ture. Good design and correct galvanizing procedures will normally prevent distortion.

- The welding of zinc-coated steel can demand a somewhat different procedure compared to uncoated steel. The welding of hot dip galvanized steel results in a degree of coating loss through the 1st and 2nd Heat Affected Zones although a portion of the original coating remains intact right up to the edge of the weld. It is necessary to recondition the coating over the weld and surrounding coating.

4.3 THE HOT DIP GALVANIZING PROCESS

General Hot Dip Galvanizing

The metallurgical reaction between steel and molten zinc, which produces a hot dip galvanized coating, can only take place if surfaces are free from contaminants. If steel surfaces are contaminated with marking paint, weld slag and other substances not readily removed by acid, these must first be removed by mechanical means, such as abrasive blasting or grinding. Moulding sand on the surfaces of castings is removed by means of abrasive blasting.

Grease and oil is removed by the galvanizer with degreasing chemicals, either caustic or acid based. Rust and millscale are removed from steel surfaces by pickling in diluted hydrochloric or sulphuric acid. After pickling and rinsing, a fluxing agent is applied. The purpose of fluxing is to dissolve surface oxides on both the steel and the molten zinc surfaces thus enabling steel and zinc to make metallic contact with each other. Fluxing can be applied in two different ways, designated wet and dry galvanizing respectively. As far as coating quality is concerned, both methods give equally good results.

In wet galvanizing the surface of the zinc bath is divided into two sections by a weir. The fluxing agent - ammonium chloride, is deposited on the zinc surface in one section of the bath. The steel components, still wet from pickling and rinsing are dipped through the molten flux into the zinc. The components are then moved into the flux-free section of the zinc bath. The flux residue and oxides are skimmed from the surface of the bath, whereupon the components can be lifted up through a pure, smooth zinc surface. Wet galvanizing is largely confined to small components and semi-automatic tube galvanizing.

Dry galvanizing is the preferred method for coating batch galvanized components. After pickling and water rinsing, the components are dipped in a flux solution of ammonium chloride and zinc chloride. In this way a thin layer of flux salts is deposited on the surfaces of components. Before components are dipped into and withdrawn from the bath, the surface of the molten zinc is skimmed to remove zinc oxide and flux residues. After withdrawal from the zinc bath, components are quenched either in a sodium dichromate rinse or plain water. Alternatively, they may be aircooled. Components are then ready for fettling (if necessary), inspection and dispatch *(figure 15)*.

Centrifuge Hot Dip Galvanizing

Small components such as nails, nuts, bolts, washers and fittings are cleaned as described above and placed in perforated baskets, which are then dipped into the molten zinc. Upon withdrawal from the zinc bath, the basket is placed in a centrifuge. Rotation has the effect of throwing excess zinc off the coated surfaces, leaving the components free from uneven deposits of zinc. The zinc layer on centrifuged articles is somewhat thinner, than that obtained by the general process. Centrifuging is essential for threaded articles, where thread clearance and coating thickness tolerance are critical *(figure 15)*.

Tube Hot Dip Galvanizing

Tubes are hot dip galvanized either by the dry or wet methods in semi-automatic production lines. Immediately after withdrawal from the zinc bath, excess zinc is wiped off external surfaces to provide a smooth and uniform coating. The thickness of the zinc coating can be controlled to some extent by adjusting the air pressure in air wiping equipment. Internal surfaces are cleaned of excess zinc with the aid of steam, which is forced down the bore of the pipe. The tube hot dip galvanizing process is normally only applied to flangeless tubes with a maximum nominal bore up to 114mm OD. Larger diameters and tubes with flanges are galvanized by way of the general process.

EVALUATION OF WET STORAGE STAIN

(Refer to Chapters 5 and 12)

VISIBLE EFFECT	CAUSE	REMEDIAL ACTION
LIGHT WHITE DISCOLOURATION - THIN, WHITE POWDERY DEPOSIT	Caused by moisture trapped between sheets or components during transportation or storage, or by condensation in the absence of adequate ventilation.	None required. The protective properties of zinc are not impaired by the presence of superficial white discolouration. Existing white discolouration deposits will slowly convert to protective basic zinc carbonate. Not suitable for post painting before removing loosely adhering deposits.
HEAVY WHITE DISCOLOURATION- THICK, CRUSTY DEPOSITS	Prolonged adverse storage or inadequate protection during transport, allowing considerable water ingress between closely stacked sheets or components.	Before painting, remove all traces of loosely adhering deposits with stiff bristle brush (not a wire brush). Check residual zinc coating thickness with an electromagnetic thickness gauge. (On continuously galvanized sheet, the electromagnetic thickness gauge is used merely as an indicator of the zinc coating thickness. The method cannot be used to fail the coating in terms of thickness.) If the coating thickness is within specification and if the sheet or component is to be used in reasonably dry or freely exposed conditions, no action is required.
BLACK STAINING AND WHITE DISCOLOURATION WITH POWDERY DEPOSITS	Usually very early stage of superficial zinc corrosion normally due to the formation of complex surface zinc corrosion product. Black staining does not imply that the zinc coating has been destroyed.	Check zinc coating thickness using an electromagnetic thickness gauge. (The electromagnetic thickness gauge is used merely as an indicator of the approximate zinc coating thickness on continuously galvanized sheeting. The method cannot be used to fail the coating in terms of thickness.) If in doubt contact the HDGASA before painting, due to the complex nature of stains.
RED RUST	Corrosion of steel substrate where zinc coating has broken down completely. Should not be confused with superficial staining.	In general, sheet or components showing red rust should be repaired or not used at all.

Table 5. Evaluation of wet storage stain.