INDIAN RAILWAYS

सत्यमेव जयते

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Description of Item	**FASTENERS FOR BOGIES OF PASSENGER COACHES**	
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SCHEDULE OF TECHNICAL REQUIREMENTS FOR PLAIN NUT, ~~PREVAILING TORQUE ALL METAL NUT WITH METALLIC INSERTS,~~ ALL METAL PREVAILING TORQUE TYPE HEXAGON NUTS, BOLTS, PINS AND SCREWS ETC. FOR BOGIES OF PASSENGER COACHES

1.0 SCOPE

This specification covers the guideline for evaluation of firms for manufacturing & testing of various types of fasteners to be used in bogies of passenger coaches.

1.1 Referred Documents: Latest version of all the referred documents shall be followed.

S. No.	Standard No.	Standard Title
1.	ISO 4017	Hexagon head bolts with thread up to head
2.	ISO 4014	Hexagon head bolts with shank
3.	IS 1364–1	HEXAGON HEAD BOLTS, SCREWS AND NUTS OF PRODUCT GRADES A AND B
4.	IS 1364–2	HEXAGON HEAD BOLTS, SCREWS AND NUTS OF PRODUCT GRADES A AND B
5.	IS 1367–3	TECHNICAL SUPPLY CONDITIONS FOR THREADED STEEL FASTENERS
6.	DIN 609	Hexagon fits bolts with long thread
7.	ISO 4032	Hexagon Nuts
8.	IS 1364–3	HEXAGON HEAD BOLTS, SCREWS AND NUTS OF PRODUCT GRADES A AND B
9.	IS 1367–6	TECHNICAL SUPPLY CONDIT-IONS FOR THREADED STEEL FASTENERS
10.	IS 5556	IS 5556: Serrated Lock Washers
11.	DIN 6798A	Serrated lock washers, Forma I - external
12.	ISO 2320	Prevailing torque type steel nuts -- Mechanical and performance properties
13.	IS 1367–8	Technical Supply Conditions for Threaded Steel Fasteners, Part 8: Prevailing Torque Type Steel Hexagon Nuts - Mechanical and Performance Properties
14.	DIN 6925	Hexagon nuts with clamping part all-metal nuts,
15.	DIN 980~~V~~	~~Metric DIN 980V All Metal Prevailing Torque Type Hex Lock Nuts~~ DIN 980 (Type V or M) - All Metal Prevailing Torque Type Hexagon Nuts.
16.	ISO 7089	Plain washers — Normal series — Product grade A
17.	EN 28738	Flat washers for clevis pins
18.	ISO 7093-1	Plain washers — Large series
19.	IS 2269	Hexagon Socket Head Cap Screws
20.	ISO 4762	Hexagon socket Head Cap Screws
21.	IS 6094–1	HEXAGON SOCKET SET SCREWS
22.	ISO 898–5	Mechanical properties of fasteners made of carbon steel and alloy steel —
23.	IS 6761	FASTENERS- COUNTER SUNK HEAD SCREWS WITH HEXAGON SOCKET SPECIFICATION
24.	ISO 10642	Hexagon socket countersunk head screws
25.	DIN 910	Hexagon Head Screw Plugs, Heavy Type, Cylindrical Thread
26.	ISO 2341	Clevis pins with head
27.	ISO 1234	Split pins
28.	ISO 9227	Corrosion tests in artificial atmospheres — Salt spray tests
29.	ASTM B117	Standard Practice for Operating Salt Spray (Fog) Apparatus1
30.	ISO 4042	Fasteners - Electroplated coatings
31.	ISO 10683	Fasteners — Non-electrolytically applied zinc flake coatings

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32.	EN 13858	Corrosion protection of metals - Non-electrolytically applied zinc flake coatings on iron or steel components
33.	IS 1367–11	TECHNICAL SUPPLY CONDITIONS FOR THREADED STEEL FASTENERS – Electroplated Coatings
34.	ISO 3269	Fasteners — Acceptance inspection
35.	ISO 898–1	Mechanical properties of fasteners made of carbon steel and alloy steel Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread
36.	ISO 898-6	ISO 898-6 - Mechanical properties of fasteners made of carbon steel and alloy steel - Part 6: Nuts with specified proof load values - Fine pitch thread (ISO/DIS 898-6:2010)
37.	DIN 65151 & DIN 25201-4	Interlock washers
38.	IS 1363-3	Hex Head bolts, screws and nuts of product grade-C
39.	ISO 3800	Axial load fatigue testing of fasteners
40.	IS 3063	Spring lock washers
41.	ISO 1207	Slotted cheese head screws
42.	ISO 7040	Prevailing torque type hexagon nuts
43.	IS 1367 - 17	TECHNICAL SUPPLY CONDITIONS FOR THREADED STEEL FASTENERS - Inspections, Sampling and Acceptance Procedure

2.0 WEATHER CONDITION

2.1 The Fasteners are used very widely under the severe weather conditions. The limiting conditions, which have to be withstood in service, are indicated as below:

S. No.	Weather condition	Limiting conditions
1	Maximum temperature	+70º C
2	Minimum temperature	-20º C
3	Max. temperature attainable by an object exposed to sun(current carrying object)	100º C
4	Maximum Relative humidity	Up to 100%
5	Average Annual Rainfall	1750 to 6250 mm
9	Maximum wind pressure	200 Kg/Sq. meter
10	Altitude	Up to 3000 m
11	The Fasteners are subjected to chemical pollution from the effluent gasesof Chemical Plants and saline atmosphere in coastal areas.	

2.2 Coach-body displacement encountered under dynamic conditions.

i) Vertically- ±100 mm

ii) Laterally - ±126 mm

ii) Longitudinally- ±10 mm

iii) Bogie rotation about center pivot- $\pm 4^0$

iv) Maximum Speed of train - 200 KMPH

3.0 GENERAL REQUIREMENTS

3.1 All firms require registration for manufacturing, testing & supply of various types of fasteners to be used in bogies of passenger coaches should be well established. This STR/Specification specified details requirement for various fasteners. However, the firm applying for registration shall ensure compliance of relevant clauses & requirement of M&Ps & T&Ps for items for which it applies for registration.

3.2 Their manufactured fasteners should have been used in Railways, Wind Mills, Turbines, Ships, Aerospace, Bridges, Heavy Transport/Commercial Vehicles ~~and~~ or Earthmovers.

4.0 SPECIFICATION FOR FASTENERS

Specifications mentioned in below table shall be used for manufacturing, Testing, Marking & Delivery of fasteners:

Types of Fasteners	Size Range	Properties Range	Hardness Range	Material/Quality Standard	Coating Requirement
Hex. Head Bolt / Screw / Stud/ Fit Bolt	M8 to M30	8.8 to 12.9	-	ISO:4017 / ISO:4014 / IS:1364 PT-1 / IS:1364 PT-2 / IS:1367 PT-3 / DIN 609	Minimum 1000 hours salt spray test according to ISO 9227 / ASTM B117/ ISO 10683
Hex. Nut	M8 to M30	8 to 12	-	ISO: 4032 / IS: 1364 PT-3 / IS: 1367 PT-6	
Serrated Washer	M8 to M30	-	200HV to 400HV	IS:5556 Type A & B / DIN 6798 A	
Hex. Nut Prevailing Torque Type	M8 to M30	8 to 12		ISO: 2320 / IS:1367 PT-8 / DIN 6925 / DIN 980V	
Plain Washer	M8 to M33	-	200HV to 400HV	ISO: 7089 / EN 28738 / ISO: 7093-1	
Hex Socket Head Cap Screw	M8 to M30	8.8 to 12.9	-	IS: 2269 / IS: 1367 PT-3 / ISO: 4762	
Hex Socket Head Screw with Flat Point	M8 to M30	8.8 to 12.9	-	IS: 6094 PT-1 / ISO: 898 PT-5	
Hex Socket Counter Sunk Head Screw	M8 to M30	8.8 to 12.9	-	IS:6761 / ISO: 10642	
Hex Head Plug Screw	M8 to M30	8 to12.9	-	IS: 1367 PT-3 / DIN 910	
Clevis Pins with Head / Split Pins	M8 to M36	-	200HV to 400HV	ISO 2341 / ISO 1234	
Interlock washers	M8 to M30	-	47≤HRC	DIN 65151/DIN 25201-4	

5.0 DRAWINGS AND DIMENSIONS

Fasteners of Standard Size(s) will be used if Drawings & dimension for specific fasteners not specified in Tender Document.

6.0 THREAD FORMATION

6.1 External Threads should be formed by cold rolling process and thread profile shall confirm to ISO 965-1, tolerance class 6g. Internal threads should be formed by tapping process and thread profile shall confirm to ISO 965-1, tolerance class 6H.

6.2 The thread profile shall be checked/measured by traveling microscope or profile projector in addition to conventional thread gauge.

7.0 COATING REQUIREMENTS (See Annexure-I)

7.1 Products of water-based family containing metallic zinc & Aluminum flakes shall be used for coating on fasteners. Thermal curing of coating shall also be ensured.

7.2 Coating procedure shall confirm to ISO 10683 / EN 13858. Coating thickness shall be 0.008 mm to 0.015 mm.

7.3 After 1,000 hours of salt spray chamber exposure, the fastener shall not exhibit any red rust.

8.0 PLANT, MACHINERY AND INFRASTRUCTURAL REQUIREMENTS FOR MANUFACTURING AND TESTING

8.1 The manufacturers shall have adequate space and covered area with cemented floor to accommodate the following:

a) Damp free place for storage of solid wire, extruded rods, dies, chemicals and other raw materials including bought out items.
b) Independent manufacturing areas for various components.
c) Place for Inspection of Finished/Semi-Finished Products.
d) Place for Chemical Mechanical Testing Lab.
e) Place for Storage of Finish Goods.

8.2 Following machines/equipment shall be available (In-House or at Sister Concern Facility) with the manufacturers for manufacturing of fasteners for use in bogies of Passenger Coaches.

i) The manufacturer shall have at least one Annealing Furnace.
ii) Cleaning Line / Chamber
iii) Wire drawing machine
iv) Cold Forging Machines with min. & max. Dia. & Length AND Hot Forging Machines with min. & max. Dia. & Length.
v) Continuous Heat Treatment Furnace (Hardening, Oil Quenching & Tempering).
vi) Head Trimming Machines.
vii) Threads Rolling Machines & Thread Tapping Machines.

viii) Coating Chamber / Room / Tank along with other facility for coating of fasteners as per this specification.
ix) Shot Blasting Chamber / Room using stainless Steel shots of sizes 0.250mm/0.275mm.
x) CNC Machines for Machining
xi) Salt Spray Chamber
xii) Hydraulic Press Machine
xiii) Punching/Blanking Machine
xiv) Coating Thickness Gauge
xv) Digital pH Meter
xvi) Digital Coating Weighing Machine
xvii) Lab Oven
xviii) Hydrometer
xix) ~~SCADA~~ Microprocessor Controlled furnace(s)
xx) Knurling machine
xxi) Sealed quenching facility
~~xxii) Geomet coating chamber~~
~~xxiii) Shot blasting~~
xxiv) Vacuum furnace

8.3 Testing facilities required for manufacturing and supply of fasteners for use in Bogies of Passenger Coaches are as below:

i) Microscope/Profile projector for threads laps.
ii) Spectroscope (For chemical composition testing)
iii) Hardness Tester
iv) Universal/Tensile Testing Machine
v) Impact Testing Machine
vi) Microscope for Measurement of Decarburization
vii) Thermocouples
viii) Magna Flux for crack detection.
ix) Adequate no. of measuring instruments and gauges (Vernier calipers/Screw Gauges, Thread Plug Gauge, Thread Ring Gauge, Go-No-Go gauges etc.).
x) Torque Wrench with load indicating device
xi) Automatic shorting parts machine for dimensional check, crack etc.
xii) Junker Vibration Testing Machine and Fatigue test for product assembly.
xiii) Surface Hardness testing Machine (HV 0.3).
xiv) Positive material identification machine.
xv) Torque Tension Testing Machine.
xvi) Surface Roughness testing Machine.
xvii) Compression testing machine upto 2000 KN
xviii) Widening testing setup.
xix) Preload testing Machine.
xx) Automatic temperature Control Cooling Chamber.
xxi) Surface Plate
xxii) Junker vibration testing machine
xxiii) Tensile testing
xxiv) Ultrasonic bolt elongation testing
xxv) Stress rupture testing
xxvi) Fatigue testing
xxvii) Hardness testing
~~xxviii) Profile/contour checking~~

Note: Whenever inspecting authority advises for third party testing, the testing shall be done in RDSO Lab/NTH/NABL accredited lab/NML only.

9.0 Manufacturing

All the fasteners shall be preferably manufactured by cold forming process.

10.0 PROPERTIES OF MATERIAL

10.1 Physical & Chemical Properties of each type of fasteners shall be checked/verified by the manufacturer as per the requirements of respective ISO/IS/EN/ASTM etc. standard for each lot. The same shall be inspected by RDSO/Purchaser/Inspecting Agency. Manufacturer shall provide free of charge labor, M&P/T&P and space for inspection/testing by RDSO/Purchaser/Inspecting Agency.

11.0 Quality Control Requirements

11.1 The manufacturer shall have valid ISO: 9001:2015 certification, ISO 45001:2018 certification, Zed certification, IATF 16949 certification, ISO 14001:2015 certification and IRIS certification.

11.2 There should be the system to ensure 'first-in first-out' for all raw materials and intermediate stages to finish products.

11.3 It should be ensured that there is a Quality Assurance Plan for the product detailing the following various aspects:

- Organisation chart
- Process flow chart
- Stage inspection details from raw materials stage to finish product stage
- Various parameters to be checked and level of acceptance of such parameters indicated and method to ensure control over them.
- Disposal system of rejected raw material and components.

11.4 The quality manual of the firm for ISO: 9001 should clearly indicate the control over manufacturing at every stage and testing of the said Railway product.

11.5 It should be ensured that proper analysis is being done on monthly basis to study the rejection at various stages of production and is documented.

11.6 There shall be at least one graduate degree holder person in relevant technology with field experience of at least five years or diploma holder with field experience of ten years on production/metallurgy/Quality Control for regular production, Testing and Quality Control.

11.7 Latest version of all the relevant specification either referred or otherwise (IS, BS, ISO, EN, ASTM, UIC, NCD, RDSO, ICF, RCF, MCF) and drawings with latest alterations should be available with the firm.

11.8 The manufacturer shall have min. 10 years of successful manufacturing experience of fasteners for applications such as Railways, Wind Mills, Turbines, Ships, Aerospace, Bridges, Heavy Transport/Commercial Vehicles and Earthmovers.

11.9 The manufacturer shall have BIS 1364 Part -1 & BIS 1364 Part -2 Certification or equivalent

certification.

11.10 The manufacturer shall have in-house NAMBL Accredited Lab for Testing.

11.11 Manufacturer shall submit past Performance letter /certificate of same for similar grade items. (minimum from 2 customers)

11.12 Each and every fastener should be tagged with Raw material, batch number, machineries handled, men handled and testing done.

12.0 Inspection and Tests

Inspection shall be carried out at the manufacturer's premises by the RDSO or Purchaser or their nominated inspection agency. Manufacturer shall have to arrange free of charge labor, M&P/T&P for inspection. Manufacturer shall also associate for the following:

i) Access to all records considered relevant for such activity by inspecting authority.

ii) Questioning of relevant personnel engaged in production, testing and quality checking activities etc. or related issues.

13.0 Inspection by Manufacturer/Purchaser/RDSO:

Inspection of fasteners shall be carried out as per ISO 3269 and IS 1367-17 and AQL shall be taken as 0.65 and 1 as applicable & LQ_{10} shall be taken as 3.0.

13.1 Visual Inspection:

i) 100% bars/wires shall be visually inspected at every stage of the production. The components shall have smooth finish and free from all visual defects like pinholes, scratches etc.

ii) Adequate number of samples selected randomly from each lot shall be passed through NDT and destructive test.

13.2 Dimensional Accuracy:

I) Dimensional accuracy of the fasteners shall be strictly in accordance to the relevant drawings/ Standard/ Specifications.

II) The coating thickness shall be checked to ensure the minimum required thickness.

Tensile and Impact Test:

i) Tensile and Impact testing on the adequate number of samples shall be ensured.

ii) The mechanical properties of the fasteners shall be recorded and presented to RDSO/Purchaser/Inspecting Authority as and when required.

14.0 Upgradation Quantity: Minimum Supplies of Bolts/Screws ~~and~~ or Nuts/Prevailing Torque Nuts or Washers shall be 250000 nos.

Annexure -I

SURFACE TREATMENT FOR NON-ELECTROLYTICALLY APPLIED ZINC FLAKE COATINGS FOR FASTENERS

1.0 Scope:
This specification covers the requirements for non-electrolytically applied zinc flake coatings for steel fasteners. It applies to coatings with or without hexavalent chromium; with or without top coat; with or without lubricant (integral lubricant and/or subsequently added lubricant).

It applies to bolts, screws, studs and nuts with ISO metric thread, to fasteners with non-ISO metric thread, and to non-threaded fasteners such as washers, pins, clips, etc. It does not apply to mechanically applied zinc coatings.
This specification is intended to help better understanding of the codal provisions. For actual design/ use the relevant reference codes as given in para 2 below shall be referred to and followed. In case of any confusion, clarification or difference of opinion etc., the provisions given in the relevant reference codes as given in para 2 below shall prevail.

2.0 Reference Codes:
Following codes has been referred while preparation of this specification:
2.1 ISO 10683:2018
2.2 EN 14399 Series (High strength structural bolting assemblies for preloading)

3.0 General Characteristics of the Coating:

3.1 Metallic Zinc & Aluminium Flake coating systems
Metallic Zinc & Aluminum flake coating systems are produced by applying zinc flake dispersion to the surface of a steel fastener, usually with the addition of aluminium flakes, in a suitable medium. Under the influence of heat (curing), a bonding amongst flakes and also between flakes and substrate is generated, thus forming an inorganic surface coating sufficiently electrically conducting to ensure cathodic protection. The coating may or may not contain hexavalent chromium, Cr(VI).
Special techniques may be necessary to avoid excessive or insufficient coating thickness. Special techniques may be necessary to prevent lightweight and/or flat fasteners from sticking together (e.g. washers, clips, fasteners with captive washer, flanged nuts).
An additional top coat can be applied to increase corrosion resistance and/or to achieve specific properties (e.g. torque/tension properties, chemical resistance, aspect, colour, electrical insulation/conductivity.

3.2 Functional properties

3.2.1 Assemblability and Mountability

Clearance between assembly components (e.g. clearance hole), dimensional tolerances of the functional parts of the fasteners, tool gripping (e.g. for retaining rings), tool insertion (e.g. for recess and internal drives) and driving should not be impaired.
For dimensional requirements after coating for threaded fasteners, (see 5.2 of this document and Annex B of reference code at para 2.1).

The compatibility of the coating system with the tightening process, especially when high speed tightening is foreseen (risk of overheating, stick/slip, etc.) should be considered. The compatibility of the coated fasteners with the clamped parts, e.g. tapped holes, clamped parts in aluminium,

magnesium, stainless steel, electrophoreticaly coated parts, hot dip galvanized parts, should be considered.
To achieve a specific clamp force and a consistent torque/clamp force relationship for fasteners with ISO metric thread, at least one of the mating threaded fasteners should be lubricated. Zinc flake coating systems provide lubricated solutions (see section 4.1 of this document). Torque/clamp force relationship can be determined in accordance with ISO 16047 and expressed as a coefficient of friction μ (or by K-factor).

3.2.2 Other properties of the assembly with coated fasteners

3.2.2.1 Chemical resistance
Organic top coats applied on zinc flake base coats are more resistant to acidic and alkaline chemicals than inorganic top coats.

3.2.2.2 Electrical conductivity
The electrical conductivity of metallic zinc & Aluminum flake base coats with inorganic top coat is generally suitable for application of electrophoretic coatings and antistatic purposes. Metallic zinc & Aluminum flake coating systems are not suitable for electrical grounding.

3.2.2.3 Cleanliness
For cleanliness requirements, the suitability of the zinc flake coating system should be checked (e.g. dust, particle size, particle type, number of particles).

3.3 Mechanical and physical properties and curing
The coating process shall not adversely influence the mechanical and physical properties of the fasteners.
Depending on the metallic zinc & Aluminum flake coating system, the curing temperatures can be up to 320 °C. The curing temperature shall not be above the tempering temperature of quenched and tempered fasteners.
WARNING: The curing process (especially with higher temperature and/or longer duration) may affect the fatigue limit of fasteners with thread rolled after heat treatment. Curing process (especially with higher temperature and/or longer duration) may have an effect on the properties/performances of fasteners:

- When the curing temperature is above the tempering temperature, reduction of hardness may affect the performances of case hardened or nitrocarburised fasteners (e.g. for thread forming screws), or elastic and plastic deformation (e.g. for clips);
- For cold worked fasteners or fasteners with thread rolled after heat treatment, residual stresses may be reduced.

3.4 Avoidance of internal hydrogen embrittlement

A characteristic of metallic zinc & Aluminum flake coating systems is that hydrogen is not generated during the deposition process.
Pre-treatment processes using alkaline/solvent cleaner followed by mechanical cleaning do not generate hydrogen, thus eliminating all risk of internal hydrogen embrittlement (IHE).
Cathodic cleaning processes are not permitted.

NOTE: Metallic Zinc & Aluminum flake coatings have a high permeability for hydrogen which, during the curing process, allows outward diffusion of hydrogen which may have been absorbed during the pre-treatment process as specified in this subclause.

4.0 Metallic Zinc & Aluminum flake coating systems and coating processes

4.1 Coating systems:

There are four basic metallic Zinc & Aluminum flake coating systems as shown in Figure 1.

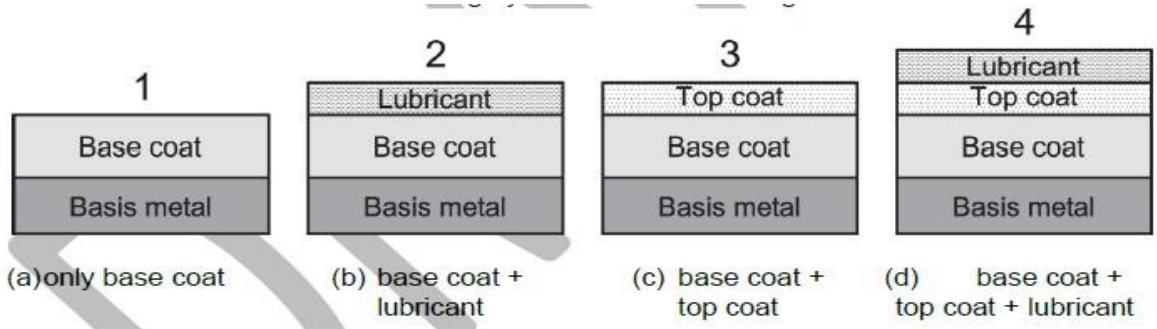

Figure 1 – Basic zinc flake coating systems

Base coat and top coat can be with integral lubricant, see detailed possible combinations in Figure 2 below.

An integral lubricant may be chosen to achieve torque/tension properties. An additional top coat may be chosen to increase corrosion resistance and to achieve other specific properties (e.g. torque/tension properties, resistance to chemicals, mechanical resistance, aspect, colour, thermal resistance, electrical insulation/conductivity, UV resistance). The selection of the nature of the top coat should be based on desired additional properties (i.e. Organic top coat: electrical insulation, high resistance to chemicals or colouring possibilities, etc. and Inorganic top coat: impact/abrasion resistance or thermal resistance, etc.). An additional lubricant may be chosen to adjust torque/tension relationship.

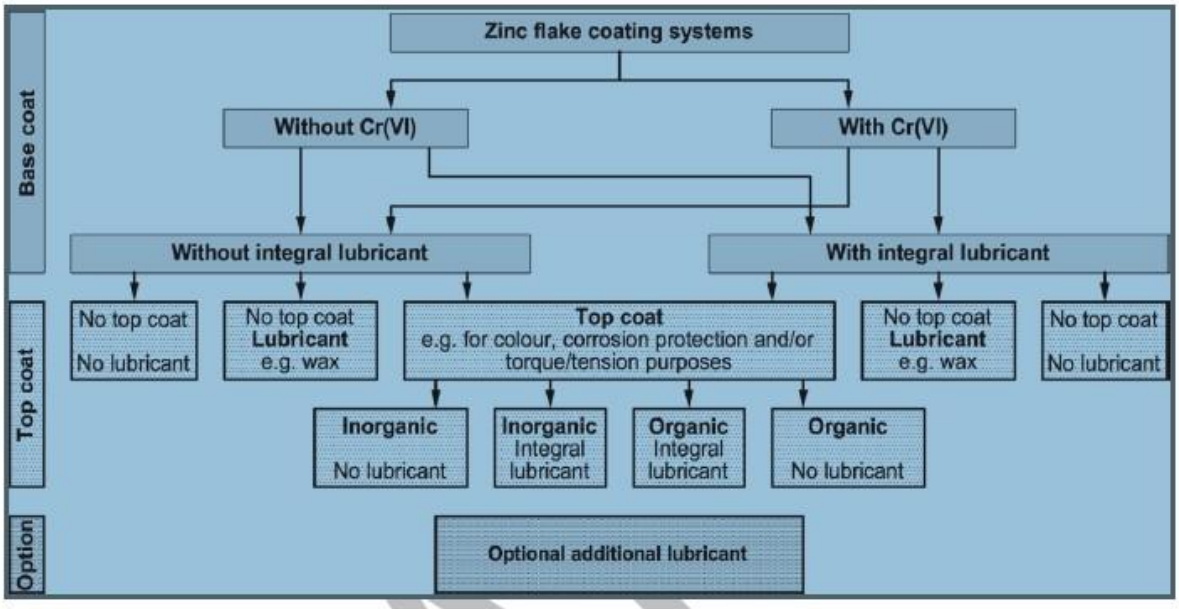

Figure 2 – Typical zinc flake coating systems

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4.2 Coating process

Metallic zinc & Aluminum flake coating systems can be applied in rack process using dip-spin or spray process.
Metallic zinc & Aluminum Zinc flake coating is generally a mass process. When lots of small quantity have to be coated, a suitable coating line and/or process may be necessary in order to achieve the required properties and performances for the coated fasteners. For fasteners of large size or mass or when the risk of thread damage has to be reduced, rack instead of bulk process may be considered.

5.0 Dimensional requirements and its testing

5.1 General

Before coating, fasteners shall be within the specified dimensions. For ISO metric threads special requirements may apply, (For details see 5.2 below).

5.2 Bolts, screws, studs and nuts with ISO metric threads

5.2.1 Coating thickness

When considering the coating thickness related to the desired corrosion resistance, the dispersion of the thickness of the coating system shall be taken into account.
Coating thickness has a significant influence on gaugeability, therefore thread tolerance and clearance in the thread shall be taken into account. The coating shall not cause the zero line (basic size) to be exceeded in the case of external threads; nor shall it fall below in the case of internal threads.

NOTE: For standard bolts, screws, studs and nuts not specifically manufactured to accommodate metallic Zinc & Aluminum flake coatings.

5.2.2 Gaugeability and Assemblability

Coated ISO metric screw threads shall be gauged in accordance with ISO 1502 with a GO-gauge of tolerance position h for external threads and H for internal threads.
When gauging a coated external thread, a maximum torque of 0.001 d^3 (Nm) is acceptable, where d is the nominal thread diameter in millimetres, see Table 1 below.

Table 1 – Maximum torque for gauging of coated ISO metric screw threads

Nominal thread diameter, d mm	**Maximum torque for gauging[a] Nm**
4 5 6	0.06 0.13 0.22
8 10 12	0.51 1.0 1.7
14 16 18	2.7 4.1 5.8
20	8.0

22 24	11 14
27 30 33	20 27 36
36 39	47 59
a For other diameters, the torque shall be calculated in accordance with 0,001 d^3 (Nm) and rounded to 2 digits.	

Acceptance procedures for assemblability may be applied by agreement between supplier and purchaser:

- For external thread, use of a suitable nut or the original mating fastener;
- For internal thread, use of a suitable mandrel (e.g. the mandrel specified for proof load in accordance with ISO 898-2) or the original mating fastener.

6.0 Mechanical and physical properties and testing

6.1 Appearance

The colour of a metallic Zinc & Aluminum flake coating is originally silver-grey. Other colours can be obtained by using a top coat. Variation in colour shall not be cause of rejection unless otherwise agreed.
The coated fastener shall be free from blisters and uncoated areas which can adversely affect the corrosion protection. Local excess of coating shall not impair functional properties (see Clause 5 and 3.2 of this document).

6.2 Corrosion resistance related to temperature

Elevated temperature can affect the corrosion protection of the coated fasteners. This test is specified for in-process control; it is not intended to check the behaviour of the coated fasteners together with the assembled parts.
After heating the coated fasteners for 3 h at 150 °C (part temperature) the corrosion resistance requirements as specified in Clause 7 of this document shall still be met.

6.3 Test methods for thickness or coating weight determination

Coating thickness or coating weight shall be determined using one of the following test methods:

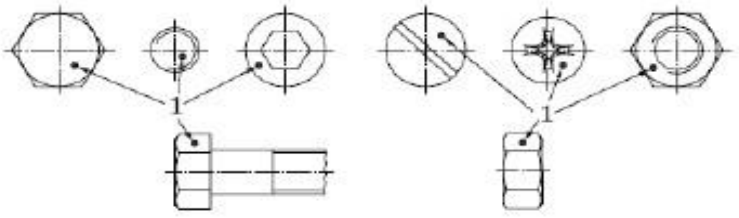
- Magnetic inductive techniques (determination of the total local thickness, on measuring areas);
- X-ray techniques (this method is only capable to determine the local thickness of the base coat, on measuring areas);
- Chemical or mechanical removal of the coating system (determination of the average total coating weight of the fastener);
- Microscopic method in accordance with ISO 1463 (determination of the total local thickness, on any area(s) of the fastener).

In case of dispute, the microscopic method in accordance with ISO 1463 shall be used. The thickness shall be measured on the reference areas specified in Figure 3 below, unless otherwise agreed.

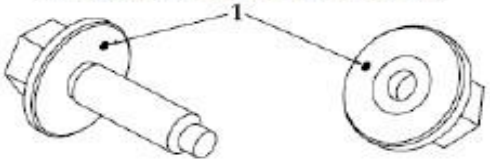
6.4 Ductility

Metallic Zinc & Aluminum flake coating systems are generally not very ductile, i.e. corrosion performance can be affected when deformation occurs after coating. Ductility shall be compatible with the elastic deformation occurring during assembly of the fastener, e.g. tightening of threaded fasteners, flattening for conical washers, bending for clips during installation.
The ability of the metallic Zinc & Aluminum flake coating system to deform should not cause impairment of the performance of the fastener, e.g. corrosion resistance, torque/clamp force relationship when specified. Therefore, suitable tests for particular applications shall be agreed between the purchaser and the supplier.

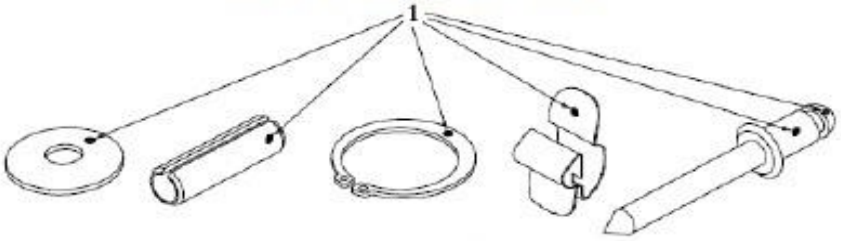
NOTE: Lack of ductility can generate cracks/chips of the coating thus impairing corrosion resistance.



a) Reference areas for threaded fasteners



b) Reference areas for captive washers



c) Reference areas for non-threaded fasteners (examples)

Key
1 reference area for local coating thickness determination

Figure 3 - Reference areas for fasteners

6.5 Adhesion/cohesion

This test may be carried out at each step of the application process.
When an adhesive tape with 25 mm width with an adhesive strength of (7 ± 1) N is firmly pressed by hand on to the surface and is subsequently pulled off rapidly and perpendicularly to the surface,

the coating shall not be peeled off the basis metal. Small amounts of the coating material left sticking to the tape are acceptable.

NOTE: Coating material visible on both surfaces of the fastener and adhesive tape usually results from lack of cohesion. Visible basis metal and coating material on the adhesive tape usually result from lack of adhesion.

6.6 Sacrificial cathodic protection

The sacrificial cathodic protection ability of the coating may be tested as follows:
The fastener shall be scratched down to the basis metal, using a tool with a nominal width of 0.5 mm. After a neutral salt spray test of 72 h duration in accordance with Clause 7 of this document, there shall be no red rust in the scratched area.

6.7 Torque/clamp force relationship

When specified, the torque/clamp force relationship may be determined for fasteners with external ISO metric thread and nuts with metallic Zinc & Aluminum flake coating systems including integral lubricant and/or subsequently added lubricant.
The test method shall be agreed between the supplier and the purchaser, in accordance with ISO 16047 or other relevant technical specifications. The requirements for torque/clamp force relationship shall be agreed between the supplier and the purchaser.
Storage conditions shall not impair the torque/clamp force performance of the coated fasteners (see para 11.10 of this document).

6.8 Determination of hexavalent chromium

The presence or absence of Cr(VI) may be determined. In this case, the determination shall be done in accordance with clause 5.5.2 of ISO 3613:2010.

7.0 Corrosion protection and its testing

7.1 General
Corrosion resistance in accelerated corrosion tests cannot be directly related to corrosion protection behaviour in particular service environments. However, accelerated tests are used to evaluate the corrosion resistance of the coating.

7.2 Neutral salt spray test

The neutral salt spray test (NSS) in accordance with ISO 9227 shall be used to evaluate the corrosion resistance of the coating systems.
When evaluation of the cabinet corrosivity is requested, it should be performed in accordance with Annex C of ISO 10683:2018.
The neutral salt spray test shall be carried out on fasteners alone, no sooner than 24 h after coating in the “as-coated” condition, i.e. before sorting, packaging and/or assembling. After the neutral salt spray test using test duration of Table 2 below, there shall be no visible basis metal corrosion (red rust). The contact points of fasteners with a holding fixture shall not be considered in the evaluation of corrosion protection.

NOTE: Guidance for the selection of coating thickness in relation to corrosion protection is given in Annex B of ISO 10683:2018.

7.3 Sulphur dioxide test (Kesternich test)

The sulfur dioxide test with general condensation of moisture in accordance with ISO 6988 shall be used to evaluate the corrosion resistance of the coating systems, the test shall be carried out with two litres of SO_2.

The sulphur dioxide test shall be carried out on fasteners alone, no sooner than 24 h after coating in the "as-coated" condition, i.e. before sorting, packaging and/or assembling.
The minimum number of cycles shall be agreed between the supplier and the purchaser at the time of the order, i.e. 2 cycles, 3, 5, 8, 10, 12, 15 cycles, etc.
The contact points of fasteners with a holding fixture shall not be considered in the evaluation of corrosion protection.

Table 2 — Standard categories for neutral salt spray test

Neutral salt spray test duration (without red rust)	**Reference thickness of the coating system (a)**
240 h	4 µm
480 h	5 µm
600 h	6 µm
720 h	8 µm
960 h	10 µm
1000 h	12 µm
a The reference thickness includes base coat(s) and top coat(s) if any, with or without Cr(VI). The corrosion resistance shall be decisive for acceptance; the reference thickness is given for guidance only.	

7.4 Bulk handling, automatic processes such as feeding and/or sorting, storage and transport

Bulk handling, automatic processes such as feeding and/or sorting, storage and transport can cause a significant reduction of corrosion protection depending on the coating system and type and geometry of the fasteners. This can especially occur for Cr(VI)-free coating systems where less self-healing effect takes place and/or where top coats are sensitive to impact damage and/or abrasion.

8.0 Applicability of tests

8.1 General
All requirements specified in para 5, 6 and 7 apply as far as they are general characteristics of the coating or are separately specified by the purchaser.

8.2 Tests mandatory for each lot
The following tests shall be carried out for each lot of fasteners (see ISO 3269).

- Gauging of thread (see 5.2.2).
- Appearance (see 6.1).
- Neutral salt spray test (see 7.0)
- Corrosion resistance: neutral salt spray test (see 7.2) or, alternatively and only when specifically required, sulfur dioxide test (see 7.3). Significant areas may be specified for the evaluation of the corrosion resistance.
- Coating thickness or coating weight (see 6.3).

- Torque/clamp force relationship (see 6.7 and Table 4).
- Ductility (see 6.4).
- Cathodic protection (see 6.6).
- Presence or absence of Cr(VI) (see 6.8).

8.3 Tests for in-process control

The following tests are not intended to be applied for each fastener lot, but shall be used for in-process control (see ISO 16426), when relevant:

- Corrosion resistance: neutral salt spray test (see 7.2) or, alternatively and only when specifically required, sulphur dioxide test (see 7.3).
- Temperature resistance (see 6.2).
- Coating thickness or coating weight (see 6.3).
- Adhesion/cohesion (see 6.5).

9.0 Designation

9.1 Designation of metallic Zinc & Aluminum flake coating systems for the order

The designation of the coating shall be added to the fastener designation in accordance with the designation system specified in ISO 8991. The metallic Zinc & Aluminum flake coating system shall be designated in accordance with Table 4 below and in the same order. A slash (/) shall be used to separate data fields in the coating designation.

9.2 Designation of zinc flake coating systems for labelling

At least the following information shall be added on the label, separated by a slash (/):

- flZn for the metallic Zinc & Aluminum flake coating (base coat);
- yc for coating with Cr(VI), or nc for Cr(VI) free coating;
- Minimum duration of corrosion resistance (neutral salt spray) in hours.

10.0 Some more issues related to fasteners and coating processes required proper attention of supplier

10.1 General

The type of fasteners should be considered when choosing a coating system and related coating process. Para 10.2 to 10.10 list the main issues for each type of fasteners. 100 % sorting is required for specific characteristic(s). Suitable measures shall be taken into account for the following potential issues.

10.2 Fasteners with ISO metric thread

- Thread damages (the heavier the part, the more sensitive it is).
- Filling of drive/recess.
- Retention of particles in threads.
- For fasteners to be coated and with pitch P < 1 mm, a special agreement between supplier and purchaser should be reached.
- Contamination with foreign parts.

10.3 Fasteners with captive washers

- Retention of particles (e.g. when shot blasting is used).
- Free rotation of the washer.
- Contamination with foreign parts.

10.4 Fasteners with adhesive or patch

Applicability on metallic Zinc & Aluminum flake coating systems and functional properties should be evaluated.

10.5 Nuts

- Retention of particles in threads.
- For fasteners to be coated and with pitch P < 1 mm, a special agreement between supplier and purchaser should be reached.
- Contamination with foreign parts.

10.6 Prevailing torque nuts

For all metal prevailing torque nuts, metallic Zinc & Aluminum flake coating systems in combination with silicate based top coat may cause scratching of the coating, fouling or even galling during tightening. In this case, an alternative top coat or additional lubricant should be used.

For prevailing torque nuts with non-metallic insert, the effect of the curing temperature should be considered.

10.7 Fasteners with recess, internal drive or cavities

Special techniques can be necessary to prevent retention of particles (e.g. when shot blasting is used as pre-treatment) and excess of coating in recesses or internal drives or cavities.

10.8 Screws which form their own mating threads

When selecting metallic Zinc & Aluminium flake coating systems, the requirements for thread-forming properties should be considered.

NOTE: It includes thread forming and thread cutting screws, tapping screws, drilling screws, chip board screws, screws for plastics and similar fasteners.

10.9 Clips and retaining rings

Plastic deformation and tangling of clips and retaining rings should be avoided during the coating process.

Special techniques can be necessary to prevent excess of coating in retention zones.

10.10 Storage of coated fasteners

During storage and before installation, direct contact with water or other liquid, condensation, exposure to dust, etc. should be avoided; such conditions can impair torque/clamp force relationship and/or corrosion resistance.