Date: 26 March 13

Our Ref: HSL/MNC/JR/20661-G

Mr Shaun Wing
1st Floor, Zone 3, IDL14
Blenheim Building
Marlborough Lines
Monxton Road
Andover
SP11 8HT

Dear Shaun

Re: Vehicle and equipment corrosion protection during storage and transit – Trial Report

Scope

To protect military vehicles in storage and transit, as well as various equipments and spares being transported in ISO containers, over a six month period at Defence Support Group (DSG) at Aschurch, on behalf of the Data, Recording, Analysis & Corrective Action System (DRACAS), using Vapour phased Corrosion Inhibitors (VpCI's), supplied and treated by HITEK-nology Solutions Ltd (HSL). This trial was started on 17th September 2012.

Aim & Objective

To prove that military vehicles, in this instance Spartan CVR(T) vehicles, in both transit and medium to long term storage as well as spares and equipment being transported in ISO containers between home and theatres of operations, can be protected from corrosion, without the requirement of expensive Controlled Humidified Environment (CHE), whilst at the same time allowing the vehicles and equipments to be placed back into operation at short notice.

General outline

There was to be three CVR(T)'s used for the trial, one was to be treated with VpCI for protection during transit, one was to be treated for protection during storage for a period of up to five years, and one was to be left with no protection as a datum, all three vehicle would be left outside open to the elements at Ashchurch.

There was also to be three ISO containers used for the trial, containing equipment and spares that would normally be stored / transported in these ISO containers. All the ISO containers would have the same amount and type

of equipment placed inside. One ISO container was to be treated with a VpCI water based treatment, one was to be treated with VpCI foam pads, and one was to be left untreated as a datum. As with the CVR(T)'s the ISO containers were to be left outside exposed to the elements at Ashchurch.

All the vehicles and ISO containers would be fitted with low grade carbon steel plates to allow a quick visual inspection of any corrosion taking place.

Treating each individual vehicle and ISO container

CVR(T) one

The first CVR(T) was washed down using VPCI 415 (a cleaner degreaser) mixed with water at a ratio of 10% VpCI 415 and 90% water.

This vehicle was then protected as though in transit using two different methods. One half of the vehicle was treated using VpCI 415 and water at a mix ratio of 50% VpCI 415 and 50% water (this half was the right hand side of the vehicle, when looking from the front). The other half of the vehicle was treated with VpCI 389D 1:1 which is a water based ready to use temporary coating, this was used at a ratio of 50% VpCI 389D and 50% water.

Both of these treatments were applied to the vehicle using a Karcher G4.10 pressure wash, it was used with its own suction hose as opposed to being fitted to an external water supply to ensure accuracy of the VpCI and water mix.

Two low grade carbon steel plates were fitted to the front of the vehicle (by the number plate), one on each half, treated in the same way as the half of the vehicle it was attached to. A third plate was hung inside the vehicle.

Half of the CVR(T) being treated with VpCI 389D 1:1, further mixed at 50% with water

The two plates fitted to the front of the CVR(T). It can also be seen from this picture that the VpCI 389D dries to a clear finish

CVR(T) two

The second CVR(T) was also washed down using VPCI 415 mixed with water at a ratio of 10% VpCI 415 and 90% water.

The following systems were then treated with additives as listed below:

- Engine – treated at a ratio of 2-5% by weight. 700ml of M529 was added to the engine oil.
- Gearbox - treated at a ratio of 2-5% by weight. 500ml of M529 was added to the gearbox oil.
- Final drives - treated at a ratio of 2-5% by weight. 65ml of M529 was added to each of the final drives oil.
- Coolant – treated at a ratio of 2-2.5% by weight. 675ml of M640L was added to the coolant system.
- Fuel – treated at a ratio of 0.1-0.15% by volume of the fuel tank. 500ml of VpCI 705 was added to the fuel tank.
- Brake – treated at a ratio of 1-1.5% by weight. 10ml of M408 were added to the brake fluid.

The vehicle was then driven approximately 100 metres and allowed to "run up" for approximately 15 minutes to allow all the additives to mix and circulate around their relative systems.

Notes:

1. All volumes were supplied by DRACAS
2. All system levels were dropped by DRACAS to ensure no overfilling when the additives were added to the systems.
3. DRACAS arranged for AES to take samples of the oils etc. before and after the additives were added to all the systems.
4. DRACAS decided not to treat the steering system so as to allow a comparison with the brake system, they both use the same fluid and the reservoirs are situated together.

After the vehicle had been run up, all external moving parts such as hatch springs, door hinges and road wheel arms etc. were treated using VpCI 369 aerosol. All exposed electrical connections, both internal and external, were treated with ElectriCorr VpCI 239 aerosol.

A low grade carbon steel plate was hung inside the vehicle.

The vehicle was then driven onto the MilCorr VpCI Shrink Film. Approximately twenty five VpCI 132 foam pads were placed at various places in and around the vehicle. The MilCorr was then pulled over the vehicle, all excess material cut off and then heat shrunk into place using a propane operated gas gun.

Road wheel arms being treated with VpCI 369

Exposed electrical connections being treated with ElectriCorr VpCI 239

The MilCorr VpCI shrink film laid on the floor prior to the CVR(T) being driven onto it

The completed CVR(T), and now protected from corrosion in all weathers

CVR(T) three

This was the datum vehicle and as such was not treated with VpCI's, it was just parked up, and a low grade carbon steel plate hung inside.

Note: A low grade carbon steel plate was also placed in a CVR(T) that was stored in the CHE, known locally as Shed One

ISO container one

The spares and equipment was placed inside the ISO container. Three litres of VpCI 337 was sprayed into the ISO containers using the Karcher G4.10 pressure wash. Two low grade carbon steel plates were hung inside the container, one attached to the container and one attached to a piece of equipment.

ISO container two

The spares and equipment was placed inside the ISO container. One hundred and twenty five (125) VpCI 132 series foam pads were hung / placed

around the container. Two low grade carbon steel plates were hung inside the container, one attached to the container and one attached to a piece of equipment.

ISO three

This was the datum ISO container and as such was not treated with VpCI's, it was just put into place, and two low grade carbon steel plate hung inside, as per the other two containers.

Note:
The amount of VpCI 337 and VpCI 132 used to treat these containers would not change irrespective of how much equipment / spares were placed inside the container, as the amount used is worked out by volume.

ISO container one, being treated with VpCI 337

ISO container two, being treated with VpCI 132 foam pads

Visual check in October 2012

On 24th October 2012 the ISO containers and CVR(T)'s were visually checked with the following result

No degradation could be seen at this stage on any of the carbon steel plates in any of the ISO containers (treated or untreated).

A difference could already be seen on CVR(T) one. The half that had been treated with VpCI 389D was in the same state as at the start of the trial, the half that had just been washed down with VpCI 415 was starting to degrade, this was particularly evident on the sacrificial plates and the tracks.

The frontal view, clearly showing the difference in the two halves as well as the carbon steel plates

Close up photos of the front of the CVR(T), the left one is the half treated with VpCI 389D. The difference between the two halves can clearly be seen on both bodywork and the carbon steel plates

The difference can already be seen between the wheels and tracks. The left side is the side treated with VpCI 389D.

Obviously CVR(T) two could only be visually checked to ensure no damage had occurred to the MilCorr, none had

CVR(T) three which had received no treatment and was being used as the datum vehicle had degraded particularly badly on the wheels and tracks especially compared to CVR(T) one

As can be seen above, CVR(T) three, having had no VpCI protection of any kind, was already showing a lot of rust on the wheels and tracks

Visual check in November 2012

On 22 November 2012 the ISO containers and CVR(T)'s were visually checked with the following result

Once again no degradation could be seen on the carbon steel plates in any of the two treated ISO containers. There was however a small rust spot appearing on the plate in the untreated container, this did look like it was in the shape of a finger print.

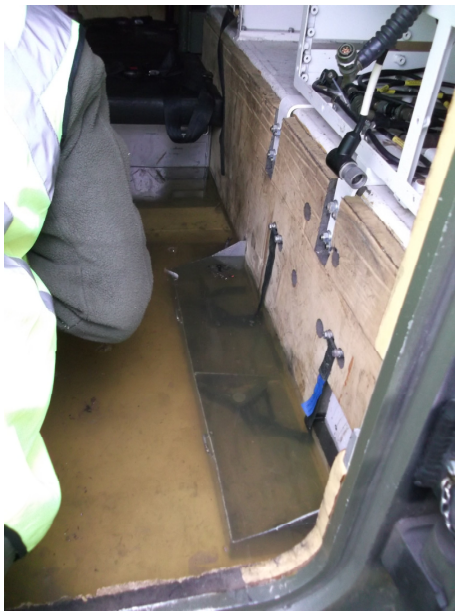
CVR(T) one continued to show a difference, the half treated with VpCI 389D was still showing no signs of any degradation. The half that had just been washed down with VpCI 415, had degraded further, this could once again be seen using the carbon steel plates and the tracks, but it was also now evident that a difference could also be seen in the state of the bow shackles fitted to the front of the vehicle

However when checking inside this CVR(T) it was apparent that the various hatch seals had failed and there was approximately 6" – 8" of water in the bottom of the vehicle. Signs of rust were seen on both the sacrificial plate fitted in the driver's compartment, and on the fitted equipment inside the vehicle. The plugs were removed from the vehicle to allow all water to drain, the plugs were left out to ensure that the vehicle would not refill with water again.

It was also decided that in December 2012, VpCI 132 foam pads would be placed inside of CVR(T) one, as well as an extra (new) low grade carbon steel plate

CVR(T) two could only be visually checked to ensure no damage had occurred to the MilCorr, none had

CVR(T) three which had received no treatment and was being used as the datum vehicle had continued to degrade on the wheels and tracks, but in addition was now starting to show signs of corrosion on the vehicle decks and also the carbon steel plate hung inside the vehicle.



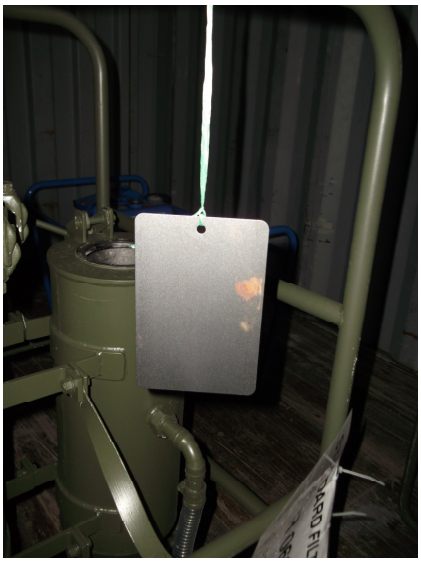
Rain water in the back of CVR(T) one

The plate showing signs of corrosion in the back of CVR(T) one due to rain water

Visual check, and re-treatment of one CVR(T)in December 2012

On 12 December 2012 the ISO containers and CVR(T)'s were visually checked, in addition the vehicle that was treated for storage was re-treated, with the following result

Once again no degradation could be seen on the carbon steel plates in any of the two treated ISO containers. The rust spot on the plate in the untreated container had got a little larger. Rust was also now appearing on the second plate in the untreated ISO container.

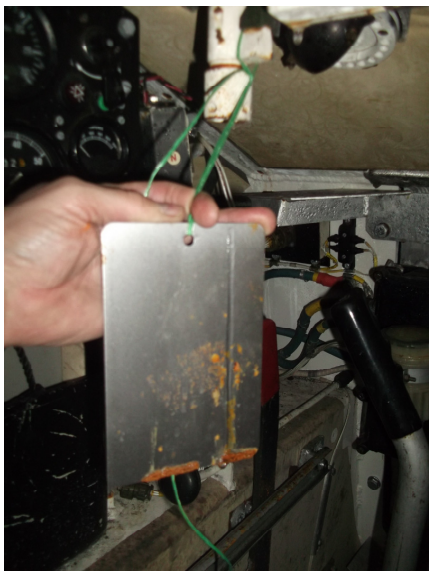


The two plates in the untreated ISO container, showing signs of corrosion

CVR(T) one continued to show a difference, the half treated with VpCI 389D was still showing no signs of any degradation. The half that had just been washed down with VpCI 415, had continued to degrade, this could once again be seen using the carbon steel plates, tracks, and various fittings on the top of the vehicle.

Although there was no standing water in the vehicle (the drain plugs had been left out once removed in November), it was evident that the environment inside the CVR(T) was damp and icy.

As planned, VpCI 132 foam pads were placed in the back of the vehicle and a fresh low grade carbon steel plate was also fitted alongside the existing plate, the old plate was left in to show that the foam pads would stop the existing corrosion in its current state as well as protect the new plate from future corrosion.



The plate in the back of CVR(T) one

VpCI 132 foam pads fitted in the back of CVR(T) one, also a new low grade carbon steel plate was fitted alongside the existing plate

CVR(T) two was unwrapped and the vehicle checked for corrosion, both inside and out, none could be seen. The plate that had been fitted in the driver's compartment at the start of the trial was as new, this plate was left in for the remainder of the trial

The vehicle was driven forward, new MilCorr laid out and the CVR(T) re-wrapped.

The additives that had been put into the oils and fuels etc. at the start of the trial were not checked at this point, nor were any additional additives added to any of the systems

CVR(T) two, during the unwrap process, showing no signs of degradation

The plate in the back of CVR(T) two was as new when checked in December 2012

CVR(T) three which had received no treatment and was being used as the datum vehicle was as expected, on the tracks etc, however the corrosion on the vehicle decks was now showing quite clearly, even from a distance.

Visual check in January 2013

On 16 January 2013 the ISO containers and CVR(T)'s were visually checked with the following result

All the plates and equipment within the ISO containers were (visually) in the same state as last month

CVR(T) one continued to show the difference in the two halves of the vehicle. The plate on the half treated with VpCI 389D had slipped down slightly, although this has no impact on the trial

The VpCI foam pads that had been fitted internally were clearly working, and stopping any further corrosion, despite obvious signs of water and ice on all the internal surfaces.

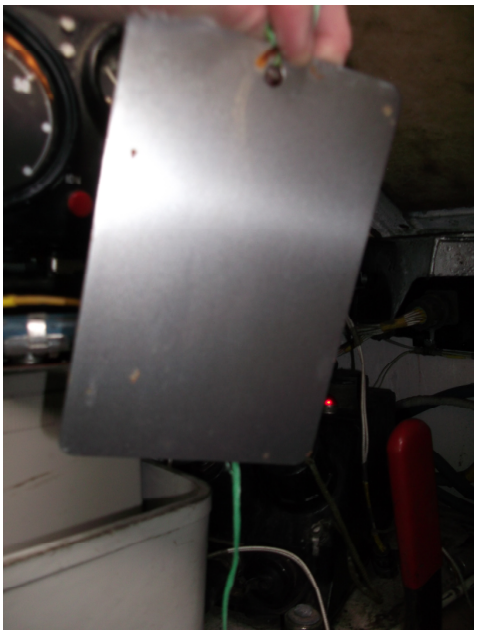
This was evident on the two plates inside the CVR(T) . The one that had been originally fitted and had corroded, was in the same state as when the foam pads had been installed in December 2012. The new plate that had been fitted in December 2012 was looking as new.

The plate fitted to the half treated with VpCI 389D had slipped

The foam pads clearly working inside of CVR(T) one. The plate on the left has had the corrosion stopped in its tracks, whilst the plate on the right (fitted the previous month) shows no sign of corrosion

CVR(T) two could only be visually checked to ensure no damage had occurred to the MilCorr, although the MilCorr was covered in ice, none had

CVR(T) three which had received no treatment and was being used as the datum vehicle was still showing the degradation as previously mentioned. In addition the plate inside the vehicle was also showing signs of corrosion



The plate fitted to CVR(T) three, showing signs of corrosion

Visual check in February 2013

On 19 February 2013 the ISO containers and CVR(T)'s were visually checked with the following result

All the plates and equipment within the treated ISO containers were (visually) in the same state as last month, the plate hung on the wall of the untreated ISO container was visually showing a small amount of extra corrosion

CVR(T) one continued to show the difference between the two halves, however in addition there appeared to be a few small rust spots or water marks appearing on the plate fitted to the half treated with VpCI 389D, no signs were evident on the vehicle itself. This is to be expected as VpCI 389D is only a temporary transit coating and the low grade carbon steel plates will corrode before the equipment itself.

Upon going around the back of the vehicle it could be seen that the rear door was open. Although it's not known exactly how long this door had been left open for, the SSgt responsible locally for the CVR(T) stated he knew of no reason for anybody to open it, so it is likely it could have been left open for the whole month.

This had allowed the inside of the vehicle to dry out, but also proved that the VpCI foam pads were working, although a few small spots could be seen from the new plate fitted internally, had there been no pads fitted and the door left open we would have expected the plates to show a lot more signs of corrosion

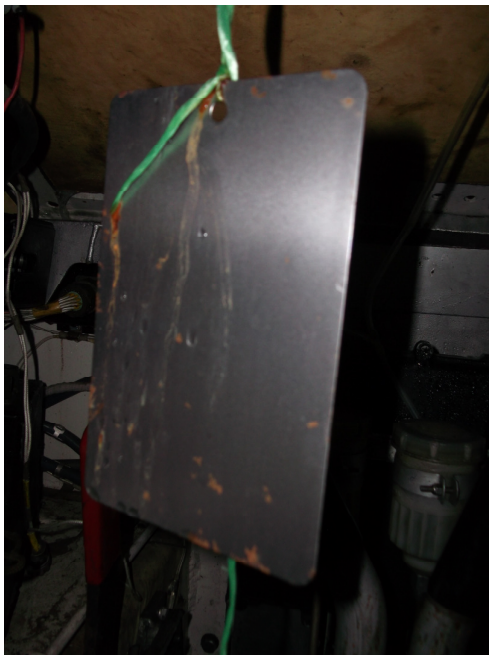
The VpCI foam pads will protect from corrosion for up to two years, clearly as the door had been left open the life of the pads would be reduced, however as the trial had only one more month left to run it was felt that the foam pads would still have enough treatment left in them, and therefore no need to put fresh ones in the CVR(T).

The door found open in February 2013

The plates fitted inside CVR(T) one, after the door had been left open

CVR(T) two could only be visually checked to ensure no damage had occurred to the MilCorr, as expected none had.

CVR(T) three which had received no treatment and was being used as the datum vehicle continued to degrade. In addition the plate inside the vehicle had continued showing more corrosion

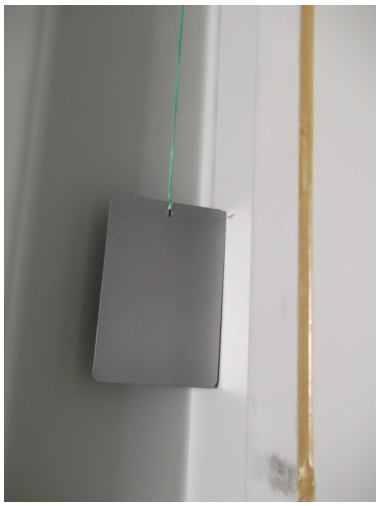


The plate fitted inside CVR(T) three, showing a greater amount of corrosion compared to the previous month

End of trial March 2013

On 20 March 2013 the trial was concluded with the following results:

As can be seen in the following pictures, the plates fitted into the ISO container that had no treatment had degraded compared to the plates fitted in the ISO containers treated with VpCI 337 and VpCI 132 foam pads



The plate fitted on the ISO container wall that was treated with VpCI 337, showing no signs of corrosion

The plate fitted on the ISO container wall that was treated with VpCI 132 foam pads showing no signs of corrosion

The plate fitted on the ISO container wall that had no treatment, showing a small covering of corrosion

The plate fitted on equipment in the ISO container that was treated with VpCI 337, showing no signs of corrosion. The surface appearance is where the VpCI 337 has made direct contact with the plate during treatment

The plate fitted on equipment in the ISO container wall that was treated with VpCI 132 foam pads, showing no signs of corrosion

The plate fitted on equipment in the ISO container that had no treatment, showing a small amount of corrosion

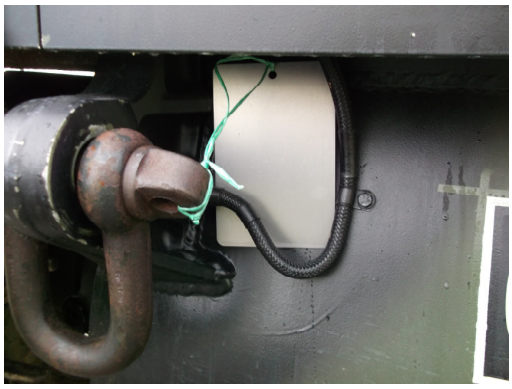
CVR(T) one continued to show the difference between the two halves. The plate fitted to the half treated with VpCI 389D did have a couple more rust spots. Below are pictures of the front of the vehicle, taken one month after the start of the trial, and every month thereafter up to and including the trial completion in March 2013

October 2012

Front view and close ups of the plate fitted to CVR(T) one, taken in October 2012, as can be seen one month in the plate treated with VpCI 389D is protecting the plate, and the vehicle

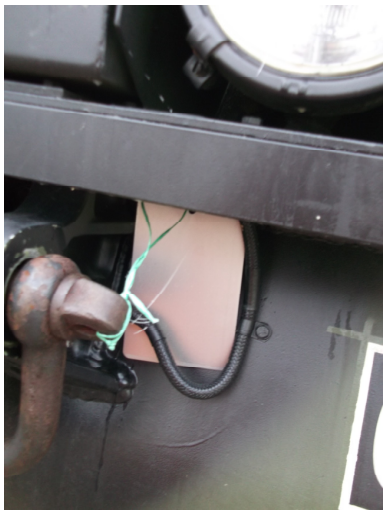
November 2012

Front view and close ups of the plates fitted to CVR(T) one, taken in November 2012, the untreated plate continues to degrade. It can also be seen that there is now a difference in the standard of the bow shackles fitted to the vehicle



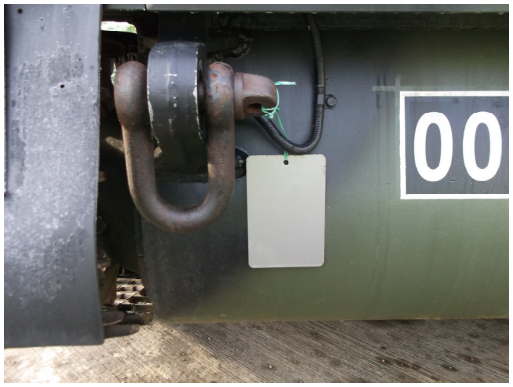
December 2012

Front view and close ups of the plates fitted to CVR(T) one, taken in December 2012, the untreated plate continues to degrade, whilst the treated plate shows no signs of degradation at all



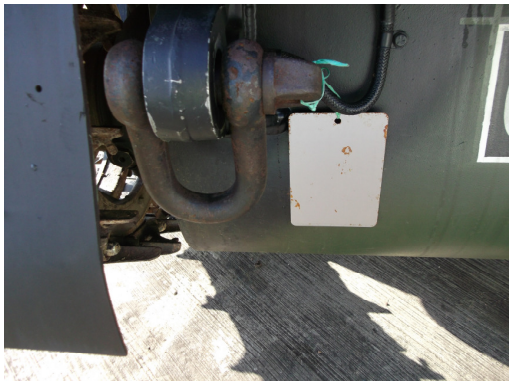
January 2013

Front view and close ups of the plates fitted to CVR(T) one, taken in January 2013, the untreated plate continues to degrade. The plate on the half treated with VpCI 389D has slipped. Also the difference of cleanliness and protection can be seen between the two halves



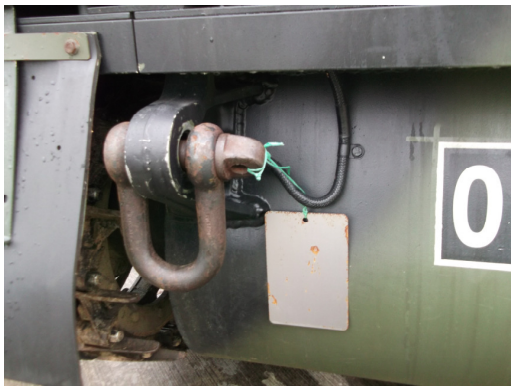
February 2013

Front view and close ups of the plates fitted to CVR(T) one, taken in February 2013. The treated plate is now showing a couple of small rust spots, although that side of the vehicle is still in good order. The untreated side is now heavily corroded, as is the bow shackle on that side



March 2013 (end of trial)

Front view and close ups of the plates fitted to CVR(T) one, taken in March 2013. Although the treated plate is now showing a small amount of rust around the edges, the vehicle still shows no visible signs of degrading. The untreated side has degraded even more



Below are pictures of the side of CVR(T) one showing the wheels / tracks, taken one months after the start of the trial, and every month thereafter up to and including the trial completion in March 2013

Pictures taken of the wheels / tracks of CVR(T) one in October 2012. The left side is the side treated with VpCI 389D.


Pictures taken of the wheels / tracks of CVR(T) one in November 2012. The left side is the side treated with VpCI 389D. A visible difference can be clearly seen


Pictures taken of the wheels / tracks of CVR(T) one in December 2012. The left side is the side treated with VpCI 389D.


Pictures taken of the wheels / tracks of CVR(T) one in January 2013. The left side is the side treated with VpCI 389D. The untreated side continues to degrade

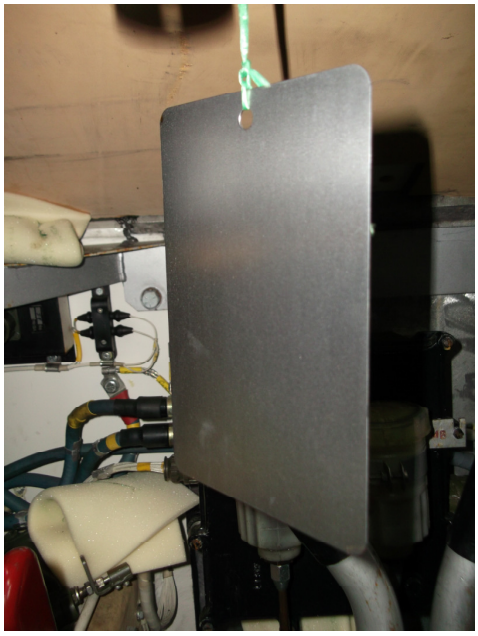

Pictures taken of the wheels / tracks of CVR(T) one in February 2013. The left side is the side treated with VpCI 389D. The treated side still looks fresh

Pictures taken of the wheels / tracks of CVR(T) one in March 2013 (completion of trial. The left side is the side treated with VpCI 389D. The difference in the two side is clear, not just on the wheels and tracks but the whole vehicle

CVR(T) two was unwrapped and the vehicle checked for corrosion, both inside and out, none could be seen. The plate that had been fitted in the driver's compartment at the start of the trial was as new.

The condition of the vehicle was as when it was first placed into the VpCI regime back in September 2012, including such things as hatch springs and road wheel arms etc.

After being unwrapped the vehicle was run up to working temperature, and driven so that the steering and brakes could be operated. AES than took samples of all the systems that had additives placed in them at the start of the trail for comparison. They also took samples from CVR(T) one and three as well as the vehicle that was stored in CHE.



CVR(T) two shown above during the unwrap.
Left is the plate that was hung in drivers compartment during the six month trial, As can be seen it is in the same state as when it was fitted, showing no signs of corrosion

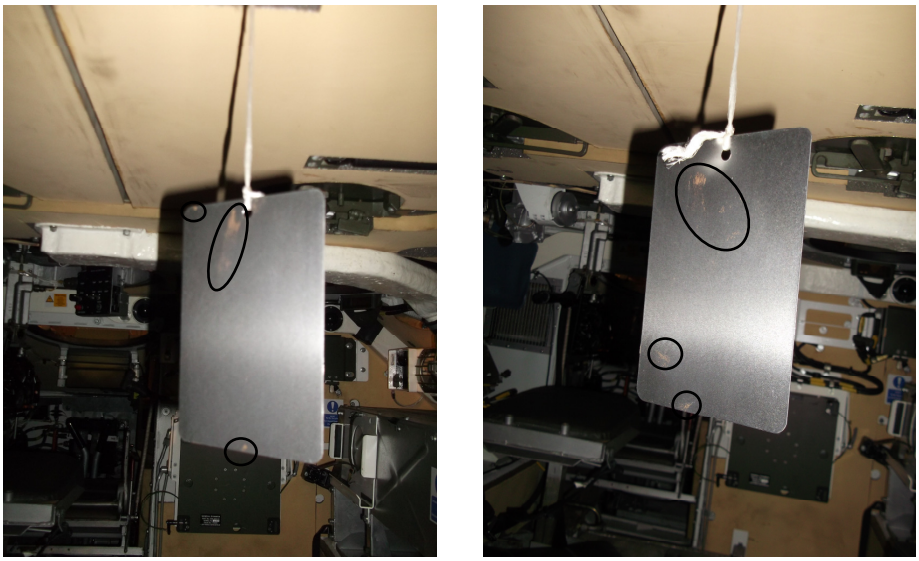
CVR(T) three which had received no treatment and was being used as the datum vehicle continued to degrade. In addition the plate inside the vehicle had continued showing more corrosion.

Below are some picture of CVR(T) three at the completion of the trial, including the plate that was fitted in the driver's compartment for the six month trial period

CVR(T) in Shed One (CHE)

As mentioned earlier in this report, a low grade carbon steel plate had been hung in the CVR(T) that was in CHE. The plate was checked at the end of the trial and was showing signs of corrosion.

This was unexpected and would suggest that for whatever reason, the environment within Shed One is not constant



Pictures taken of both sides of the plate that was hung in the CVR(T) that was stored in the CHE, some of the rust spots are circled

Results

The overall trial was a complete success.

It proved that vehicles etc. can be stored outside in all weathers with no degradation, using a VpCI regime of wrapping and additives, without the requirement of CHE.

It also proved that vehicles could be protected both in transit and during temporary outdoors storage with a water based temporary coating for the outside of vehicles and VpCI foam pads for the inside.
Also proved was that equipment being transported in ISO containers can be protected from corrosion using VpCI technology

Recommendations and observations

Although the spares and plates in the untreated ISO container did not rust as much as was expected, a clear difference could still be seen when compared to the treated ISO containers, it is believed the spares and plates in the untreated container would have degraded more had they been in a sea air environment or subjected to greater temperature differences. It should be said in fairness that the weather during the trial did include, rain, snow, frost, ice and sun.

It was decided that out of the two treatments used in the containers, (VpCI 337 and VpCI 132 foam pads) that the VpCI 132 foam pads would be a better solution as no clean up of equipment is required after transport / storage, whereas with the VpCI 337, equipment and spares (used for this trial) would need to be washed of afterwards.

The CVR(T) that was treated with VpCI 389D (temporary transit coating) also benefited internally from having VpCI 132 foam pads placed inside them, as was seen after the vehicle flooded

Comparisons

Below are some comparisons at the completion of the trial

The decks of CVR(T) three (untreated)

The decks of CVR(T) two (treated with a additives and MilCorr)

The side of CVR(T) three (untreated)

The side view of CVR(T) one (treated with VpCI 389D)

The side view of CVR(T) two (treated with additives and MilCorr)

Mark Cresswell

Operations Director