

## ***Stress Corrosion Cracking***

### ***STRESS CORROSION CRACKING IN THE INDOOR POOL ENVIRONMENT***

Stainless steel has long been used in the building of swimming pools and pool buildings because of its corrosion resistant properties. It is used over a wide range of applications from pool equipment to structural components to plant equipment.

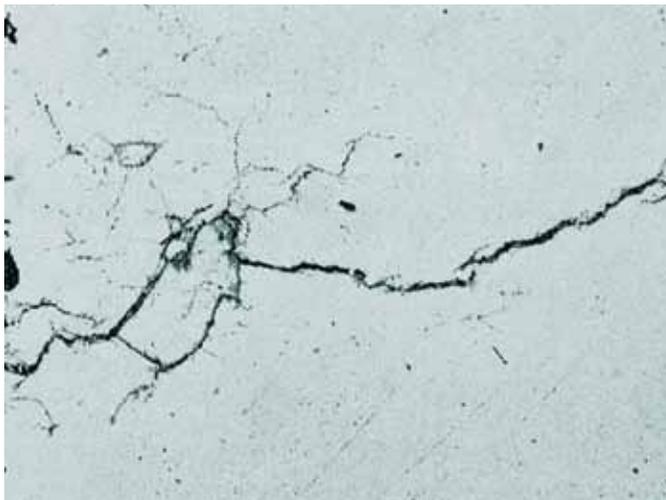
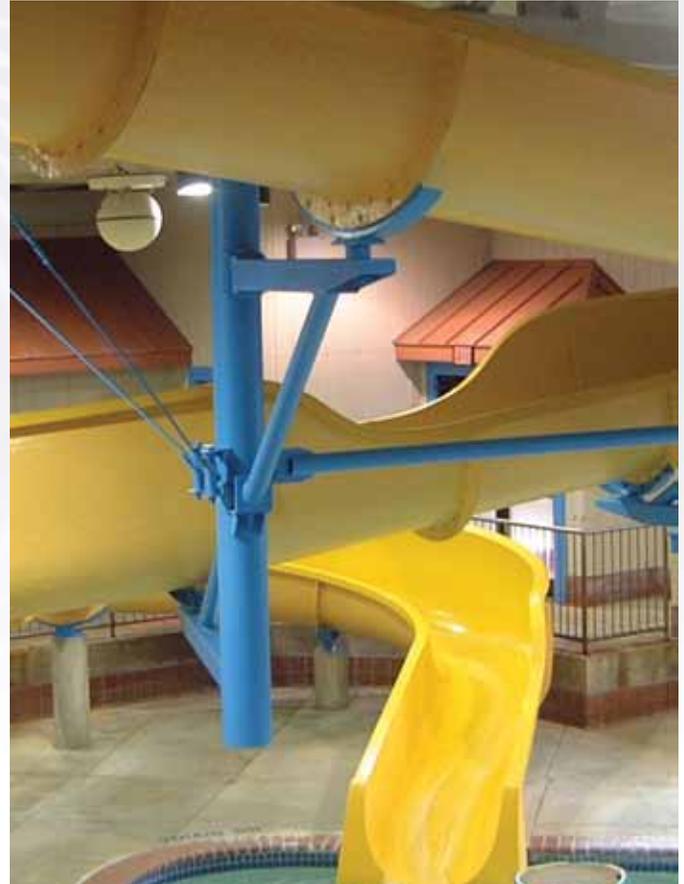
However, there are increasing incidents of mechanical failures known as stress corrosion cracking (SCC). While SCC can occur in many metals, it is more prone in stainless steel alloys that are subject to tensile stress in corrosive conditions. Failure can occur without notice and often with tragic consequences.

The evidence that SCC is becoming a greater problem is due in part to the increased demand placed on indoor pools. Both air and water temperatures have increased to improve occupant comfort. Add to this an array of water features for an overall increased evaporation rate. As the occupant load increases, larger amounts of chemical disinfectants are added to the water to control bacteria and viruses. Unfortunately, the increased evaporation rate of disinfectant byproducts and the resulting corrosive environment are detrimental to stainless steel.

### ***POOL CHEMISTRY 101***

Disinfecting agents used to maintain a sterile pool come in many forms with chlorine-based agents being one of the most popular. Free chlorine dissolved in water itself does not give off an odor, but when combined with nitrogen-based substances like sweat and urine, it produces an off gassing called chloramines. It's chloramines that produce the telltale odor and eye irritation familiar with indoor pools.

As chloramines enter the pool atmosphere through the process of evaporation, they can reform as condensate, decompose and form a corrosive compound that will attack metallic surfaces. The presence of chloramines is the key environmental factor in the corrosion of stainless steel components.



### ***WHAT IS SCC***

Stress corrosion cracking causes microscopic cracks in steel, which can propagate quickly and cause immediate failure. It is particularly dangerous because there is little visible surface evidence, and it can cause structural failure without warning.

Evidence suggests that it can only affect stainless steel under tensile stress with structural components such as fasteners, rods or wires that support a load or from which a load is suspended. Stress caused by residual fabrication and welding can also lead to SCC.

SCC occurs in indoor pool buildings under a unique set of circumstances where the pool is sanitized with chlorine and the structural member is under a stress condition. The chloramines, through condensation, form on cold surfaces and accumulate into heavy concentrations. If not properly and frequently cleaned, corrosion cracking will propagate.

**GOOD DESIGN CHARACTERISTICS GUARD AGAINST CATASTROPHIC SCC FAILURE**

It is the pool designer's responsibility to understand the corrosive conditions of an indoor pool and to choose materials capable of maintaining structural integrity throughout the facility, especially when using stainless steel. Both the grade of stainless steel and the structural design will influence SCC.

Typical areas of concern that are load bearing and can affect the safety of the poolroom occupants are supporting brackets for lights, piping and ducting, suspended ceiling supports, wire rope supports, bar supports for water features and fasteners.

Of all the grades of stainless steels available, austenitic steels are very popular in pool structures. The high levels of chromium and nickel deliver good corrosion resistance. However, it has been found that standard grades like 304 and 316 are susceptible to SCC and should not be used under stress conditions in a pool atmosphere. Rather, more highly alloyed grades of stainless are available when SCC is an issue. Standard grades of austenitic steels are acceptable for components that are fully immersed in pool water or kept wet during daily sessions, are occasionally wet but not load bearing or are safety critical.

In another example, many suspended acoustical panel systems above swimming pools using 300 Series stainless steel wires have experienced support wire failure. The cause was determined to be SCC because of the load condition and the chloramine-laden environment. Monel 400 Series wire is now recommended as an alternative to 300 Series stainless steel. It is a nickel-copper alloy with excellent corrosion resistance and a low susceptibility to stress corrosion cracking.

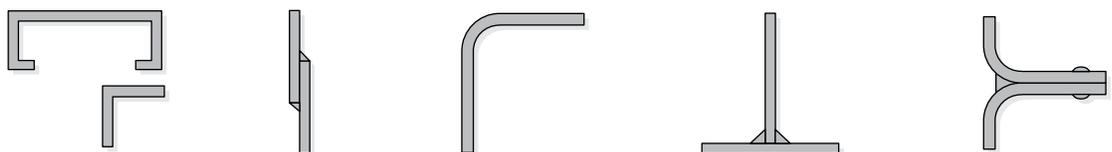
When designing structural components, care must be taken to avoid crevices or niches where corrosive compounds can form and cannot be easily cleaned. Smooth surfaces and corners are needed to prevent condensation and allow for easy inspection.

If stainless steel is used in load-bearing areas critical to safety, structural components must include fail-safe measures to avoid catastrophic failure. Other design considerations include surface finishes and construction techniques.

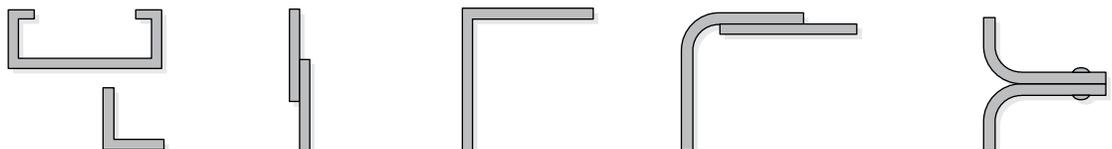
Even the location of bath/toilet facilities is important to encourage pre and post swim showering, along with educating swimmers on the role hygiene plays in natatorium structural safety.



**PROPER FABRICATION METHODS**



**AVOID THESE FABRICATION METHODS**



## **DETECTING SCC**

Stress corrosion cracking is difficult to identify in its early stages and cannot be detected by visual inspection. Brown stains on stainless steel components are the result of superficial pitting of the alloy and may be an indication of an SCC condition. Because it's a corrosive condition characterized by fine cracks, more involved methods such as 10X magnification and dye penetration tests may be required by a qualified individual.

Smaller structural components such as fasteners, clips, suspension wire and wire rope are especially prone to SCC due to their small diameter and the continuous stresses they are normally subjected to. Because they are difficult or even impossible to clean, corrosive compounds are likely to build up and lead to failure. Simple tests like tightening/loosening bolts and flexing clips and wires will often expose problem conditions.

## **NOT ALL INDOOR POOL STAINLESS STEEL APPLICATIONS ARE SUSCEPTIBLE**

SCC is found only in indoor pool structures with little evidence to suggest that outdoor pools are affected by the same problem. Incidents of SCC are found only where chloramines accumulate on stainless steel components under a tensile stress load. The vast majority of typical swimming pool components such as rails, ladders, seating and entryways are usually unaffected. Likewise, SCC does not affect stainless steel components, which are regularly immersed or saturated with pool water.



## **MAINTENANCE**

It is recommended that pool management institute a maintenance program with cleaning and inspection performed two or more times a year. Proper cleaning requires plenty of fresh water to remove chloramine deposits, while simple damp cloth wiping is not adequate. Carbon steel brushes and other abrasive carbon steel products should never be used to clean stainless steel. Attempting to clean cracked, corroded components will not correct existing structural damage. Damaged components should be replaced immediately with a higher alloy stainless steel or another material.

## **ENVIRONMENTAL CONTROL OF THE POOLROOM**

All too frequently it is the pool facility's dehumidification/ventilation system that is blamed for inadequate performance when chloramine odors and bodily irritation are noticed. The reality remains that the pool chemistry is not properly balanced and chloramine gases are at the source.

Ventilating the facility may temporarily lower or reduce the symptoms but will not remedy the problem. The best solution is to maintain proper pool chemistry and utilize a properly sized dehumidification system with ventilation capabilities.

Additionally, correct ducting of treated or ventilation air is necessary to allow for complete circulation around the pool space. Good airflow eliminates stagnant, moisture-bearing zones where condensation can form.

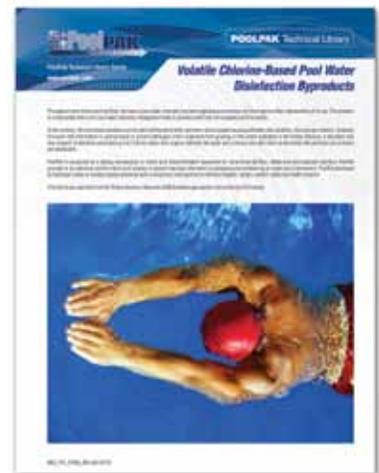
A PoolPak dehumidification unit will maintain desired water temperature, space temperature and RH for optimum performance and economy. The PoolPak's condensation prevention system will further eliminate the formation of corrosive condensation on cold metallic surfaces, the leading cause of SCC.

SCC risks can be greatly reduced by taking into account a few simple practices. First, maintain proper pool chemistry and monitor frequently as conditions change. Monitor and control air quality through designated ventilation practices, and establish an inspection and cleaning program as a preventative measure.

**OTHER POOLPAK TECHNICAL LIBRARY LITERATURE**

**All the Information You Need to Know About Indoor Pools**

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