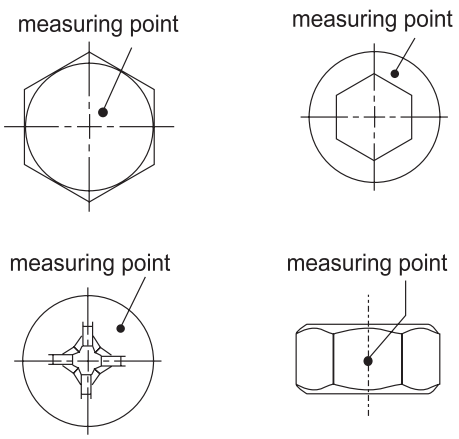
Electroplated Coatings

1. These technical conditions are in particular related to threaded fasteners (mainly bolts and nuts), but are also applicable to the whole range of mechanical fasteners. An electrolytically applied coating shall be defined as a protective metallic layer being deposited onto the surface of metal articles by immersing these parts in an aqueous solution through which an electrical current is passed.
   Note: The use of the nomenclature "galvanizing" for this treatment is not correct.

2. **Local Thickness Measuring Point**
   Because of the variations in layer thickness on electroplated surfaces on mechanical fasteners, the local layer thickness is measured at a given spot considered significant for the purpose of assessing the protection against corrosion as is indicated in the following examples:



3. **Hydrogen Embrittlement**
   Due to the risk of hydrogen-induced delayed brittle fracture bolts and screws with a tensile strength $R_m \geq 1000 N/mm^2$ or a hardness ≥ 300 HV (F ≥ 98N) have to be baked on 200 ± 10°C as soon as possible but within 4 hours after the coating process.

   This is also mandatory for resilient (springy) fasteners with a hardness ≥ 400 HV (F ≥ 98N).

Hot Dip Galvanizing

1. These technical conditions are in particular related to threaded fasteners (mainly bolts and nuts) with M6 up to and including M36 coarse thread and property classes up to and including 10.9 for bolts and 10 for nuts.
   The minimum coating thicknesses also apply to other accessories such as washers. Hot dip galvanizing shall be defined as a protective zinc layer deposited onto the surface of metal articles by immersing these parts in liquid zinc.

2. **Layer Thickness**
   The minimum coating thickness can refer to the following table for reference (ISO 1461:1999):

Coating minimum thicknesses on samples that are centrifuged

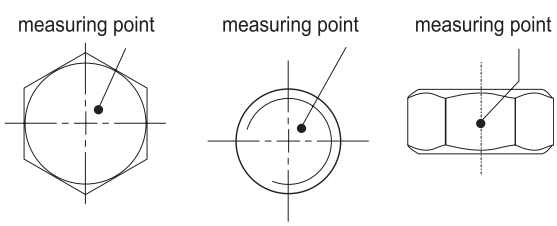
Article and its thickness	Local coating thinkness (minimum)[a] µm	Mean coating thinkness (minimum)[b] µm
Article with threads:		
≥ 20mm diameter	45	55
≥ 6mm to < 20mm diameter	35	45
< 6 mm diameter	20	25
Other articles (including castings):		
≥ 3mm	45	55
< 3 mm	35	45

a) local coating thickness
the mean value of coating thickness obtained from the specified number of measurements within a reference area for a magnetic test or the single value from a gravimetric test

b) mean coating thickness
the average value of the local thicknesses either on one large article or on all the articles in the control sample

Note: This table is for general use; fastener coating standards and individual product standards may have different requirements.

The measuring point is a given spot considered significant for the purpose of accessing the protection against corrosion as is indicated in the following examples:



The thread is tapped in the nut after hot dip galvanizing. The bolt thread shall not be recut after galvanizing.

3. **Screw Thread Tolerances**
   To ensure that the bolt/nut assembly continues to function properly after hot dip galvanizing without impairing the thread, one of the following methods shall be used:

   - Standard bolts are hot dip galvanized and become "oversize" thread. These bolts have to be combined with nuts, which have been tapped "oversize" (about 0.3mm larger) after galvanizing. They do not meet the usual thread fit. These bolts and nuts have to be used as a set. This combination is usually applied and is recommended.

- The bolts have to be prepared thinner. Because the thread profile shall not at any point transgress the zero line it means that the bolts after galvanizing have to meet the go-gauge with tolerance position h.

These "ISO metric mating" hot dip galvanized bolts have to be combined with nuts, which have been normally tapped after galvanizing and so have to meet the go-gauge with tolerance position H. This method satisfies the usual thread fit and can be used with nuts or in tapped holes with standard ISO metric thread.

4. Hydrogen Embrittlement

Hot dip galvanizing itself does not cause hydrogen embrittlement.

Pre-treatments like pickling have to be processed professionally, because careless treatment may induce hydrogen embrittlement.

5. After-treatment

When in high strength joints a better torque/tension relationship is required, it is necessary to provide the bolt or nut with an adequate lubricant e.g. molybdenum disulfide MoS_2.

6. Color

The color of the zinc coating may vary from bright to grayish, depending on different circumstances.

The color however is not an indication of the quality of protection against corrosion and cannot be an argument for rejection, although as bright and glossy an appearance as possible has to be aimed at.

7. Loadability

Generally it can be stated that the mechanical properties of the bolts and nuts in accordance with BS3692:2001.

However, taking in account the reduced overlap of the bolt and nut threads, the loadability of the bolt/nut combination is reduced by about 5% for the largest size M36 and gradually increases to 20% for the smallest size M6. Due to the fundamental deviations of the thread tolerances the screw thread of the bolt is allowed to strip off at the minimum ultimate tensile load.

8. Corrosion Protection

Because zinc is a lesser noble metal than iron (steel), the zinc will corrode first, protecting the steel against rusting until all zinc has dissolved.

A good example of this phenomenon occurs with the screw thread of hot dip galvanized nuts, which are tapped after galvanizing. The zinc layer on the bolt thread completely takes over the protection of the uncoated nut thread. The hot dipped galvanized zinc layer consists, besides a thick outer layer of pure zinc (the solidification-layer), of 3 alloy layers, of which the iron percentage decreases to the outside. The corrosion resistance of these layers is equal to or better than that of pure zinc, while the resistance against wearing is much higher.

Influence of the climate on the time of protection of hot dipped galvanized steel