HIGH CORROSION RESISTANCE COATINGS (HCRC)

1. SCOPE

1.1 This specification covers requirements for high corrosion resistance coatings (HCRC) for fastener and design parts. Three high corrosion resistant (HCR) coating Types and corresponding Classes are described, see Table 1. This specification should be used for all new and updated engineering drawings for parts that require HCR coatings. HCR coatings approved to this specification are listed in the MAT0320Q (47646765) HCR Coatings Approved Materials specification.

1.2 Effective 06 March, 2014 with MAT0320 revision D Types 2 and 4, and all Class B coatings are withdrawn. Type 2 coatings with an electroplated zinc base coat and Class B coatings containing hexavalent chromium shall not be specified on drawings for new CNH applications. Hexavalent chromium is not permitted in any coating supplied to this specification. For existing drawings: where Type 2 coatings are specified, Type 1 coatings shall be substituted; where Class B is specified, Class A coatings of the same Type shall be substituted. See also Table 3.

1.2.1 Type 4 Class A coating is reestablished for use on drawings with MAT0320 revision E.

Table 1 HCR Coating Types, Classes and Material Description

HCR Coating		**Availability:** All HCR coating Types are available globally. HCR coating manufacturers have identified approved or licensed local coating applicators.	
Type [(1)]	**Class**	**Color**	**Description**
1	**A**	Silver to matte gray	Inorganic zinc rich base coat plus aluminum-rich topcoat with integral lubricant [(1)]. Type 1A coatings have exhibited good fertilizer corrosion protection, testing required.
	A	Silver to matte gray	Inorganic zinc/aluminum-rich base coat and inorganic sealant (clear) with integral lubricant [(1)].
3	**BL**	Black	Low to medium gloss. Same base coat as Type 3A plus black topcoat with integral lubricant. Comparable in appearance to zinc phosphate coating. Preferred for black exposed parts where appearance is important.
	LK-R	Red	Same base coat as Type 3A. The topcoat sealer is pigmented red with a modified amount of integral lubricant providing a special low K-factor of 0.11
4	**A**	Silver to matte gray	Inorganic zinc/aluminum rich coating with integral lubricant. Single coat material, no topcoat is applied. May require multiple layers to achieve specified corrosion resistance.

(1) Zinc rich base coats provide sacrificial corrosion protection for metal substrates while durable topcoats give improved chemical resistance and contact protection compared to zinc electroplating.

2. APPLICATION

2.1 HCR coatings described provide significantly higher corrosion resistance than conventional zinc plating and, in many cases, painting. These HCR coatings exhibit improved K-Factor (torque coefficient) repeatability with less scatter compared to zinc plating and phosphate coating. The coatings do not involve zinc electroplating and therefore also significantly reduce the potential for hydrogen assisted cracking (HAC) in susceptible parts.

Table 2 High Corrosion Resistance Coating - Requirements						
All Coating Types may be applied for fastener sizes M6, 1/4 inch, and larger (1)						
CNH Type (2)	Class	Color	Torque Coefficient (K-Factor)	Corrosion Resistance (Hours,minimum)		Typical Coating Thickness (microns)
				White	Red	
1	A	Silver to matte gray	0.17 ± 0.03	240 (3)	720	12
3	A	Silver to matte gray	0.17 ± 0.03			9
	BL	Black				
	LK-R	Red	0.11 ± 0.03			
4	A	Silver to matte gray	0.17 ± 0.03			

(1) Applies to internal and external thread sizes unless otherwise specified
(2) Type 2 and all Class B coatings have been withdrawn; see Section 1.2 and Table 3 for designated replacement coatings.
(3) HCR coatings contain zinc flakes that are sacrificial to corrosion agents and may exhibit a superficial white surface blush before 240 hours. Distinct white corrosion on significant surfaces is not acceptable, see Section 4.4.2.

Table 3 Withdrawn HCR Coatings - Replacements			
Withdrawn Coating		Replacement Coating	
Type	Class	Type	Class
1	B	1	A
2	A		
	B		
3	B	3	A
4	B	4	A

2.2 HCR coatings are used primarily as a protective coating on ferrous based materials. They are applied to extend the corrosion resistance of the substrate material. Required corrosion protection, cost, and appearance are factors to consider before specifying an HCR coating for an application. Applications that may utilize HCR coatings include nuts, bolts, pins, hardware, and other parts where corrosion resistance that significantly exceeds zinc plating is required. HCR coatings applied to threaded fasteners must meet specific torque coefficient requirements, see Section 4.5.1.

2.2.1 Springs: HCR coatings are flexible, and have been used successfully in spring applications. However, HCR coating cure temperatures can affect spring material properties and performance. The higher cure temperatures of water based coatings compared to solvent based coatings (see Sect 4.3.1) will have a greater thermal effect on spring properties. This thermal effect, i.e. relaxation, is more pronounced on cold drawn plain carbon steels, such as music wire. This effect is less pronounced on chromium-silicon grades of spring wire. For precision applications, CNH engineering should consider the impact of the HCR coating cure temperatures related to potential load loss.

2.3 Increased cost typically associated with HCR coatings compared to zinc plating should be considered for an application before specifying these HCR coatings for improved corrosion resistance. Some HCR coating suppliers provide a list of applicators for their products on their internet websites. Pricing for these coatings and finished coated parts can vary between applicators depending on the process required to apply the coating, part size, and quantity or volume.

2.4 HCR coatings described are not suitable for all sizes of threaded fasteners, see Table 2. For smaller fastener sizes, corrosion protection processes such as zinc plating are available, see CNH MAT0310 (87303277) Zinc Plating. In some cases, HCR coatings may not be acceptable for internal recess drive fasteners due to “head fill”.

2.5 HYDROGEN EMBRITTLEMENT

HCR coating Types described are not electrolytically applied. This significantly reduces the potential for hydrogen embrittlement when applied to parts with higher surface hardness that may be susceptible to hydrogen embrittlement. As a result these HCR coatings can be used on all applicable threaded and non-threaded parts. Since these coatings may have a zinc phosphate pre-treatment, acid cleaning is not permitted on externally threaded parts with hardness greater than Class 10.9 or Grade 8 (> 39 HRC). See also Sect 4.2.1. Review CNH MAT0310, Hydrogen Embrittlement / Baking guidelines for additional information related to parts that are susceptible to hydrogen embrittlement.

2.6 HCR coatings can be applied via dip-spin, spray or dip-drain-spin technology. The dip-spin process is recommended for parts that are coated over their entire surface. Parts that are larger or have areas that need to be masked may be more easily coated using a spray process. On a cost per unit basis, dip-spin is less expensive than spray due to less preparation and manual labor.

2.7 Standard hardware with common HCR coatings is available. See CNH Engineering Standards STPA020 and STPA110 for standard fastener finishes and guidelines for use on drawings and in bills of material (BOM). Table 4 shows STPA020 abbreviations for HCR coatings on standard hardware.

Table 4	HCR Coatings, STPA020 Fastener Finishes	
CNH HCR Coating		STPA Designation
Type	Class	
1	A	DOR
3	A	DAC
3	BL	BGM

3. RELATED SPECIFICATIONS

ASTM B183 Practice for Preparation of Low Carbon Steel for Electroplating
ASTM B242 Practice for Preparation of High Carbon Steel for Electroplating
ASTM B320 Practice for Preparation of Iron Castings for Electroplating
ASTM F1136 Zinc/Aluminum Corrosion Protective Coatings for Fasteners
ASTM D3359 Standard Test Methods for Measuring Adhesion by Tape Test
CNH ENPJ100 (86619032) Significant Characteristics
CNH ENS7001 (86629329) Tightening of Threaded Fasteners
CNH MAT0320Q (47646765) HCR Coatings Approved Materials
CNH MTM0108 (86628048) Chemical Resistance
CNH MTM0109 (87523705) Fertilizer Corrosion Resistance
CNH STPA020 (87026717) Fastener Finish and Materials Specifications
CNH STPA110 (87026718) Fastener Finish and Design Considerations
ISO 16047 Fasteners – Torque / Clamp Force Testing
FIAT 9.57511 Corrosion Resistant Zn, AL & Chromate Base Chemical Coatings-Ferrous Metal Parts
FIAT 9.57513 Aluminum and Zinc Lamellar Base Anti-Corrosion Coating, Ferrous Metal Parts

4. REQUIREMENTS

4.1 HCR coated parts shall meet all requirements of this specification in addition to any special requirements specified on the drawing. Requirements of this specification apply only to coated significant surfaces unless otherwise specified. Significant surfaces are those where the coating is necessary to the function or appearance of the part after assembly and may be defined on the drawing or previously agreed upon in the purchase order. In general it is that portion of the visible surface on the part that can be contacted by a 13 mm (0.50 inch) diameter sphere. Unless otherwise specified; holes, recesses, threads, sharp edged rims, and angles are considered non-significant surfaces. Non-significant surfaces must be visibly coated and are expected to have a minimum of 50% of the specified thickness for the coating Type and Class specified.

4.2 SURFACE PREPARATION

4.2.1 Prior to coating, parts shall be thoroughly cleaned and free of rust, scale, oil, pits, foreign matter, and any surface conditions detrimental to coating finish or adhesion. Cleaning operations, particularly acid cleaning, must be controlled to prevent hydrogen embrittlement, particularly on parts that are hardened, cold worked, and/or highly stressed in service. Acid cleaning is not permitted for parts with hardness above 39 HRC (or equivalent). It is recommended that appropriate cleaning practices be used, such as ASTM B183, ASTM B242, or ASTM B320.

4.2.2 Previously coated or electrolytically plated fasteners shall not be stripped or acid cleaned and then coated per this specification. This includes acid cleaning to remove any oxides present on parts following processes such as black oxide treatment or quenching and tempering. Parts may be shot blasted to remove zinc phosphate coating where required prior to HCR coating application.

4.3 CURE CYCLES – PART TEMPERING

4.3.1 Cure temperatures of HCR coatings are typically 180-260°C (355–500°F) for solvent based systems and 250-320°C (480–610°F) for water base systems with baking cycle times ranging from 15 to 60 minutes or more at temperature. This must be considered for parts that require heat treatment (e.g. quenching and tempering) to specified hardness to achieve required properties. These cure cycles effectively act as a tempering cycle that can cause reduced surface hardness in heat treated parts.

4.3.2 Stress relieving of parts or elevated temperature processes exceeding the continuous temperature resistance of HCR coatings, approximately 250°C (482°F), shall not be performed after HCR coatings are applied and cured.

4.4 CORROSION RESISTANCE

4.4.1 Red Corrosion

Parts coated with HCR coatings shall be capable of withstanding neutral salt spray testing per ASTM B117 for 720 hours as required in Table 2. After test, there shall be no more than one spot of red corrosion visible to the unaided eye per 650 square millimeters (one spot per square inch) of significant surface. On pieces having less than 650 square millimeters (1 square inch) of significant surface, a maximum of one spot of red corrosion is permissible. No individual red corrosion spot larger than 1.5 mm (0.060 inches) in diameter is permissible.

4.4.2 White Corrosion

HCR coatings shall meet neutral salt spray testing per ASTM B117 for 240 hours as required in Table 2. Distinct white corrosion visible to the unaided eye on significant surfaces is not acceptable. HCR coatings contain zinc particles that are sacrificial to corrosion agents and may exhibit a superficial white surface blush of white corrosion before 240 hours of testing. The presence of this white surface blush is not considered a basis to fail an HCR coating sample. See Section 11, Figures 1 and 2 for test sample pictures.

4.4.3 Fertilizer Corrosion Resistance

Nitrogen fertilizer is recognized as an aggressive corrosive agent. Special processing of an HCR coating may be required to achieve acceptable corrosion resistance for parts with recurring fertilizer exposure. Suppliers may recommend multiple coating layers or increased coating thickness. Fertilizer corrosion resistance of HCR coatings for specific applications may be confirmed by testing according to MTM0109 or equivalent. Consult with suppliers for HCR coating selection and any special processing required.

4.5 TORQUE COEFFICIENT (K-Factor)

4.5.1 Controlled and consistent frictional characteristics are important for the successful application of HCR coatings on fasteners. Torque coefficients for HCR coatings covered by this specification must meet the requirements listed in Table 2, measured on representative M10 fasteners in accordance with ISO 16047. The torque coefficient (K) is determined with the following formula from the tightening torque and clamp force relation:

$$K = T / (Fd)$$

T = Tightening torque
F = Clamp force
d = Nominal thread diameter

Unless otherwise specified, the determination shall include the point with the clamp force at 75% of the proof load of the test part or the part to be tested, whichever is lower per ISO 16047.

4.5.2 For bolted joints where controlled clamping load is required (e.g. wheel bolts), tests of the actual joint, representative of the assembly procedure, must be conducted to determine the specific frictional characteristics of the coating. Resulting torque ranges should then be specified on the Engineering Drawing. Consult CNH Engineering Specification ENS7001 for typical torque ranges. Note that torque ranges are dependent upon the type of equipment used to tighten the joint, which is dependent upon criticality of the joint. For critical joints CNH Engineering may decide to designate these torque ranges as a significant characteristic on the drawing.

4.6 COATING THICKNESS

4.6.1 Expected nominal coating thickness on significant surfaces is listed in Table 2. An excessive coating thickness is cost prohibitive and may interfere with the fit of a threaded part and its counterpart surface. A part shall be coated with the lowest practical coating thickness and still meet the specified corrosion resistance requirement.

4.6.2 When applied to fasteners, excessive buildup of coating material can interfere with thread engagement and affect torque-tension characteristics. HCR coated fasteners must meet all of the dimensional requirements stated in the applicable CNH or former company Standard Parts document. Coating interference with thread engagement is not permitted.

4.7 DIMENSIONS AND TOLERANCES

General Parts: Dimensions specified on drawings where an HCR coating is specified shall be after coating unless otherwise specified.

4.8 ADHESION

4.8.1 All HCR coatings when applied to a part shall demonstrate satisfactory adhesion to the part by passing adhesion testing as specified in Section 6.4.

4.8.2 Paint materials applied over an HCR coating on a part shall demonstrate satisfactory adhesion to the HCR coating to assure acceptable appearance of the part during normal operating conditions.

4.9 CHEMICAL RESISTANCE

All HCR coatings exhibit good chemical resistance to organic solvents, automotive fuels and fluids, based on supplier product information. If specific chemical resistance is required, confirmation tests can be run according to CNH MTM0108. These tests are applicable to HCR coatings although they are typically used to evaluate paint materials.

4.10 COATING QUALITY & APPEARANCE

The coating shall be dense, uniform, and free of porosity, pinholes, blisters, flaking, cracks, and stains. The coating shall be free of other discontinuities that affect appearance, part reliability or corrosion resistance. All coated parts shall be dry to the touch when received by the procuring facility. A coated part shall withstand normal handling and installation without a resulting loss of coating. Any loss of coating from normal handling and installation will cause the part to be considered unacceptable.

5. SPECIAL REQUIREMENTS

5.1 Special surface colors, high temperature resistance coatings, test conditions or methods, coating thicknesses or corrosion resistance may be applied as special requirements (SPCL). These requirements shall be indicated on the engineering drawing and apply to the specified CNH HCR coating.

5.2 HCR coatings with color and torque coefficients that vary from those specified in Table 2 are available but shall not be used unless the coating for an application is approved by CNH Materials Engineering, and is agreed to by the procuring CNH facility. Applying waxes is not permitted. If an alternate coating is required for fasteners, testing to establish compliance with required corrosion resistance and required torque-tension values is required before final production approval is granted.

5.3 Certain HCR coatings can be obtained in additional colors which may available for a price increase. Unique color requirements may be specified on the drawing as a special requirement or obtained by agreement between the procuring CNH facility and supplier. Painting may provide a lower cost alternative and better color matching over ordering parts with HCR coating special finish colors. Paint is generally not applied to threaded fasteners prior to assembly.

6. METHODS OF TEST

Suppliers must ascertain that their products will conform to the specification requirements when tested by the specified methods. The specified methods will be used to reconcile disputed results. All National Standards and related test method designations are to be latest issue unless otherwise specified.

6.1 TEST SAMPLES

Test samples of actual parts to be supplied to CNH should be obtained whenever possible to verify conformance to specified requirements. Where actual part samples are not available, comparable parts produced with the specified HCR coating material and processes to be used in production may be used for testing of property verification. Representative test samples used to verify part conformance to this specification shall be retained for at least one year.

6.2 COATING THICKNESS

Coating thickness shall be measured on significant surfaces using one of the following methods: magnetic induction; X-ray fluorescence spectroscopy; microscopic examination of a cross-section taken perpendicular to the significant surfaces; all per ASTM F1136. Coating thickness on threaded fasteners shall be determined on the shank, bolt head, hexagon flats, or other smooth surfaces.

6.3 CORROSION RESISTANCE

6.3.1 The neutral salt spray test shall be performed per ASTM B117 Salt Spray (Fog) Testing or equivalent. Evaluation of results will be based only on significant surfaces unless otherwise specified on the Engineering drawing. The coating shall conform to corrosion resistance limitations as defined in Section 4.4.

6.3.2 Test specimens shall be suitably clean, free of fingerprints and other stains before starting the salt spray testing. Loose particles should be removed by gentle wiping with a clean, dry, soft cloth. Rinsing the sample with warm water is recommended if required to remove dirt or other surface contaminants. Oily or greasy surfaces should not be used for corrosion testing. Degreasing of test specimens with organic solvents is not permitted.

6.3.3 For testing corrosion resistance, the complete part is the preferred test specimen size. Parts may be cut into smaller test specimens when necessary, but shall not be less than 150 mm (6 inches) in length. For all threaded fasteners, testing of the complete part is required.

6.4 ADHESION

Coated parts, other than threaded surfaces of fasteners, shall be subjected to adhesion testing according to ASTM D3359 Test Method A if adequate surface area is available for this test. Where testing per ASTM D3359 is not feasible, adhesion testing shall be conducted according to ISO 10683. For either test method, the minimum adhesive peel strength of the tape shall be 7.0 ± 1.0 N per 25 mm width.

7. MATERIAL APPROVAL

Materials defined by this specification must be approved by CNH Materials Engineering. Approval shall be based on laboratory and engineering testing performed or coordinated by CNH Materials Engineering. HCR coating materials that comply with the requirements of this specification are listed in the CNH MAT0320Q High Corrosion Resistant Coatings, Approved Materials specification.

8. NEW MATERIALS AND SOURCES

No shipments of HCR coatings for production shall be made by a new source until samples of the material they propose to supply to this specification have been approved by CNH Materials Engineering. When CNH Purchasing requests evaluation of a new material, the supplier shall furnish samples for formal qualification, which may include performance testing. Material submitted to CNH Material Engineering for qualification shall be accompanied by detailed test information, certification that the material meets all requirements of this specification, and a completed Material Safety Data Sheet (MSDS). Additional samples may also be required by the receiving CNH location in advance of the first and subsequent production shipments in accordance with the provisions of one or more CNH quality assurance programs.

9. INSPECTION AND REJECTION

All HCR coating materials supplied to this specification shall be equivalent in all characteristics to samples originally approved by CNH Materials Engineering. Prior to making any changes to an HCR coating material used for an application under this specification, whether or not the change affects the HCR coating material or the part meeting specified requirements, the supplier shall notify the procuring CNH facility and CNH Materials Engineering of the proposed changes. No changes in formulation, processing, or place of manufacture are permitted without prior written approval from CNH Materials Engineering. Test data, test samples, a new supplier code, or other information may be required for the proposed material change. While the procuring location may test samples from incoming shipments for quality assurance, the supplier is responsible for ensuring that shipments meet the stated requirements without depending upon the purchaser's inspection.

10. DRAWING SPECIFICATIONS

10.1 Specifying a restricted (RSTR) or special (SPCL) coating Type, thickness, color or process may require the use of a significant characteristic per CNH Engineering Procedure ENPJ100 (86619032). This determination will be made as part of the design review process.

10.2 Per local practice, HCR coatings may be specified on an engineering drawing with a material note or using the Engineering Parts List (EPL) method. Where a material note is used the notation shall include the generic name (HCR COATING), CNH Material Specification number, and the high corrosion resistance coating (HCRC) finish Type and Class. Where the EPL method is used, see Table 5 for Type and Class descriptions and corresponding part numbers and examples in Section 10.2.3. The following are examples of HCR coatings designations specified on drawings.

10.2.1 HCR Coating –Type and Class

CNH Material
NOT APPLICABLE
Local Material
ISO 898-1, CLASS 10.9

Material Note (on drawing above title block):
HCR COATING, CNH MAT0320, HCRC-3BL

10.2.2 HCR Coating, Restricted (RSTR) for specific HCR coating material.

CNH Material
NOT APPLICABLE
Local Material
ISO 898-1, CLASS 10.9

Material Note (on drawing above title block):
HCR COATING, CNH MAT0320, HCRC-3A, RSTR
GEOMET® 321 PLUS ML
NO ALTERNATE HCR COATING PERMITTED

10.2.3 HCR Coating designations using the Engineering Part List (EPL) method

- Material notes may be required for any special requirements or restrictions

10.2.3.1 Standard (purchased) Part type, no part number assigned for the HCR coated part:

(Engineering Parts List directly above the Title Block)

1	0		8xxxxxx		PLATING, HCRC TYPE 3A CNH MAT0320
ITEM	QUANTITY	U/M	PART NUMBER	TYPE	NOUN, DESCRIPTION
ENGINEERING PARTS LIST					

(Blocks extracted from CNH Drawing Title Block)

CNH Material	
NOT APPLICABLE	
Local Material	
ISO 898-1, CLASS 10.9	
Noun Description	Part Number
BOLT	8XXXXXXX

10.2.3.2 Designed Part type, part number typically assigned in EPL for the HCR coated part:

(Engineering Parts List directly above the Title Block)

2	0		8xxxxxx		PLATING, HCRC TYPE 4A CNH MAT0320
1	1		8XXXXXX1		PLATE
ITEM	QUANTITY	U/M	PART NUMBER	TYPE	NOUN, DESCRIPTION
Description					Part Number
PLATE					8XXXXXX2
ENGINEERING PARTS LIST					

(Blocks extracted from CNH Drawing Title Block)

CNH Material	
HR PLATE, CNH MAT1015, Grade B	
Local Material	
EN 10025-2 S235JR	
Noun Description	Part Number
PLATE	8XXXXXX1

11. HCR COATING TYPE AND CLASS PART NUMBERS

TABLE 5	HCRC Type, Class, Part Numbers for EPL Method
PART NUMBER	**DESCRIPTION**
48080361	PLATING, HCRC TYPE 1A CNH MAT0320
48080364	PLATING, HCRC TYPE 3A CNH MAT0320
48080365	PLATING, HCRC TYPE 3BL CNH MAT0320
48080367	PLATING, HCRC TYPE 3LK-R CNH MAT0320
48080373	PLATING, HCRC TYPE 4A CNH MAT0320

11. WHITE CORROSION – TEST SAMPLES

The formation of a superficial, fine blush of white corrosion can occur relatively early during salt spray testing of HCR coatings. The sample on the right in Figure 1 shows a characteristic white blush that is considered acceptable after 240 hours of salt spray exposure. The sample on the right in Figure 2 shows a higher level of distinct white corrosion that would be considered unacceptable after 240 hours of salt spray exposure. A new sample is shown on the left side in each image for comparison.

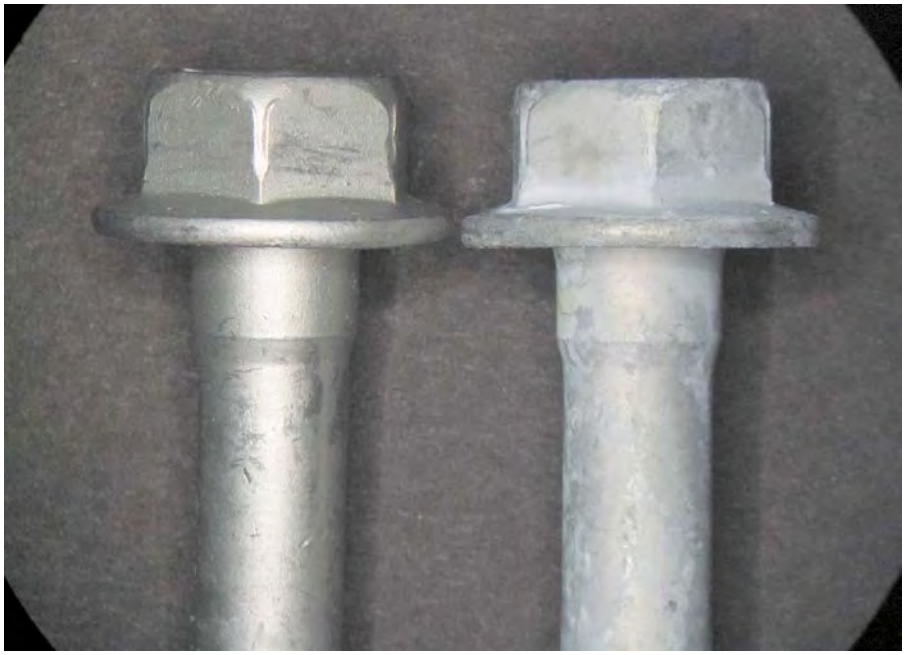

Figure 1 White Blush (right) – Acceptable

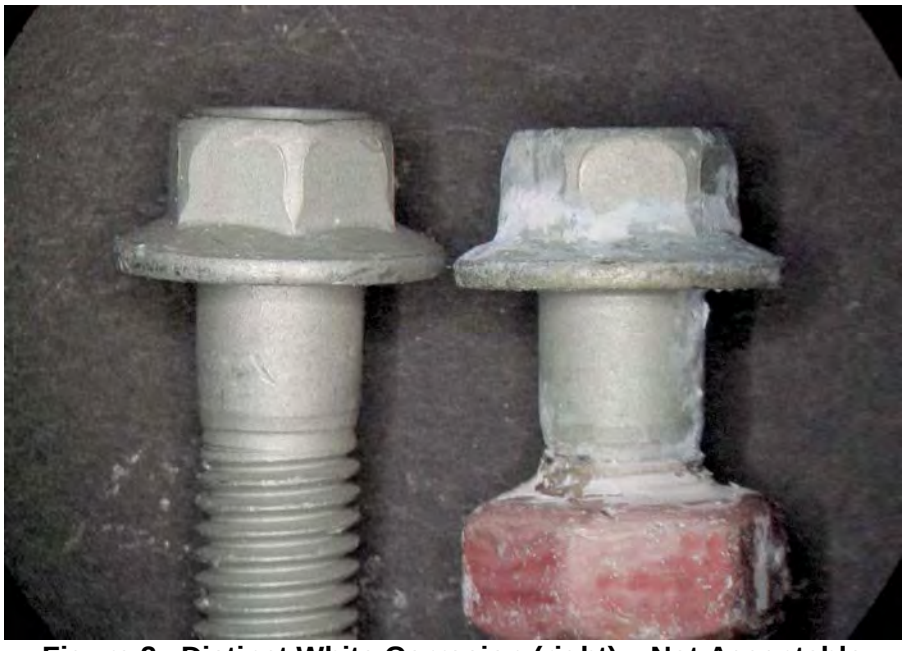

Figure 2 Distinct White Corrosion (right) – Not Acceptable