10.0 Summary Guidelines for Engineers

In order to assist design engineers in understanding the complexities involved in maximising the unique properties of nickel aluminium bronze, some of the main points from the earlier sections are listed below:

- For maximum corrosion resistance in seawater and other corrosive environments ensure the nickel content exceeds the iron content, preferably by 0.5% or more.

- Castings and welded structures should be annealed between 675 and 725ºC for a minimum of six hours, depending on section, to maximise the corrosion resistance.

- Avoid the creation of crevices in engineering designs, particularly in areas where there is likely to be stagnant seawater.

- It is vitally important in the commissioning of equipment, particularly in seawater applications, that the system is flushed through with clean aerated seawater for extended periods if possible. This helps build up the protective layer and is important for long-term corrosion resistance.

- Avoid designs or media which may become polluted or contaminated with sulphide-generating bacteria.

- Investigate galvanic interaction as regards relative position of the metals coupled together in the galvanic table and their relative surface area ratios. If a small area of nickel aluminium bronze is coupled to a relatively large area of a more noble alloy, as might be the case with fasteners, then consideration should be given to electrical isolation.

- If using washers or seals, avoid products which may contain graphite as this can create galvanic/crevice corrosion problems due to its high nobility in the galvanic table.

- If flowing seawater contains a high level of contaminants as sand, give consideration to filter systems to avoid erosion/corrosion and limit flow rates to less than 4.3 m/sec.

- Cathodic protection can change the electrochemical potential of metals and may also reduce the natural low susceptibility of aluminium bronzes to the attachment of marine organisms.

- In seawater flow systems, avoid rapid changes in section, protrusions or cavities where erosion corrosion can occur through turbulent flow. Erosion corrosion does not always occur at the change of section but can be generated some distance downstream from the creation point.

- Avoid contact with mercury, or mercury salts, moist ammonia compounds, nitrates and moist sulphur dioxide as these can lead to stress corrosion cracking.

- When welding, use matching filler rods, particularly for the capping pass.

- If heavy machining has taken place and there is difficulty in holding final machining tolerances, give consideration to a low temperature stress relief. For removing machining stress, heat treatments can be conducted at temperatures between 300-450ºC for various times depending on cross-section and these have little impact on mechanical properties or microstructures.

- Give consideration to recycling used components and turnings that are generated and keep them free from other contaminants.