

## IALA GUIDELINE G1151



### FERROUS METAL (IRON)

Ferrous metal (iron) is a common material used in AtoN structures. Iron is used in a variety of its commercially manufactured alloys: wrought iron, cast iron, mild steel, and stainless steel.

**Wrought iron** is relatively soft, malleable, tough, fatigue-resistant, and easily worked by forging, bending, rolling and drawing. Until steel was available, wrought iron was used structurally for beams and girders as it had strength in both tension and compression.

**Cast iron** is one of the oldest ferrous metals used in construction. It is an iron-carbon alloy and has a relatively high carbon content of 2% to 5%. It is hard, brittle, non-malleable (i.e. it cannot be bent, stretched or hammered into shape) and more fusible than steel. Its structure is crystalline, and it fractures under excessive tensile loading with little prior distortion. Cast iron is, however, very good in compression. Cast iron was a common material in AtoN construction as structural elements could be readily bolted together. Some AtoN structures can consist solely of cast iron, but many structures will contain a combination of cast iron elements and components manufactured from different metals. Cast iron is generally resistant to corrosion, however, when combined with other materials, can corrode due to galvanic action of dissimilar metals.



**Mild steel** is an alloy of iron and carbon that contains not more than 2% carbon and is malleable in block or ingot form. Steel may include phosphorus, sulfur, oxygen, manganese, silicon, aluminium, copper, titanium, molybdenum and nickel. The properties of steel can vary greatly in relation to the chemical composition and the type of heat treatment and mechanical working used during manufacture. Characteristics affected by these differences include strength, hardness, ductility, resistance to abrasion, weldability, machinability and resistance to corrosion. A grade of

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medium carbon steel is typically used for most AtoN applications today such as handrails, equipment brackets, new light support structures, etc.

**Galvanised steel:** hot dip galvanising is the immersion of clean steel in molten zinc to apply a protective coating to the steel. A series of zinc-iron alloy layers are formed by a metallurgical reaction between the steel and zinc, providing a robust coating which is an integral part of the steel. A major advantage of zinc coating on steel is that if the zinc is worn away or broken down and the steel is exposed to the atmosphere, galvanic corrosion of the zinc occurs, as it is more base than steel, thus protecting the more noble steel.

**Stainless steel:** is defined as a steel containing sufficient chromium, or chromium and nickel, to render it highly resistant to corrosion. Stainless steel is malleable, hardened by cold working, and resistant to oxidation, corrosion and heat. It has characteristics of high

thermal expansion and low heat conductivity, and can be forged, soldered, brazed, and welded. Because of its relatively inert properties, stainless steel bolts are frequently used where the possibility of galvanic corrosion could occur. Stainless steel is available in various grades with SS316 being the most commonly used in the marine environment. Given the complexity of the issues and potential application, the selection of the proper grade of stainless steel for use in a particular application requires careful evaluation by an Engineer.

Possible forces that can act on a ferrous AtoN structure component and lead to its failure include:



**o Corrosion,** in one form or another, is the major cause of the deterioration of ferrous lighthouse components. Often called oxidation, it is the chemical reaction of a metal with oxygen or other substances. The main forms of corrosion include oxidation, galvanic corrosion, graphitization and crevice corrosion.

**o Inherent flaws,** castings may also be fractured or flawed because of imperfections in the original manufacturing process such as air pockets, porosity, or cooling stresses.

**o Mechanical breakdown,** components can also fail from purely physical causes such as abrasion, metal fatigue, overloading or a combination of physical and chemical attack.

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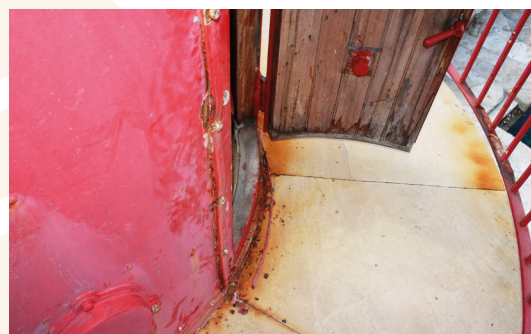
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**o Weathering,** ferrous components subjected to the weather are exposed to various chemical and physical agents singly and in combinations of several at one time. The result is a kind of synergism where the total effect is greater than the sum of the individual effects taken separately. For example, the rate of corrosion accelerates with increases of temperature, humidity and surface deposits of salts, dirt and pollution.-

**o Connection failure,** the failure of the connections of ferrous components, especially structural members, can also be caused by a combination of physical and/or chemical agents. The most common type of connections used for ferrous structural elements include bolting, riveting, pinning and welding.

**The most common and effective way to preserve ferrous components is to maintain a protective paint or coating on the metal.** The effective protective lifespan of an existing paint or coating can be greatly increased by routinely touching up areas of deterioration. A small break in the protective finish can lead to accelerated corrosion of the underlying ferrous material.



**The types of paints** available for protecting iron have significantly changed over the years and manufacturers continue to change product formulations to comply with current environmental regulations. A key factor to consider in selection of coating systems is the variety of conditions affecting existing and new materials on a particular structure.

Stainless steel and galvanised steel components generally require little or no maintenance, other than checking to ensure that the various connections are secure and that contact with different metals are suitably separated to prevent galvanic corrosion.

Cathodic protection is a recognised method of protecting metalwork against corrosion, where structural components are in direct contact with saltwater.

Regular inspections and periodic maintenance are important to ensure the integrity of ferrous AtoN structures and components is maintained.

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Inspections should check for deformation, surface coating damage, foundations integrity, anchors and hardware problems, corrosion evidence and water damage.

Repairs to ferrous AtoN structures can include replacement of the affected component, installation of additional support or bracing to maintain structural integrity or surface restoration with suitable coating systems.

In certain instances, major cracks or corrosion damage can be repaired on site by brazing or welding and should be carried out using experienced welders.

