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GLASS IS EVERYTHING™



T E C H T A L K

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H E A T S O A K T E S T I N G

# HEAT SOAK TESTING

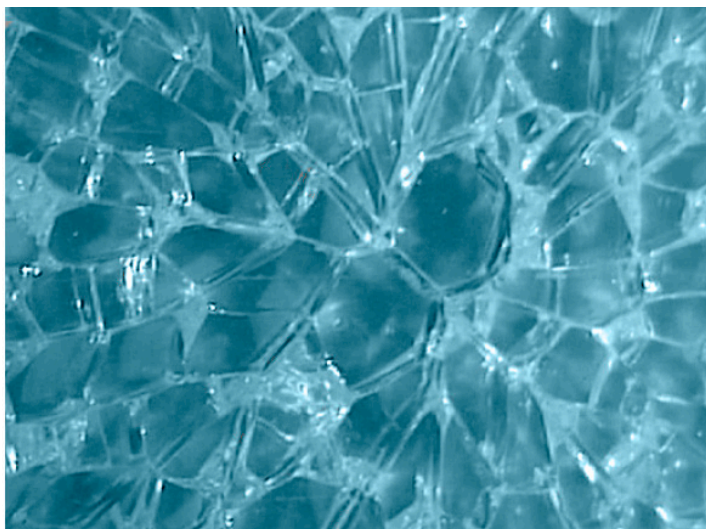
This Tech Talk provides information on how to reduce the risk of nickel sulfide inclusion breakage of tempered glass, using alternative heat-treating methods and heat soaking.

## Introduction

### NICKEL SULFIDE INCLUSIONS

Tempered glass may break without warning due to the expansion of nickel sulfide inclusions (NiS) present within float glass. To avoid the risk of spontaneous glass breakage in fully tempered glass, a common practice is to avoid the use of tempered glass whenever possible.

Although the incidence of tempered glass breakage due to these inclusions is rare, greater publicity of their occurrence has resulted in an increased awareness of this phenomenon. In fact, limiting the use of tempered glass in commercial building applications has become the recommendation of a number of glass suppliers, including Viracon.



*Tempered glass break pattern*

## Breakage Reduction

### THE USE OF HEAT STRENGTHENED GLASS

Tempered glass has been used extensively over the years and has served the industry well. It may be argued that as a result of its excellent track record, tempered glass was “automatically” specified in certain applications where it may not have been required. Floor to ceiling glass design, where a walking surface occurs on one or both sides of an insulating glass unit, was the primary application where tempered glass was required unless other design considerations were utilized. Sloped glazing applications are

another example, where for years, tempered glass was specified as the outboard glass ply of an insulating glass unit.

Over the past 15 years, the trend has been to move away from tempered glass in these applications and toward heat strengthened glass. The reasons are obvious, when you consider the inherent difference in breakage characteristics of these two products. Heat strengthened glass has a greater tendency to remain in the opening after breakage has occurred as compared to tempered glass, which can completely evacuate the opening.

## Heat Soak Testing

### REDUCE THE POTENTIAL FOR SPONTANEOUS BREAKAGE

In some situations however, tempered glass is required to meet safety glazing requirements or for added strength. In these cases, Viracon will perform a heat soak test to provide the building owner with added assurance that significant spontaneous breakage will not occur. Glass suppliers have offered heat soak tests in the past to reduce the potential for spontaneous breakage and building owners have accepted the process as a means to limit liability. Today, Viracon’s heat soak process is improved to provide even greater assurance.

### THE FORMATION OF NICKEL SULFIDE INCLUSIONS

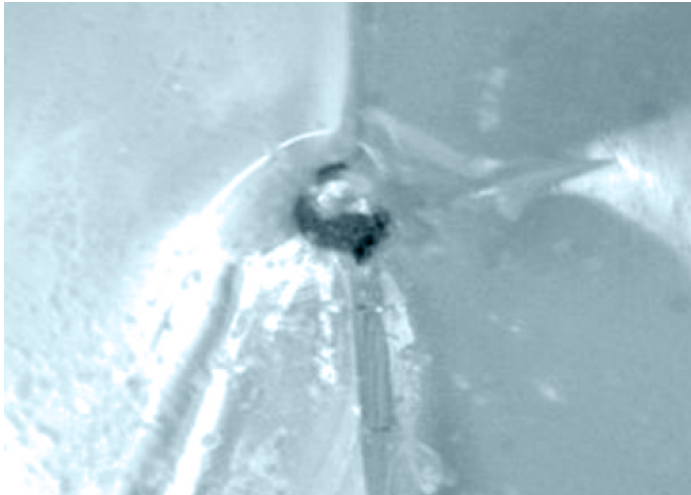
In order to understand the heat soak test, it is important to understand how these inclusions can contribute to breakage.

In the float glass manufacturing process, soda ash, lime, silica sand, salt cake and other ingredients are combined and melted in a furnace at temperatures near 2870°F (1576°C). After melting, the molten glass is formed by introducing it to the tin bath where it literally “floats” on top of a layer of molten tin to form the desired glass thickness.

After the float glass has been formed, it is cooled uniformly in an annealing lehr. Proper “annealing” results in uniform cooling rate of the glass surface, edges and core to reduce residual stress within the glass.

During the manufacturing process, undissolved particles of the batch material, inclusions, are formed within the glass. There are a number of types of inclu-

sions which may be found in float glass and are, for the most part, aesthetic imperfections. The float glass manufacturers take extraordinary steps in sourcing the highest quality materials for use in the batch mixture to reduce the number of inclusions that may occur. ASTM C 1036, the industry standard for flat glass, lists the allowable size and minimum separation between inclusions for each glass quality level.



*Nickel sulfide inclusion — .006219"*

ASTM C 1036 generally refers to undissolved particles as gaseous inclusions, knots, dirt and stones. As stated previously, some of these inclusions may cause glass breakage. The most notorious of course, being nickel sulfide. Nickel sulfide inclusions are formed when minute nickelrich particulates combine with sulfur in the furnace fuels or other glass batch materials. Since these inclusion tend to be less than 1/64" (0.4mm) in diameter, they are impossible to totally eliminate and all glass has some present.

## Surface Compression

### RESPONSE TO NICKEL SULFIDE INCLUSIONS

Even though annealed glass may have nickel sulfide inclusions present, breakage from these inclusions is unlikely due to the very low residual stresses in annealed glass. The same can be said of heat strengthened glass which has carefully controlled surface compression levels. ASTM C 1048, which is the industry standard for heat treated glass, requires heat strengthened glass to have a surface compression within the range of 3,500 psi to 7,500 psi. Viracon produces heat strengthened glass with a surface compression level of 4,000 psi to 7,000 psi in order to minimize the potential for nickel sulfide breakage.

Viracon has been producing heat strengthened glass with surface compressions within a range of 4,000

psi to 7,000 psi since 1985 and within this time, has not experienced a single incidence of spontaneous breakage in heat strengthened glass. Tempered glass, according to ASTM C 1048, must have a surface compression level greater than 10,000 psi. As a result of the high residual stresses in tempered glass, the potential for inclusion breakage exists.

## The Heat Soak Process

When glass is heat treated, these nickel sulphide inclusions undergo a phase change as a function of time and temperature. If located near the central tension core of the glass, the expansion of these inclusions may provide sufficient stresses to produce spontaneous breakage. The inclusion expands at a rate greater than the glass and literally causes the glass to break from within.

When tempered glass is heat soak tested, the glass is placed in an oven and subjected to temperatures of 554°F±18°F (290°C±10°C). Careful temperature controls must be enforced to establish when the hold time or dwell time begins. The dwell time at peak temperature is another critical factor in the heat soak process. Viracon has determined that a two hour dwell time is capable of reducing the potential for spontaneous breakage in heat soak tested glass.

## Glass In Service

At Viracon, we have been offering the heat soak test since 1984 and we have not had a single incidence of spontaneous breakage occur in heat soak tested glass. With the two hour dwell time, we are confident that we have minimized the potential for breakage to its lowest level. Viracon offers a heat soaked tempered glass warranty for breakage due to verifiable NiS inclusions. Should breakage exceed 0.3% (3/1000), Viracon will replace the glass and pay for the cost of resonable market replacement labor.

The heat soak test provided by Viracon is offered at a minimal charge to provide greater assurance against nickel sulfide breakage. When compared to the actual cost of replacing broken tempered glass in the field, there is substantial justification for the additional process charges.

We realize that there are situations where tempered glass simply must be used because of its superior strength and break-safe characteristics. In these situations, we feel compelled to provide this alternative

service as a means to avoid the potentially serious occurrences of spontaneous breakage.

## Glass Solutions

### THE LEADER IN GLASS FABRICATION

As an international company, Viracon offers the most complete range of high-performance architectural glass products available worldwide. We're a company that not only fabricates glass, we're also a company that delivers design, aesthetic, budget and performance solutions for client projects. Our success is reflected in our long-lasting client relationships, which have given Viracon a visible presence on skylines around the world, including Asia, Africa, Australia, Europe, North America, South America and the Middle East.

Since 1970, Viracon has expanded its facilities to perform more glass fabricating processes at a single site than any other fabricator in the world. We believe in selling glass solutions, which means helping clients explore all the options for each step of a project. Our complete product line includes tempered, heat-strengthened, insulating, laminated, silkscreened, spandrel, hurricane-resistant, acoustical and high-performance coated glass.



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