Manganese Phosphate Coating

1. SCOPE

1.1 This specification provides CNH requirements for manganese phosphate (MnPhos) chemical conversion coating on ferrous metal parts. This specification covers one CNH Class of manganese phosphate coating. It is intended to replace CNH Former Company Material Specifications listed in Table 1 and should be used on all applicable new drawings.

1.2 Annex A pictures illustrate good quality manganese phosphate coating (Figure 1) and unacceptable severe etch pitting of a hardened and ground ferrous metal substrate surface (Figure 2) resulting from the phosphate coating process. These photos are provided for engineering guidance only.

1.3 Annex B provides reference information on typical process bath parameters with suggested check frequency and manganese coating defect types along with their common causes for occurrence. This information is provided for engineering guidance only.

1.4 All National Standards and related test method designations are to be latest issue unless otherwise specified.

Table 1 Former CNH Company Material Specifications

CNH Class (Part Number)	CASE	NH Pennsylvania FNHA Standard	NH – Zedelgem Engineering Stds.	NH Tractor Engineering
A (87692732)	MS-90	-	-	Fiat 9.57408 F.FAG6 Fiat 9.57408 F.FAG3 I

2. APPLICATION

2.1 This coating is intended to prevent seizing, scoring, scuffing, or galling during assembly and initial service, and to provide some lubricity and limited corrosion resistance. These properties are due to the manganese phosphate coating heavy crystal structure that is coarser and more porous than other phosphate coatings, which offers more oil-absorbing and retaining surfaces to prevent seizure.

2.2 Manganese phosphate coatings are used in applications where rapid break-in of new parts, such as cylinder liners, pistons, rings, camshafts, tappets, bushings and gears needs to be accomplished without harmful effects. It is also used for threaded fasteners, such as cylinder head bolts, in oil rich environments due the consistent torque tension performance provided by the phosphate coating. It is not recommended for surface pretreatment of metal parts to be painted.

2.3 Manganese phosphate coating begins to deteriorate at 107°C (225°F). This is not a concern for applications where the coating is expected to wear away quickly when specified for rapid break-in of new parts, such as those in section 2.2. In other types of applications this coating is not recommended for parts with continuous service temperatures above 100°C (212°F).

Table 2 CNH Class and Material Description

CNH Class (Part Number)	Description
A (87692732)	Manganese phosphate coating on ferrous metals is intended to prevent wear during initial service and provide a limited degree of corrosion resistance

2.4 Hardened and ground surfaces, such as gear teeth and bearing surfaces are very susceptible to localized chemical attack during manganese phosphate coating. Precise control of the coating baths is especially important in order to avoid chemical attack on the base metal, see section 4.1.

2.5 Since manganese phosphate coating is a chemical conversion coating with no electric current used, the coating thickness is solely dependent upon the solution contacting the work. Therefore, reasonably uniform coatings may be produced on irregularly shaped objects and recessed areas.

3. RELATED SPECIFICATIONS

CNH DWGA110 (86641921) Requirements for Painted Parts
CNH ENPJ100 (86619032) Significant Characteristics
CNH MAT1003 (86979049) Metallic Material Designations on Engineering Drawings
CNH MTM0160 (87556314) Determination of Phosphate Coating Weight
ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
Fiat 9.57408 Phosphate Coating for Ferrous Parts
Iveco 18-1106 Phosphating of Ferrous Components

4. REQUIREMENTS

4.1 PROCESSING

Manganese phosphate coating must be done in strict accordance with the chemical manufacturer's requirements. Coating baths should be maintained to the chemical manufacturer's specifications, checked and adjusted as necessary for conformance. Iron build-up and pH are two important control parameters that must be monitored and recorded. The manganese phosphate coating process is also expected to adhere to the following general process guidelines.

4.1.1 Cleaning

Parts shall be cleaned using either an alkaline or an emulsion type cleaner. Parts shall be thoroughly clean and free of rust, scale, oil, and other foreign material. Dry abrasive blasting may be necessary to achieve the required cleanliness.

4.1.2 Pre-rinsing

Parts shall next be rinsed in a clean, slightly overflowing, hot water rinse. If petroleum cleaners have been used, a cold water rinse preceding the hot water rinse shall be employed.

4.1.3 Pre-conditioning

A preconditioning treatment is required for parts that have been alkaline cleaned; preconditioning is optional if part cleaning has been done with an emulsion type cleaner.

4.1.4 Phosphating

Parts shall be immersed in phosphating solution, whose composition and temperature are closely controlled, for the appropriate time necessary to produce a coating that meets all the requirements of this specification.

4.1.5 Post-phosphating Rinsing and Drying

4.1.5.1 Parts shall be rinsed in water as soon as possible after phosphating. The rinse bath shall be slightly overflowing and closely monitored to ensure it does not become contaminated. A cold water rinse is satisfactory if parts are to be subsequently finished with water-soluble oil.

4.1.5.2 If other than water-soluble oil will be used to finish the parts, a hot water rinse is preferred to facilitate drying. Drying shall be done immediately after this hot water rinse. Parts which do not dry quickly should be blown off with air or placed on a heated tray or in a drying oven. Part temperature during drying shall not exceed 105°C (220°F).

4.1.6 Oiling

Phosphated parts shall be finished by dipping or spraying with oil.

4.1.6.1 Corrosion Resistance

As-received parts or test specimens, phosphate coated and oiled per this specification, shall exhibit no corrosion. There shall be no corrosion on machined surfaces after a minimum of 90 days indoor storage. If samples are salt spray tested, they shall be tested as-received in the oiled condition and exhibit no corrosion after four (4) hours of neutral salt spray testing.

4.2 SURFACE QUALITY

4.2.1 Phosphate Coated Surfaces

Examine the phosphate coated surfaces at 15-20 magnifications using a stereomicroscope.

4.2.1.1 The finished parts shall be completely (100%) coated with a dense, continuous, adherent, evenly deposited, uniform fine crystalline manganese phosphate coating. The coated surfaces shall be grey to black or black-brown in color. It shall be free of rust, fingerprints, mottled appearance, streaks, and stains such as those from dried phosphating solution. No pits or high spots of ferrous metal substrate are permissible.

4.2.1.2 For ground surfaces with an initial roughness of 0.40 µm (16 µ-inch) Ra or greater, a faint pattern of the original grinding furrows shall be visible when illuminated with a concentrated light source positioned at an angle of 5-10 degrees to the surface. The ability to see these faint patterns in the phosphate coated surfaces is evidence that excessive etching attack has not taken place.

4.2.2 Ferrous Metal Ground Surface Substrates (Phosphate Coating Removed)

After removing the phosphate coating per CNH MTM0160 or comparable procedure, examine the substrate surfaces using a stereomicroscope and a concentrated light source set at an angle of 5-10 degrees to those surfaces. In some cases on hardened and ground surfaces where the bath was controlled poorly during phosphate coating, severe etch pitting has occurred. Resulting asperities (roughness) on the etched surface have led to serious early wear of critical components. See Annex A, Figures 2 and 3 for examples of severe etch pitting of the base metal.

4.2.2.1 Visually locate and identify those areas that appear worst in terms of surface roughness. Measure the surface finish in those areas. The phosphate coating process shall not increase the roughness of the original substrate surface by more than 5%. In no instance shall the surface roughness of the substrate, upon removal of the phosphate coating, exceed the maximum surface roughness requirement specified on the drawing.

4.2.2.2 On ground surfaces pitting is not acceptable. Depending on the particular application, a few isolated pits not exceeding 0.005 mm (0.0002 inches) in depth may be allowed with evaluation and acceptance of such deviation by the CNH procuring facility.

4.3 PHOSPHATE COATING PROPERTIES

4.3.1 Coating Weight and Thickness

4.3.1.1 Phosphate coating weight on test panels or pins processed with the parts supplied to this specification shall be 8-20 g/m^2 (750-1850 mg/ft^2).

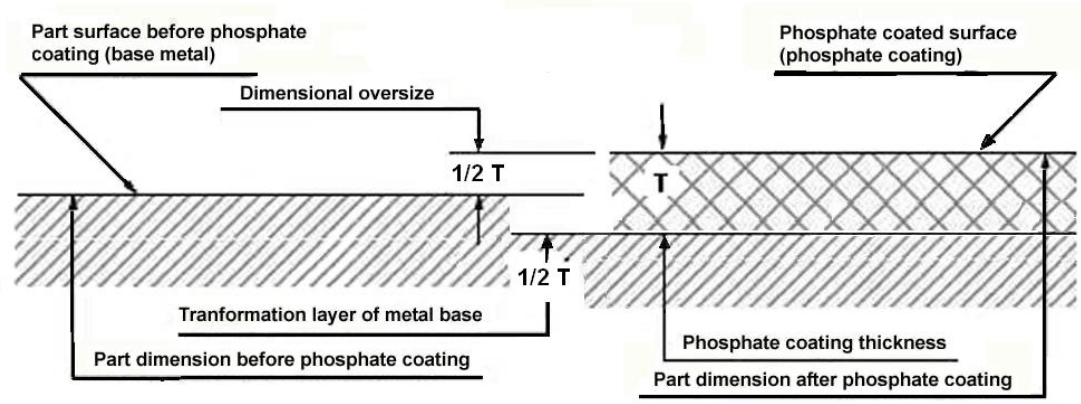
4.3.1.2 Coating weight (mass) may be specified on the drawing as a minimum or range. If coating weight requirements are not specified, the parts shall be furnished to the standard coating weight range specified above.

4.3.1.3 Coating thickness on parts is typically in the range of 4-10 µm (0.00015-0.00040 inches).

4.4 DIMENSIONS AND TOLERANCES

Dimensions of the finished part shall meet the tolerance specified on the drawing after phosphate coating. Part dimensions shall allow for dimensional changes due to reaction of the phosphate solution with the ferrous substrate resulting in a transformation layer as illustrated in Diagram 1. All coating thickness is not added to the original part dimension; therefore it may be necessary to adjust the part size before coating in order to meet final size dimensions. Final dimensions and tolerances required should be reviewed with the phosphate coated part supplier.

Diagram 1 (1)



(1) The transformation layer thickness (1/2 T) shown is only an estimate of the relationship to the final phosphate coating total thickness (T).

5 TEST METHODS

5.1 Verify coating weight per CNH MTM0160, Determination of Phosphate Coating Weight.

5.2 Determine corrosion resistance to neutral salt spray test according to ASTM B117.

5.3 Measure the coating thickness by magnetic gage or other comparable equipment.

6. SPECIAL REQUIREMENTS

6.1 Optional conditions or treatments may be applied as special requirements (SPCL). These requirements shall be indicated on the engineering drawing.

7. INSPECTION AND REJECTION

All manganese phosphate coated parts supplied to this specification shall be equivalent in every respect to samples approved by the procuring CNH location. 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 inspection by the procuring location.

8. DRAWING SPECIFICATIONS

8.1 Specifying a restricted (RSTR) or special (SPCL) coating thickness, color, corrosion resistance requirement 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.

8.2 Manganese phosphate coating may be specified on an engineering drawing using the Engineering Parts List (EPL) method or with a material note. Where a material note is used the notation shall include the generic name (MnPhos coating), CNH Material Specification number, and the coating Class. See also CNH DWGA110 for information on specifying coatings on drawings

8.3 The following are examples of manganese phosphate coating designations on drawings.

8.3.1 Manganese Phosphate Coating

Example 1: MnPhos coating designation using material notes

CNH Material CD Round, CNH MAT1030, Grade A
Local Material CD Round, ASTM A108, 1018

(Material Note on drawing above title block):
MnPhos Coating, CNH MAT0330, Class A

Example 2: MnPhos coating designation using the Engineering Part List (EPL)
Material notes may be required for any special requirements or restrictions

(Engineering Parts List directly above the Title Block)

1	0		87692732		MnPhos Coating, Class A STD 87556313
ITEM	QUANTITY	U/M	PART NUMBER	TYPE	NOUN, DESCRIPTION
ENGINEERING PARTS LIST					

(Material blocks extracted from CNH Drawing Title Block)

CNH Material CD Round, CNH MAT1030, Grade A
Local Material CD Round, ASTM A108, 1018

8.3.2 Restricted Manganese Phosphate Coating (RSTR)

CNH Material DOM Rd Tube, CNH MAT1007, Grade A
Local Material DOM Rd Tube, DIN 2394, St52-3 BKM

(Material Note on drawing above title block):
MnPhos Coating, CNH MAT0330, Class A, RSTR
Coating Weight of 12-20 g/m^2
No alternate Coating permitted

8.3.3 Special Requirements (SPCL)

8.3.3.1 Special Coating Finish Color

Specify non-standard coating color as a special requirement in a material note on the drawing.

CNH Material DOM Rd Tube, CNH MAT1007, Grade A
Local Material DOM Rd Tube, DIN 2394, St52-3 BKM

(Material Note on drawing above title block):

MnPhos Coating, CNH MAT0330, Class A, SPCL
Special Requirements Are:
Black Finish

8.3.3.2 Special Coating Weight

For a non-standard or special coating weight, specify the required minimum or maximum coating weight, any additional treatment, and corrosion resistance requirements as special requirements in a material note on the drawing.

CNH Material DOM Rd Tube, CNH MAT1007, Grade A
Local Material DOM Rd Tube, DIN 2394, St52-3 BKM

(Material Note on drawing above title block):

MnPhos Coating, CNH MAT0330, Class A, SPCL
Special Requirements Are:
Coating Weight of 25 g/m^2 Min.
Chromate-passivating rinsed and oiled with rust inhibiting oil
24 Hours Min. Red Corrosion Resistance

ANNEX A

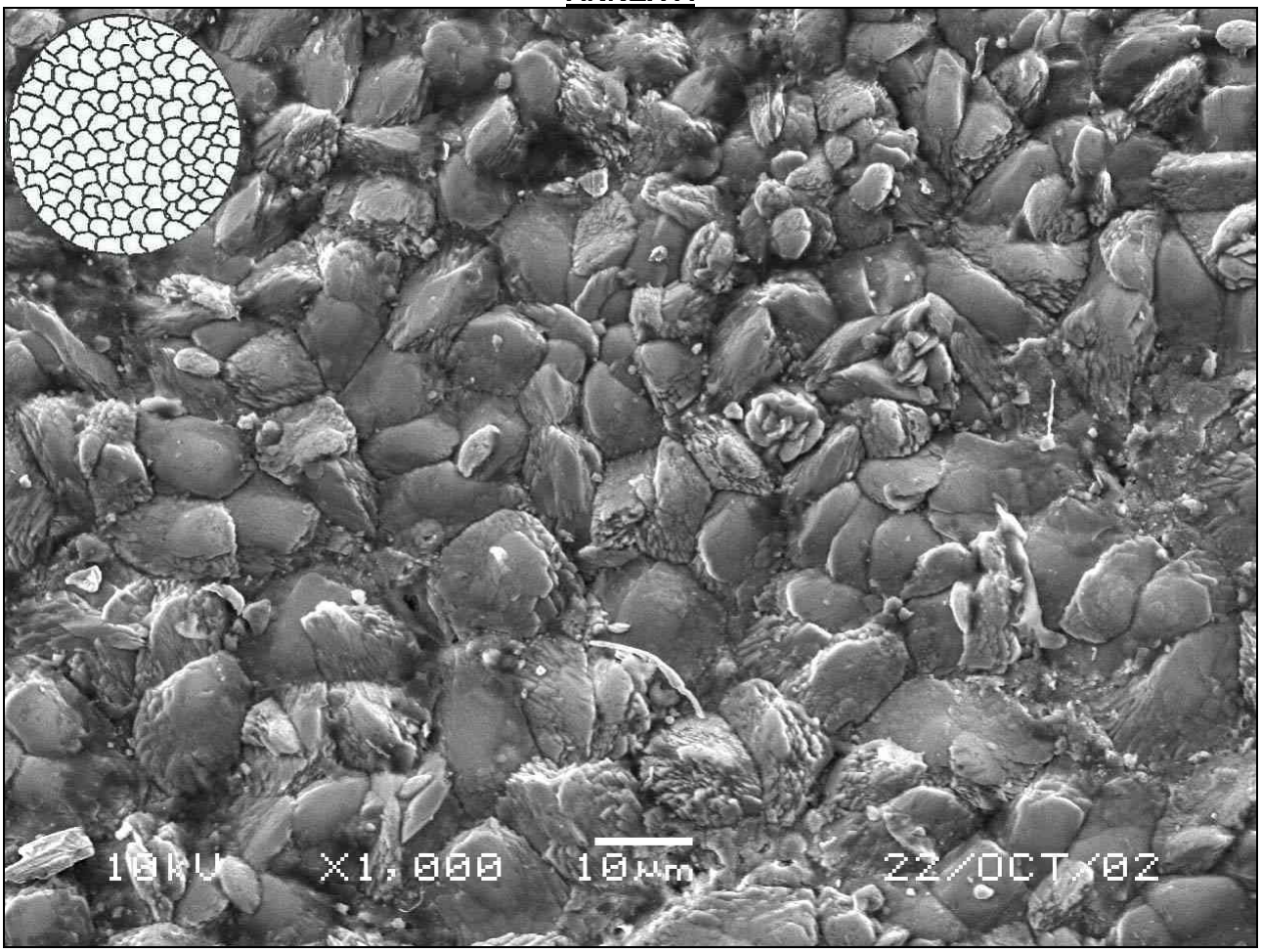


Figure 1: Scanning electron microscope photo of manganese phosphate fully coated surface showing prismatic crystal structure typical of good quality manganese phosphate coating. The inserted schematic illustrates a manganese phosphate coating consisting of prismatic crystals having rounded edges and partially overlapping in the manner of scales; acicular or lamellar crystals are un-acceptable (Reference: Fiat Auto Standards, Fiat 9.57408). Typical measured dimensions of prismatic crystals are 10-15 µm.

ANNEX A (Continued)

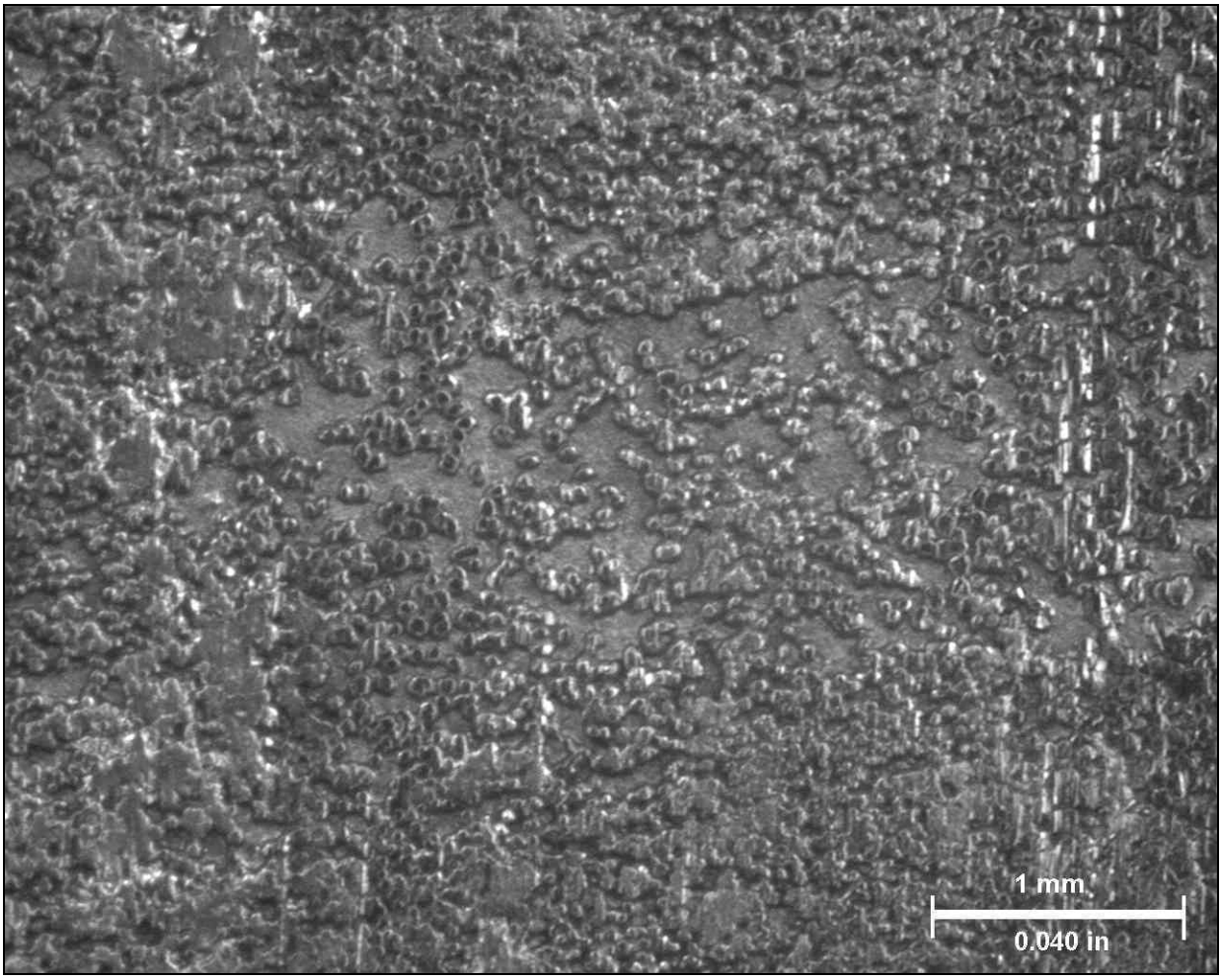


Figure 2: Stereo-microscope photo of a hardened, ground and manganese phosphate coated surface; the phosphate coating has been removed. The phosphate coating process caused unacceptable severe etch pitting of the metal substrate, leaving hard asperities that can aggressively wear mating surface.

ANNEX A (Continued)

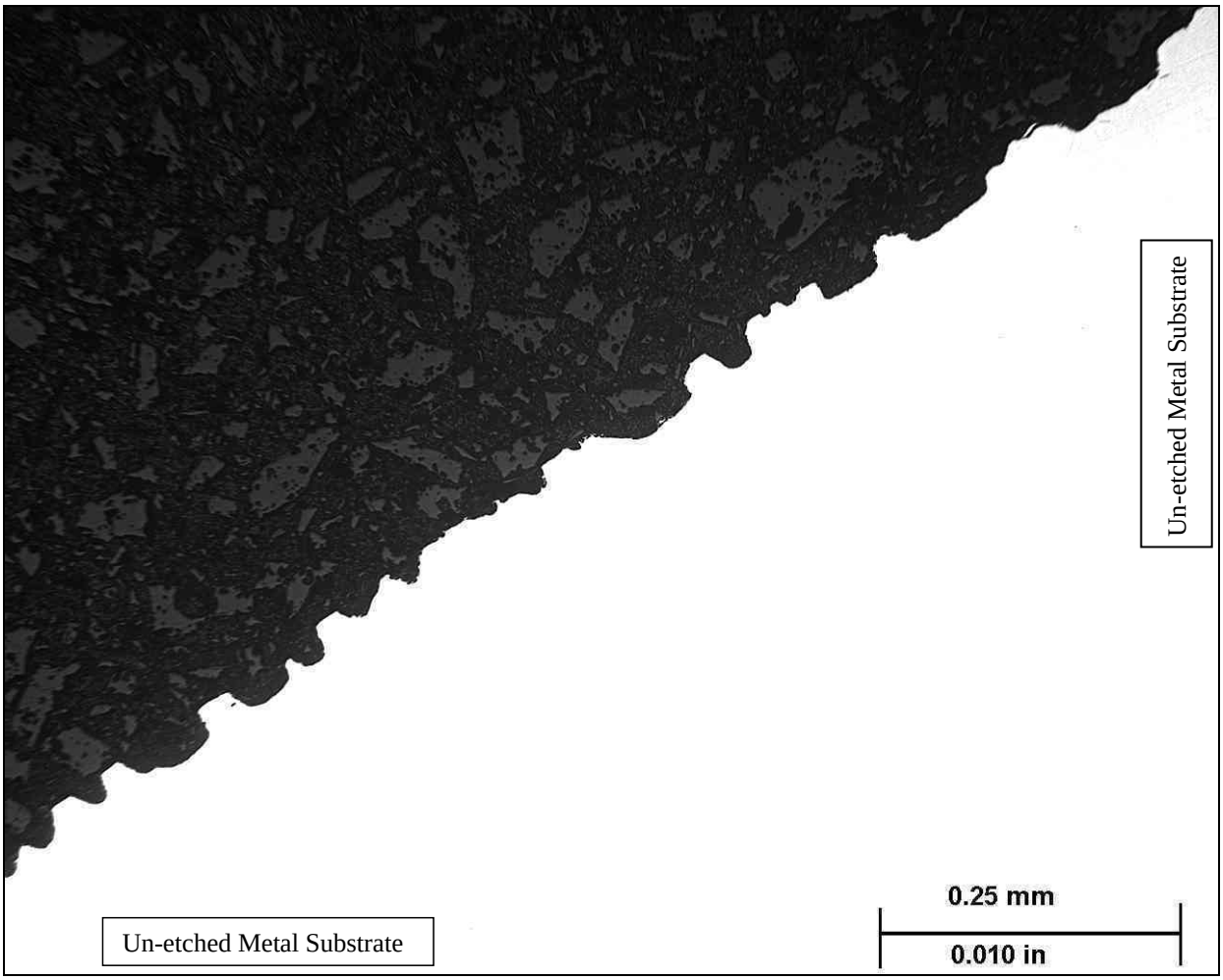


Figure 3: Microscopic cross sectional view of the surface shown in Figure 2 showing asperities (white jagged areas in photo) that can aggressively wear mating surfaces.

ANNEX B

Table B1 MnPhos Process Baths – Typical Control Parameters and Suggested Check Frequency (1)		
Process Baths	**Parameters to be Controlled**	**Check Frequency**
Alkaline Cleaning	• Total Free Alkalinity • Percentage Oil	Hourly to Daily
	• Time • Temperature	Continuous monitoring
Pre-Rinsing	• Total Free Alkalinity (carry over)	Hourly to Daily
	• Time	Continuous monitoring
Conditioner	• Additives per volume of parts	Daily
	• Time • Temperature	Continuous monitoring
Phosphate	• Acid Ratio (Free Acid; Total Acid)	Hourly
	• Iron Content • Time • Temperature	Continuous monitoring
Post-Rinsing	• Total Acid (carry over)	Hourly to Daily
	• Time	Continuous monitoring
De-Watering Oil	• Water Contamination • Time	Continuous monitoring

(1) Table provides typical bath parameters to be controlled along with their check frequency. Table B1 information is for engineering guidance only and not a requirement of this specification. Suppliers of coated parts need to identify and control bath parameters in accordance with chemical supplier requirements for the production of quality coating. Though the table provides recommended check frequency it is solely the responsibility of the coating supplier to do required checks as necessary to produce quality coating to meet the requirements of CNH MAT0330.

Table B2 MnPhos Coating – Defect Types and Common Causes for Occurrence (1)		
Defect Type	**Common Causes for Occurrence**	
Pitting	• Phosphate bath free acid level • Phosphate bath iron concentration • Phosphate bath temperature/time	• Sludge or particles • Poor Conditioning • Poor Rinsing
Low Coating Weight	• Cleaning bath (uncontrolled - alkalinity, time, temperature) • Improper conditioning	• Phosphate bath (low total acid, uncontrolled time and temperature)
Coarser Crystal	• Improper phosphate bath chemistry balance (iron content, free acid, total acid)	• Poor Conditioning
Partial or No Coating	• Poor cleaning	• Poor phosphate bath control

(1) Table provides MnPhos coating defect types and common causes for their occurrence. The table is for engineering guidance only and not a requirement of this specification.

General Guidance

- Statistical Process Control/Trend Charting should be performed on a periodic basis for better process control.
- Chemical additions made to process baths should be more frequent, in small quantities, and slower rates to keep chemistry in equilibrium.
- Quality Control (QC) should inspect process slugs and parts on a periodic basis. QC samples shall be microscopically evaluated for pitting, coating weights, and crystal structure.
- Bath system/s required adjustments should be made as needed to maintain process control.