If two different metals are placed in electrical contact and bridged by an electrolyte, a current flows through the solution from the anodic to the cathodic or more noble metal. As a result, the cathodic metal tends to be protected but the anodic materials may suffer great corrosion.

Figure 1, shows a Galvanic Table which lists metals from the least active (noble) to the most active metals. Such tables are of significant value in drawing the attention of designers to the dangers of bi-metallic corrosion. The tables, however, must be interpreted not only on a basis of the potential difference between the metals in the table, but the area relationship between cathodic and anodic metals and the ability of some materials to form stable passive oxides. The latter phenomenon can control the overall corrosion reaction leading to a significant decrease in the rate of material loss.

A guide to the compatibility of various metals and alloys in contact is shown in Figure 2.

One exception to the necessity for the two metals or alloys to be in direct electrical contact for metallic corrosion to occur, is when the noble metal corrodes slightly and dissolves in water which subsequently flows over a less noble material. The corrosion product from the more noble metal may then deposit on the less noble metal forming a true bi-metallic contact.

An example of this reaction is when copper can dissolve very slightly in some natural waters and re-deposit on zinc or zinc/aluminium coated steel. Hence bi-metallic corrosion may be experienced when two dissimilar metals or alloys, not in direct contact are nevertheless connected electrically.

Obviously bi-metallic corrosion is more severe under immersed conditions than when exposed to normal atmospheric environments. In the case of atmospheric environments, corrosion will only occur when the bi-metallic couple is wet.
This is related to many factors such as the presence of moisture in crevices, speed of evaporation and specific time of wetness. Generally, under atmospheric conditions bi-metallic corrosion is usually localised at the point of contact. Our experience has shown that significant corrosion of the less noble or the more anodic component is dependent upon the time of wetness which can be further accelerated by contamination of the surface with conductive salts.

A typical example of this reaction can be seen to be associated with stainless steel self drilling roof screws which have been incorrectly used to fix COLORBOND® prepainted steel roof sheeting. The consequent establishment of an area of corrosion approximately 40 mm in diameter on the roof sheeting about the screw head is initiated by the deposition of detritus from the environment, which greatly extends the time of wetness. The deposit contains salts from the surrounding environment and extends to a discontinuance in the organic coating on the sheeting adjacent to the fastener.

This effectively couples the “insulated” noble fastener material to the more anodic steel sheet resulting in corrosion of the COLORBOND® steel sheeting about the fastener head.

This mechanism is further enhanced should the washer used to seal the fastener contain carbon black. Carbon black is highly conductive and is capable of initiating and maintaining a significant corrosion reaction even in the absence of a noble or cathodic fastener. Washers free of carbon black are readily available.

One unusual example of such galvanic activity is related to the corrosion induced by the use of common black marking pencils on bare galvanized and ZINALUME® zinc/aluminium alloy-coated steel products. Black “lead” pencils contain graphite/carbon rather than lead. This reacts with the metallic coating resulting in indelible marking or fine corrosion of the sheet surface and, in aggressive environments, severe knife like corrosion of the metallic coating.

The information and advice contained in this Bulletin is of a general nature only, and has not been prepared with your specific needs in mind. You should always obtain specialist advice to ensure that the materials, approach and techniques referred to in this Bulletin meet your specific requirements.

BlueScope Steel Limited makes no warranty as to the accuracy, completeness or reliability of any estimates, opinions or other information contained in this Bulletin, and to the maximum extent permitted by law, BlueScope Steel Limited disclaims all liability and responsibility for any loss or damage, direct or indirect, which may be suffered by any person acting in reliance on anything contained in or omitted from this document.

ZINALUME® and COLORBOND® are registered trade marks of BlueScope Steel Limited. BlueScope is a trade mark of BlueScope Steel Limited.

Please ensure you have the current Technical Bulletin as displayed at www.bluescopesteel.com.au

BlueScope Steel
Copyright® 2003 BlueScope Steel Limited
BlueScope Steel Limited ABN 16 000 011 058
BlueScope Steel (AIS) Pty Ltd ABN 19 000 019 625

AUSTRAlia
SYDNEY
Telephone: (02) 9795 6700
MELBOURNE
Telephone: (03) 9586 2222
BRISBANE
Telephone: (07) 3845 9300
ADELAIDE
Telephone: (08) 8243 7353
PERTH
Telephone: (08) 9330 0666

BlueScope Steel (Thailand) Limited
Telephone: (66 38) 685 710
PT BlueScope Steel Indonesia
Telephone: (62 21) 570 7564
BlueScope Steel Southern Africa (Pty) Limited
Telephone: (27 21) 555 4265

Produced by Artimprint (02) 9384 8598