centre of gravity was located, 1775mm from the front axle,
43mm above the top of the main chassis rail
1mm offset from centre line

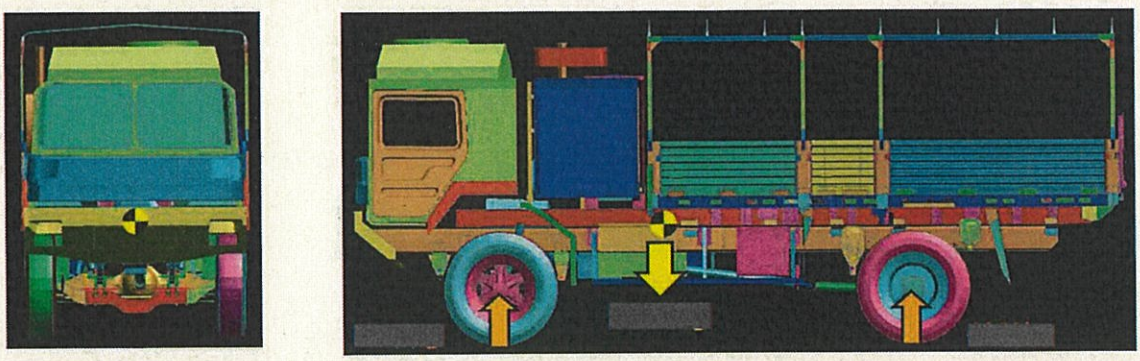


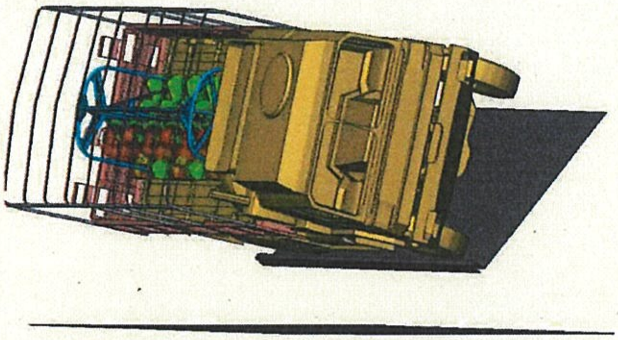
Fig. 2.6 : HX60 CAE model Centre of Gravity plots

It could be approximated that [redacted] truck mass acts on the TCVES frame during roll over

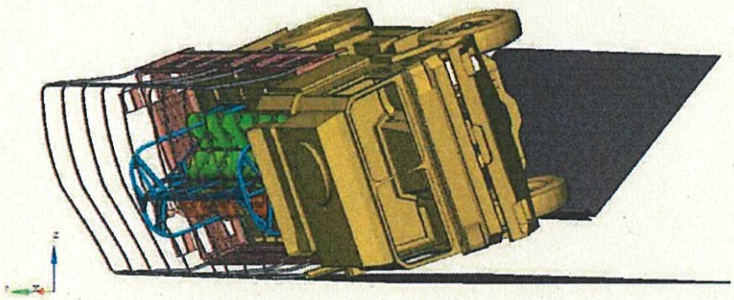
3.0 Results

Refer to animation files *TCVES_Mk1_HX60_truck_ECE66_Tilt_1view.avi* & *TCVES_Mk1_HX60_truck_ECE66_Tilt_2views.avi*

3.1 Tilt Event Kinematics

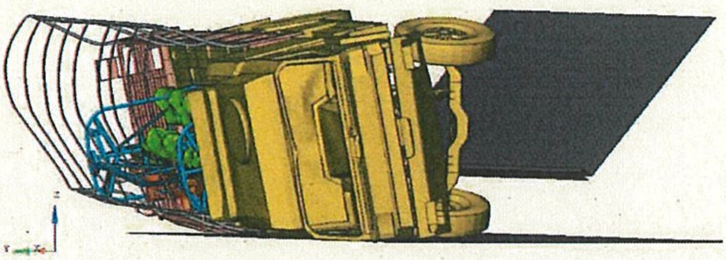


The truck begins to tip



The load bed frame and cab impact the ground

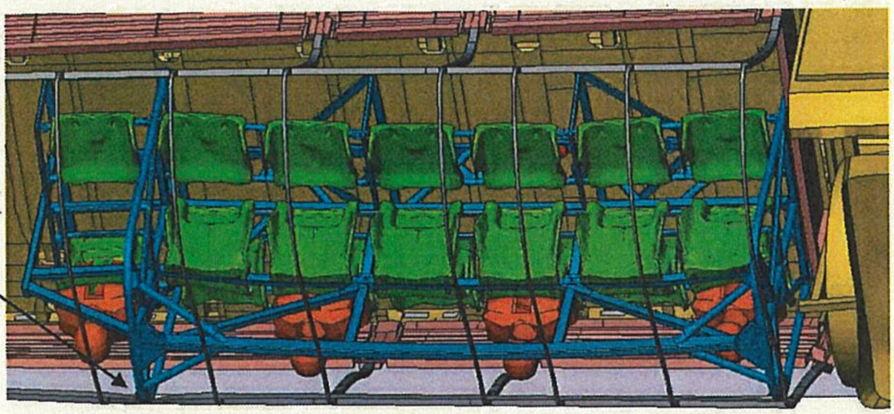
The TCVES frame impacts the ground



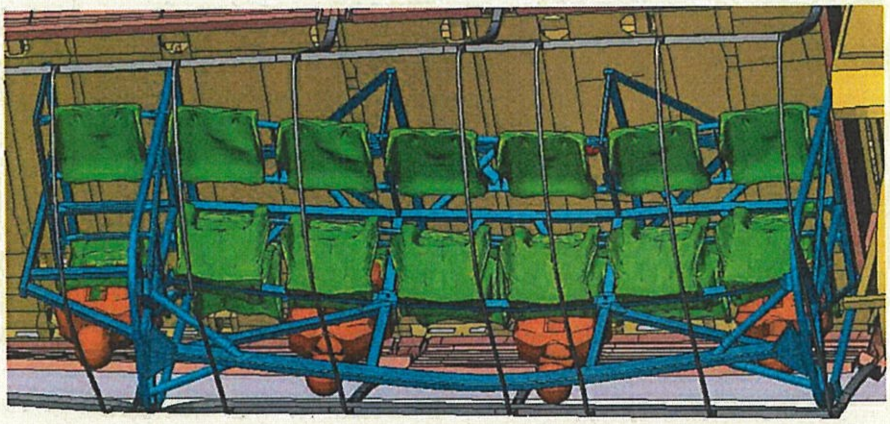
The truck slides outwards and rolls back onto it's side

3.2 Structural Behaviour of TCVES

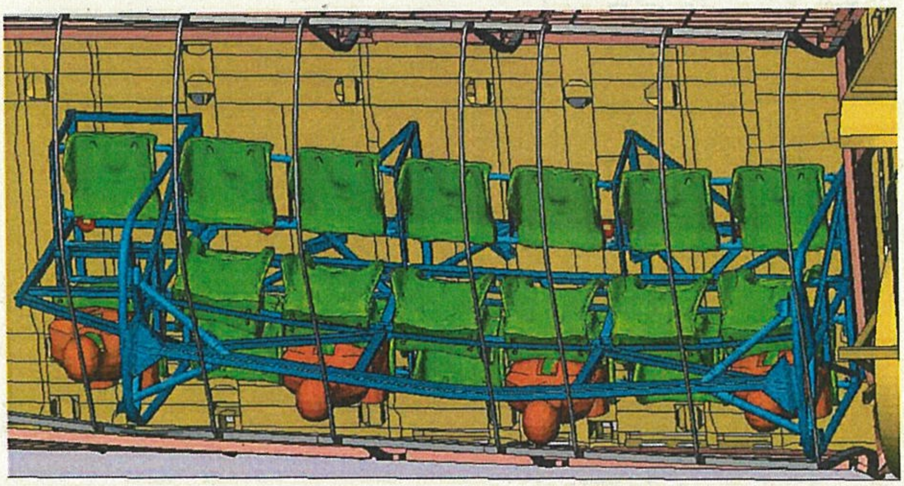
Initial TCVES Impact
The rear roll hoop and load bed frame suffer local deformation at the impact point



Mid Impact
The roll hoops suffer low levels of deformation and as a result stop very abruptly. The large occupant mass acting through the central frame continues downwards, bending the central beams



Post Impact
The frame is bowed & some of the clasp joints have separated (see overleaf) but the overall frame assembly remains intact.

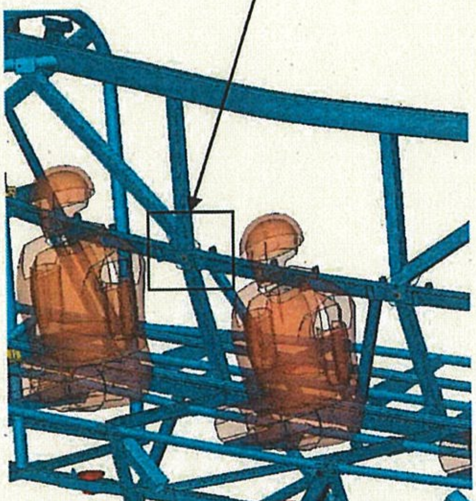


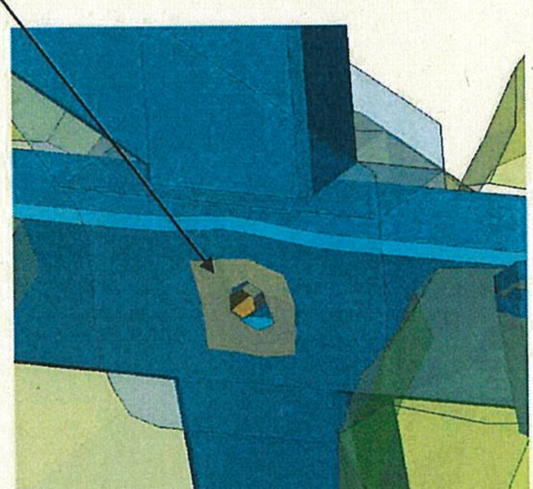
Acceleration was recorded at a point on the roll hoop central upright at occupant shoulder height. These results show an acceleration spike at 60g at the forward hoop and 40g at the rearward hoop. The 1.1Tonnes weight of 12 occupants acting on central frame, multiplied by the impact acceleration, results in deformation to the central beams and joints

After impact, corner braces show separation

The clasp joints of the mid central beam to roll hoop have deformed and detached

The central uprights distort due to the highly concentrated load acting through the pin joint, elongating the hole around the pin





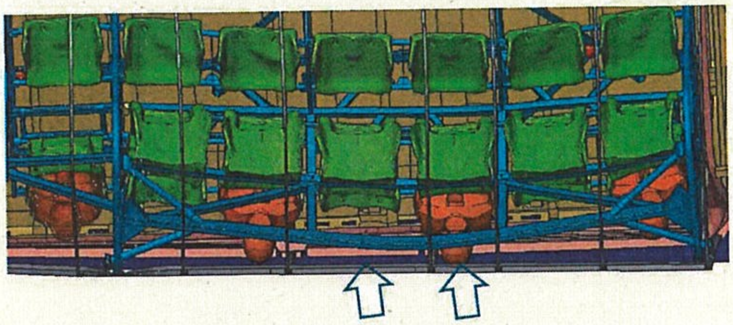
Despite some joint separation, enough connectivity remains in the other frame connections to retain the system integrity.

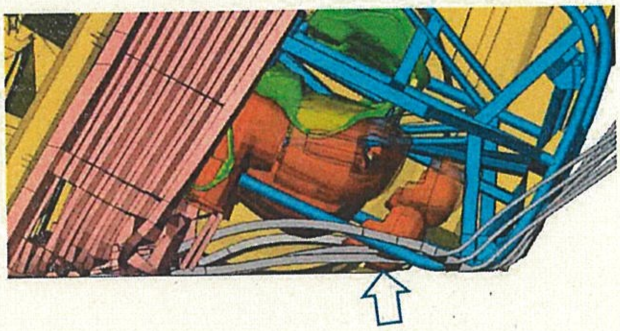
3.3 Effect on Survival Space Around the Occupants

As the structure remains intact, the occupant restraint anchorages are predicted to remain sound.

For the majority of the occupant seats, the roll frame prevents the ground from encroaching into the occupant volume.

For the central seats, impact side, the bending of the central seating beams result in the ground just touching, but not compromising the 95%tile occupant volume.

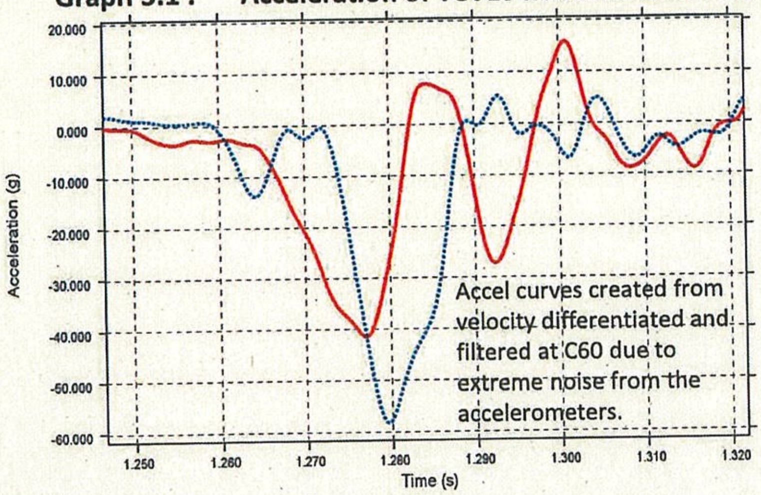


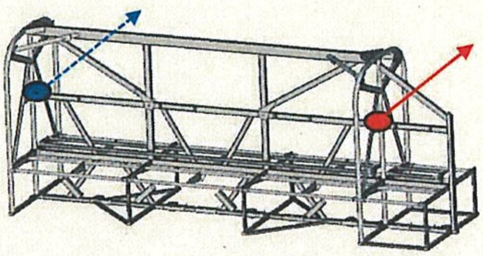


3.4 Impact Accelerations

ECE regulation 66 is a test of structural strength and survival space around the occupants. It is not a test of occupant injury. However, for reference in any potential future development work, lateral accelerations of the frame at occupant shoulder height are presented below for the instant of frame to ground impact. These could be used to assess the actions of the occupants.

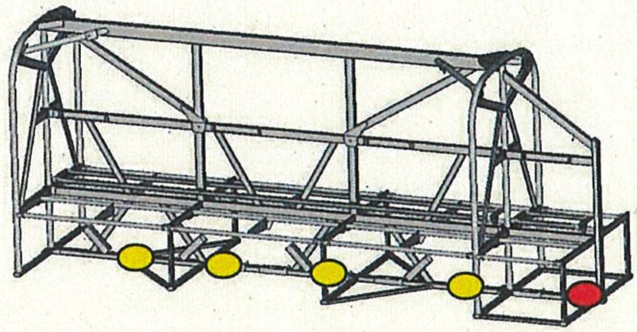
Graph 3.1 : Acceleration of TCVES frame in local lateral axis during initial ground impact





3.5 Force Acting Through the Floor Fixings

The peak force, acting normal to the floor predicted through the worst case fixing under ECE66 Tilt impact was **47kN.** This occurred at the rearmost fixing



4.0 Conclusions

- The Mk1 TCVES frame is predicted to provide a survival space at least as large as the volume of a 95%tile occupant at all seat positions under ECE66 Tilt testing with a full compliment of 14 95%tile occupants.

- Upon impact of frame to ground, deformation of the roll over hoops is relatively low but the sudden deceleration combined with 1.1Tonnes weight of 12 occupants acting on central longitudinal beams, results in deformation to the central beams and joints. Some 'clasp' joints deform and open up and high strain is applied through the pins of the central uprights, however, enough connectivity is predicted to remain in the frame to retain the system integrity. Occupant restraint anchorages are predicted to remain sound.

- For the central seats, impact side, the bending of the central seating beams result in the ground just touching, but not compromising the 95%tile occupant volume.

- The kerb weight of the HX60 truck, plus equipment mass, results in a rear axle load of [redacted] This, together with the 1330kg weight of occupants could be approximated as applying [redacted] through the TCVES frame on roll over.

- The peak force acting through the worst case TCVES floor fixing, along the length of the fixing (normal to the floor) is predicted to be 47kN.

- ECE regulation 66 is a test of structural strength and survival space around the occupants. It is not a test of occupant injury. However, for reference in any potential future development work, lateral accelerations of the frame at occupant shoulder height are presented within this report.

5.0 Recommendations

- The conclusions gained from this study should be considered along side those of parallel studies investigating the seating system and vehicle combined structural performance, occupant restraint strength and front impact protection.

Appendix A

HX58 Truck Model Construction & Conversion to HX60

Appendix A HX58 Truck Model

Load Bed

The load bed was modelled from manufacturers CAD and is considered to be an accurate representation of the structure in terms of geometry and stiffness for this level of structural prediction.

Load Bed CAD file Supplied on 14/12/2015 :
HX58 Non-Winch.stp

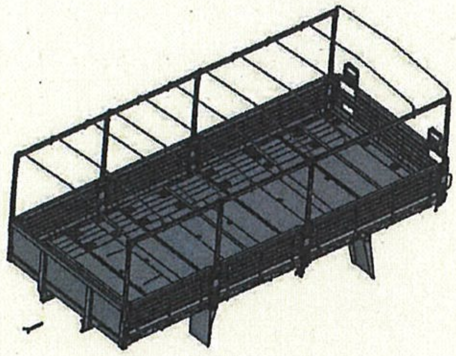
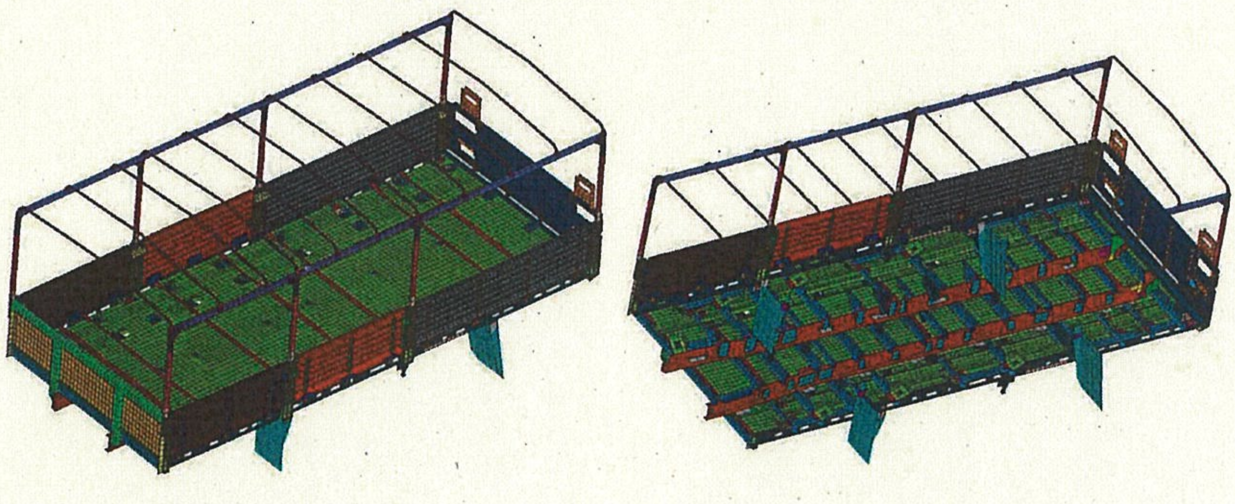
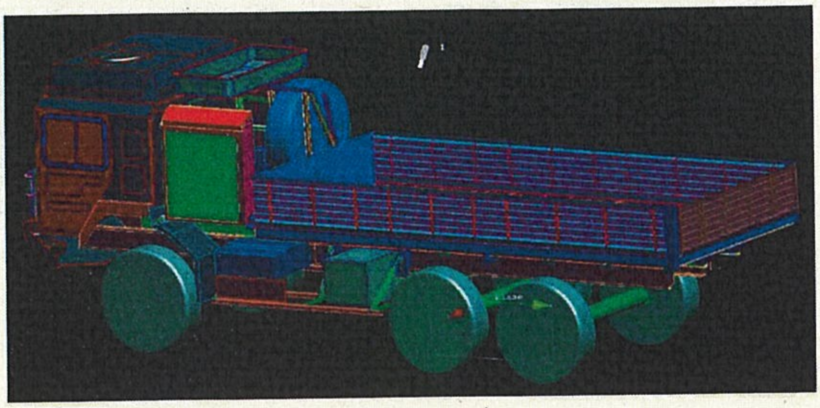


Fig. A1.1 : HX58 Load Bed CAE model



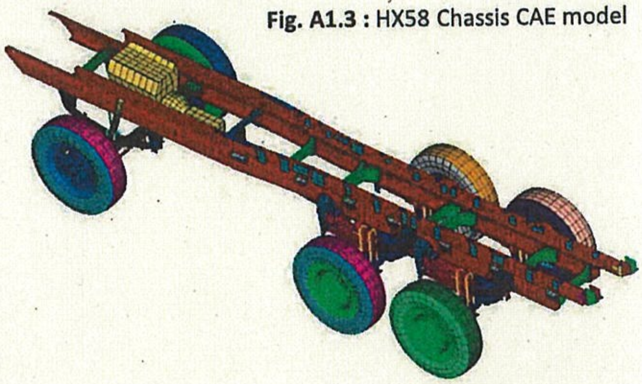
Truck Model
Manufacturers CAD data could not be supplied for the truck. Instead, CAD was created from a scan of the exterior surfaces of the truck chassis and cab.

Fig. A1.2 : HX58 Truck Exterior scan



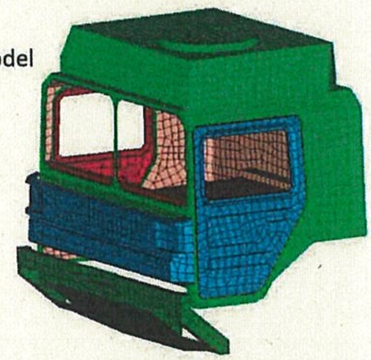
Chassis Model
Due to the lack of definition in suspension, wheel/tyre and chassis data, these parts were obtained from an open source truck model, described in Appendix C of this report,. The parts were scaled, translated and duplicated then combined with the scanned chassis rail CAD to create the HX58 Truck chassis model of representative chassis size, ride height, wheel base & track and tyre size.

Fig. A1.3 : HX58 Chassis CAE model



Cab Model
The cab model contained geometrically correct representations of main inner & outer panels, frt bumper, frt panel, IP beam and door inner & outer panels. The lack of design info relating to reinforcement panels and gauges meant that the cab stiffness was not accurate. The overall roll impact stiffness of the cab was tuned (through panel gauge adjustment) to match the levels of deflection observed in roll testing of a Bedford truck of similar size but of older design

Fig. A1.4 : HX58 Cab Model



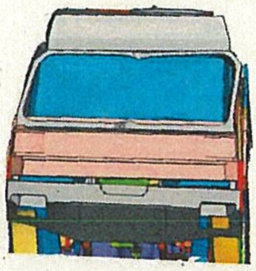
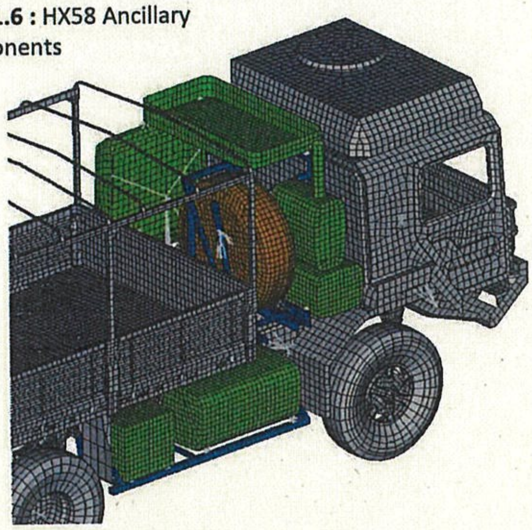


Fig. A1.5 : Comparison, tilt test cab deformation - HX58 CAE Model vs Bedford truck test

Fig. A1.6 : HX58 Ancillary components



Ancillary components were modelled from the surface scan CAD. The spare wheel is considered representative as it has the rubber and inflation characteristics of the mains wheels. Other components however are accurate in geometry but not necessarily stiffness.

Full Truck CAE Model

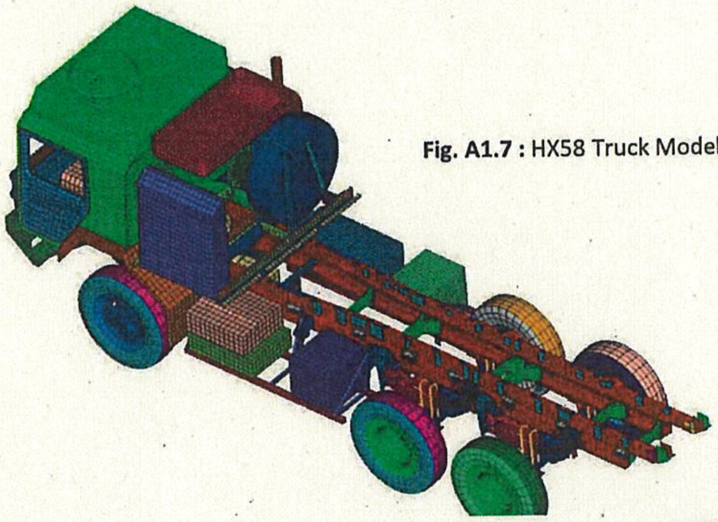
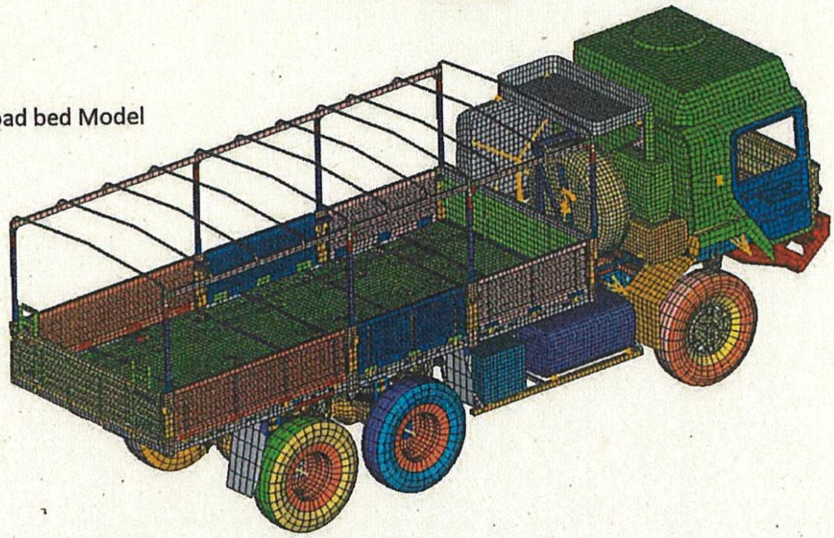


Fig. A1.7 : HX58 Truck Model

Fig. A1.8 : HX58 Truck & Load bed Model



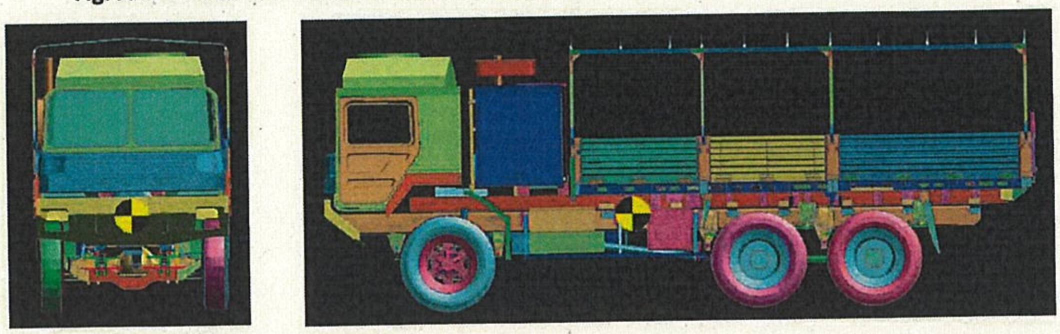
HX58 Truck Mass

Additional masses were added to the CAE model components for each of the sub assemblies defined in the spreadsheet *HX58 CoG & weight Data.xlsx*, supplied on 21/01/2016. The breakdown of this is shown in Appendix D. Cab armour as defined in the spread sheet was not added.

The total HX58 truck mass attained was [redacted]

The centre of gravity was located, 2394mm from the front axle,
45mm below the top of the main chassis rail
80mm offset from centre line (towards offside)

Fig. A1.9 : HX58 CAE model Centre of Gravity plots



2.2.2 Conversion to HX60 Truck Model

The truck model was converted from HX58 to HX60 based on the assumptions : HX60 has a single rear axle, the load bed is 800mm shorter, The kerb weight is [redacted] lighter & the wheel base is 4500mm. Cab and rear of cab components were considered to be carry over.

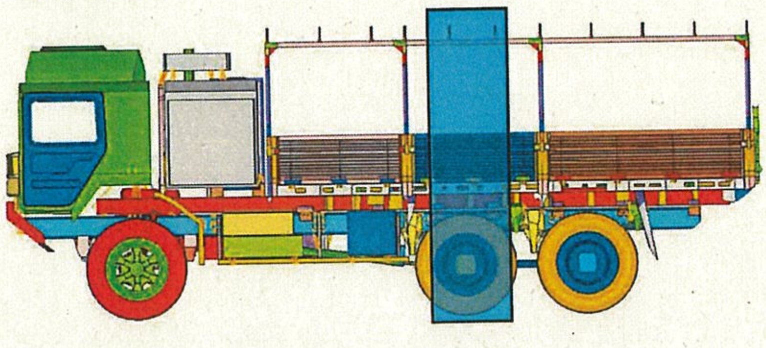


Fig. A1.10 : HX60 CAE conversion sketch

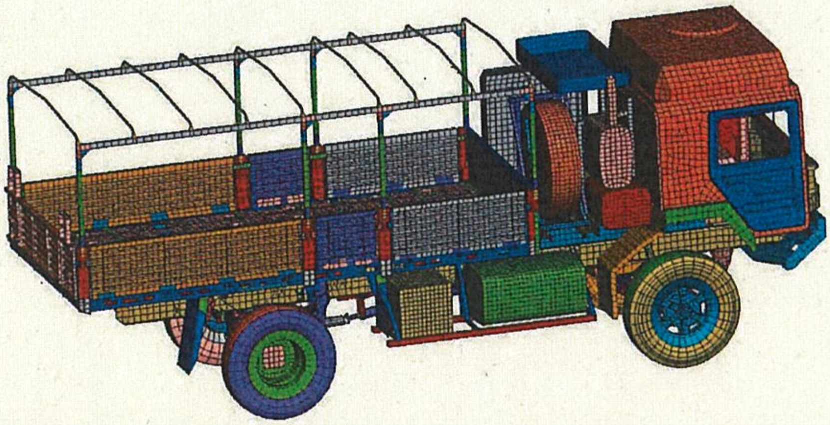
800mm was removed from the centre of the load bed and chassis along with one axle.

The remaining rear axle and suspension was moved to wheel base 4500mm.

[redacted] mass was removed. This was distributed across engine ancillaries, drive train, axles, chassis and load bed.

Full Truck CAE Model

Fig. A1.11 : HX60 Truck & Load bed Model

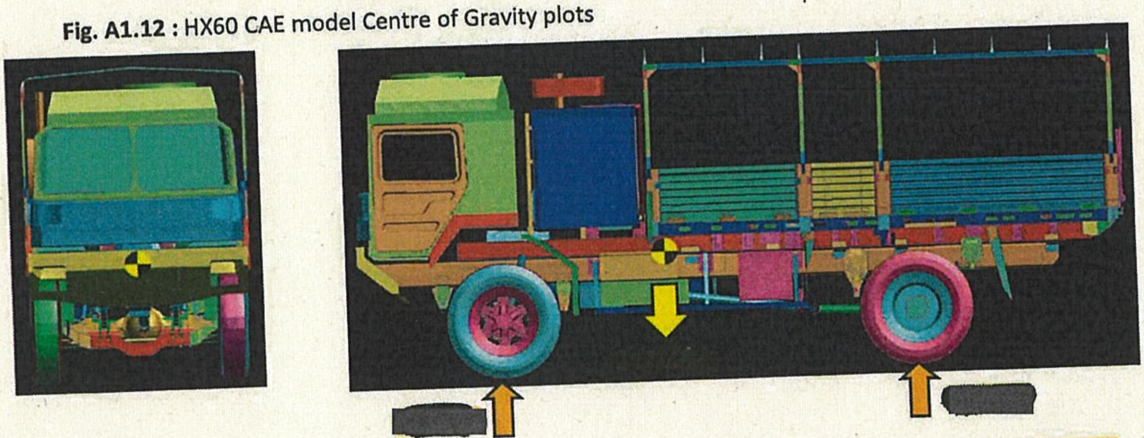


HX60 Truck Mass

The total mass of the HX60 truck model was [redacted]

The centre of gravity was located, 1775mm from the front axle,
43mm above the top of the main chassis rail
1mm offset from centre line

Fig. A1.12 : HX60 CAE model Centre of Gravity plots



[redacted] [redacted]

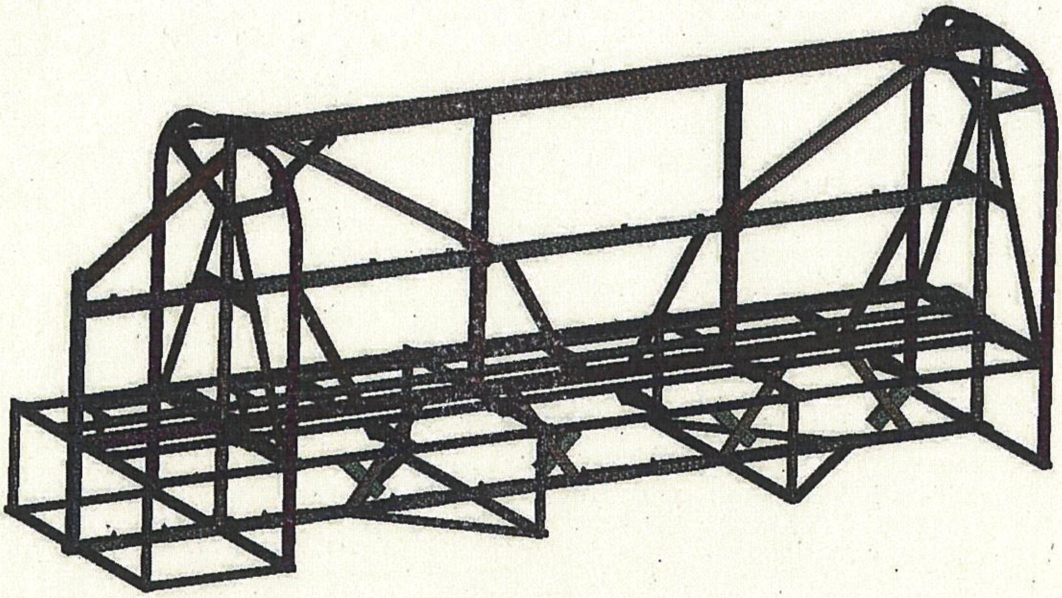
It could be approximated that [redacted] truck mass acts on the TCVES frame during roll over

Appendix B

Finite Element Model Detail
Mk1 TCVES Frame

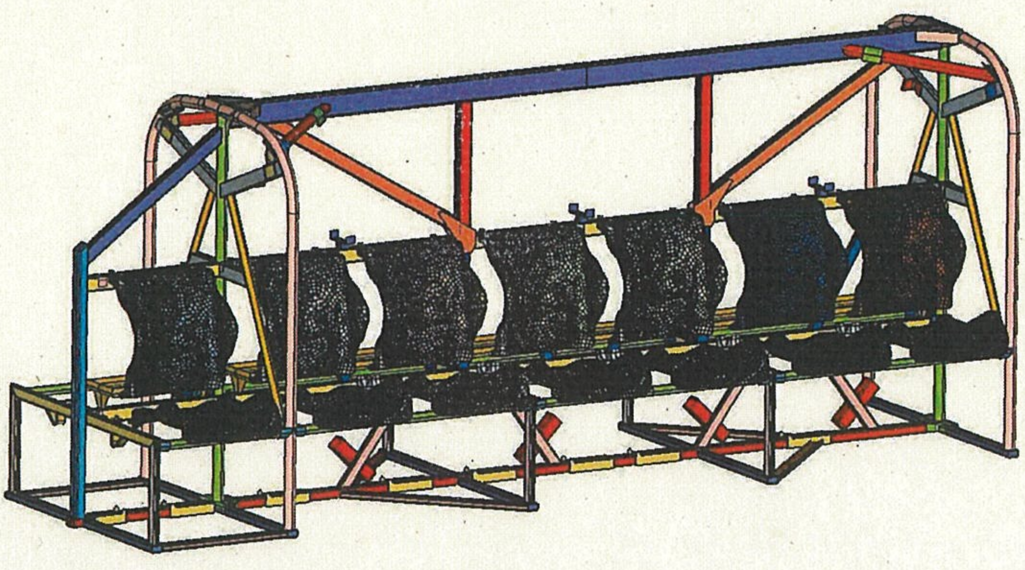
CAE Model Summary

Finite element (FE) models of the Mk1 frame structure and floor constraints matching HX60 installation, for the full frame including rear extension were created in LS DYNA code format.



Design Data

The Mk1 frame model was constructed from CAD data provided from scanned data of an actual frame. The frame was scanned by 'Surfdev Ltd' and the resulting CAD data supplied as file 'SurfDev-release-seat-frame-assy-iges.rar' on the 11th Nov 2015 as shown below.



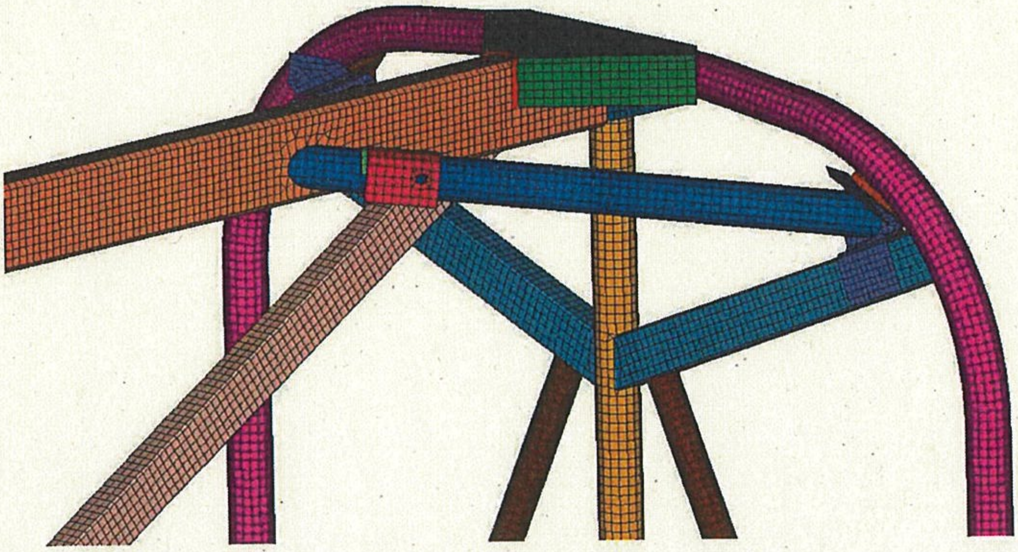
Design Data

It was not feasible to capture all of the detail in the frame, hence physical inspection and photos of the frame were used to capture important details of the frame.

Detail of pin jointed frame connection

Finite Element Model Detail

The frame model is primarily constructed in Thin-Shell elements, predominantly 4-node QUADs and some 3-node TRIAs. Average element size was 10mm with refinement around important details. Thickness was assigned as defined in the scanned data provided. All parts were modelled to mid-surface.



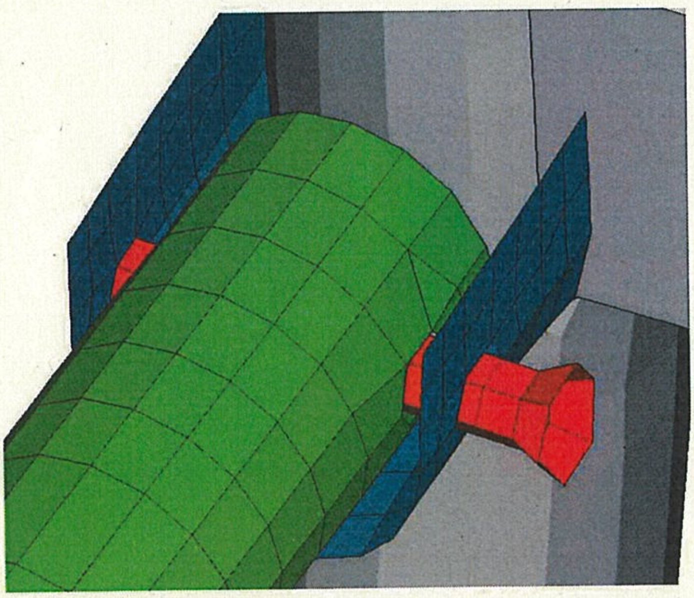
Finite Element Model Detail

Welded Joints

At welded joints, parts were connected by shared nodes, or, where this was infeasible without mesh distortion, through the use of singular node to node rigid links.

Pin Joints

The MK1 TCVES frame contains a number of joints connected by a pin loosely fitted through holes. The flexibility of this joint and potential deformation of the holes were captured in the CAE model. The pin was included as a rigid surface, connected to one side of the outer component and passing through clearance holes in the connecting component and far side of the outer component. A node to surface contact was added to react the surface of each pin against the hole perimeters. The free end of the pin was flared to prevent it pulling out of the holes.



Material Data

Material grades were allocated as defined in the earlier frame CAE study, *Mk 1 TCVES REG 66 Assessment Iss 1.pdf*, dated 09/2015, supplied by Burgess Consulting. The post yield material definition was modified from the simplified bi-linear data of the original study.

Extract from report Mk 1 TCVES REG 66 Assessment Iss 1

All round tubes were simulated as Clubman 500, all box sections as ERW200 and all platework as S275.

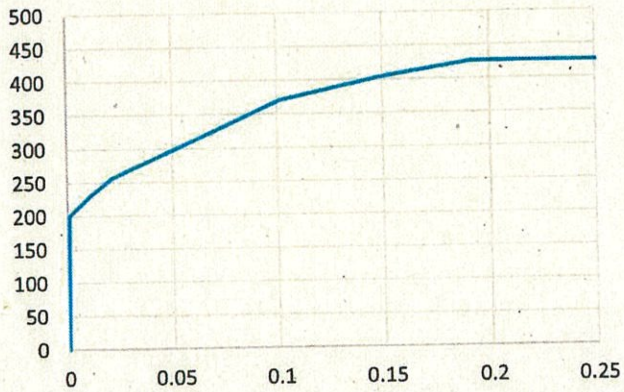
Property	S275	Clubman 500	ERW200
Youngs Modulus (GPa)	210	210	210
Poissons Ratio (%)	0.3	0.3	0.3
Yield (MPa)	275	355	200

Library data for typical steels of yield 200, 275 and 355 was used to describe the post yield behaviour of the materials :

Steel, Yield 200MPa

Properties Applied :
Density 7.85e-9 Mg/mm³
Elastic Modulus 210,000MPa
Poissons Ratio 0.3
Yield Stress 203MPa
Failure Strain 25%
Strain Rate Hardening Coefficients
C=1300.0 P=5.0

Stress-strain Plot : 200 yield

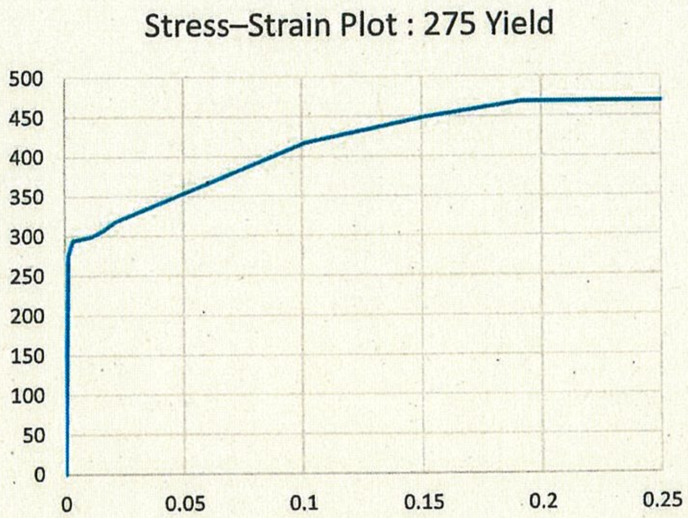


Steel, Yield 275MPa

Properties Applied :

Density	7.85e-9 Mg/mm³
Elastic Modulus	210,000MPa
Poissons Ratio	0.3
Yield Stress	275MPa
Failure Strain	25%

Strain Rate Hardening Coefficients
C=1300.0 P=5.0

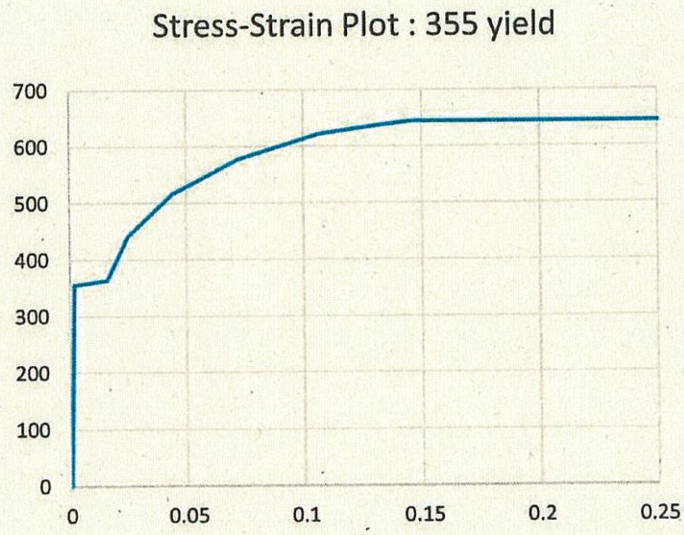


Steel, Yield 355MPa

Properties Applied :

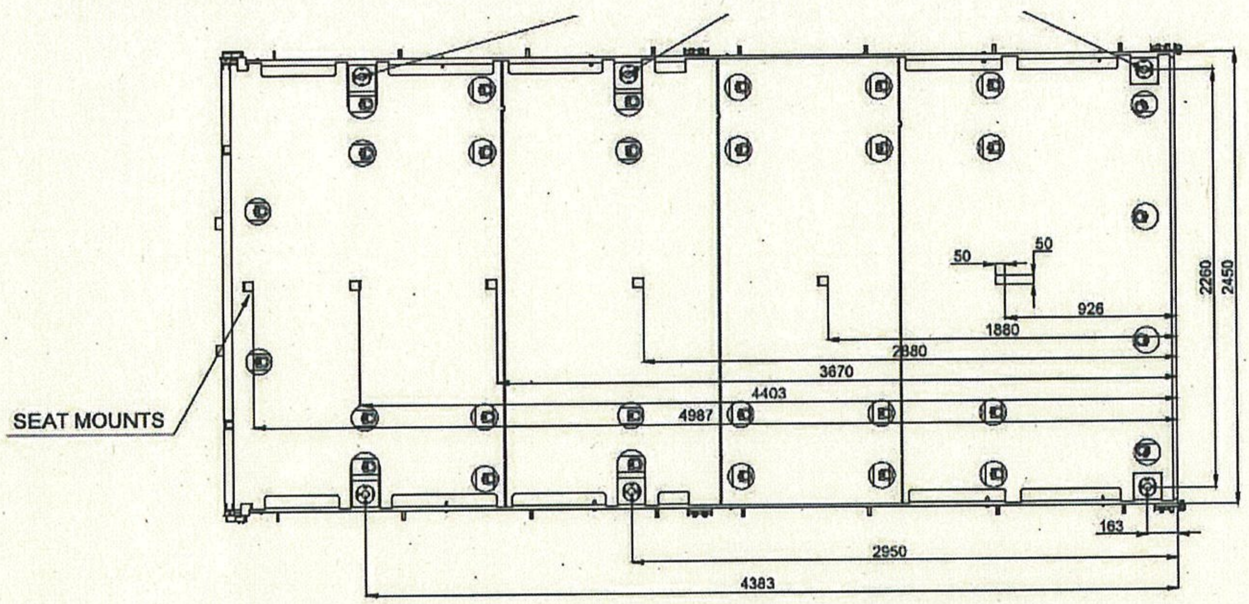
Density	7.85e-9 Mg/mm³
Elastic Modulus	210,000MPa
Poissons Ratio	0.3
Yield Stress	275MPa
Failure Strain	25%

Strain Rate Hardening Coefficients
C=1300.0 P=5.0

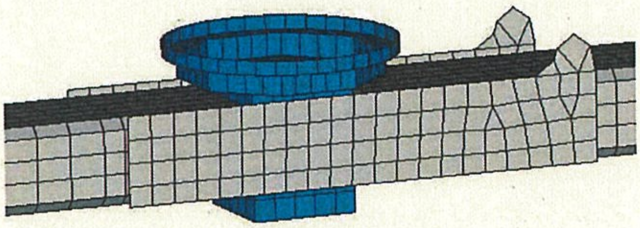


Constraints

A rigid floor was placed under the frames. The frames were attached to the floor by five clamps positioned at seat mounting points as directed in document *TD-MSV- 3003-Load Interfaces Safe Designers Guide Iss 4.*



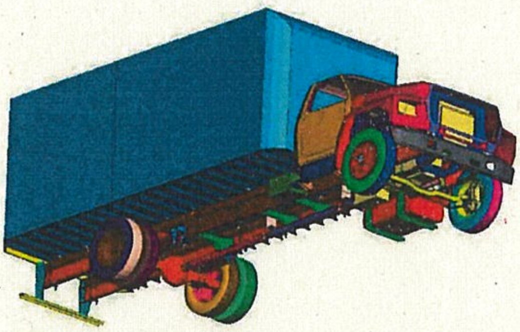
The clamps were modelled as fully fixed rigid surfaces and constrained the frame via a surface to surface contact. No preload (clamping force) was modelled. Note that this study assesses the strength of the frame and not the strength of the clamping mechanism. Forces between clamps and frame can be extracted to facilitate a future clamp strength assessment.



This method of constraint allows the frame to separate from the clamp under severe deformation to facilitate accurate representation of frame distortion.

Appendix C

Donor Finite Element Model from which, Suspension, Drive train and Chassis Components were obtained



Filename : F800.k

$---
$- This model has been developed by the National Crash Analysis Center at The
$- George Washington University. The FE model is based on a 1995 Ford F800
$- Single unit truck. The model has been validated to an oblique impact test
$- into an F-shape barrier (test conducted at FOIL). The results are published
$- in the International Journal of Vehicle Systems Modeling and Testing
$- http://www.inderscience.com/search/index.php?action=record&rec_id=11423
$-
$- The model was further improved by Battelle Memorial Institute.
$- http://thyme.ornl.gov/FHWA/F800WebPage/partSets/partSets.html
$-
$- The model is continuously updated to improve its capabilities in
$- predicting responses in various impact scenarios. However, the user must
$- verify his own results. Neither NCAC, GWU, FHWA or NHTSA assume any
$- responsibility for the validity, accuracy, or applicability of any results
$- obtained from this model.
$-
$- Please feel free to contact us with any suggestions, comments, or
$- questions.
$-
$- [redacted]
$-

Appendix D

Mass Breakdown for Man HX58 Truck

Appendix C : Mass Breakdown for Man HX58 Truck

[redacted]

Appendix C Continued.... Mass Breakdown for Man HX58 Truck

[redacted]

Vectayn Data Reference

Analysis Code : LS-Dyna **Analyst :** [redacted]

CAD :
P:\W15013-Revolve_ROPS\Data_In\15_12_14_Load_Bed\MARSHALL DOWN LOAD\HX58 Non-Winch.stp
P:\W15013-Revolve_ROPS\Data_In\15_11_11-Mk1_scan_data
P:\W15013-Revolve_ROPS\Data_In\16_11_03_Truck_CAD

Load Bed Constraint Dimensions
P:\W15013-Revolve_ROPS\Data_In\15_09_10_designers_guides
TD-MSV- 3003-Load Interfaces Safe Designers Guide Iss 4.pdf

Material Curves
P:\W15013-Revolve_ROPS\Reports\Steel_curves_used.xlsx

Analyses
P:\W15013-Revolve_ROPS\Analysis\Mk_1\Truck_runs\Tilt
HX60_Mk1_TCVES_22042016_ECE66_OccMass95d_47362

Include Files
P:\W15013-Revolve_ROPS\Analysis\Mk_1\Truck_runs\INCL_4

Supporting Animation Files
P:\W15013-Revolve_ROPS\Reports\Animations
TCVES_Mk1_HX60_truck_ECE66_Tilt_1view.avi
TCVES_Mk1_HX60_truck_ECE66_Tilt_2views.avi

This Report :
W15013_011_TCVES_Mk1_Reg66_Truck_Tilt_CAE_simulation_25052016.pptx

(SV Team)
Specialist Logistics Vehicles PT
Defence Equipment and Support
Spruce 3c # 1315, Abbey Wood
Bristol BS34 8JH

de&S

LAND EQUIPMENT

SAFETY NOTICE – SLV/SV/LC/TCV/SAF/12-051V3

DATE OF ISSUE: 17/05/2012

SUPPLEMENTARY INSTRUCTION – TCVES MK2 – SECONDARY TIE-DOWN

SAFETY NOTICE – SLV/SV/LC/TCV/SAF/12-051 was issued on 26th March 2012. This instruction supplements that notice by providing further information on methods of tie-down for the ratchet straps used as secondary security.

POC:

For further information, contact [redacted] at Specialist Logistic Vehicles Project team at DE&S Abbey Wood, Bristol.
Email: DESLEGSG-SLV-SV-Cargo-ESM@mod.uk
[redacted]

OVERVIEW

SUBJECT:

TCVES MK2 POD (8 Man) 2540-99-802-7565
TCVES MK2 POD (6 Man) 2540-99-304-8550

Vehicle Fits Affected: MAN SV, Leyland DAF 4T, Bedford 4T

HAZARD: Detachment of Seating systems in a vehicle rollover.

TCVES MK2 REVISED FITTING INSTRUCTION

1. Current published installation instructions for the fitting of the MK2 sets, state that the installer tensions down the seating systems with two ratchet straps supplied in the CES, (Ratchet strap 2540-99-241-7085) prior to tightening the securing clamps. Once the clamps have been secured the installer is then instructed to remove the ratchet straps. (2320-G-300-411) This procedure has now been amended to the following:-

- **1.1.** Ensure you have enough ratchet straps.
- **1.2.** Fit the Mk2 Latches in the seat frame positions.
- **1.3.** Tension down the Seating pods to the load bed using the ratchet straps supplied.
- **1.4.** Tighten and lock the MK2 latches as described in the installation instructions.
- **1.5.** Insert a cable tie through the latch locking lever, to act as a secondary security device. (See fig 1)
- **1.6. RE-POSITION THE RATCHET STRAPS AND RE-TIGHTEN, LEAVING THEM IN PLACE.** (See figs 2-6 for securing method.) This will provide further security for the seating pods, and avoid potential trip hazards by drawing in the straps.
- **1.7.** Drivers daily checks should ensure the ratchet straps are still tight, and look for any obvious

visual movement of the latches. (There should be no sign of the latch lifting out of its mounting) Any such occurrences are to be reported, and the seating systems re-tightened.

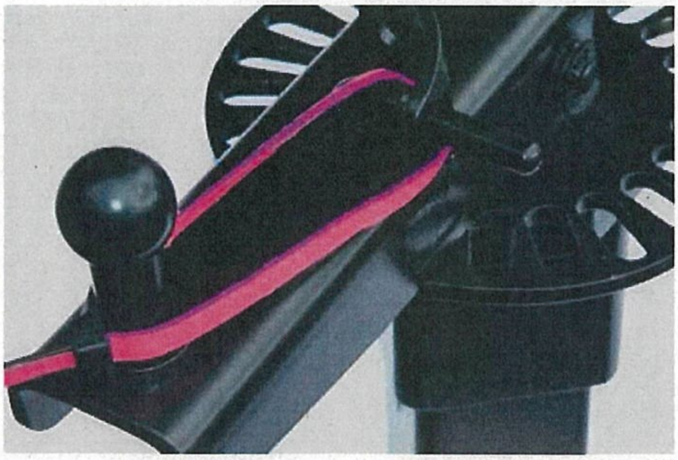
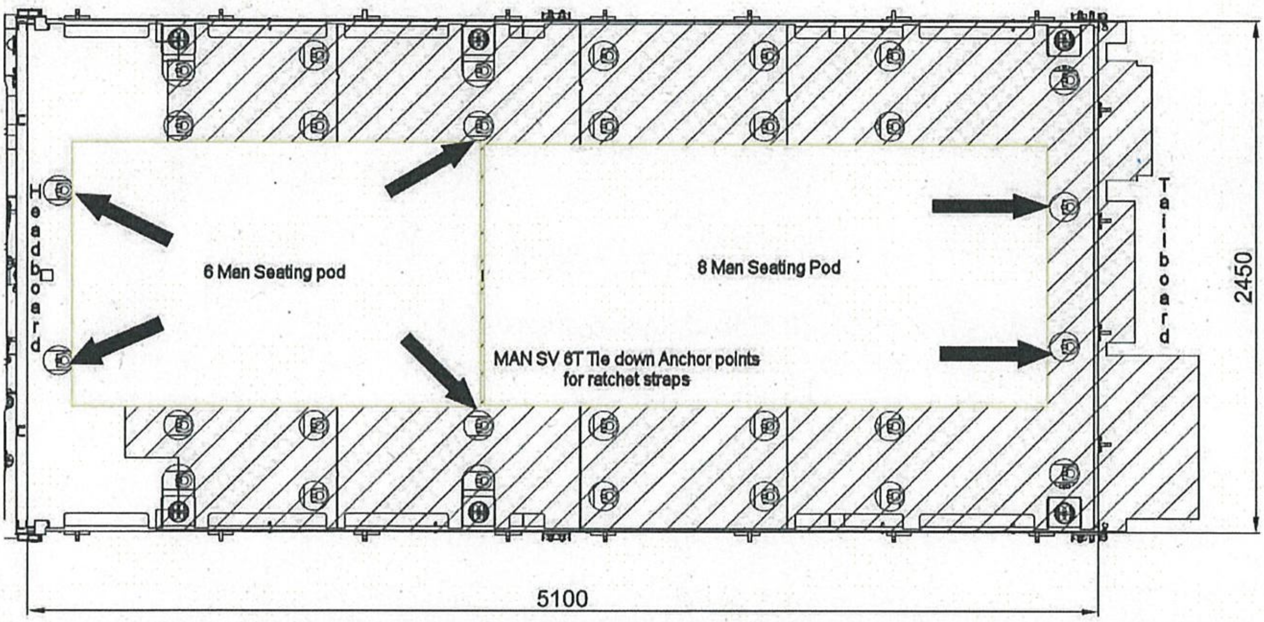


Fig 1- Locking lever secured with a cable tie.

Fig 2- below- Ratchet strap positions, MAN SV.



1.8. The following method is recommended as best practise, and uses the inboard cargo lashing points. It will require removing the ratchet straps (once the Seating pod locking latches have been secured) and re-positioning them as laid out below. This method uses 3 straps in total for a MAN SV using a 6 and 8 Man pod together, with ratchet straps fitted by the headboard, at the rear, and a single in the centre locking both seats together to the floor.

Fig 3- Strap fitted at rear tailboard end

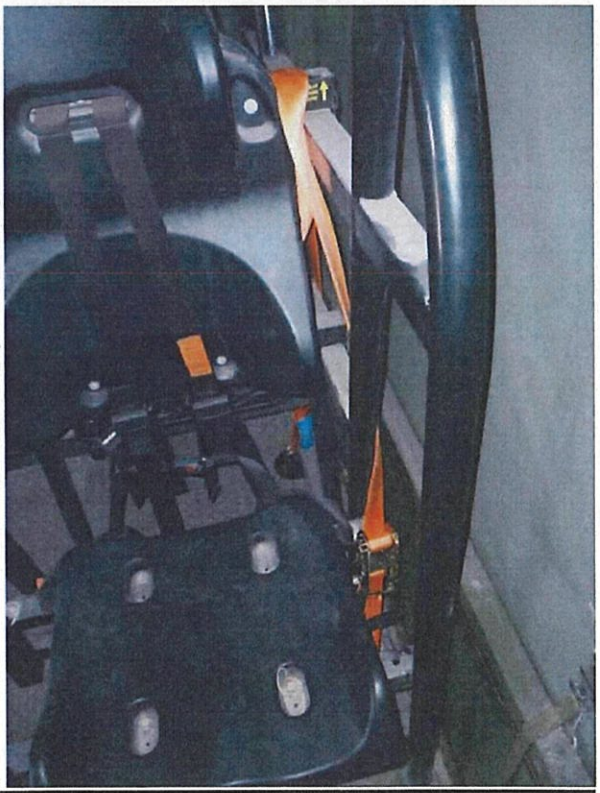


Fig 4- Centre Mount strap position.

Fig 5- Headboard strap position.

TCVES MK2 sets fitted to DAF 4T ratchet strap fitting guide

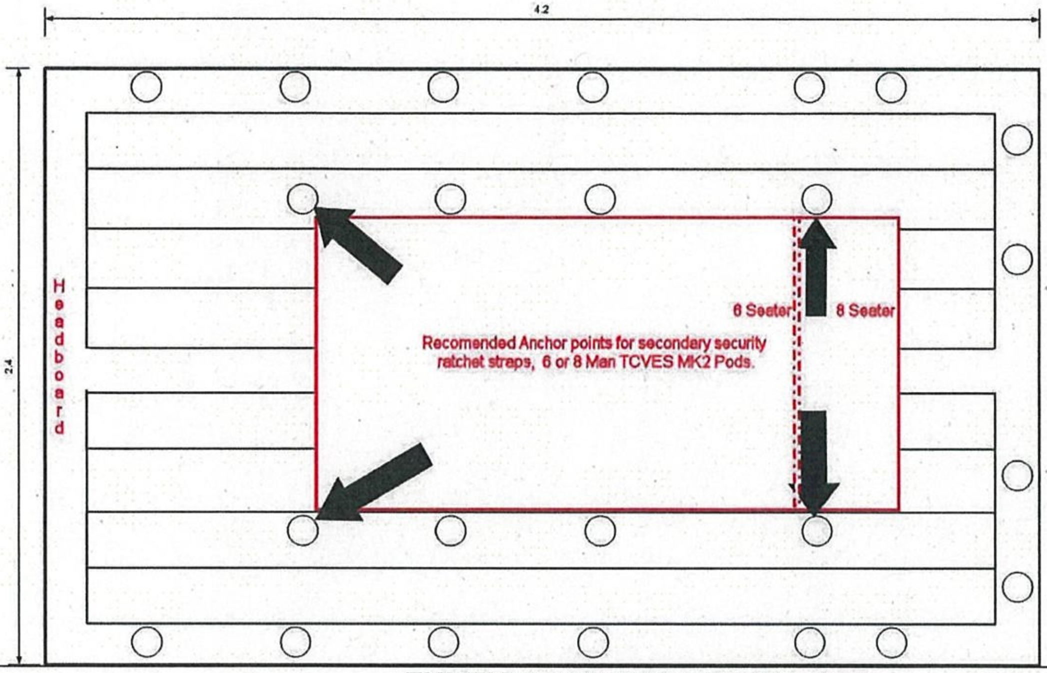


Fig 6- Daf 4T Load bed layout

Re-position the ratchet straps to use the inner anchor points and re-tighten, leaving them in place.

FURTHER MITIGATION ACTION

1.9. On six monthly inspections (VM or equivalent Trade) the latches are to be checked for security, and any movement of the latches from their position. Any irregularities are to be recorded and reported via the EFR system. The latches are then to be removed, and inspected for serviceability. Following this technical inspection, serviceable latches are to be re-fitted according to sub-paragraphs 1.1 to 1.6. Damaged latches are to be reported on the EFR system.

1.10. The AESP will be corrected by formal amendment.

ACTION REQUIREMENTS

This Safety Notice will remain extant until AESP 2320-G-300-111 & 411 has been updated. (Update to be carried out by SLV PT.)

SAFETY NOTICE VERSION CONTROL

Date	Issue No	Reason for Change
17/05/2012	3	Inclusion of Ratchet strap fitting plan.

DISTRIBUTION

Internal	External
[redacted]	Army HQ DEME(A) ARTD HQ Fleet HQ Air

AUTHORISATION

APPROVED	AUTHORISED
[redacted] Date:17/05/2012 Safety Manager Specialist Logisitic Vehicle Project Team	[redacted] Date:17/05/2012 ESM Legacy Cargo Specialist Logisitic Vehicle Project Team