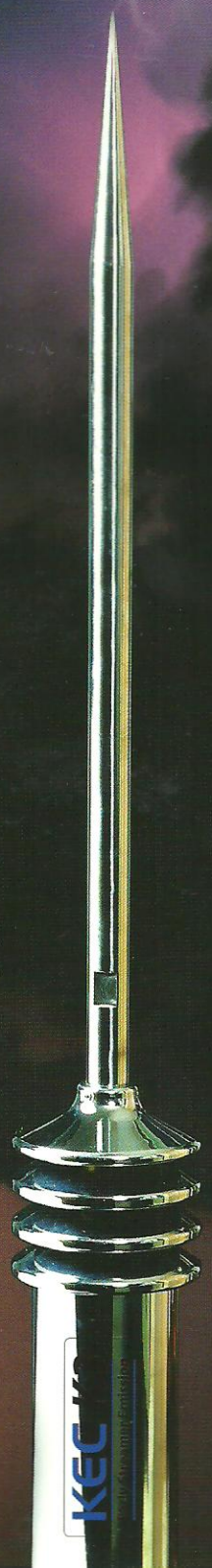
SCIENTIFIC LIGHTNING RODS of KEC

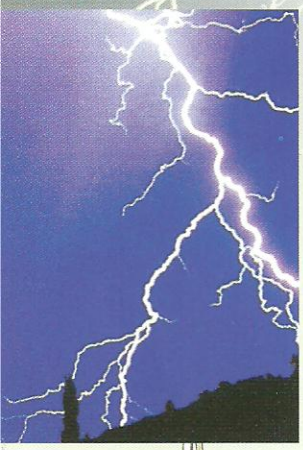


KEC

The safest and most effective
Early Streamer Emission(ESE)
System for Lightning Protection

SCIENTIFIC LIGHTNING RODS of KEC

EFFECTS OF LIGHTNING



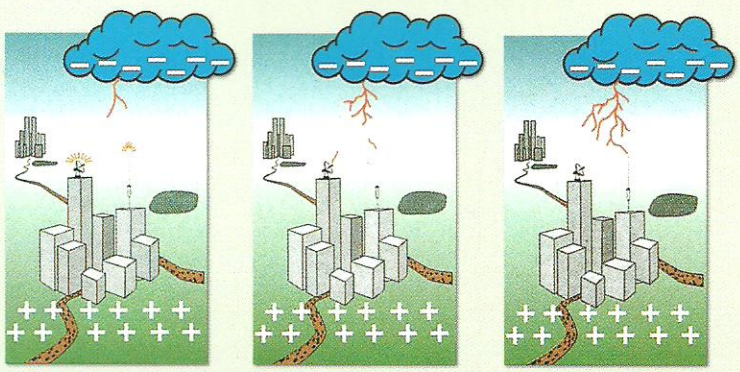
Statistics indicate that approximately 5000 thunderstorms happen on earth simultaneously with danger for persons, structures, and material. The average intensity of a lightning flash is estimated to be of 20000 amps, however lightning intensities of up to 200000 amps were registered.
Each year about two million flashes of lightning occur all over the peninsulas and the regions, causing death to persons and animals. In industry the damage and failures due to lightning are estimated to be in the range of thousands of millions of Commercial foreign currencies.

The frequency and the intensity of thunderstorms in an area are determined by the characteristics of the area, however the risk of lightning can vary within a certain region. The knowledge about the areas with high lightning risk is an important information in order to effectively determine the most appropriate type of lightning protection.

The effects of lightning can be produced by direct lightning strokes or by indirect causes.
While a direct stroke may generate disastrous consequences for structures, persons and animals, indirect effects produced by lightning are frequently noticed and usually they produce significant economic losses. Indirect effects of lightning are observed when the lightning flash strikes close to a structure and produces by induction surge voltages in the electrical conductors.

LIGHTNING FLASHES:

Under certain atmospheric conditions the loads within a cloud get separated, where the negative loads move to the bottom of the cloud and the positive loads to the top of it. The electrical potential within the cloud can reach the range of millions of volts.



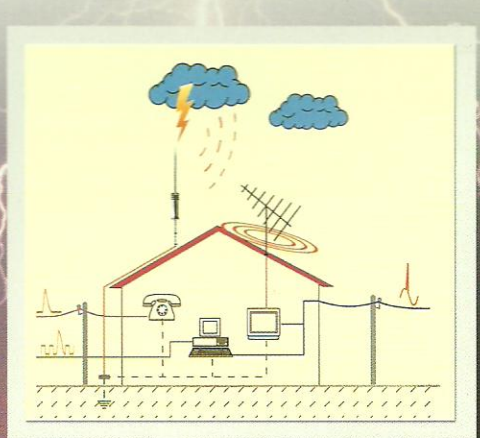
On the surface of the earth this effect is produced in a similar way, however with opposite polarity.

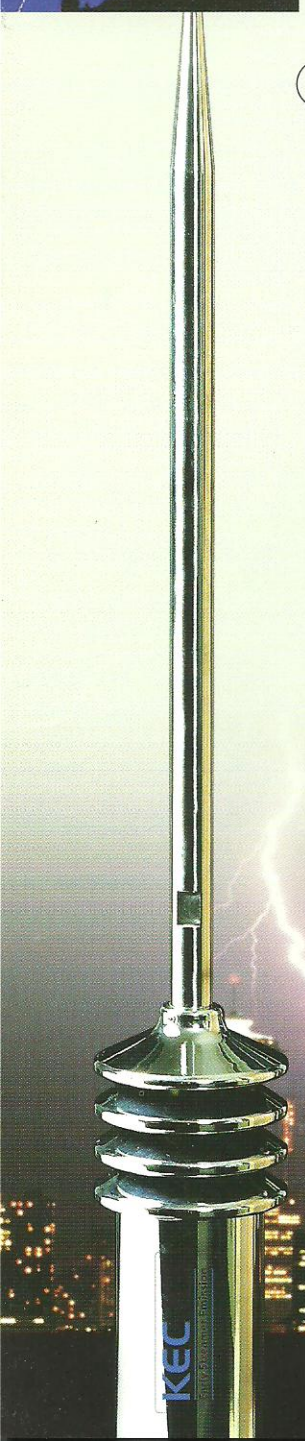
The electrical field between the bottom of the cloud and the surface of the earth under the cloud can become so strong that small electrical discharges from the cloud will be produced which are called downward leaders. When these discharges reach the surface of the earth, an up-going steam of positive load is generated. When the up-going steam meets with the discharges, then the circuit becomes closed and a discharge current between 10 to 200 kA can be produced.

In the illustrations on the left it is shown how the small discharges from the cloud and the up-going streams, which finally lead to the flash of lightning, are initiated.

Protection against lightning:

The decision to protect an installation against lightning by means of a Lightning Protection System (LPS) depends on parameters such as the probability of lightning in the area, its intensity and the potential consequences for people, material and the functioning of the installation.
In order to provide an appropriate protection, the installation has to be equipped with two types of protections: an external protection against a direct impact of a lightning stroke (lightning rod, wire air-termination system or mesh air-termination system), and an internal protection against surge voltages produced by lightning strokes in the proximity or on conductors of the electrical network.
The external and the internal protection require a good earthing system to evacuate the lightning currents, and equal potentiality within the earthing system, both of the protection system and of the electrical circuits to be protected.





SCIENTIFIC LIGHTNING RODS of KEC

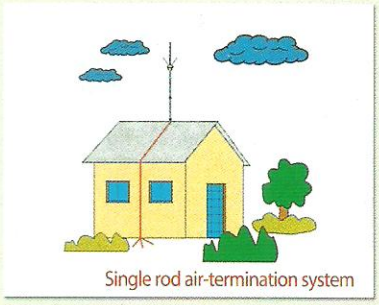
PROTECTION AGAINST DIRECT LIGHTNING STROKES

For the protection of structures, persons or objects a Lightning Protection System (LPS) is needed, which attracts the lightning stroke and leads the lightning currents to earth.

Among the structures which require a LPS are buildings, open areas accessible to the public, structures which are dangerous to the environment due to the possible emission of contaminated substances, historical buildings, etc...

The following systems are currently used for the external protection against lightning:

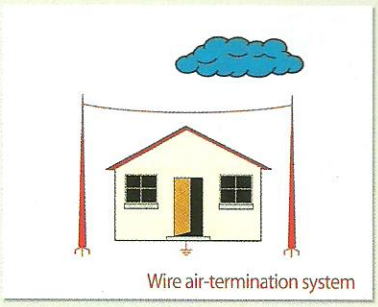
SINGE ROD AIR-TERMINATION SYSTEM: The lightning rod is located higher than any other point of the area or structure to be protected, and its objective is to intercept the discharge and to derive the lightning current to earth.



Single rod air-termination system

- Capturing lightning rod with mast.
- One or more down-conductors.
- A disconnector on each down-conductor to test the resistivity of the structure.
- A protection element against mechanical forces in the final two meters of the down-conductor.
- An earth electrode for each down-conductor.
- Equipotential bonding of the earth electrodes and general earth termination system.

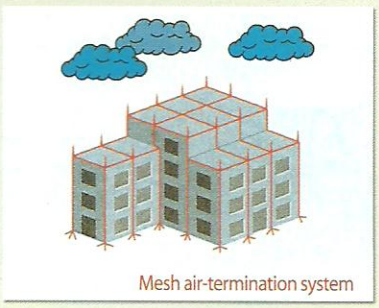
WIREAIR-TERMINATION SYSTEM: The protection is formed by one or more air-wires located above the installation or area to be protected. The conductors are connected to earth through masts on each side. The protected area is the area within the masts or down-conductors.



Wire air-termination system

- One or more air-wire conductors.
- A mast on each end of the conductor.
- An earth electrode for each down-conductor.
- Equipotential bonding of the earth electrodes and general earth termination system.

MESHAIR-TERMINATION SYSTEM: The system consists of several capturing points connected with each other through conductors. A network is formed which is extended with conductors leading to earth.



Mesh air-termination system

- Multiple capturing points.
- A connecting mesh for the capturing points.
- For each capturing point one down-conductor.
- One earth electrode for each down-conductor.
- Equipotential bonding of the earth electrodes and general earth termination system.

LIGHTNING ROD WITH FEEDING DEVICE KEC

Advantages of a system with feeding device:

The KEC system releases electrical discharges with opposite polarity to the lightning stokes. This way the system achieves to attract the lightning flash and to raise the strike point to an altitude higher than the structure to be protected. The effect is that a larger protection area is created than obtained with standard lightning rods.

In the figure it can be seen that the protection area obtained with this system is much larger than that obtained with other protection devices, so that with a single capturing element the protection of buildings and installations with large size can be achieved.

A lightning rod of type KEC is not like a singe capturing point of a mesh air-termination system, but rather like all these capturing points which would be needed to protect the area. An important cost saving can be achieved due to the saving of materials such as the number of down-conductors, earth terminations, equipotential bonding, etc.
The system also offers advantages compared to other systems in the protection of open areas such as sport fields, etc.

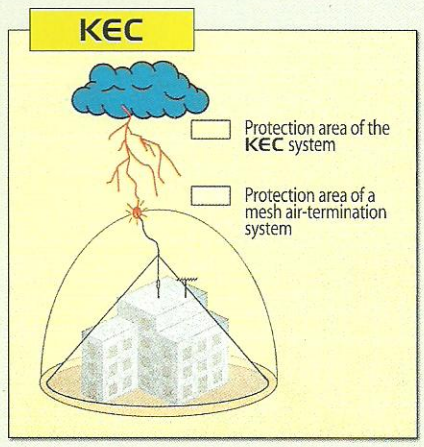
As a consequence the KEC system has several important advantages and a reduced cost compared to other passive capturing systems.

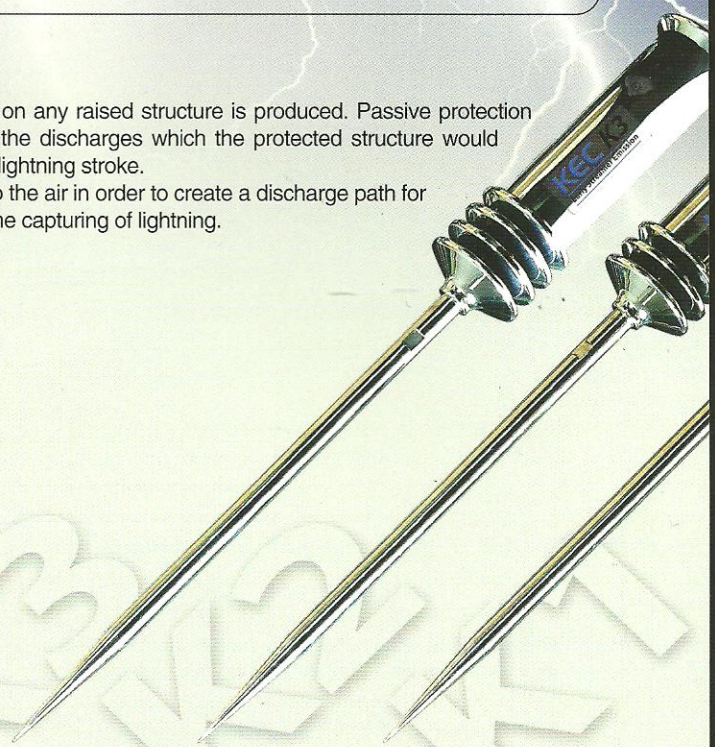
SCIENTIFIC LIGHTNING RODS of KEC

AN EFFECTIVE FEEDING DEVICE

ADVANTAGES

In the instant when a lightning flash goes to earth a discharge on any raised structure is produced. Passive protection systems such as a mesh air-termination system only capture the discharges which the protected structure would receive, due to the lack of a capturing system which attracts the lightning stroke.
The feeding device of type KEC releases electrical discharges to the air in order to create a discharge path for the lightning stroke assuring this way an improved efficiency in the capturing of lightning.





WORKING PRINCIPLE

By means of the feeding device, the system emits a high voltage signal with a certain frequency and amplitude. Its efficiency is obtained by creating an up-going path up to the down-going path of the lightning stroke. This way a striking point on an altitude higher than the protected structure is created which increases the radius of the protected area if compared with a standard lightning rod.

ENERGY AUTONOMY

The feeding device does not need any auxiliary power supply such as other lightning capturing systems. The KEC obtains the energy for the generation of the high voltage signals from the electro-magnetic field which is automatically created during thunderstorms (between 10 to 20 KV/m).

The values determined in the tests correspond to average values. These values are evaluated in the standards NF C 17 -102 or in UNE 21 186 according to the random nature of lightning.

SCIENTIFIC LIGHTNING RODS of KEC

INSTALLATION GUIDE

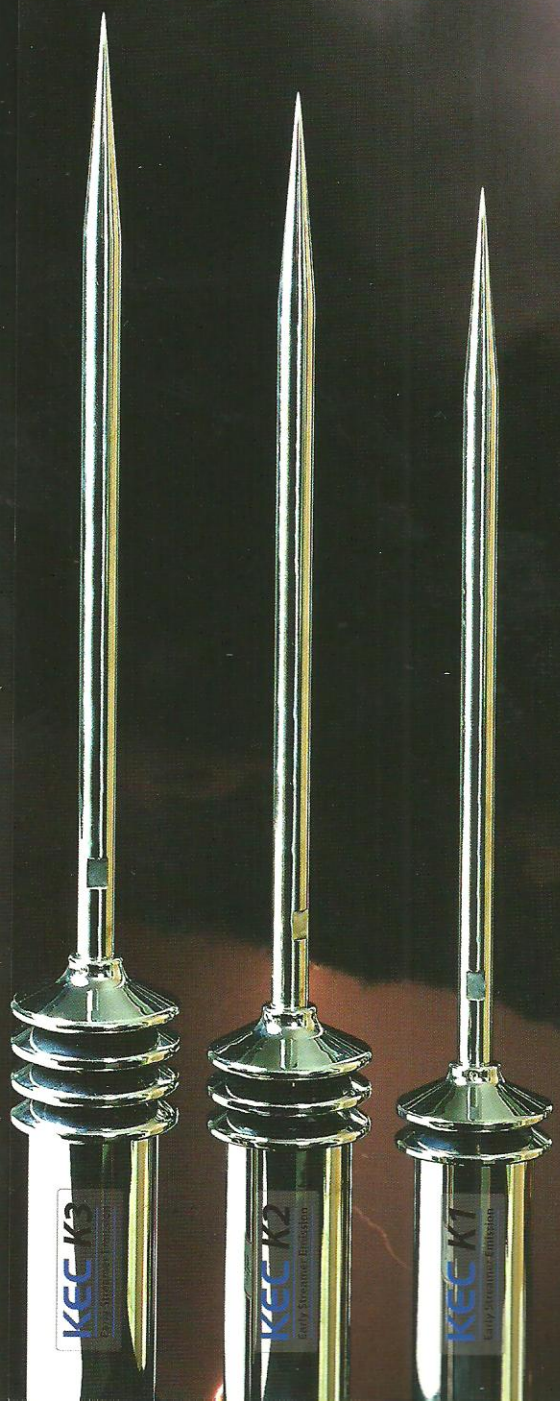
1. -CAPTURING HEAD: the peak has to be located 2 m. above the highest parts of the area to be protected.

2. -ADAPTOR ELEMENT: it has to provide the electrical contact between the capturing point and the downgoing conductor. It is put on the mast, on light poles, pillars, etc...

3-5. -MAST- MAST FIXATION: the mast provides the appropriate height corresponing to the area to be protected by the lightning rod and is usually mounted with 2 or 3 fixings depending on its length.

6. -DOWN-CONDUCTOR: it leads the current of the lightning stroke from the capturing head to the earth electrode. The conductors can be of sheet, plain twist, twisted or round cable, and the minimum area has to be 50 mm2.

Each lightning rod has to have at least on down-conductor, except in the following cases, where two down-conductors are needed: - structures higher than 28 m.
- the horizontal projection is larger than the vertical projection



The path has to be the most rectilinear possible with the shortest distance, avoiding curves. The covering radius should not be less than 20 cm. The down-conductor should avoid crossing or the proximity of electrical or telecommunication networks.

When the crossing cannot be avoided, then the line has to be inside of a metallic shield which needs to be extended 1 m on each side of the crossing.
Cornices or elevations should be avoided. A maximum height of 40 cm is allowed with an angle of up to 45 º.

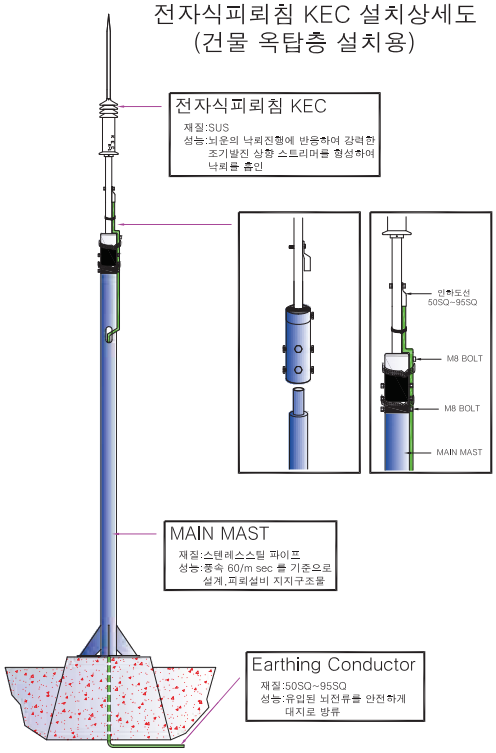
7.-CONDUCTOR HOLDING FIXTURES: Independent of the fixture type, three fixtures per meter are used for the down-conductor. The fixtures must not be in direct contact with inflammable material.

8.-DISCHARGE COUNTER: This counter is installed above the control joint, and in all cases 2 m. Above the ground. It is mounted on the down-conductor.

9.-TEST JOINT: Each down-conductor has to incorporate a test joint, which allows to disconnect the earth electrode and thus allows to measure the resistivity. The test joint is mounted two meters above the ground.

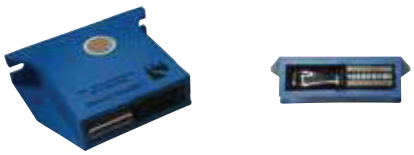
10.-PROTECTION PIPE: It is put between the ground and the control joint in order to protect the down-conductor against mechanical forces. The pipe is of metallic material and has a length of 2 m. It is mounted with three fixtures.

■ EARLY STREAMER EMISSION LIGHTNING ROD(전자식 피뢰침 KEC)



NP	Level I			Level II			Level III		
LIGHTNING ROD MODER	KEC	KEC	KEC	KEC	KEC	KEC	KEC	KEC	KEC
RP(M)	K-1	K-2	K-3	K-1	K-2	K-3	K-1	K-2	K-3
h(m)									
3	25	35	48	34	45	59	39	50	65
4	34	46	64	46	60	79	52	67	87
5	42	58	79	57	75	97	65	84	107
6	43	58	79	58	76	97	66	84	107

■ LIGHTNING STRIKE COUNTER (낙뢰계수기)



K-300

K-500

CERTIFICATE OF TEST

KESRI
Bldg. 130, Seoul National University,
1 Gwanak-ro, Gwanak-gu, Seoul, Korea
TEL : +82-2-885-9443, FAX : +82-2-883-0827

Certificate No : TR-16-009

1. Client
   - ○ Name : KOREA ELECTRIC COMPANY co., Ltd.
   - ○ Address : 12, Jong-ro 22-gil, Jongro-gu, Seoul, Korea
   - ○ Date of Receipt : 2016.01.11 (Receipt No.: KESRI-X-16-004)

2. Use of Report : For submission

3. Test Sample
   - ○ Name of Sample : ESE LIGHTNING ROD
   - ○ Name of Model : KEC K-1, KEC K-2, KEC K-3
   - ○ Sample Quantity : 3 EA

4. Date of Test : 2016.01.11.

5. Test method
   - ○ Client specification (Refer to the NF C 17-102 : 2011)

6. Testing Environment
   - ○ Temperature : (19 ± 3) ℃ Relative Humidity : (17 ± 5) % R.H.

7. Test Results : See the following pages

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

Affirmation	Edited by Name : Dong-Kyu Kim (signature)	Approved by Title : Technical Manager Name : Ju-Hong Eom (signature)

2016. 02. 26.

Korea Electrical Engineering and Science Research Institute
Test Laboratory

TEST RESULTS

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(1) Impulse voltage test

▷KEC K-1

Test method	Mode	Polarity	Result	
			Voltage	Rising time (T_P)
- Test wave : Switching impulse (250/2 500 μs), 600 kV - Mode : Plate electrode - ESE Lightning rod - Polarity : Negative - Applied impulse time : 10 times - Plate electrode - ESE Lightning rod distance : 1 m	Ref.	(-)	-597.1 kV	211.4 μs
	Plate electrode - ESE Lightning rod		-418.3 kV	83.16 μs
			-441.6 kV	91.35 μs
			-422.7 kV	84.70 μs
			-428.3 kV	86.76 μs
			-431.9 kV	88.06 μs
			-427.1 kV	86.34 μs
			-420.6 kV	83.95 μs
			-410.5 kV	80.53 μs
			-415.2 kV	82.23 μs
			-415.8 kV	82.39 μs

▷KEC K-2

Test method	Mode	Polarity	Result	
			Voltage	Rising time (T_P)
- Test wave : Switching impulse (250/2 500 μs), 600 kV - Mode : Plate electrode - ESE Lightning rod - Polarity : Negative - Applied impulse time : 10 times - Plate electrode - ESE Lightning rod distance : 1 m	Ref.	(-)	-597.1 kV	211.4 μs
	Plate electrode - ESE Lightning rod		-422.9 kV	84.89 μs
			-414.0 kV	81.76 μs
			-406.4 kV	79.23 μs
			-434.7 kV	89.05 μs
			-403.4 kV	78.24 μs
			-413.0 kV	81.39 μs
			-423.8 kV	85.10 μs
			-431.8 kV	87.79 μs
			-453.6 kV	96.09 μs
			-410.0 kV	80.40 μs

TEST RESULTS

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Certificate No : TR-16-009

▷KEC K-3

Test method	Mode	Polarity	Result	
			Voltage	Rising time (T_P)
- Test wave : Switching impulse (250/2 500 μs), 600 kV - Mode : Plate electrode - ESE Lightning rod - Polarity : Negative - Applied impulse time : 10 times - Plate electrode – ESE Lightning rod distance : 1 m	Ref.	(-)	-597.1 kV	211.4 μs
	Plate electrode - ESE Lightning rod		-430.1 kV	87.27 μs
			-429.8 kV	87.30 μs
			-402.1 kV	77.78 μs
			-411.8 kV	80.98 μs
			-408.1 kV	79.81 μs
			-411.1 kV	80.71 μs
			-416.5 kV	82.41 μs
			-400.0 kV	77.12 μs
			-438.0 kV	90.31 μs
			-417.3 kV	85.28 μs

※Additional information : See Appendix (Total number of pages 6). The End.

Appendix

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Note 1. Equipment

Instrument	Manufacturer & Model	Serial number	Specification
Impulse Voltage Test System	HIGHVOLT, IP240/2400G	524 608	2400 kV, 240 kJ

Appendix

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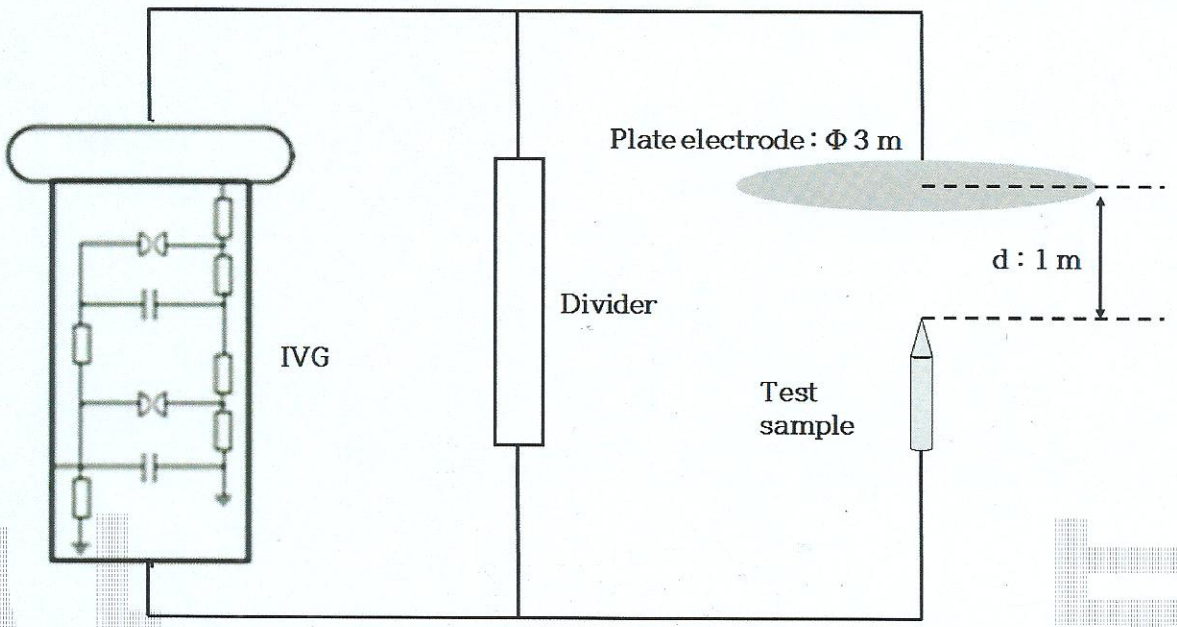
A.1 Test diagram



Appendix

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A.2 Test sample

	
Test sample (KEC K-1)	Test sample (KEC K-2)
	BLANK
Test sample (KEC K-3)	

Appendix

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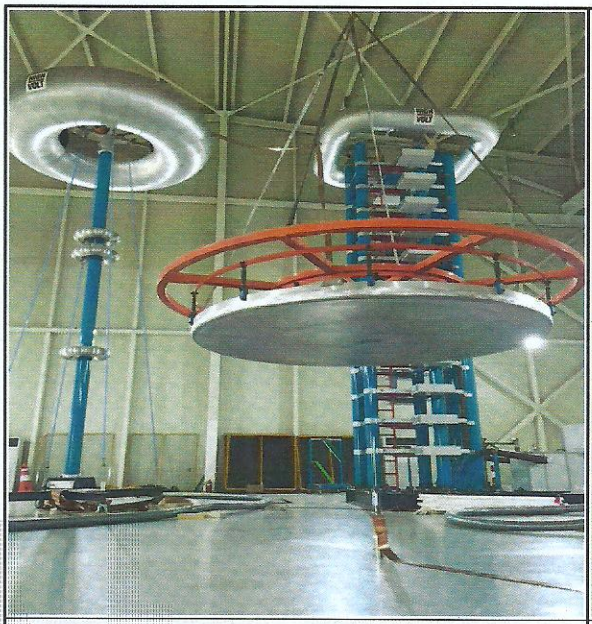
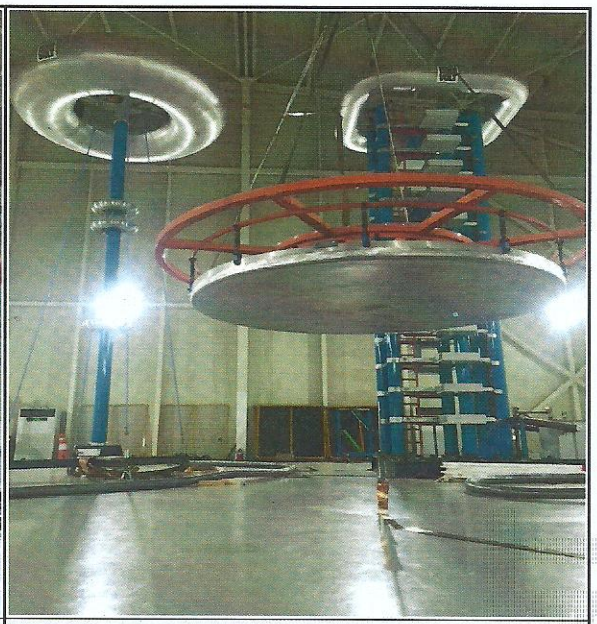
A.3 Test view



Test view (KEC K-1)



Test view (KEC K-2)

Test view (KEC K-3)

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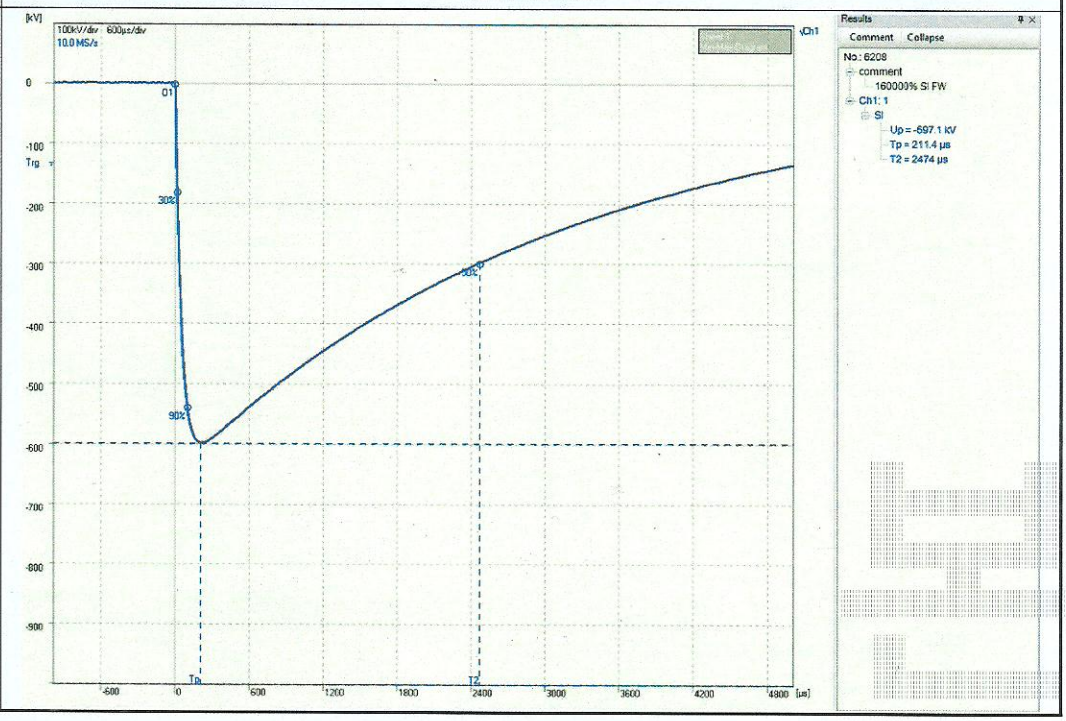
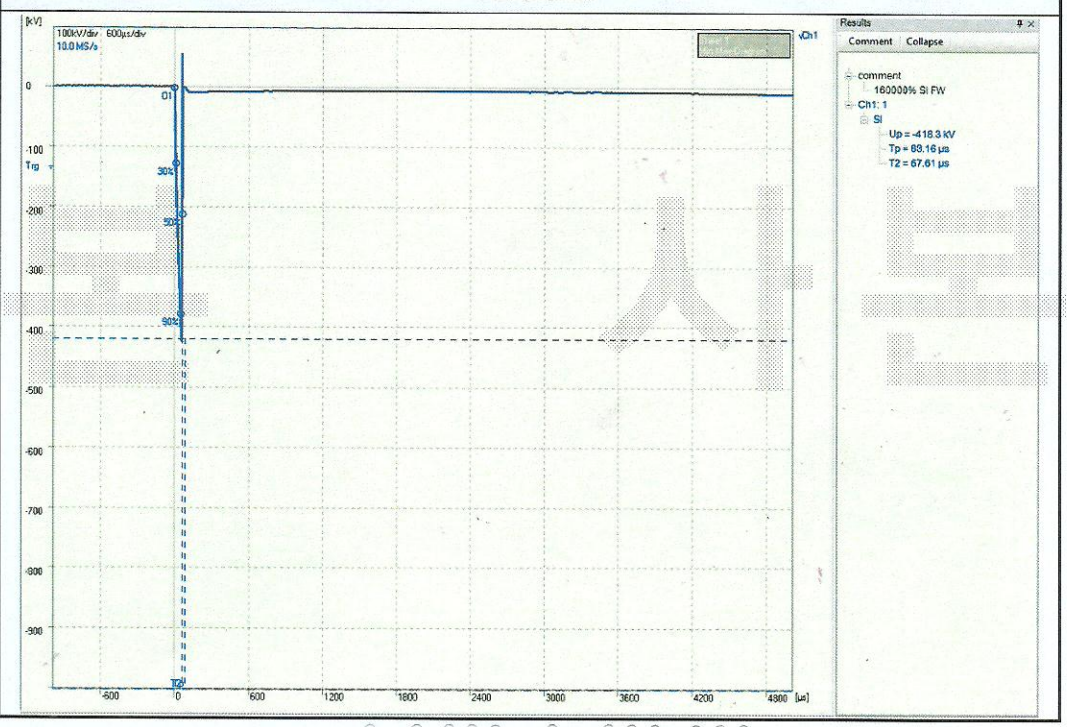
B.1 Waveforms of Impulse voltage test

▷ Applied voltage 600 kV

Mode	Polarity	Waveform
Ref.	(-)	

▷ KEC K-1

Mode	Polarity	Waveform
Plate electrode - Lightning rod	(-)	

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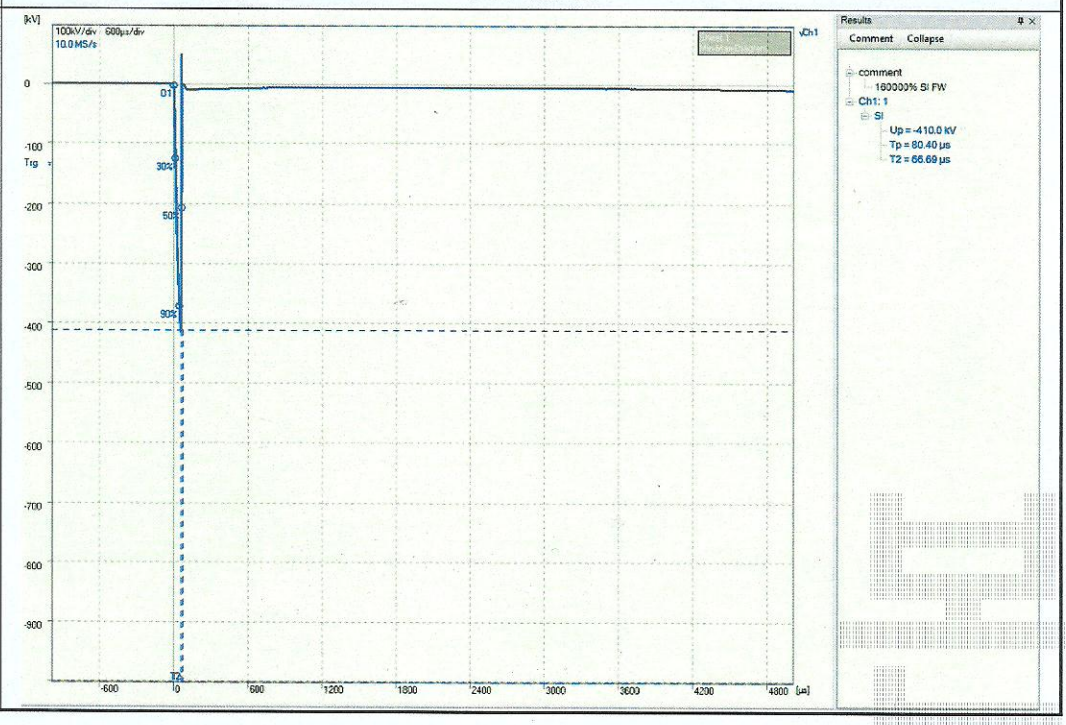
Certificate No : TR-16-009

▷ KEC K-2

Mode	Polarity	Waveform
Plate electrode - Lightning rod	(-)	

▷ KEC K-3

Mode	Polarity	Waveform
Plate electrode - Lightning rod	(-)