SEDIVER

Sediver® toughened glass insulators for HVAC applications

Experts & Pioneers

USA

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

600 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
- 3 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

France	Head office Sales office Technical Assistance R&D Center Testing facilities Warehousing
Canada	Sales office Technical Assistance Warehousing
USA	Sales office Technical Assistance Manufacturing plant Testing facilities Warehousing
Italy	Sales office Manufacturing plant Testing facilities Warehousing
Algeria	BU with SONELGAZ Manufacturing plant Warehousing
Brazil	Sales office Technical Assistance Warehousing
China	Sales office Technical Assistance Manufacturing plants Testing facilities Warehousing

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

	China	France	Italy	USA
Dielectric tests on insulator units	✔	✔	✔	✔
Dielectric tests on complete strings		up to 800 kV		
AC Salt-fog Pollution tests		150 kV		
AC Solid layer Pollution tests		250 kV		
DC Pollution tests (salt fog/solid layer)		120 kV		
DC Sample tests according to IEC 61325	✔	✔	✔	✔
DC Type tests according to IEC 61325		✔		
Mechanical tests on insulator units	✔	✔	✔	✔
Thermal-mechanical tests	✔	✔	✔	✔
Long duration vibration tests on complete strings		up to 800 kV		
Standard sample tests according to national and international standards	✔	✔	✔	✔

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.

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.

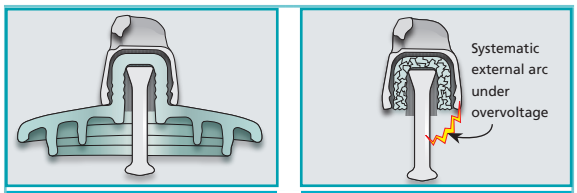
Live-line maintenance and worker safety

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.

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.



Shell intact	Shell shattered
Guaranteed absence of internal cracks or electrical punctures.	**- Residual mechanical strength** 80% of the mechanical rating, guaranteed over prolonged periods of time even with in-service dynamic loads and temperature cycling. **- Residual electrical strength** Avoiding internal puncture and forcing overvoltage induced discharges externally.

Therefore

- No need of instruments for condition inspection of glass insulator strings.
- Enhanced worker's safety in live line operations.
- Very low cost of inspection for the entire service life of the line.
- No risk of separation or line drops.
- No urgency in replacing a unit with broken shell.
- Long-term savings in maintenance operations.

❑ **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.

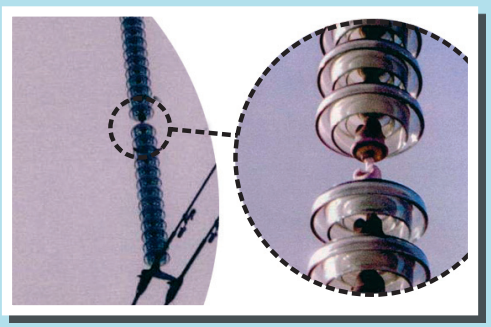
❑ **Environmental considerations**
- Complete recycling: toughened glass insulators are made of fully recyclable components, so they do not represent an environmental liability.
- Visual impact: toughened glass insulators, thanks to their transparency, easily blend with the sky or any background and 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				
Type of test	**Test designation**	**ANSI C29.2B-2013 requirements**	**Sediver® criteria**	**User benefits**
Design tests	**Thermal-mechanical load-cycle test** ■ Four 24-hour cycles of temperature variation ■ After the thermal cycles, the insulators are subjected to mechanical test up to breakage	Test on 10 units Temperature range: -22°F/ +104°F Applied tensile load: 60% of the rating Evaluation: $\overline{X}$ ≥ rating + 3 S	Test on 20 units Temperature range:-60° F/ +120°F 10 units followed by a steep front wave impulse test: no puncture Applied tensile load: 70% of the rating Evaluation: $\overline{X}$ ≥ rating + 4 S*	**High reliability along service life** ■ No aging ■ High mechanical strength even in case of extreme service conditions or natural disasters
	Residual strength test Mechanical tensile load test on 25 insulator units which have had the shells completely broken off	No thermal cycles Evaluation : $\overline{X}$ ≥ 0.6 x rating + 1.645 S	Test on insulators after thermal cycles Evaluation: $\overline{X}$ ≥ 0.8 x rating + 1.645 S	**Reduced maintenance costs** High residual strength means that replacement is not urgent and can be safely scheduled. This results in reduced maintenance costs
	Impact test	45 to 90 in-lbs	400 in-lbs	**Reduced damages** High impact strength reduces damages during handling and installation
Quality conformity tests (on each lot)	**Combined Mechanical and Electrical test** A mechanical tensile load is applied to insulator units up to failure	Evaluation: $\overline{X}$ ≥ rating + 3 S Individual values ≥ rating	Evaluation: $\overline{X}$ ≥ rating + 4 S* Individual values ≥ rating	**Reinforced reliability** A narrow standard deviation is the result of high quality components and manufacturing; this means enhanced safety and dependability
	Power-frequency puncture test	A low frequency voltage is applied to the insulator units immersed in oil	■ A steep front wave impulse simulating real lightning stress is applied to the insulator units with a peak voltage of 2.8 p.u. (see IEC 61211) ■ No puncture allowed	**No risk of puncture** ■ Even in case of lightning
Routine test	**Visual inspection**	None	■ Inspection whether there are no visual defects that would be prejudicial to satisfactory performance in service ■ Marking verification	**Complete traceability** ■ Complete identification of each insulator ■ Quality Control full traceability to the finished product
	Tension proof test	50 % Rating	■ 50 % Rating ■ Marking proving that each insulator passed the routine test	**Guarantee** that each insulator passed the mechanical test
	Dimensional verification	None	Spacing verification of each unit	**Dimensional conformity** ■ Guarantee of the string spacing ■ Easy installation
	Thermal shocks	One cold-to-hot shock One hot-to-cold shock	Such as required by ANSI with additional thermal treatments specific to Sediver® on each glass shell	**Reduced operating cost** ■ Extremely low shattering rate in service thanks to a very high quality glass
S : Standard deviation of the test results			$\overline{X}$: average value of test results	

*Upon request

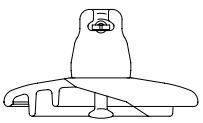
Sediver® toughened glass suspension insulators

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.

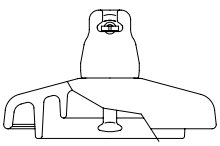
Standard profile:

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/cm^2. (Examples: zones E1 to E4).



Fog type profile:

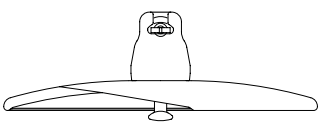
The fog type profile is characterized by long and widely-spaced under-ribs so as to avoid arc bridging between adjacent ribs. It features a « leakage distance/spacing » ratio of around 3.2 and is particularly effective in coastal areas (Salt fog) as well as in polluted areas where a higher specific leakage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

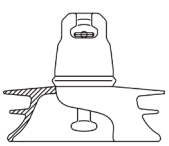
It is also effective for dead-end strings in cases of extreme industrial pollution and can solve ice-bridging problems when it is alternated with others profiles in the string.



External shed profile:

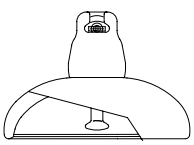
This profile offers a leakage distance equivalent to the anti-pollution profile and is adapted to the most extreme cases of solid pollution.

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.

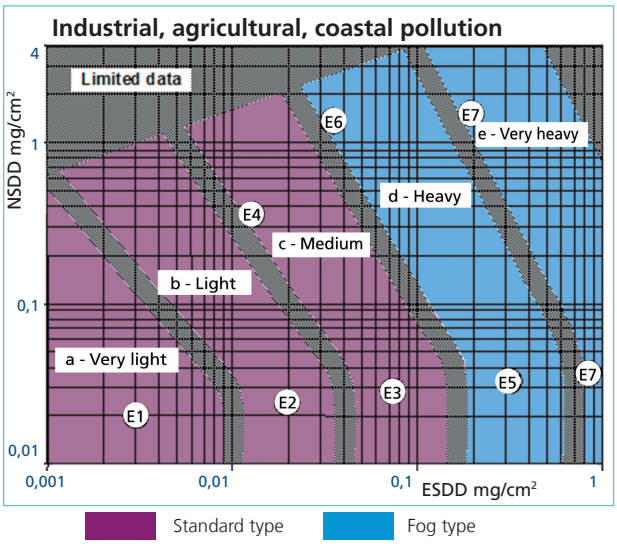


* or creepage distance

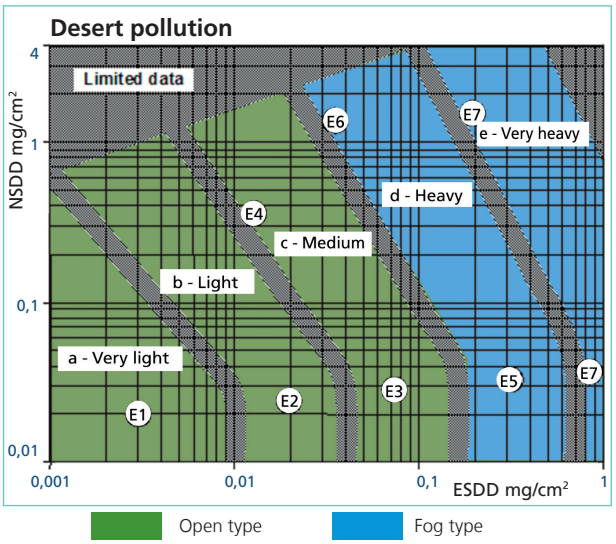
Selection criteria for pollution management

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.



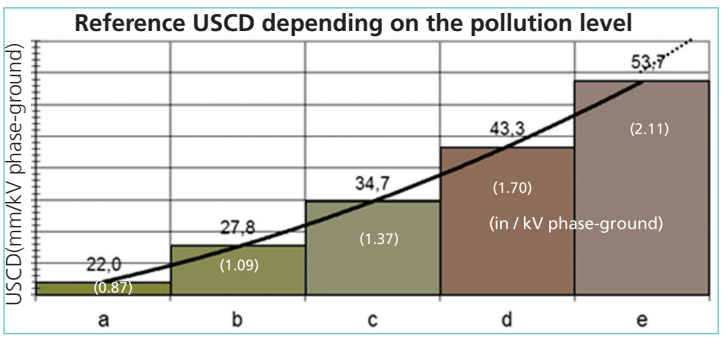
In the case of industrial, agricultural and coastal pollution, Sediver® recommends the use of the standard profile in very light, light and medium polluted areas and the fog type profile in heavy and very heavy polluted areas.



In the case of desert pollution Sediver® recommends the use of the open profile in very light, light and medium polluted areas and the fog type profile in heavy and very heavy polluted areas.

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.



(*) USCD = Leakage distance of the string of insulators divided by the RMS value of the highest power frequency voltage seen by the string (phase - ground).

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 x303 = **515.1 inch.**

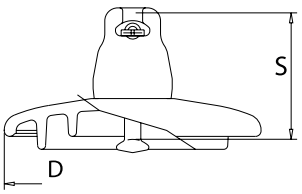
Number of insulators in the string:
- 515.1 / 21.5 = 24 **insulators.**

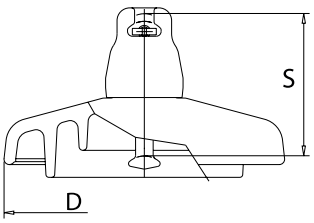
SEDICOAT : RTV coated glass

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 page13)

Sediver® toughened glass suspension insulators

Ball & Socket coupling





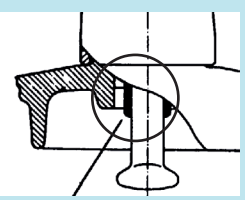
		Standard Profile			Fog Profile		
CATALOG No		**N100/146**	**N14/146**	**N180/146**	**N100P/146DC**	**N14P/146DC**	**N180P/160DC**
ANSI class		52-3-H	52-5-H	52-8-H			
Ball and socket coupling		Type B	Type J	Type K	Type B	Type J	Type K
MECHANICAL CHARACTERISTICS							
Combined M&E strength	lbs	22,000	30,000	40,000	22,000	30,000	40,000
	kN	*100*	*136*	*180*	*100*	*136*	*180*
Impact strength	in-lbs	400	400	400	400	400	400
	N-m	*45*	*45*	*45*	*45*	*45*	*45*
Tension proof	lbs	11,000	15,000	20,000	11,000	15,000	20,000
	kN	*50*	*68*	*90*	*50*	*68*	*90*
DIMENSIONS							
Diameter (D)	in	10	10	11	11	11	13
	mm	*255*	*255*	*280*	*280*	*280*	*330*
Spacing (S)	in	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	6 5/16
	mm	*146*	*146*	*146*	*146*	*146*	*160*
Leakage distance	in	12 5/8	12 5/8	15	17 1/2	17 1/2	21 5/8
	mm	*320*	*320*	*380*	*445*	*445*	*550*
ELECTRICAL CHARACTERISTICS							
Low frequency dry flashover	kV	80	80	80	100	100	105
Low frequency wet flashover	kV	50	50	50	60	60	65
Critical impulse flashover +	kV	125	125	125	140	140	145
Critical impulse flashover -	kV	130	130	130	140	140	145
Low frequency puncture voltage	kV	130	130	130	130	130	130
R.I.V low frequency test voltage	kV	10	10	10	10	10	10
Max. RIV at 1 MHz	µV	50	50	50	50	50	50
PACKING AND SHIPPING DATA							
Approx. net weight per unit	lbs	8.1	10.1	12.8	12.1	13.4	19.6
No of insulators per crate		6	6	6	6	6	6
Volume per crate	ft³	1.977	1.977	2.472	2.47	2.47	2.82
Gross weight per crate	lbs	59.5	66.7	92.7	84.9	87.3	126.4
No. of insulators per pallet		72| 96	72| 96	54	54	54	54
Volume per pallet	ft³	35.3| 49.4	35.3| 49.4	42.3	42.3	42.3	46
Gross weight per pallet	lbs	790| 1050	880| 1165	934	862	886	1245
Former designation		**N8**	**N14**	**N18**	**N8HL**	**N14HL**	

ANSI designations 52-3-L, 52-5-L, 52-8-L and custom products are also available

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).



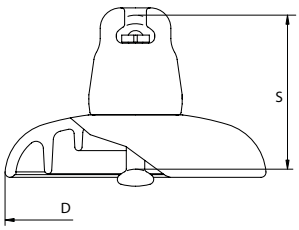
Corrosion prevention sleeve

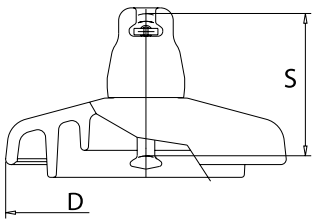
Heavy galvanization

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



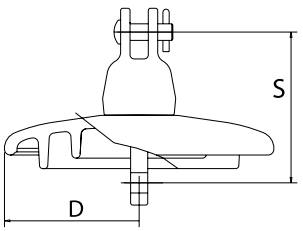


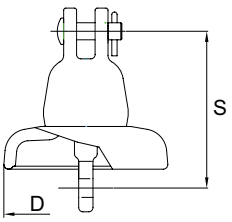
		Standard Profile				Fog Profile	
CATALOG No		**N21/156**	**F300/195**	**F400/205**	**F530/240**	**N21P/171DC**	**F300P/195DC**
ANSI class		52-11					
Ball and socket coupling		Type K	IEC 24	IEC 28	IEC 32	Type K	IEC 24
MECHANICAL CHARACTERISTICS							
Combined M&E strength	lbs	50,000	66,000	90,000	120,000	50,000	66,000
	kN	*222*	*300*	*400*	*530*	*222*	*300*
Impact strength	in-lbs	400	400	400	400	400	400
	N-m	*45*	*45*	*45*	*45*	*45*	*45*
Tension proof	lbs	25,000	33,000	45,000	60,000	25,000	33,000
	kN	*111*	*150*	*200*	*265*	*111*	*150*
DIMENSIONS							
Diameter (D)	in	11	13	14 1/8	14 1/8	13	14 1/8
	mm	*280*	*330*	*360*	*360*	*330*	*360*
Spacing (S)	in	6 1/8	7 5/8	8	9 1/2	6 3/4	7 5/8
	mm	*156*	*195*	*205*	*240*	*171*	*195*
Leakage distance	In	15	19	21 5/8	25	21 5/8	25
	mm	*380*	*480*	*550*	*635*	*550*	*635*
ELECTRICAL CHARACTERISTICS							
Low frequency dry flashover	kV	80	95	100	100	100	105
Low frequency wet flashover	kV	50	55	60	60	60	65
Critical impulse flashover +	kV	140	145	145	170	150	170
Critical impulse flashover -	kV	140	145	150	170	150	160
Low frequency puncture voltage	kV	130	130	130	130	130	130
R.I.V low frequency test voltage	kV	10	10	10	10	10	10
Max. RIV at 1 MHz	µV	50	50	50	50	50	50
PACKING AND SHIPPING DATA							
Approx. net weight per unit	lbs	13.9	21.6	30.8	39.5	20.7	27.3
N° of insulators per crate		6	5	2	2	6	5
Volume per crate	ft³	2.472	3.531	2.503	2.118	3.04	4.944
Gross weight per crate	lbs	100.5	130	72	83.6	140.4	167
No. of insulators per pallet		54	45	36	36	54	45
Volume per pallet	ft³	42.3	45.9	46.4	55.6	48	39.6
Gross weight per pallet	lbs	1005	1268	1394	1605	1360	1607
Former designation		**N21**				**N222P**	

Custom products are also available

Sediver® toughened glass suspension insulators

Clevis coupling CT





		Standard Profile		Ground wire insulator
CATALOG N°		CT100/146	CT14/146	CT14-6/146
ANSI class		52-4-H	52-6-H	
MECHANICAL CHARACTERISTICS				
Combined M&E strength	lbs	22,000	30,000	30,000
	kN	*100*	*136*	*136*
Impact strength	in-lbs	400	400	400
	N-m	*45*	*45*	*45*
Tension proof	lbs	11,000	15,000	15,000
	kN	*50*	*68*	*68*
DIMENSIONS				
Diameter (D)	In	10	10	6
	mm	*255*	*255*	*155*
Spacing (S)	In	5 3/4	5 3/4	5 3/4
	mm	*146*	*146*	*146*
Leakage distance	In	12 5/8	12 5/8	5 1/3
	mm	*320*	*320*	*135*
ELECTRICAL CHARACTERISTICS				
Low frequency dry flashover	kV	80	80	40
Low frequency wet flashover	kV	50	50	20
Critical impulse flashover pos.	kV	125	125	70
Critical impulse flashover neg.	kV	130	130	70
Low frequency puncture voltage	kV	130	130	90
R.I.V low frequency test voltage	kV	10	10	7.5
Max. RIV at 1 MHz	µV	50	50	50
PACKING AND SHIPPING DATA				
Approx. net weight per unit	lbs	9	9	5.5
N° of insulators per crate		6	6	6
Volume per crate	ft³	1.977	1.977	0.70
Gross weight per crate	lbs	59.5	66.7	32.2
No. of insulators per pallet		72|96	72|96	150
Volume per pallet	ft³	35.3|49.4	35.3|49.4	28.8
Gross weight per pallet	lbs	790|1050	880|1165	833
Former designation		CT8	CT14	

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.

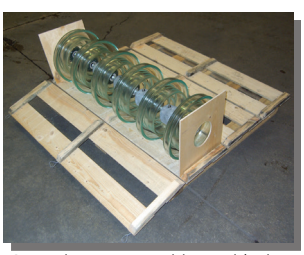
Custom products and clevis insulators for distribution applications are also available

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



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

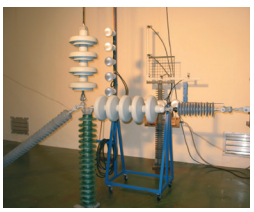
Sedicoat insulators are Sediver toughened glass insulators coated with silicone. The silicone coating procures hydrophobic properties to the surface of the glass shell and thus significantly enhances its electrical performance under extreme pollution. The hydrophobic behavior of the surface helps mitigating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

Salt fog withstand test

2000h aging test



Power arc test

Scratch test

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.

	Diameter / Spacing Ø 10 / 5 3/4 - Ø 11 / 5 3/4				Diameter / Spacing Ø 11 / 6 1/8			
Catalog N°	N100/146 - N14/146 - N 180/146				N21/156			
Number of units	Low frequency flashover voltage (kV)		Critical impulse flashover voltage (kV)		Low frequency flashover voltage (kV)		Critical impulse flashover voltage (kV)	
	DRY	WET	+	-	DRY	WET	+	-
2	145	90	220	225	145	90	230	230
3	205	130	315	320	210	130	325	330
4	270	170	410	420	275	170	425	440
5	325	215	500	510	330	215	515	540
6	380	255	595	605	385	255	610	630
7	435	295	670	695	435	295	700	720
8	485	335	760	780	490	335	790	810
9	540	375	845	860	540	375	880	900
10	590	415	930	945	595	415	970	990
11	640	455	1015	1025	645	455	1060	1075
12	690	490	1105	1115	695	490	1150	1160
13	735	525	1185	1195	745	525	1240	1245
14	785	565	1265	1275	790	565	1330	1330
15	830	600	1345	1360	840	600	1415	1420
16	875	635	1425	1440	890	635	1500	1510
17	920	670	1505	1530	935	670	1585	1605
18	965	705	1585	1615	980	705	1670	1700
19	1010	740	1665	1700	1025	740	1755	1795
20	1050	775	1745	1785	1070	775	1840	1890
21	1100	810	1825	1870	1115	810	1925	1985
22	1135	845	1905	1955	1160	845	2010	2080
23	1180	880	1985	2040	1205	880	2095	2175
24	1220	915	2065	2125	1250	915	2180	2270
25	1260	950	2145	2210	1290	950	2260	2365
26	1300	985	2220	2295	1330	958	2390	2465
27	1340	1015	2300	2380	1370	1015	2470	2555
28	1380	1045	2375	2465	1410	1045	2570	2650
29	1425	1080	2455	2550	1455	1080	2650	2740
30	1460	1110	2530	2635	1490	1110	2740	2830

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.

Catalog N°	Diameter / Spacing Ø 11 / 5 3/4				Diameter / Spacing Ø 13 / 6 3/4			
	N100P/146DC - N14P/146DC				N21P/171DC			
Number of units	Low frequency flashover voltage (kV)		Critical impulse flashover voltage (kV)		Low frequency flashover voltage (kV)		Critical impulse flashover voltage (kV)	
	DRY	WET	+	-	DRY	WET	+	-
2	155	95	270	260	160	110	315	300
3	215	130	380	355	230	145	440	410
4	270	165	475	435	290	155	550	505
5	325	200	570	520	350	225	660	605
6	380	240	665	605	405	265	775	705
7	435	275	750	690	460	310	870	800
8	485	315	835	775	515	355	970	900
9	540	350	920	860	570	390	1070	1000
10	590	375	1005	950	625	430	1170	1105
11	640	410	1090	1040	680	460	1270	1210
12	690	440	1175	1130	735	495	1370	1315
13	735	470	1260	1220	790	530	1465	1420
14	785	500	1345	1310	840	565	1565	1525
15	830	525	1430	1400	885	595	1665	1630
16	875	555	1515	1490	935	630	1765	1735
17	920	580	1600	1595	980	660	1860	1845
18	965	615	1685	1670	1030	690	1960	1945
19	1010	640	1770	1755	1075	725	2060	2040
20	1055	670	1850	1840	1120	755	2155	2140
21	1100	695	1930	1925	1165	785	2245	2240
22	1145	725	2010	2010	1210	820	2340	2340
23	1190	750	2090	2095	1255	850	2430	2440
24	1235	780	2170	2180	1300	885	2525	2540
25	1280	810	2250	2265	1345	910	2620	2635
26	1325	835	2330	2350	1385	945	2710	2735
27	1370	860	2410	2435	1430	975	2805	2835
28	1410	890	2490	2520	1470	1005	2900	2935
29	1455	915	2560	2600	1515	1035	2980	3025
30	1495	940	2630	2680	1555	1065	3060	3120

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.

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, 36BMT10, 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:

- GEORGE JM. / BROCARD E. / VIRLOGEUX F. / LEPLEY D. "DC pollution performance: current approximations & future needs" INMR 2017 World Congress, nov 5 - 8 2017, BARCELONA, SPAIN
- 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
- VIRLOGEUX F. / BROCARD E. / GEORGE J.M. "Correlation assessment between actual pollution performance of insulator strings in DC and theoretical models" INSUCON 2017, 13th International Insulation Conference,16-18 May 2017, Birmingham, UK
- GEORGE JM. "*HVDC insulators"* INMR World Congress 2015, MUNICH, GERMANY, 2015
- GEORGE JM., PRAT S., VIRLOGEUX F. *"Silicone coating on toughened glass insulator: Review of laboratory and field performance"* 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., PRAT S., VIRLOGEUX F.*"Coating Glass Insulators for Service in Severe Environments"* INMR Quarter 4, 2014
- 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
- PAIVA O.; SUASSUNA R.; DUMORA D.; PARRAUD R.; FERREIRA L.; NAMORA M. *"Recommendations to solve corrosion problem on HV insulator strings in tropical environment"* CIGRE SYMPOSIUM CAIRNS, 2001 Paper 300-05
- DUMORA D., PARRAUD R. *"Corrosion mechanism of insulators in tropical environment"* CIGRE SYMPOSIUM CAIRNS, 2001 Paper 300-04
- PARRAUD R.; PECLY H. *"Long term performance of toughened glass insulators on AC and DC transmission lines : improvement, field experience and recommendations"* CIGRE INTERNATIONAL WORKSHOP ON INSULATORS – RIO DE JANEIRO, BRAZIL, JUNE 1998
- CROUCH A.; SWIFT D.; PARRAUD R.; DE DECKER D. *"Aging mechanisms of AC energised insulators"* CIGRE 1990, Paper 22-203
- PARRAUD R.; LUMB C.; SARDIN JP. *"Reflexions on the evaluation of the long term reliability of ceramic insulators"* IEEE WG INSUL.STRENGTH RATING 1987
- PARGAMIN L.; PARRAUD R.*" A key for the choice of insulators for DC transmission lines"* IEEE HVDC TRANSMISSION MADRAS, 1986
- PARRAUD R.; LUMB C. *"Lightning stresses on overhead lines"* IEEE BANGKOK, 1985
- MAILFERT R.; PARGAMIN L.; RIVIERE D. *"Electrical reliability of DC line insulators"* IEEE ELECTRICAL INSULATION 1981 N° 3
- COUQUELET F.; RIVIERE D.; WILLEM M. *"Experimental assessment of suspension insulator reliability"* IEEE CONFERENCE PAPER 1972 Paper 173-8

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