

**ENGINEERING CHANGE
SUPPORT PACKAGE**

FMMSA004

**INTERIM MITIGATION
FOR STRUCTURAL FLOOR
CORROSION OF
MARK 4 SV**

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1 DESCRIPTION & JUSTIFICATION FOR CHANGE

1.1 INTRODUCTION

The Mark 4 SV kitchen contains four sinks, a hot water boiler/font installation with drip tray and a dishwasher mounted in a single run of kitchen units adjacent to the vehicle bodyside. These “wet” items are all prone to leakage for a variety of reasons, and any leakage will inevitably accumulate in the vehicle underfloor area, there being no drip tray or other backup drainage arrangements. See Reference 1 for details

Experience has shown that whilst some SVs are fairly dry in the underfloor area and in fair condition, some have become flooded to a greater or lesser extent, and corrosion is occurring. Even in the dry vehicles, the paint applied to the inside surface of the structural underfloor is peeling off revealing bare metal underneath.

A method of draining out the water and rectifying the corrosion present is therefore needed. To do this properly requires full access to the corroded surfaces to dry them out, remove all debris and loose paint, and apply corrosion inhibitor and new paint.

Interfleet was commissioned to undertake assignment T25458 to produce a method for lifting the floor in the central walkway area of the kitchen. This was found to be practicable and a procedure (Reference 2) is now available for lifting the floor in the central walkway area of the kitchen and rectifying the corrosion beneath. However there is no equivalent available for addressing the area underneath the kitchen units. A brief study of the way the units are installed has concluded that removal of the units is not practicable in the short to medium term.

It is therefore necessary to carry out some interim mitigation work to:

- a) Provide some drainage to the underfloor area
- b) Stop the existing corrosion and minimise opportunities for new corrosion to form.

It is recognised that the very limited access will impose restrictions on what is achievable in terms of corrosion protection.

1.2 DESCRIPTION OF CHANGE

The proposed change is described in detail in Appendix A and can be summarised as follows:

- 1) Drill holes in the “troughs” of the underfloor corrugated sheeting at the positions indicated in Appendix B. Allow all water to drain out.
- 2) From the underside of the vehicle, spray Rustbuster Fe-123 corrosion converter. Allow to dry for 4 hours.
- 3) Install air lines and allow air to blow continuously through the treated areas of the underframe during the drying time.
- 4) Again from the underside of the vehicle, spray Rustbuster MIL SPEC ASTM wax.
- 5) Plug holes shown in Appendix A as requiring plugging using fire resistant plugs.

The above process will leave the vehicle in the following condition:

- Drain holes provided in the troughs of the structural floor sheets which pass under the “wet” kitchen units.
- Voids under kitchen units impregnated with corrosion converter.
- Voids coated internally with protective wax.

Any debris, loose paint etc on the internal surface of the structural underfloor will remain in place.

1.3 JUSTIFICATION FOR CHANGE

There is a requirement for the issue of corrosion of the underfloor sheeting to be addressed. As it is not practicable to remove the kitchen units in the short to medium term, a method is required that can be carried out in situ.

The underfloor sheeting is divided into 3 discrete sections by the bolster and by other underframe features, yet only one section is currently provided with any drainage holes. These existing holes are of small diameter and are prone to blockage by cooking fat and corrosion debris. Several vehicles have experienced underfloor flooding as a result of this inadequate drainage provision.

If no action is taken the corrosion of the floor sheeting will continue and will ultimately lead to holes forming. Thus ultimately the structural integrity of the vehicle could be compromised.

NB: To date, hole formation is known to have occurred on only one vehicle, which appears to have been an exceptional case and which has been fully repaired. This modification is intended to prevent a repeat of this level of damage but not to return the vehicles to an as-new state.

Rustbuster will be required to provide training in the use of their products and the spray equipment.

It is proposed that Interfleet will witness the first off treatment of an SV and to inspect within the voids using an endoscope to verify the level of coverage achieved. Changes to the procedure can be introduced at this point.

2 RISK ASSESSMENT

Hazard identification has been carried out using Interfleet’s specialist experience rather than the generic hazard identification list IQF509 (included as Appendix D). This decision has been taken because it is considered that the generic list is not appropriate to identify all the relevant hazards for this type of change.

A qualitative approach has been taken to risk ranking, with the objective of identifying the relative significance of the risks and to identify where mitigation measures would be justifiable.

The standard 5*5 matrix has been used, multiplying estimated severity by estimated likelihood to determine the overall risk of the hazard.

		Estimated severity					
		1	2	3	4	5	
		No effect	Passenger discomfort	Potential for minor injuries	Potential for major injuries	Fatalities	
Estimated likelihood	1	Improbable	1	2	3	4	5
	2	Possible	2	4	6	8	10
	3	Occasional	3	6	9	12	15
	4	Frequent	4	8	12	16	20
	5	Daily occurrence	5	10	15	20	25

The risk scores are classified as follows:

Range	Acceptability
1-6	Acceptable without further mitigations
7-11	Acceptable with additional mitigations
12-25	Unacceptable

Hazard	Consequence	Likelihood	Severity	Risk	Mitigation
Risks associated with application of the rust converter and wax for mitigation of floor corrosion					
1 Introduction of new material increases fire load of vehicle.	Fire on vehicle	1	5	5	<p>The new inhibitor and wax combination has been fire tested and is shown to give adequate resistance. See Appendix C.</p> <p>The volume of material is relatively limited given that 1 litre of rust converter and 4 litres of wax are enough to cover 5 square metres.</p> <p>The area to be covered in this case is approx 4m² so the mass of coatings involved will be approx 4kg per vehicle.</p> <p>The grommets to be used are considered small enough to be insignificant.</p>
2 Degradation of the fire barrier through introduction of holes.	Spread of fire into the vehicle from outside	1	5	5	<p>The need for the floor to form a fire barrier is only mandated for new builds, however any degradation of existing provision should be minimised.</p> <p>The vehicles already have four holes in this sheeting introduced as part of a previous modification.</p> <p>15 holes of a relatively small diameter (max 20mm) are being introduced, of which 2 are enlargements of existing holes and 6 are to be plugged. The increase in hole size is to ensure that drain holes do not become blocked.</p> <p>The holes lead into a void under the kitchen units rather than directly into a passenger space and so the path into any potentially flammable materials is long and indirect.</p>

Hazard	Consequence	Likelihood	Severity	Risk	Mitigation
3 Toxicity of the new material upon application	Health risk to personnel	1	2	2	The risk is acceptable, as this material is not toxic as stated in the material data sheet, Reference 3.
4 Toxicity of the new material during maintenance activities	Health risk to personnel	1	2	2	The risk is acceptable, as this material is not toxic as stated in the material data sheet, Reference 3.
5 Degradation of the vehicle structure	Failure of the vehicle underfloor	1	4	4	<p>The holes to be drilled are small compared to existing holes already present for drains and electrical conduits. The stress concentrations formed by the holes are no more severe than the multiple stress concentrations already formed by the fillet welds used to attach cross members to the floor sheets.</p> <p>There will be no appreciable decrease in strength of the underfloor.</p>
6 Water running out of floor sheeting into underframe equipment	Damage to equipment, particularly electrical components	1	3	3	<p>Where holes are being drilled above the battery box, these will be plugged following application of the rust converter and wax.</p> <p>In other locations where holes are to act as drains these have been located so as to ensure that they are not above sensitive locations such as electrical equipment.</p>
7 Failure to stop corrosion	Loss of structural integrity through excessive corrosion	2	2	4	<p>The rust converter has been proven in many non-railway applications and trialled on small sections of corroded material. It mixes readily with dampness and soaks into corrosion debris, giving very good coverage.</p> <p>Application of the product is thus likely to be beneficial, whilst provision of larger drain holes will avoid blockage by fat and thus prevent build-up of standing water.</p>

Hazard	Consequence	Likelihood	Severity	Risk	Mitigation
					<p>It is not possible to be certain that these measures will completely prevent corrosion but they are likely to reduce its rate of progress.</p> <p>A re-check of floors is considered necessary at the next OH1.</p>
8 Disruption to overhaul	Delay in getting vehicle back into service	1	2	2	The application process for the product can be undertaken in one day and can be carried out at any point in the overhaul process while the bogies are off. This will ensure minimal disruption or increase in overhaul time.
9 Contamination of interior of cupboards.	Damage to kitchen equipment	3	3	9	Mitigation required – sealing of holes using masking tape and cleaning of interiors of cupboards after application.
10 Drilling through services	Damage to vehicle, in the worst case leading to vehicle having to be taken out of service	2	2	4	<p>All holes to be drilled have been located away from services, so as to avoid the risk of this occurring.</p> <p>The services are mounted externally on the underframe and therefore their position is apparent.</p>
11 Errors in carrying out process, or deficiencies with process	Ineffective treatment or damage to vehicle.	3	3	9	<p>Rustbuster to provide training in use of their products.</p> <p>Interfleet to witness first off modification and update procedure as necessary.</p>

3 DOCUMENT REVIEW

EV/VI4225 and EV/VI5225 have both been reviewed. Neither document appears to contain any reference to the existing drain holes or drainage grommets.

It is recommended that a check is introduced on major exams as follows:

- Inspect drain holes and check that they are not blocked.
- Check for presence of plugs and renew any missing items.

These clauses could be added to Level 4 job UU0128 (Underframe Access Doors and Panels – Examine) which is currently carried out on C & D exams.

The vehicle drawings should be amended to record the presence of the holes and bungs. A suggested way to do this would be to add a note to drawing BB002B03 (Structural Underframe Type B) referencing this change pack or possibly a new modification drawing.

4 SUPPORTING DOCUMENTATION

Please see the following supporting documentation:

4.1 REFERENCE DOCUMENTATION

The following reference documentation has been supplied previously and is not included as with this document.

Reference 1: Interfleet report ITLR/T24815/001 "Mark 4 SV – mitigating and resolving leakage problems"

Reference 2: EV/MP1909 "Partial Renewal of Mark 4 SV Kitchen Floor to Facilitate Corrosion Inspection".

Reference 3: Rustbuster Fe-123 Molecular Rust Converter data sheet "High Performance Sealants and Adhesives for the Restoration, Construction and Maintenance of Specialist Vehicles", produced by Rustbuster Ltd.

4.2 SUPPORTING DOCUMENTATION

None

4.3 CALCULATIONS

None

4.4 REFERENCE DRAWINGS

2006961 SV floor panel layout
2009335 Fixing points to vehicle floor
2009353 Equipment layout
2009354 Equipment layout elevations
2009385 Kitchen GA
2009386 Kitchen GA sections
2009950 Floor drains
2009951 Floor drain sections
2009986 Fixing brackets
BB002B03 Structural underframe type B

4.5 ISSUED DRAWINGS

None

5 APPENDIX A – APPLICATION METHOD

5.1 TECHNICAL INFORMATION

REFERENCE DOCUMENTS		
Item	Document Number	Document Title
1	-	Product safety data sheet Fe-123 rust converter
2	-	Product safety data sheet MIL SPEC ASTM wax

SPARE PARTS			
Item	Description	Qty	Cat. No.
1	20mm blind grommets, for 20mm hole dia x 1.6 plate thickness, black	6	RS 605-661

SPECIAL TOOLS			
Item	Description	Qty	Cat. No.
1	Air operated workshop drill, right angle drive	1	Local supply
2	20mm drill bit	1	Local supply
3	Hand deburring tool	1	Local supply
4	Wax injection kit comprising spray tip, injection probes, 1 litre vessel and spray gun	2	Rustbuster AT1001
5	Free-standing workshop heater, typical output 30kW	2	Local supply
6	Buckets or other receptacles to catch overflow of chemicals	As reqd	Local supply

CONSUMABLE MATERIALS			
Item	Description	Qty	Cat. No.
1	Masking tape 50mm	As reqd	Local supply
2	Rustbuster Fe-123 rust converter	5 litres	Local supply
3	Rustbuster MIL SPEC ASTM wax	5 litres	Local supply
4	QD primer, BR spec 81 item 106.	As reqd	028/005999
5	Gloss black, BR spec 81 item 205	As reqd	028/005319

5.2 APPLICABILITY

This process applies to SV cars only at OH2.

5.3 FACILITIES AND ACCESS REQUIRED

Vehicle in workshop on stands. Bogies and battery module removed.

Workshop air supply available.

Wear eye protection when drilling and spraying.

5.4 PREPARATION

- 1) Using an air operated drill, drill holes in the “troughs” of the underfloor corrugated sheeting in the groups A to H indicated in Appendix B. Allow all water to drain out.

WARNING: Wear eye protection

NOTES:

- *Holes to be drilled 20mm diameter.*
 - *In some locations access is poor and it may be necessary to drill into the side of the corrugation not the base. Where this is done, ensure that the hole touches the base of the corrugation to provide an effective drain for standing water.*
- 2) De-burr all holes by hand internally and externally.
 - 3) Remove kitchen utensils/crockery from all floor-level cabinets under sink units. Seal holes temporarily using making tape, consumable item 1, to prevent ingress of corrosion protection fluids.
 - 4) Paint cut edges of holes using BR spec 81 anti-corrosive primer, consumable item 4. Allow to dry.
 - 5) Paint primed areas with black gloss, consumable item 5.

5.5 APPLICATION OF COATING

- 1) From the underside of the vehicle, spray 0.5 litres of Rustbuster Fe-123 corrosion converter, consumable item 2, into one of each hole in the groups lettered A-H on the diagram in Appendix B. Use the air operated wax injection equipment and injection probes, pushing the probe as far as possible into the void to be treated and then withdrawing it slowly while spraying.

WARNING: Wear eye protection

NOTES:

- *The Fe-123 solution is water soluble and so there is no need to fully dry surfaces before application.*
 - *On application the excess liquid will drain out of the access holes. Suitable containers should be placed to collect this.*
- 2) Position a portable heater under the vehicle, each side of the bolster and direct warm air onto the underframe sheeting.

- 3) Insert air lines into one hole in each of the groups A, D and H, and temporarily secure in position. Allow compressed air to bleed continuously through the treated areas of the underframe for 4 hours.

WARNING: Wear eye protection when setting up air feeds

- 4) From the underside of the vehicle, spray Rustbuster MIL SPEC ASTM wax, consumable item 3, into one of each hole in the groups lettered A-H on the diagram in Appendix B.

WARNING: Wear eye protection

5.6 COMPLETION OF WORK

- 1) Plug holes according to Appendix B using blind grommets, item 1.
- 2) Remove temporary masking tape from kitchen units and replace removed kitchen utensils/crockery. Clean interior of cupboards where necessary to remove any ingress of chemicals.

- 6 APPENDIX B – DIAGRAM OF HOLE POSITIONS
- 7 APPENDIX C – FIRE TEST REPORT
- 8 APPENDIX D – HAZARD IDENTIFICATION FORM