



Elisha Reference: LR 1423

Corrosion Comparison of Plated and  
Topcoating Systems for  
Nylon Insert Nut Applications

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## Summary

Elisha® mineral-based coating systems\*\* have been shown to outperform trivalent chromate in certain topcoated applications and on certain parts that have extreme deformation for assembly or installation, such as nylon insert lock nuts. Ford Motor Company has ongoing initiatives to identify and validate non-chromate containing coating systems to reduce the environmental risk of corrosion protection systems and define potential performance improvements.

Ford fastener coating specification S440 was initially established as a non-hexavalent chromate system. Elisha Technologies 0251 (Magni 561) has been approved to Ford S440. The Elisha 0251 alternative contains no Hexavalent or Trivalent Chrome thereby eliminating potential concern over Chrome content compliance.

Upon request from Ford, Elisha developed a test plan to compare Elisha 0251 (zinc plate/Elisha EMC/Magni B18) to several other Ford S440 systems that use a trivalent chromate passivate in the coating system.

A representative part number was selected by the lock nut vendor, MacLean Vehicle Systems, (MVS) and parts were coated on production equipment using several trichrome based systems as well as Elisha 0251. After coating, the nylon insert assembly was performed on MVS production equipment and tooling.

Initial screening in ASTM B117 neutral salt spray protocol on Nylon insert nut assemblies mounted on plastic racks is nearly complete. Additional testing is underway using nut assemblies installed with a bolt. Sample configuration for ongoing evaluation uses the nut assembly mounted on ACT 4'X12" galv test panels which were "E" coated by PPG. The nuts were installed on M10X20 Hex bolts through the "E" coated panel and tightened using a ½" air impact wrench. Sample groups in this series of tests are currently in ASTM B-117, GM 9540P, and SAE 2334 corrosion environments

In initial testing using ASTM B117 testing of assembled parts without installation into panels, Elisha® 0251 has been shown to offer a significant improvement over Zinc plate/Tri Cr/B18 coating systems. Average time to first Red rust of the Elisha 0251 sample group was 123% greater than the average for the Tri Chrome passivated systems, and 50% better than the best Tri Chrome system.

ASTM B117 testing at 840 hours of assembled parts installed into panels is also showing a distinct improvement in performance over trivalent chrome Ford S440 coating systems. The test was terminated at 1512 hours, with none of the Elisha 0251 systems showing 5% red rust failure.

GM9540P testing at 60 cycles of assembled parts installed into panels is also showing a distinct improvement in performance of Elisha 0251 over trivalent chromate systems.

## Background of the Project

A meeting was held at Ford Engineering on August 24, 2004, attended by Duane Droblich, Ford; Matt Metikosh, Magni; and Bradford Jorgensen, Wayne Soucie, and Nancy Heimann, all of Elisha Technologies. The primary topic of the meeting was approval of NO Chrome Elisha 0251 coating system to Ford S440 specification. The discussion included a review of adequate performance of the Elisha 0251 against the requirements of the S440 specification and availability of the proposed coating system.

After evaluation of the data submitted, it was determined that Elisha 0251 would be approved to S440 with Erieview Metal Treating, and Orscheln Products as approved applicators of this NO Chrome S440 finish. This decision was documented in letters to Orscheln Products and Erieview Metal Treating

dated September 1, 2005 giving approval to run Elisha 0251 (also described in Magni literature as Magni 561) for S440 specified parts. A copy of the letter is attached as Appendix A.

The S440 specification describes a zinc plate plus a non-hexavalent containing passivates, topcoated with an aluminum-filled heat cured epoxy paint. Based on this understanding that non-hex containing could mean either trichrome or NO chrome, and with some follow-on email discussion, it was determined that the specification did not require modification to allow for the approval of NO Chrome containing finish, such as Elisha 0251.

Additional discussion continued on the unique quality of Elisha 0251 to withstand severe deformation that would be required for items such as rivets, cable and hose end fittings, and nylon insert lock nuts. Ford and Magni representatives relayed an on-going problem with nylon insert lock nuts coated with Magni 560, a trichrome-containing S440 coating system. The problem resulted in bleeding red rust earlier than acceptable in the life of the nut.

After discussion and review of data brought by Elisha with regard to superior performance in crimped or deformed fastener applications, a test plan was developed to compare the NO Chrome Elisha 0251 system with currently available trivalent-chrome-containing S440 coatings. MacLean Vehicle Systems (MSV) was referred to Elisha as the vendor of nylon insert lock nuts for the test.

## Test Design

Six coating systems are being tested by Elisha Technologies Co., L.L.C. under lab tracking number LR 1423. The NO Chrome Elisha 0251 system is to be compared to five trivalent chromate-containing systems. Zinc plate and coating thickness for all sample groups was per S440 specification.

The objective of this experiment is to assess and rank the performance of the various coating systems in various corrosion environments after assembly and after installation with a bolt. Corrosion testing includes neutral salt fog corrosion conducted under ASTM B117 protocol, cyclic corrosion conducted under GM 9540 protocol, and cyclic corrosion conducted under SAE J2334 protocol.

The nut used in this test was selected based on recommendation from MVS engineering. The selected nut has been reported to experience the described failure mode of early red rust, and is a typical size and geometry as to be representative to the scope of target parts.

Approximately 800 pounds of PN W520213 nut blanks were purchased from MVS in late 2004. The parts were divided and sent to several applicators for coating. After coating, the parts were delivered to MVS facility in Mundelein IL where the nylon ring was inserted and crimping was accomplished using production equipment and tooling.

## ASTM B117 Neutral Salt Spray Testing of Assemblies

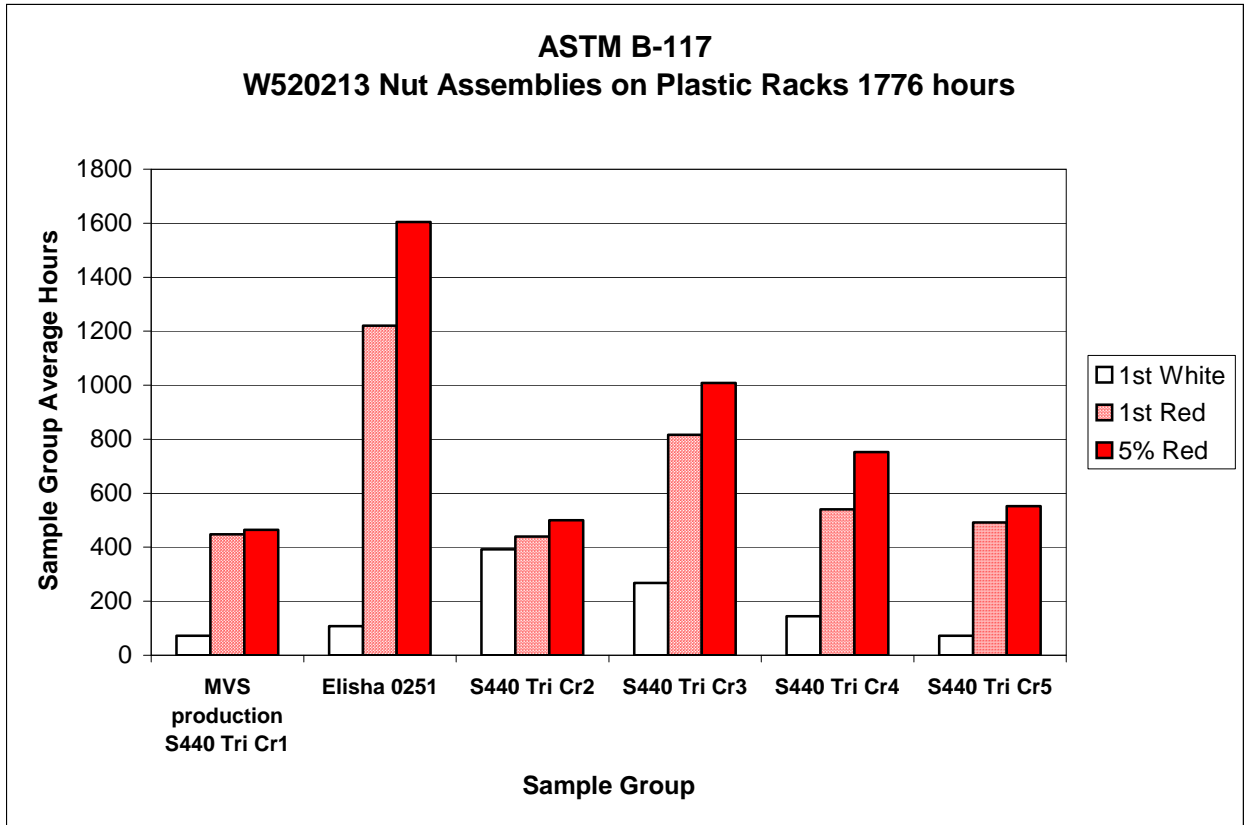
ASTM B117 accelerated corrosion protocol was used for initial scoping of corrosion performance. Nylon insert flange nut assemblies were tested, mounted on plastic racks, without an installation onto a bolt. The objective of this portion of the test was to understand general performance, in a test that was quickest to implement.

### RESULTS.

First White Rust performance: Average time to First White rust of the Elisha 0251 samples was approximately 43% lower than the average time for the Tri Chrome passivated systems and 60% lower than the best Tri Chrome system.

First Red Rust performance: Average time to first Red rust of the Elisha 0251 sample group was 123% greater than the average for the Tri Chrome passivated systems, and 50% better than the best Tri Chrome system.

5% Red Failure performance: Average time to 5% Red rust failure of the Elisha 0251 sample group was 145% greater than the average for the Tri Chrome passivated systems, and 59% better than the best Tri Chrome system.

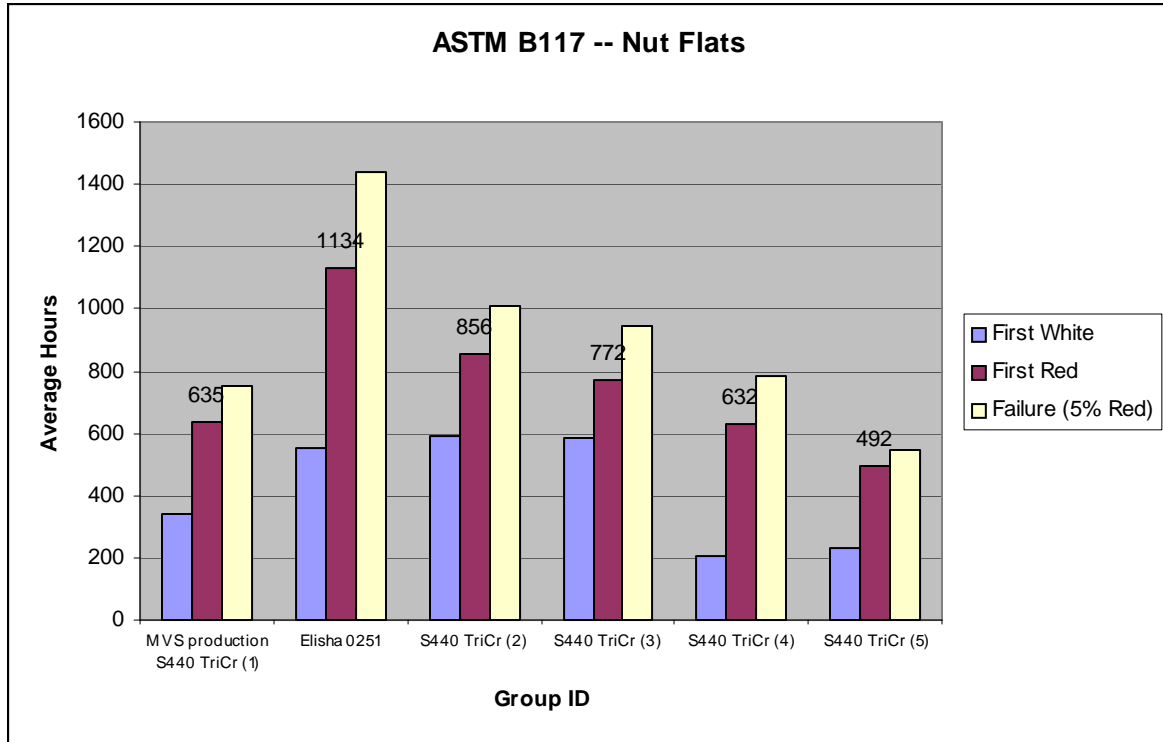


PHOTOS Available on request

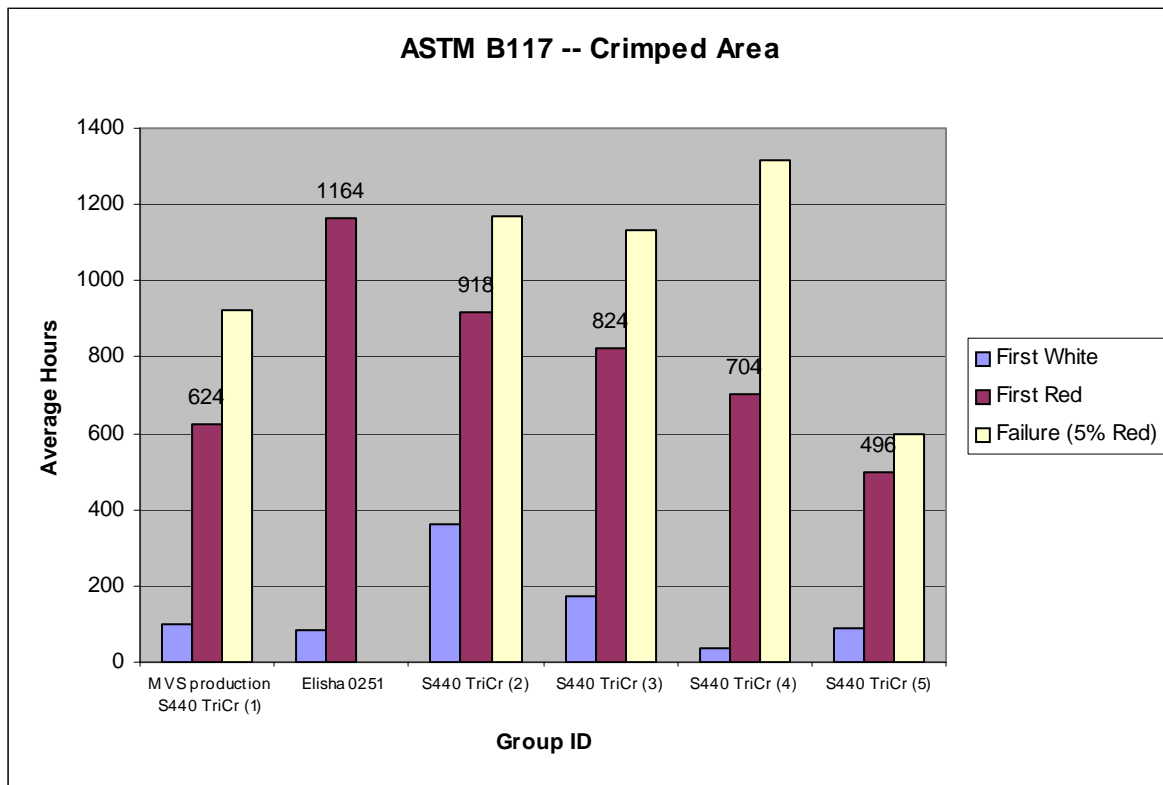
## ASTM B-117 Testing of Assemblies Installed on Panels

Nylon insert nut assemblies were mounted on ACT 4'X12" egalv test panels which were "E" coated by PPG. The nuts were installed on M10X20 Hex bolts through the "E" coated panel and tightened using a 1/2" air impact wrench. The M10 bolts used on the S440 trivalent chrome nut installations also incorporated trivalent chrome passivate. The M10 bolts used in conjunction with the Elisha 0251 nut installations were produced using the Elisha 0251 process. Inspection protocol differentiates the stake area independent of the nuts flats/body of the Nut assembly.

The following tables illustrate is a summary of corrosion data. Data for the flat/body of the Nut assembly is shown first, then the average corrosion data for the crimped area.



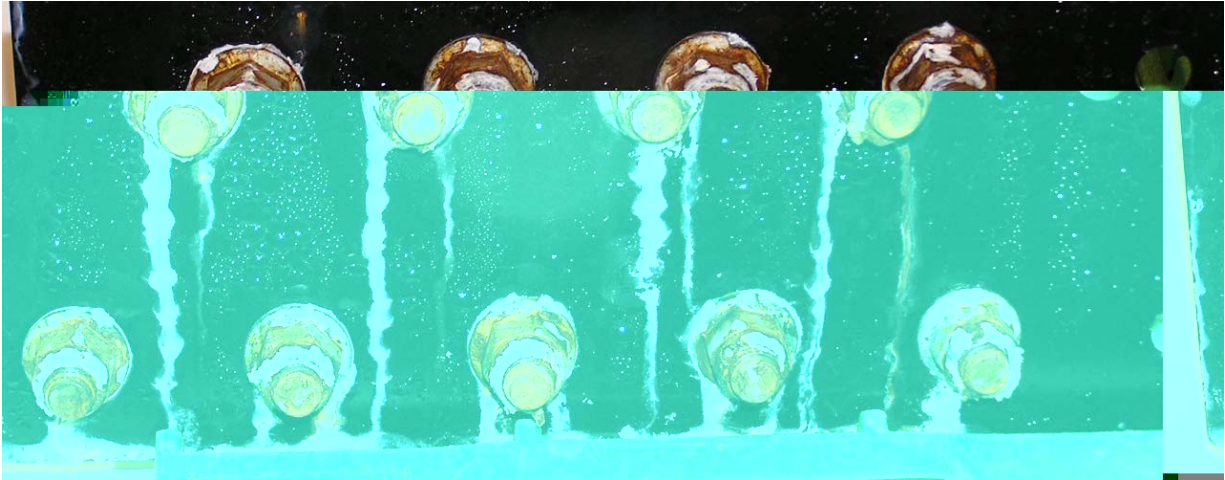
Crimped Nuts Installed into Panels – ASTM B117 Test Termination – Flats



Crimped Nuts Installed into Panels – ASTM B117 Test Termination – Crimped Area  
 Note – Test was terminated at 1512 hours, with none of the Elisha 0251 parts showing failure.

The Elisha 0251 was shown to be best performer to average first red and average red rust failure (5%), with average performance 146% of the current production and 125% better than the best performing trichrome-based S440 system.

Subjective visual observations are consistent with the average corrosion data in the above charts. Photographs of each group in testing at 1000 hours ASTM B117 is as follows.



Production MVS (S440 Tri Cr1) – ASTM B-117 at 1008 hours



Elisha 0251 – ASTM B-117 at 1008 hours



S440 Tri Cr3 – ASTM B-117 at 1008 hours

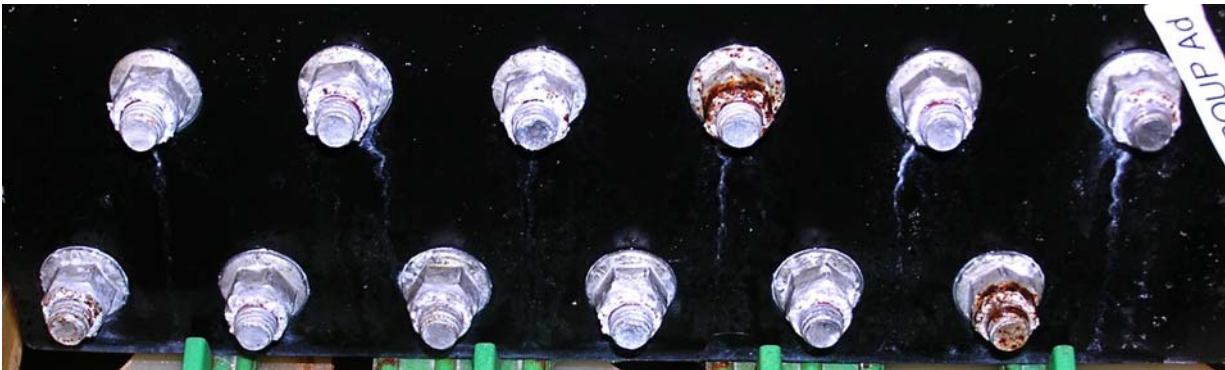


S440 Tri Cr5 – ASTM B-117 at 1008 hours

## GM 9540P Cyclic Corrosion Testing of Assemblies Installed on Panels

Nut, bolt, panel, and installation conditions were the same as described in the ASTM B-117 assembly and installed test previously described. Sample groups in this series of tests are currently at approximately 75 cycles of exposure.

Insufficient quantities of samples have converted to red corrosion to apply significant average performance. Preliminary analysis of photographic results indicates a continued trend of Elisha 0251 outperforming the trichrome-based S440 systems tested. Photographs of each groups is shown at 60 and 70 cycles.



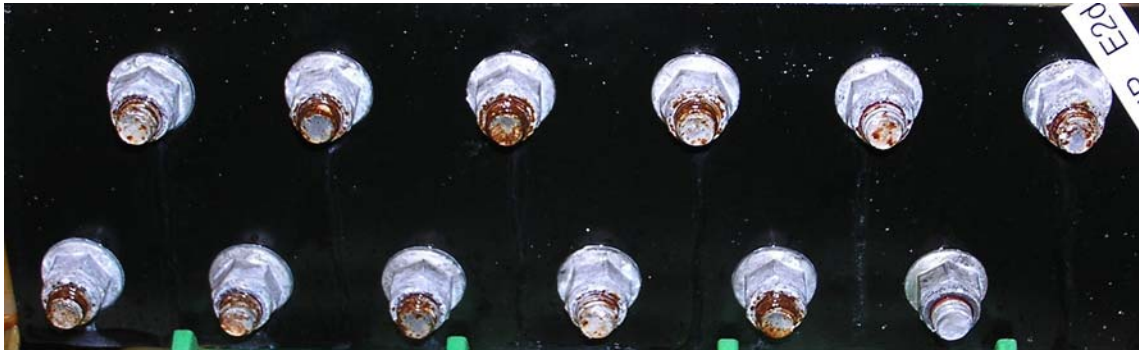
Production MVS (S440 Tri Cr1) – GM 9540P at 60 cycles



Elisha 0251 – GM 9540P at 60 cycles



S440 TriCr (3) – GM9540P at 60 cycles



S440 TriCr (4) – GM 9540P at 60 cycles



S440 TriCr (4) – GM 9540P at 60 cycles

## Testing at facilities outside of Elisha Technologies

Additional sample panels with nut and bolt installations were produced at Elisha Technologies at the same time those panels for in house testing was accomplished. Sample panels labeled and ready for corrosion testing were shipped to Magni's Hamond facility for testing.

### ASTM B-117 Testing of Assemblies Installed on Panels at Magni

No data available at this time. Data from this testing will be submitted as supplemental findings.

### SAE J2334 Cyclic Corrosion Testing of Assemblies Installed on Panels at Magni

No data available at this time. Data from this testing will be submitted as supplemental findings.

## Conclusions

In initial testing using ASTM B117 testing of assembled parts without installation into panels, Elisha 0251 coating system has been shown to offer a significant improvement to first red rust over trivalent chrome Ford S440 systems. Testing of assembled parts installed into panels show improvement in red rust performance when using Elisha 0251. Cyclic corrosion data of assembled parts installed into panels is also consistent with the conclusions of the other two protocols. Elisha 0251 is the best performing system tested.

In summary, based on B117 results, Elisha 0251 provides significantly more protection to red rust than trivalent chromate based Ford S440 coatings.