Sediver® toughened glass insulators for HVAC applications
Sediver, Experts and Pioneers in insulation technology

This catalog presents a selection of the Sediver® toughened glass insulator range of products answering the needs of USA customers in term of standards (ANSI), current practices and environmental conditions. ANSI standard C29.2B sets the basic and minimum requirements for wet-process porcelain and toughened glass transmission suspension insulators. Sediver® toughened glass insulators meet and exceed the performance requirements of ANSI standards.

Our expertise
500 million toughened glass insulators installed in more than 150 countries up to 1,000 kV AC & 800 kV DC.
- 8.5 million toughened glass DC insulators
- 5 million composite insulators up to 735 kV
- 2 million Sedicoat insulators, silicone coated toughened glass insulators for both AC and DC applications
- 50 years of service experience in the USA, with 20 million units installed

Research & Development, a permanent and continuous investment
Always on the lookout for continuous technological improvements, Sediver heavily invests in Research and Development. Our research and testing facilities as well as our high voltage CEB laboratory both located in France boast state-of-the-art equipment that allows extensive research programs as well as testing of complete strings for systems up to 800 kV.

Global presence – reinforced proximity

[Map of global presence with locations for France, Canada, USA, Italy, Brazil, and China]
Our experts at your service

In-depth technical expertise
Our team of multidisciplinary and highly skilled engineers is dedicated to the research and development of optimum solutions in the field of high-voltage insulation and protection.

Innovative products
Our engineers and scientists are always searching for new materials, products, designs and technologies that will contribute to improve the performance and the reliability of your systems while reducing the environmental impact and carbon footprint.

Sediver technical assistance
Our technical assistance teams help you throughout all the stages of the insulation related matters from the selection of the optimum insulation solution to the monitoring of performance in service. We offer specifically:

- Testing and evaluation programs
- Joint research programs related to solving insulation issues
- Training programs dedicated to design, handling, construction and maintenance teams
- End-of-life and failure diagnostics
- Optimization of line insulation for polluted environments

Cutting edge research and testing facilities
The equipment and facilities of our 7 research and testing centers ensure the development of insulators with excellent long term behavior and performance.

- **Investigation and research in material science:** Vital to ensure a high level of performance and reliability of our insulators

- **Mechanical endurance testing:** Essential to designing insulators with excellent long term behavior under extreme service conditions

- **Evaluation of the insulators’ electrical performance:** Fundamental to assess the performance of any type of insulator string configuration

- **Evaluation of the pollution performance of insulators and complete strings:** Critical for the choice of the right insulator adapted to each specific environmental condition

Main testing equipment per country

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Brazil</th>
<th>China</th>
<th>France</th>
<th>Italy</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric tests on insulator units</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Dielectric tests on complete strings</td>
<td></td>
<td></td>
<td>✔</td>
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<td>✔</td>
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<tr>
<td>AC Salt-fog Pollution tests</td>
<td></td>
<td></td>
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<td>✔</td>
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<tr>
<td>AC Solid layer Pollution tests</td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<tr>
<td>DC Pollution tests (salt fog/solid layer)</td>
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<td></td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>DC Sample tests according to IEC 61325</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>✔</td>
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<td>DC Type tests according to IEC 61325</td>
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<tr>
<td>Mechanical tests on insulator units</td>
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<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Thermal-mechanical tests</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Long duration vibration tests on complete strings</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Standard sample tests according to national and international standards</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

Sediver laboratories are all ISO 9001 or ISO 17025 certified
Toughened glass design features and advantages...

What is Toughened Glass?

The toughening process consists in inducing pre-stresses to the glass shell by a rapid and precisely controlled cooling of the still hot molded glass. The pre-stresses result in compressive forces on the outer surface layer balanced by tensile forces inside the body of the glass shell.

The presence of permanent outer surface compressive stresses prevents crack formation or propagation in the glass shell for an unlimited period of time (no aging).

The combination of compressive and tensile stresses in the glass shell body gives toughened glass insulators the unique property of always breaking in a predictable pattern when overstressed mechanically or electrically. Crumbling of the glass shell always results in small corn-size chunks with no razor-edged shards.

Live-line maintenance and worker safety

While more and more utilities are faced with the technical and economical challenge of keeping their lines energized “whatever happens”, live-line work is often a necessity. Live-line maintenance requires specialized crews and equipment and rigorous procedures which generates higher cost than traditional de-energized maintenance operations. However the financial impact of live-line maintenance is negligible compared to shutting down a line.

Before working on a live line, maintenance crews have to assess the condition of insulator strings to avoid risks of flashover or mechanical failure while they are working on them. Doing this assessment in safe manner is very expensive with porcelain, and even more so with polymer insulators without highly sophisticated and specialized thermal imaging, corona inspection or e-field measurement equipment. Thanks to the unique properties of toughened glass, which cannot have hidden puncture nor become conductive due to tracking, maintenance crews can do live-line work in full confidence since there are no hidden risks due to internally damaged insulators. A simple glance at the string gives a complete and reliable assessment of the electrical condition of each insulator. Even with a missing shell, Sediver remaining stub is non-conducting and maintains a guaranteed mechanical strength (at least 80% of the rating) to safely support the line.

Sediver® Toughened Glass offers exclusive features that porcelain or composite insulators cannot offer:

- **Endurance and no aging**
  
  Sediver® Toughened Glass have the unique ability to resist the effects of time and the elements with no degradation of mechanical or electrical performance for the following reasons:
  
  - Toughened glass shell is immune to the effects of micro-crack propagation with time and load / temperature cycling, which is typical of porcelain.
  - The hot cured alumina cement used in Sediver® Toughened Glass insulators is very strong, stable, and immune to any cement growth phenomena.
  - A highly automated manufacturing process, perfected along the years by Sediver, guarantees an extremely homogenous and consistently high level of quality in the materials and the final product assembly. The stability over time of the quality of Sediver® Toughened Glass is demonstrated not only by in-service experience records but also by numerous laboratory test results which confirm that the fluctuation of normal electrical, mechanical and thermal stresses over many decades does not degrade the electrical or mechanical characteristics of Sediver® Toughened Glass insulators.

- **Live-line maintenance:**
  
  Sediver® Toughened Glass insulators are, above any other technology, highly suitable for safe live-line maintenance operations.

**What is Toughened Glass?**

**Live-line maintenance and worker safety**
Toughened glass design features and advantages

- **High residual strength and no risk of line drop:**
  Sediver® Toughened Glass insulators can only exist in two well defined conditions: intact or shattered. There is no intermediate cracked or punctured state. Therefore it is easy to quickly and infallibly inspect strings of toughened glass, with no need for instruments other than the naked eye.

- **Safety in handling and construction**
  Because of the impossibility of hidden internal damage, it is not possible to install mistakenly a faulty string of Sediver® Toughened Glass insulators.

- **Puncture resistance**
  Thanks to the homogeneous and amorphous internal structure of the toughened glass shell, Sediver® insulators resist the most extreme surges such as switching surges, steep front lightning strikes and power arcs. There can be no hidden puncture in a Sediver® Toughened Glass insulator.

- **Environmental considerations**
  - Complete recycling: toughened glass insulators are made of fully recyclable components, so they do not represent an environmental liability.
  - Visual impact: toughened glass insulators, thanks to their transparency, easily blend with the sky or any background and consequently have minimal visual impact once installed on any line.

Infallible and easy visual inspection and low maintenance costs: Reliability at a glance

Power supply reliability is of great concern to all utilities. With time, as HV systems age, utilities need to carry out more frequent diagnostics of their lines and insulation in order to prevent unforeseen failures.

Inspection of porcelain and particularly composite insulators is recognized as being very difficult. For both of them, a visit to each support structure by a ground or helicopter crew is necessary in order to “buzz” or examine the insulators with specialized equipment.

On the other hand, with toughened glass, if the external shell is visible, the insulator is good. A damaged glass shell will instantly reveal its condition by shattering into small fragments. Sediver remaining “stub” is electromechanically sound.

Condition assessment of Sediver® Toughened Glass insulator strings can therefore be accomplished by a simple “at-a-glance” inspection from a distance by ground patrol or from a helicopter, without the need to climb towers. Complete 100% inspection of each insulator can be done by helicopter at a rate of up to 100 line-miles per hour, for any voltage level.

Therefore, the inspection and condition assessment of long and remote glass insulated HV lines can be done very quickly and at a fraction of the cost required for lines equipped with porcelain or composite insulators. To achieve such a complete and reliable inspection, porcelain and composite insulators need to be individually tested, an operation which is prohibitively expensive and not practical for long lines.

Due to their long life and ease of inspection, Sediver® Toughened Glass insulators offer the lowest life cycle cost of all insulating solutions.
Sediver®’s unique manufacturing processes

Sediver design and manufacturing processes have been developed over the past 70 years, taking advantage of exclusive know-how gained from millions of insulators supplied and leading to the emergence of new technologies, with always the same goal in mind: the highest performance and reliability.

Sediver®’s unique processes

Glass composition and melting
Sediver® glass is obtained through a unique melting process based on the use of a specific furnace technology and proprietary Sediver manufacturing process control and parameters. The technology developed by Sediver:
- Ensures an outstanding homogeneity in the chemical composition of the glass
- Provides high purity glass without heterogeneity

Molding
Our unique know-how enables us to create complex glass shapes and products up to 16.5” (420 mm) in diameter and weighing more than 22 lbs. (10 kg).

Toughening
The toughening process developed by Sediver generates a permanent compressive pre-stress on the surface of the glass shells which confers to the glass:
- high mechanical strength
- high resistance to thermal shocks and mechanical impacts
- immunity to the effects of aging
Thanks to the toughening, the behavior of the dielectric shell becomes binary:
1) either the glass is intact: no possible internal cracks nor puncture
2) or the glass is shattered: the glass is no longer visible outside the metal cap (stub)

Assembly of the glass shell with metal fittings
The assembly of Sediver® glass insulators is done by a specific hot curing process, using a chemically inert cement (high strength aluminous cement). Thanks to this process our insulators offer:
- outstanding mechanical stability over time
- very high residual mechanical strength

Systematic control and inspection of the insulators during manufacturing
Guaranteed quality thanks to continuous inspection and control of the production lines
- All glass shells undergo specific and repeated thermal shocks and successive quality controls so as to eliminate pieces that could present defects
- All insulators are subjected to stringent quality inspection by automated systems
The entire process is constantly monitored by highly qualified inspectors.

User’s benefits

Appropriate solutions
Thanks to the different shapes of the glass shells and to mechanical strengths ranging up to 170 klbs., Sediver offers solutions adapted to all applications and the most varied environmental conditions.

Easy installation, inspection and detection
As Sediver® glass insulators are very resistant to mechanical shocks, the stringing and line construction is much easier. The number of accidentally damaged insulators is significantly lower than with porcelain and polymer insulators. As the detection of any damages during installation is evident and immediate, the risk of installing a damaged unit is non-existent.

Reduced inspection and maintenance costs
- Unlike other materials, such as porcelain or composites, a quick and easy visual inspection is enough to identify the state of the toughened glass insulators and this without any possible mistake. The inspection costs are thus reduced to a minimum throughout the life cycle of the line.
- Sediver® toughened glass insulators are unpuncturable and resistant to overvoltage stresses thanks to a defect-free dielectric body and the homogeneity of the glass shell.
- The shattering rate of glass shells in service is negligible thanks to the high purity of Sediver® glass.
- The residual mechanical strength of Sediver® glass insulators remains almost unchanged compared to an intact insulator thanks to unique hot cured aluminous cement assembly process. Therefore, there is no urgency to replace an insulator with a broken glass shell.

Asset longevity
The life time of Sediver® glass insulators equals or exceeds the life time of the conductors, hardware and structure. Since they do not age, there is no need to replace the insulators during the life of the line.

Product consistency and traceability
As Sediver® technology and quality are homogenous throughout all its production sites, Sediver can therefore guarantee full consistency of its product performance worldwide. Each insulator is marked with the manufacturing plant’s identification code and the production batch. The marking and QA system implemented by Sediver allow total traceability of our insulators.
### Sediver® toughened glass: beyond standard performance

When developing and manufacturing toughened glass insulators, Sediver does not limit itself to minimum standard requirements but offers a superior level of performance to its products providing higher safety margins and benefits for end-users.

#### Comparison of ANSI requirements and Sediver® glass criteria

<table>
<thead>
<tr>
<th>Type of test</th>
<th>Test designation</th>
<th>ANSI C29.2B-2013 requirements</th>
<th>Sediver® criteria</th>
<th>User benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design tests</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermal-mechanical load-cycle test</td>
<td>Test on 10 units</td>
<td>Temperature range: -22°F/ +104°F</td>
<td>Test on 20 units</td>
<td>High reliability along service life</td>
</tr>
<tr>
<td>■ Four 24-hour cycles of temperature variation</td>
<td>Applied tensile load: 60% of the rating</td>
<td>Evaluation: ( \bar{X} \geq \text{rating} + 3 \sigma )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>■ After the thermal cycles, the insulators are subjected to mechanical test up to breakage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual strength test</td>
<td>No thermal cycles</td>
<td>Evaluation: ( \bar{X} \geq 0.8 \times \text{rating} + 1.645 \sigma )</td>
<td></td>
<td>Reduced maintenance costs</td>
</tr>
<tr>
<td>Mechanical tensile load test on 25 insulator units which have had the shells completely broken off</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact test</td>
<td>45 to 90 in-lbs</td>
<td>400 in-lbs</td>
<td></td>
<td>Reduced damages</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality conformity tests (on each lot)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined Mechanical and Electrical test</td>
<td>A mechanical tensile load is applied to insulator units up to failure</td>
<td>Evaluation: ( \bar{X} \geq \text{rating} + 3 \sigma )</td>
<td></td>
<td>Reinforced reliability</td>
</tr>
<tr>
<td>A low frequency voltage is applied to the insulator units immersed in oil</td>
<td>Individual values ( \geq \text{rating} )</td>
<td></td>
<td>A narrow standard deviation is the result of high quality components and manufacturing; this means enhanced safety and dependability</td>
<td></td>
</tr>
<tr>
<td><strong>Routine test</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual inspection</td>
<td>None</td>
<td></td>
<td>Complete traceability</td>
<td></td>
</tr>
<tr>
<td>■ Inspection whether there are no visual defects that would be prejudicial to satisfactory performance in service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>■ Marking verification</td>
<td></td>
<td></td>
<td>Complete identification of each insulator</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quality Control full traceability to the finished product</td>
<td></td>
</tr>
<tr>
<td>Tension proof test</td>
<td>50 % Rating</td>
<td></td>
<td>Guarantee that each insulator passed the mechanical test</td>
<td></td>
</tr>
<tr>
<td>■ 50 % Rating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>■ Marking proving that each insulator passed the routine test</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dimensional verification</td>
<td>None</td>
<td>Spacing verification of each unit</td>
<td>Dimensional conformity</td>
<td></td>
</tr>
<tr>
<td>■ Guarantee of the string spacing</td>
<td></td>
<td></td>
<td>Easy installation</td>
<td></td>
</tr>
<tr>
<td>Thermal shocks</td>
<td>One cold-to-hot shock</td>
<td>Such as required by ANSI with additional thermal treatments specific to Sediver® on each glass shell</td>
<td>Reduced operating cost</td>
<td></td>
</tr>
<tr>
<td>One hot-to-cold shock</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \sigma \): Standard deviation of the test results  
\( \bar{X} \): average value of test results  

*Upon request
Sediver® toughened glass suspension insulators

Dielectric shell profiles
Throughout decades, Sediver engineers have developed and designed different types of insulators adapted to all climates and environments, such as described in technical standard IEC 60815-1.

**Standard profile:**
The standard profile is characterized by a leakage distance* higher than the values indicated in the ANSI C29.2B and by well-spaced under-ribs that allow an effective self-cleaning action by wind or rain. It features a “leakage distance/spacing” ratio of around 2.2 and is particularly effective in suspension and tension applications in very light to medium polluted areas where typically the pollution level (ESDD) is lower than 0.1 mg/cm². (Examples: zones E1 to E4).

**Fog type profile:**
The fog type profile is characterized by long and widely-spaced under-ribs so as to avoid arc bridging between adjacent ribs. It features a « leakage distance/spacing » ratio of around 3.2 and is particularly effective in coastal areas (Salt fog) as well as in polluted areas where a higher specific leakage distance is required. (Examples: areas E5 to E7).

**Open profile:**
The open type profile features a « leakage distance/spacing » ratio of around 2.4, with no under-ribs so as to avoid the accumulation of solid pollution deposits (dust, sand) on its lower surface. It is particularly adapted to suspension and tension applications in dry desertic areas where wind is predominant and rain infrequent. (Example: areas E1 to E4). It is also effective for dead-end strings in cases of extreme industrial pollution and can solve ice-bridging problems when it is alternated with others profiles in the string.

**External shed profile:**
This profile offers a leakage distance equivalent to the anti-pollution profile and is adapted to the most extreme cases of solid pollution. The elimination of the under-ribs reduces pollution build-up, promotes self-cleaning and facilitates manual cleaning when necessary.

**Spherical profile:**
The spherical shape offers a leakage distance equivalent to that of standard profile type. With a spherical profile manual cleaning is easy and effective.

* or creepage distance
Selection criteria for pollution management

Choice of the insulator profile
Technical standard IEC 60815-1 defines 5 levels of pollution according to the pollution severity: very light, light, medium, heavy and very heavy.
The levels of pollution are defined according to the Equivalent Salt Deposit Density (ESDD) and the Non-Soluble Deposit Density (NSDD) on the surface of the insulator.

String dimensioning example:
For a 500 kV line, 
(max. phase-ground voltage: 525 / √ 3 = 303 kV)
located on the coast in a heavy pollution level
Selected insulator: N 180P / 160
(fog type profile with 21
1/2 in leakage distance)
Total leakage distance needed:
- 1.7 x 303 = 515.1 inch.
Number of insulators in the string:
- 515.1 / 21.5 = 24 insulators.

Choice of insulation level
The number of insulators per string depends on the maximum voltage of the transmission line and the pollution severity of the region.
It should be calculated in accordance with the specific creepage distance (USCD*) as defined by the IEC 60815-2 standard.

Reference USCD depending on the pollution level

String dimensioning example:
For a 500 kV line, 
(max. phase-ground voltage: 525 / √ 3 = 303 kV)
located on the coast in a heavy pollution level
Selected insulator: N 180P / 160
(fog type profile with 21⅜ in leakage distance)
Total leakage distance needed:
- 1.7 x 303 = 515.1 inch.
Number of insulators in the string:
- 515.1 / 21.5 = 24 insulators.

SEDICOAT® : RTV coated glass
In cases of extreme pollution when regular washing of the insulator strings may become necessary, Sediver® offers Sedicoat®:
Sediver® silicone coated toughened glass insulator (see page 13)

Sediver thanks the International Electrotechnical Commission (IEC) for allowing the use in this catalog of figure 1 page 18 of the Technical Specification 60815-1:2008 and figure 1 page 9 of the Technical Specification 60815-2:2008. These extracts are subjected to the IEC, Geneva, Switzerland copyright (www.iec.ch). The IEC is not liable of the use in which these extracts have been reproduced by Sediver nor can be held responsible for its content and exactness.
**Sediver® toughened glass suspension insulators**

**Ball & Socket coupling**

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**MECHANICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>CATALOG No</th>
<th>Standard Profile</th>
<th>Fog Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N100/146</td>
<td>N14/146</td>
</tr>
<tr>
<td>ANSI class</td>
<td>52-3-H</td>
<td>52-5-H</td>
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<tr>
<td>Ball and socket coupling</td>
<td>Type B</td>
<td>Type J</td>
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<tr>
<td>MECHANICAL CHARACTERISTICS</td>
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</tr>
<tr>
<td>Combined M&amp;E strength</td>
<td>lbs</td>
<td>22,000</td>
</tr>
<tr>
<td></td>
<td>kN</td>
<td>100</td>
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<tr>
<td>Impact strength</td>
<td>in-lbs</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>N-m</td>
<td>45</td>
</tr>
<tr>
<td>Tension proof</td>
<td>lbs</td>
<td>11,000</td>
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<tr>
<td></td>
<td>kN</td>
<td>50</td>
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**DIMENSIONS**

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<tr>
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<th>Standard Profile</th>
<th>Fog Profile</th>
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<tbody>
<tr>
<td>Diameter (D)</td>
<td>in</td>
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</tr>
<tr>
<td></td>
<td>mm</td>
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</tr>
<tr>
<td>Spacing (S)</td>
<td>in</td>
<td>5 3/4</td>
</tr>
<tr>
<td></td>
<td>mm</td>
<td>146</td>
</tr>
<tr>
<td>Leakage distance</td>
<td>in</td>
<td>12 5/8</td>
</tr>
<tr>
<td></td>
<td>mm</td>
<td>320</td>
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**ELECTRICAL CHARACTERISTICS**

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<thead>
<tr>
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<th>Standard Profile</th>
<th>Fog Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low frequency dry flashover</td>
<td>kV</td>
<td>80</td>
</tr>
<tr>
<td>Low frequency wet flashover</td>
<td>kV</td>
<td>50</td>
</tr>
<tr>
<td>Critical impulse flashover +</td>
<td>kV</td>
<td>125</td>
</tr>
<tr>
<td>Critical impulse flashover -</td>
<td>kV</td>
<td>130</td>
</tr>
<tr>
<td>Low frequency puncture voltage</td>
<td>kV</td>
<td>130</td>
</tr>
<tr>
<td>R.I.V low frequency test voltage</td>
<td>kV</td>
<td>10</td>
</tr>
<tr>
<td>Max. R.I.V at 1 MHz</td>
<td>µV</td>
<td>50</td>
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</table>

**PACKING AND SHIPPING DATA**

<table>
<thead>
<tr>
<th></th>
<th>Standard Profile</th>
<th>Fog Profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx. net weight per unit</td>
<td>lbs</td>
<td>8.1</td>
</tr>
<tr>
<td>No of insulators per crate</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Volume per crate</td>
<td>ft³</td>
<td>1.977</td>
</tr>
<tr>
<td>Gross weight per crate</td>
<td>lbs</td>
<td>59.5</td>
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<tr>
<td>No. of insulators per pallet</td>
<td>72</td>
<td>96</td>
</tr>
<tr>
<td>Volume per pallet</td>
<td>ft³</td>
<td>35.3</td>
</tr>
<tr>
<td>Gross weight per pallet</td>
<td>lbs</td>
<td>790</td>
</tr>
</tbody>
</table>

**Corrosion prevention solutions**

**Corrosion prevention sleeve**

In severely corrosive marine and industrial atmospheres, the galvanized coating on suspension insulator pins may deteriorate over time and be followed by corrosion of the pin itself. To prevent this form of pin damage, Sediver can supply insulators equipped with a corrosion prevention sleeve made of high-purity zinc. The insulators are then designated by “DC” (N100/146 with zinc sleeve becomes N100/146DC).

**Heavy galvanization**

All Sediver ferrous metal fittings are hot-dip galvanized. ANSI C29.2B and ASTM A153 require a zinc coating mass of 2.00/1.80 oz/ft² (610/550 g/m²) corresponding to a thickness of 3.4/3.1 mil (86/79 µm). In severe conditions, where this standard protection is known to be insufficient, Sediver offers enhanced protection of the cap and the pin by increasing the thickness of zinc to 4.3/3.9 mil (110/100 µm), or up to 4.9/4.5 mil (125/114 µm), upon request.
Sediver® toughened glass suspension insulators

Ball & Socket coupling

<table>
<thead>
<tr>
<th>CATALOG No</th>
<th>Standard Profile</th>
<th>Fog Profile</th>
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<tr>
<td>ANSI class</td>
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<td>Type K</td>
<td>IEC 24</td>
</tr>
<tr>
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<td>Type K</td>
<td>IEC 24</td>
</tr>
<tr>
<td>MECHANICAL CHARACTERISTICS</td>
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<tr>
<td>Combined M&amp;E strength</td>
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</tr>
<tr>
<td></td>
<td>kN</td>
<td>222</td>
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<tr>
<td>Impact strength</td>
<td>in-lbs</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>N-m</td>
<td>45</td>
</tr>
<tr>
<td>Tension proof</td>
<td>lbs</td>
<td>25,000</td>
</tr>
<tr>
<td></td>
<td>kN</td>
<td>111</td>
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<tr>
<td>DIMENSIONS</td>
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<tr>
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</tr>
<tr>
<td></td>
<td>mm</td>
<td>280</td>
</tr>
<tr>
<td>Spacing (S)</td>
<td>in</td>
<td>6 1/8</td>
</tr>
<tr>
<td></td>
<td>mm</td>
<td>156</td>
</tr>
<tr>
<td>Leakage distance</td>
<td>in</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>mm</td>
<td>380</td>
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<td>ELECTRICAL CHARACTERISTICS</td>
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<tr>
<td>Low frequency dry flashover</td>
<td>kV</td>
<td>80</td>
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<tr>
<td>Low frequency wet flashover</td>
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<td>50</td>
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<td>Critical impulse flashover +</td>
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<td>Critical impulse flashover -</td>
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<tr>
<td>Low frequency puncture voltage</td>
<td>kV</td>
<td>130</td>
</tr>
<tr>
<td>R.I.V low frequency test voltage</td>
<td>kV</td>
<td>10</td>
</tr>
<tr>
<td>Max. R.I.V at 1 MHz</td>
<td>µV</td>
<td>50</td>
</tr>
<tr>
<td>PACKING AND SHIPPING DATA</td>
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<td></td>
</tr>
<tr>
<td>Approx. net weight per unit</td>
<td>lbs</td>
<td>13.9</td>
</tr>
<tr>
<td>N° of insulators per crate</td>
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<td>6</td>
</tr>
<tr>
<td>Volume per crate</td>
<td>ft³</td>
<td>2.472</td>
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<tr>
<td>Gross weight per crate</td>
<td>lbs</td>
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<td>No. of insulators per pallet</td>
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<tr>
<td>Volume per pallet</td>
<td>ft³</td>
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<td>lbs</td>
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<td>Former designation</td>
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Custom products are also available
Sediver® toughened glass suspension insulators

Clevis coupling CT

### Mechanical Characteristics

<table>
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<tr>
<th>Category</th>
<th>CT100/146</th>
<th>CT14/146</th>
<th>CT14-6/146</th>
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</thead>
<tbody>
<tr>
<td>ANSI class</td>
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<td>52-6-H</td>
<td>52-6-H</td>
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<tr>
<td>Combined M&amp;E strength</td>
<td>22,000 lbs</td>
<td>30,000 lbs</td>
<td>30,000 lbs</td>
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<tr>
<td></td>
<td>100 kN</td>
<td>130 kN</td>
<td>136 kN</td>
</tr>
<tr>
<td>Impact strength</td>
<td>400 in-lbs</td>
<td>400 in-lbs</td>
<td>400 in-lbs</td>
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<tr>
<td></td>
<td>45 N-m</td>
<td>45 N-m</td>
<td>45 N-m</td>
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<tr>
<td>Tension proof</td>
<td>11,000 lbs</td>
<td>15,000 lbs</td>
<td>15,000 lbs</td>
</tr>
<tr>
<td></td>
<td>50 kN</td>
<td>68 kN</td>
<td>68 kN</td>
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### Dimensions

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<tr>
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<th>CT100/146</th>
<th>CT14/146</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (D)</td>
<td>10 in</td>
<td>10 in</td>
</tr>
<tr>
<td></td>
<td>255 mm</td>
<td>255 mm</td>
</tr>
<tr>
<td>Spacing (S)</td>
<td>5 3/4 in</td>
<td>5 3/4 in</td>
</tr>
<tr>
<td></td>
<td>146 mm</td>
<td>146 mm</td>
</tr>
<tr>
<td>Leakage distance</td>
<td>12 5/8 in</td>
<td>12 5/8 in</td>
</tr>
<tr>
<td></td>
<td>320 mm</td>
<td>320 mm</td>
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</tbody>
</table>

### Electrical Characteristics

<table>
<thead>
<tr>
<th>Category</th>
<th>CT100/146</th>
<th>CT14/146</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low frequency dry flashover</td>
<td>80 kV</td>
<td>80 kV</td>
</tr>
<tr>
<td>Low frequency wet flashover</td>
<td>50 kV</td>
<td>50 kV</td>
</tr>
<tr>
<td>Critical impulse flashover pos.</td>
<td>125 kV</td>
<td>125 kV</td>
</tr>
<tr>
<td>Critical impulse flashover neg.</td>
<td>130 kV</td>
<td>130 kV</td>
</tr>
<tr>
<td>Low frequency puncture voltage</td>
<td>90 kV</td>
<td>90 kV</td>
</tr>
<tr>
<td>R.L.V low frequency test voltage</td>
<td>10 kV</td>
<td>10 kV</td>
</tr>
<tr>
<td>Max. RIV at 1 MHz</td>
<td>50 µV</td>
<td>50 µV</td>
</tr>
</tbody>
</table>

### Packing and Shipping Data

<table>
<thead>
<tr>
<th>Category</th>
<th>CT100/146</th>
<th>CT14/146</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx. net weight per unit</td>
<td>9 lbs</td>
<td>9 lbs</td>
</tr>
<tr>
<td>N° of insulators per crate</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Volume per crate</td>
<td>1.977 ft³</td>
<td>1.977 ft³</td>
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<tr>
<td>Gross weight per crate</td>
<td>59.5 lbs</td>
<td>66.7 lbs</td>
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<tr>
<td>No. of insulators per pallet</td>
<td>7286</td>
<td>7286</td>
</tr>
<tr>
<td>Volume per pallet</td>
<td>35.3 ft³</td>
<td>35.3 ft³</td>
</tr>
<tr>
<td>Gross weight per pallet</td>
<td>790 lbs</td>
<td>880 lbs</td>
</tr>
</tbody>
</table>

### Former designation

| CT8 | CT14 |

---

**Packing**

The methods employed by Sediver to pack and palletize our toughened glass insulators are the result of the experience we gained from shipping hundreds of millions of insulators to warehouses and construction sites in 150 countries worldwide.

Factory-assembled short strings of Sediver® Insulators are packed in wooden crates, which are reinforced and held closed by external wire bindings (no nails are used).

Custom packing are also available.

Sediver® model CT14-6/146 is an ideal solution for supporting and insulating ground (shield) wires.

It can be installed in either suspension or dead-end configurations.

Custom products and clevis insulators for distribution applications are also available.

---

**Crate in open position with its internal brace to permit stacking.**

**Crates are evenly stacked on a sturdy four-way wooden pallet. This assembly is held tightly in place with either steel or plastic bands, and is protected with a polyethylene film.**
For extreme pollution: Sedicoat® solution

In case of extreme or exceptional pollution, it may become necessary to wash the glass and porcelain insulators so as to reduce the risk of flashover due to the critical deposit of pollution. Composite insulators can be used in these conditions, nonetheless the benefits linked to the hydrophobicity and profile of this kind of insulators are outweighed by the difficulties of inspection and diagnosis of the aging as well as the difficulty of live line working.

Sedicoat®: no washing is needed anymore

Sedicoat® insulators are Sediver® toughened glass insulators coated with silicone. The silicone coating procures hydrophobic properties to the surface of the glass shell and thus significantly enhances its electrical performance under extreme pollution. The hydrophobic behavior of the surface helps mitigating extreme pollution problems by reducing wetting and leakage currents.

Sedicoat® insulators offer a solution that eliminates the need for regular washing in extreme pollution conditions.

A Sediver R&D qualification program

The performance and lifetime of silicone coatings depend on the silicone type, the adherence of the silicone layer to the glass shell, the thickness and the homogeneity of the coating.

To obtain optimum performance, Sediver® has set in place a stringent R&D program. The silicones qualified by Sediver® have been specifically selected to resist quite severe electrical constraints undergone by cap and pin insulators on overhead lines in polluted environments.

<table>
<thead>
<tr>
<th>Salt fog withstand test</th>
<th>2000h aging test</th>
<th>Power arc test</th>
<th>Scratch test</th>
</tr>
</thead>
</table>

The application of the coating is done at the factory according to a specific industrial process qualified by Sediver.

Applications

- Coastal areas
- Industrial pollution areas
- Desert areas
- Mixed pollution areas
- Applications in HVAC and HVDC

Main advantages:

- Reduce the maintenance cost as there is no need for washing
- Keep the inherent properties of the toughened glass in terms of:
  - easiness and reliability of visual inspection
  - safe live-line working
  - long term electrical and mechanical reliability
  - no aging
- No need to modify line design
- Can be applied on all glass profiles

A solution confirmed by

- +2 million insulators in service &
- +15 years of satisfactory service

Sedicoat® is the solution that maintains the unique properties of Sediver® toughened glass insulators while eliminating the need for washing under extreme pollution conditions thanks to the silicone coating.
### Sediver® toughened glass suspension insulators

#### ANSI string electrical ratings

**Standard profile**

Standard profile suspension insulator string flashover voltages based on the test procedure of the American Standard ANSI C 29.2B.

<table>
<thead>
<tr>
<th>Catalog N°</th>
<th>Diameter / Spacing Ø 10 / 5⅜ - Ø 11 / 5⅜</th>
<th>Diameter / Spacing Ø 11 / 6⅜</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N100/146 - N14/146 - N 180/146</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Low frequency flashover voltage (kV)</td>
<td>Critical impulse flashover voltage (kV)</td>
</tr>
<tr>
<td></td>
<td>DRY</td>
<td>WET</td>
</tr>
<tr>
<td>2</td>
<td>145</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>205</td>
<td>130</td>
</tr>
<tr>
<td>4</td>
<td>270</td>
<td>170</td>
</tr>
<tr>
<td>5</td>
<td>325</td>
<td>215</td>
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<tr>
<td>6</td>
<td>380</td>
<td>255</td>
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<td>7</td>
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<td>590</td>
<td>415</td>
</tr>
<tr>
<td>11</td>
<td>640</td>
<td>455</td>
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<td>12</td>
<td>690</td>
<td>490</td>
</tr>
<tr>
<td>13</td>
<td>735</td>
<td>525</td>
</tr>
<tr>
<td>14</td>
<td>785</td>
<td>565</td>
</tr>
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<td>15</td>
<td>830</td>
<td>600</td>
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<tr>
<td>16</td>
<td>875</td>
<td>635</td>
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<td>705</td>
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<td>20</td>
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<tr>
<td>21</td>
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<td>810</td>
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<td>1425</td>
<td>1080</td>
</tr>
<tr>
<td>30</td>
<td>1460</td>
<td>1110</td>
</tr>
</tbody>
</table>

These electrical ratings are applicable to Sediver® suspension insulator strings not equipped with arcing devices or grading rings.

According to the American Standard the average value of three tested strings shall equal or exceed:

- 95% of the guaranteed values as given in the data sheet, for low frequency dry flashover,
- 90% of the guaranteed values as given in the data sheet, for low frequency wet flashover,
- 92% of the guaranteed values as given in the data sheet, for critical impulse flashover.
Sediver® toughened glass suspension insulators
ANSI string electrical ratings

Fog type profile
Fog type profile suspension insulator string flashover voltages based on the test procedure of the American
Standard ANSI C 29.2B.

<table>
<thead>
<tr>
<th>Diameter / Spacing</th>
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</thead>
<tbody>
<tr>
<td>N100P/146DC - N14P/146DC</td>
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</tr>
<tr>
<td><strong>Catalog N°</strong></td>
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</tr>
<tr>
<td>Number of units</td>
<td>Low frequency flashover voltage (kV)</td>
</tr>
<tr>
<td></td>
<td>DRY</td>
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<tr>
<td>2</td>
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<td>30</td>
<td>1495</td>
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</table>

These electrical ratings are applicable to Sediver® suspension insulator strings not equipped with arcing devices or grading rings.
95% of the guaranteed values as given in the data sheet, for low frequency dry flashover,
90% of the guaranteed values as given in the data sheet, for low frequency wet flashover,
92% of the guaranteed values as given in the data sheet, for critical impulse flashover.
Active contribution to international committees

Since the very beginning of international technical cooperation, Sediver has always been an active member in fields of research and standardization in international committees and working groups dealing with all aspects of high voltage insulation; for example Sediver experts are Project Leaders in IEC working groups 36WG11, 36BM10, CIGRE D1-B2 and contribute to the activities of NEMA-ANSI, IEEE and CSA standard Committees.

Extract of Sediver articles in IEEE and international publications on glass:

- VIRLOGEUX F, / GEORGE JM, “Key parameters for HVDC overhead lines insulators” GCC POWER 2017, 13th International Conference for GCC, 16 - 18 Oct 2017, MUSCAT, SULTANATE OF OMAN
- GEORGE JM, “HVDC insulators” INMR World Congress 2015, MUNICH, GERMANY, 2015
- VIRLOGEUX F, / PRAT S, / GEORGE JM, “Ageing and degradation mechanisms of silicone polymers used for outdoor electrical insulation” ISH 2015 - PILSEN, CZECH REPUBLIC
- KLASSEN D, / ZOGHBY E, / KIELOCH Z, “Assessment of toughened glass insulators removed from HVDC lines after more than 40 years in service” CIGRE CANADA CONFERENCE, 2015
- GEORGE JM, / LODI Z, “Mechanical and electrical behaviour of a damaged toughened glass insulator” EDM - FORT COLLINS USA, 2014
- GEORGE JM, / PRAT S, / TARTIER S, / LODI Z, “Electrical characteristics and properties of a stub” ISH 2013 SEOUL, KOREA
- GEORGE JM, / DEL BELLO E, “Assessment of electrical and mechanical performance of toughened glass insulators removed from existing HV lines” CIGRE REGIONAL MEETING – CALGARY, CANADA, AUGUST 2007
- PARGAMIN L, / PARRAUD R, “A key for the choice of insulators for DC transmission lines” IEEE HVDC TRANSMISSION MADRAS, 1986

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info.usa@sediver.com

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