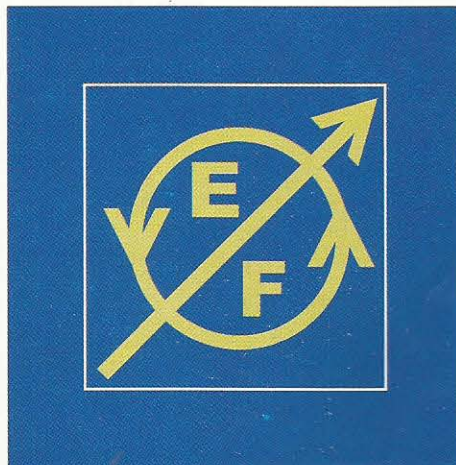


# **Introduction to the ★E.F.★ Carrier System**



**of**

## **Lightning Protection**

# ★ E.F. ★ Lightning Terminal



# ★E.F.★ Key Words

## ● TERMINAL

Sealed and high voltage, ensuring an emission of  $60 \times 10^{12}$  electrons / second per milliamp of current, regulated by the magnitude of lightning itself.

## ● EARLY STREAMER EMISSION

Feature of the Terminal in order to trigger an early initiation of the upward connecting streamer

## ● CARRIER

Coaxial structured downconductor designed for the purpose of hermetically conveying lightning discharges without electrification of the structures.

## ● TRANSIENT ABSORPTION TECHNOLOGY (TAT)

Function incorporated into the Carrier that suppresses the primary lightning overvoltage.

## ● LIGHTNING PROTECTION SYSTEM

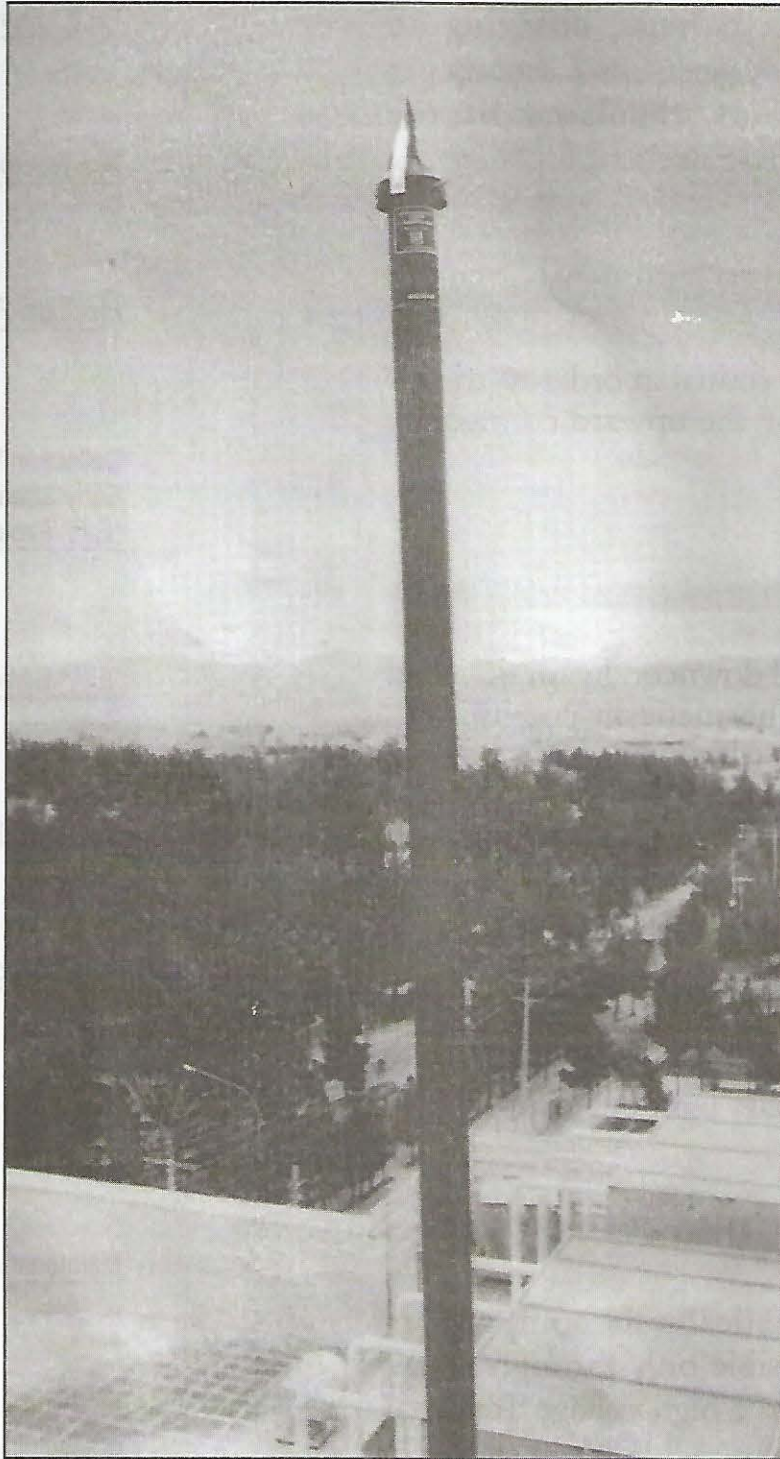
Integrates hermetically its components which is made possible only through a new and unique design of a high voltage Terminal and Carrier.

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# ★ E.F. ★ Installation



# The Electrical Storm

Let us begin by reviewing the generation of a lightning stroke and its interaction with structures and objects on the ground.

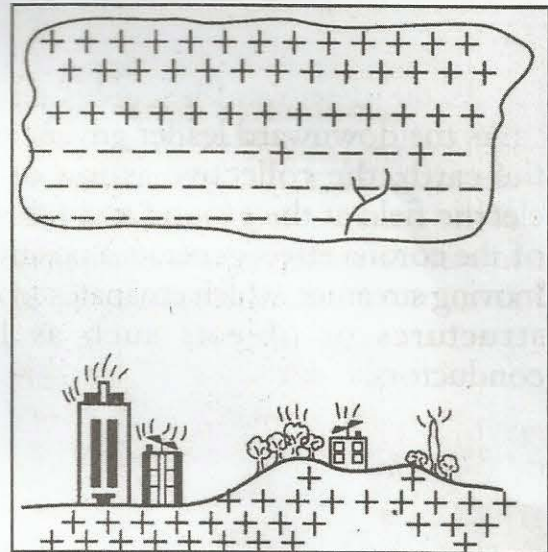
In order for lightning to form, the weather must become unstable, which means that a drastic difference between the pressure and the temperature in the atmosphere must develop, thereby allowing the movement of a rising packet of air to become self-sustaining.

The condition of this updraft exists in the cumulonimbus, the thundercloud..

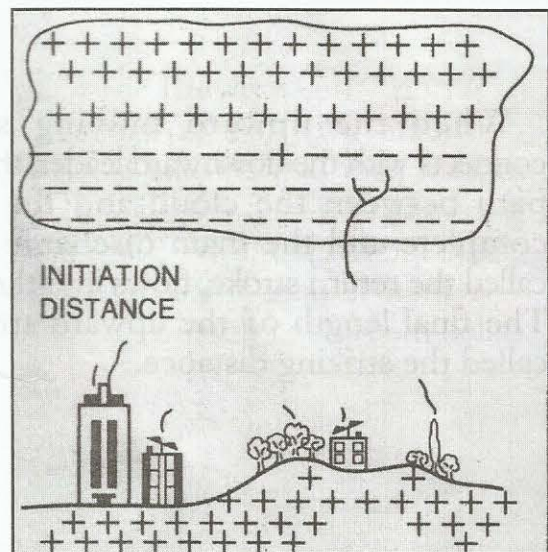
Inside the cumulonimbus, the updraft separates the charges by carrying the finer positively-charged precipitation to higher altitudes, while the heavier negatively-charged precipitation falls to the floor of the cloud. Most of the electrical discharges happen between the negative cloud and the positive earth.

Meanwhile, back on the ground, the atmospheric electric field escalates to rates over 10 kV/m, and a corona effect develops on particular structures such as buildings.

Within the negative storm cloud, a downward leader forms and moves in steps towards the ground.



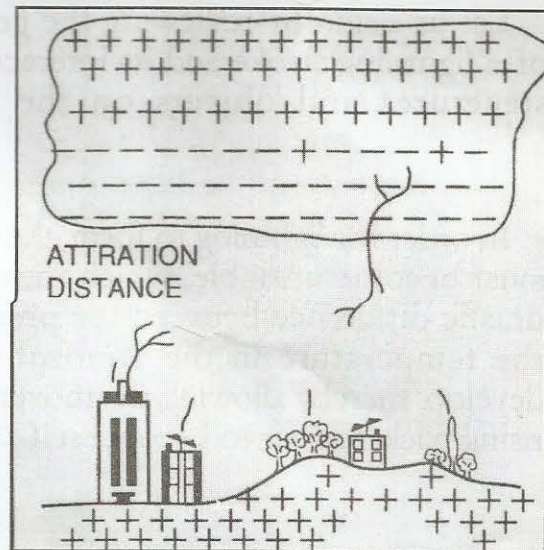
Phase 1



Phase 2

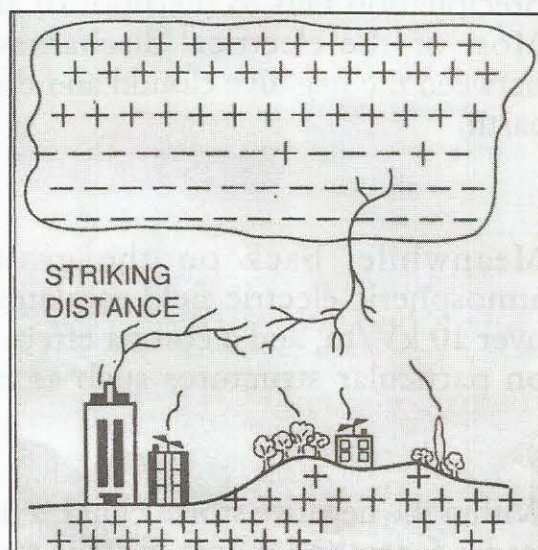


As the downward leader advances towards the earth, the collective action of the high electric field at the ground and the ionization of the corona effect generate a positive upward *moving streamer*, which emanates from certain structures or objects such as lightning conductors.



Phase 3

When the upward moving streamer connects with the downward leader, the ionized path between the cloud and the earth is complete and the main discharge current, called the return stroke, flows into the ground. The final length of the upward streamer is called the striking distance.



Phase 4

# Electric Field Intensification

A high electric field develops between a thundercloud and the earth during a storm.

The strength of this field at any ground point plays a critical role in determining the possible candidacy of the point as a source of an upward streamer.

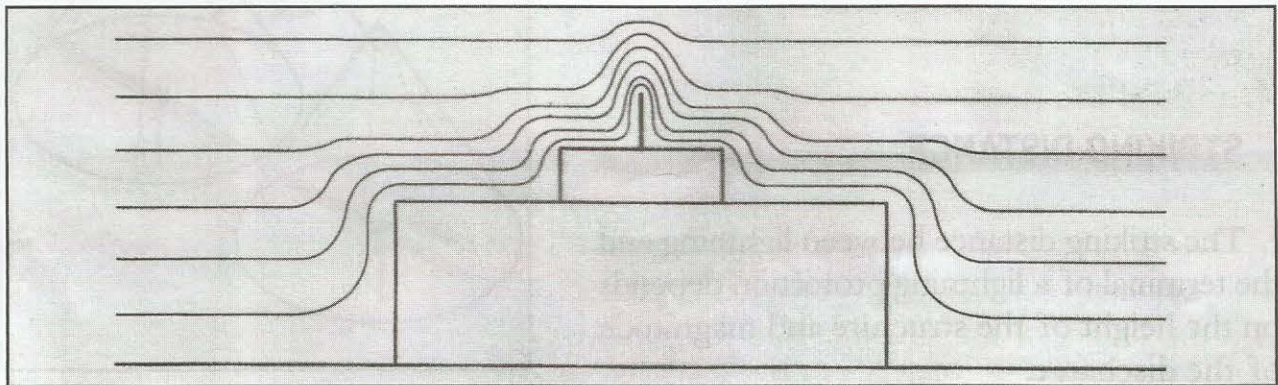
Structures and objects that protrude into the uniform electric field skew the field lines and create areas of intensification.

Geometric configurations such as corners, edges, and especially sharp projections experience a concentrated electrical field, and these locations have an enhanced ability to cast upward streamers and to become potential strike points.

Due to its high slenderness ratio, a sharp projection has the maximum capacity to "give and receive", especially if located at the highest point of a structure, hence, the shape and location of many lightning conductors.

The effects of a structure projecting into a uniform electric field can be seen in figure below.

In effect, all buildings and objects will produce field intensification. The degree of intensity depends on height, shape, and location.





# Collection Volumes

## Early Streamer Emission

### ★E.F.★ Protective Radius

#### ELECTROGEOMETRICAL MODEL

It is adopted by most Codes. But, above 50 metres high, new phenomena occur, which increase the frequency and supersede the theory.

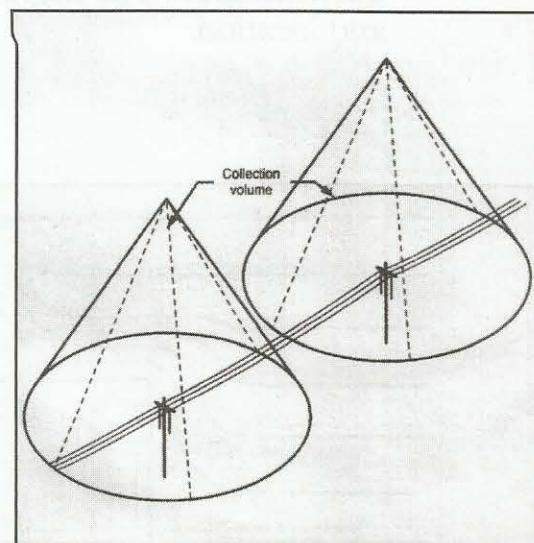
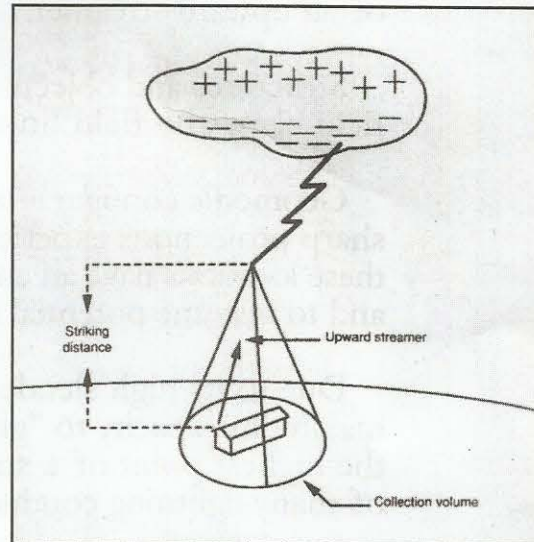
#### PROTECTIVE AREAS OF THE FRANKLIN ROD

The protective areas of the Franklin rod are as follows :

Class I giving the best protection : 30 degrees  
Class II for a "normal" protection : 45 degrees  
Class III for a "decreased" protection: 60 degrees

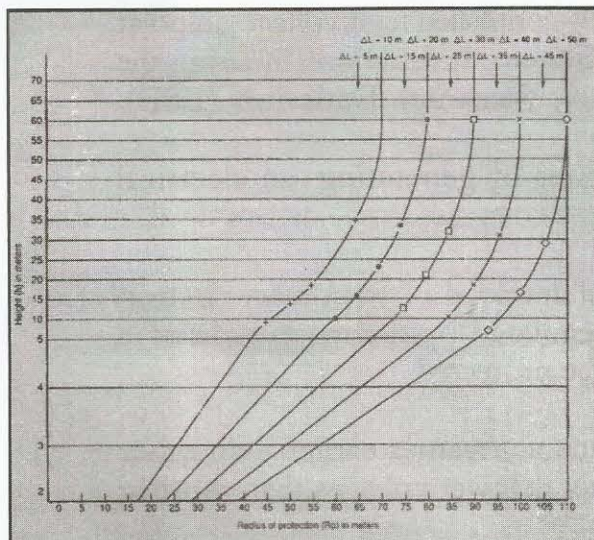
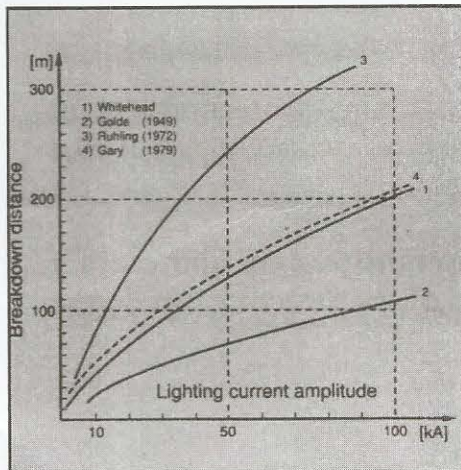
#### STRIKING DISTANCE

The striking distance between lightning and the terminal of a lightning protection depends on the height of the structure and magnitude of the discharge.





## STRIKING DISTANCES AS PER SEVERAL AUTHORS



Determinataion of Rp. as function of h  
and L for protection level III by NFPA 781  
Early Streamer Emission Committee.

## \*E.F.\* PROTECTIVE RADIUS

Due to \*E.F.\* Terminal's emission of  $6 \times 10^{12}$  electrons /second per milliamp of current and an extended experimentation in the field with average lightning discharges of 25 kA, following values are obtained:

Height in metres	Radius in metres
5	95
10	100
20	110
30	120
40	130
50	140
60	150
70	160
80	170
90	180
100	190
110	200

As a safety measure, the protection given  
by \*E.F.\* is restricted to 200 metres.



# ★E.F.★ Basic Components

An effective lightning protection system involves the integration of the air terminal, the downconductor, and the earthing system.

## Air Terminal

An air terminal is the component of the lightning protection system designed to intercept a lightning discharge and immediately pass it to a downconductor.

An air terminal is devised to launch an upwardstreamer and capture the lightning flash before any vulnerable parts of the structure can do the same.

## ● THE ★E.F.★ LIGHTNING TERMINAL

The ★E.F.★ Lightning Terminal is the self-controlled high voltage unipolar upper part of the Lightning Protection System. It functions by using the atmospheric electricity to initiate Early Streamer Emission (ESE).

The ★E.F.★ Lightning Terminal operates by generating an electrical arcing at the tip.

The arcing produced by the air terminal develops a free primary electron current with intensities automatically regulated by the magnitude of a lightning stroke approaching the area to be protected.

In effect, the terminal is able to launch a streamer earlier than other surrounding areas and to launch a streamer at lower voltages than those at other points.

Lightning Terminals placed at strategic geometric location of tall structures can significantly reduce the need for much of the expensive conventional Faraday cage protection.

In addition, the ★E.F.★ Lightning Terminal is not radioactive, because it derives its energy from the natural electromagnetic field that occurs during a thunderstorm. Thus, it is totally environmentally safe.

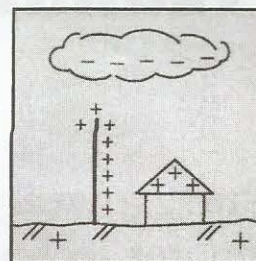


## The Downconductor

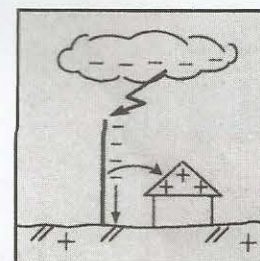
The primary role of a downconductor is to contain the lightning discharge and to channel it to the ground without the danger of side flashing, especially arounds bends of a building where field intensification occurs.

Side-flashing is a phenomenon in which lightning jumps from a downconductor to nearby objects or people. Side-flashing is a major cause of fires and electrical breakdowns.

### The Side-Flashing Mechanism



Before Lightning Discharge

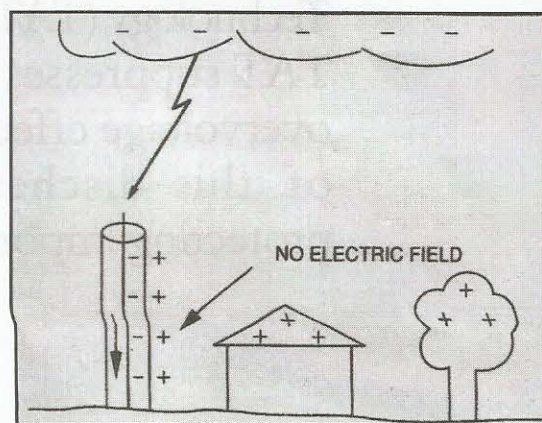


During Lightning Discharge

## ● THE \*E.F.\* Lightning Carrier

The coaxial cable's construction eliminates the problem of side-flashing. This lightning Carrier transports the lightning in the inner conductor while the outer concentric conductor acts as a shield.

Thus, the \*E.F.\* Lightning Carrier is able to carry lightning to the ground without the electrification of the protected structure. In this way, the \*E.E\* Carrier can be run safely around the bends of a building and even inside the structure.



Shielding Effect of the \*E.F.\* Downconductor

The \*E.F.\* Lightning Carrier scale 1:1 is represented on last cover page.

# TRANSIENT ABSORPTION TECHNOLOGY (TAT)

The growing use of sophisticated computer technology, even in small and medium-sized firms, require that more lightning protection be given to prevent lightning overvoltage from entering power lines and damaging data lines or destroying the equipment.

Because this need has arisen, E.F. has incorporated the Transient Absorption Technology (TAT) into its Lightning Carrier. TAT suppresses the lightning destructive overvoltage effect by assimilating the bulk of this discharge as it travels, thus protecting important data and equipment.

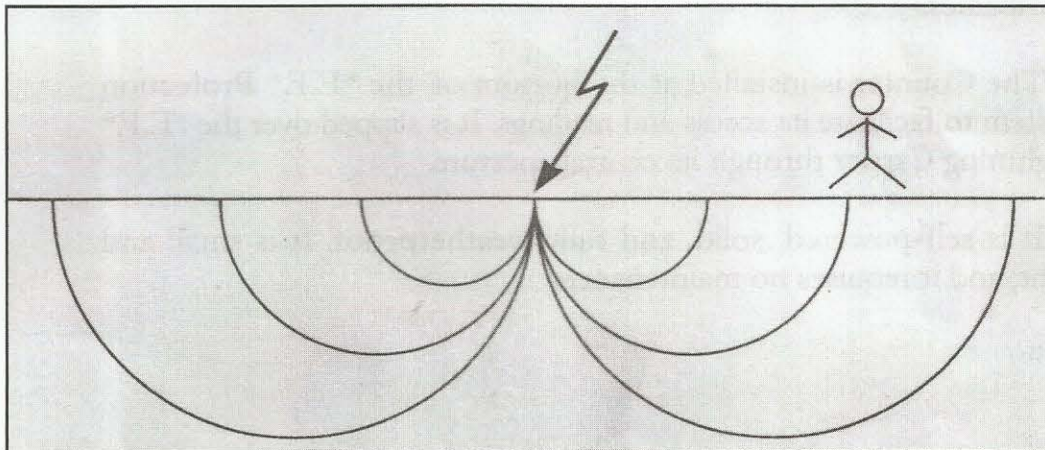


## ● EARTHING SYSTEM

Besides its ability to capture a lightning stroke and to safely convey the current to the ground, a lightning protection system must also be able to dissipate the current into the earth with a low impedance earthing grid.

The earthing system is vital to the overall security of a lightning protection system. If the ground resistance is high, then the ground voltage will be high during a lightning strike.

In engaging the current to the earth, the strike point escalates to a high voltage. The potential will taper exponentially with increased distance from the discharge point. Hence, voltage differentials, "step potentials", are created and will adversely affect people and equipment. Telephone and power line breakdown can also result from high voltages in an earthing system.



Effective earthing is of dire importance: the earth receiving the discharge current from the downconductor must be ensured to embody the lowest possible resistivity.

The \*E.F.\* Lightning Carrier has a unique property: it can hermetically convey lightning underground up to a location where lightning can be dissipated in the best conditions. During this underground route inside the \*E.F.\* Lightning Carrier, no side-flash will occur on the structures, oil tanks, telecommunications, etc.

## ● \*E.F.\* LIGHTNING COUNTER

The \*E.F.\* Lightning Counter continuously and reliably monitors the \*E.F.\* Lightning Protection System efficiency.

Lightning discharges going through the \*E.F.\* Lightning Carrier generate a transient magnetic field that activates the numerical recording in the \*E.F.\* Lightning Counter, making the figure move forward. The \*E.F.\* Lightning Counter is designed to record lightning discharges from 1 kA as well as for all amperages they might reach. Lightning strokes up to 999,999 are catalogued, and the counter is non-resettable.

The \*E.F.\* Lightning Counter documents the performance of the \*E.F.\* System. It can be fitted on Telecommunication towers, aerial power towers, industrial buildings or complexes. It also provides statistical accounts especially for forecast services and insurance companies.

The Counter is installed at the bottom of the \*E.F.\* Protection System to facilitate its access and readings. It is slipped over the \*E.F.\* Lightning Carrier through its central aperture.

It is self-powered, solid, and fully weatherproof. It is small and light, and it requires no maintenance.



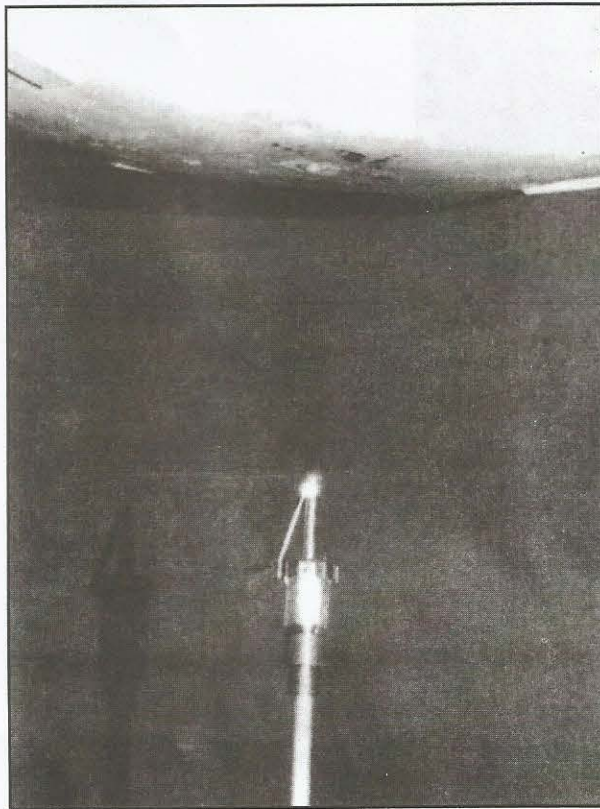
# High Voltage Laboratory Tests

## \*E.F.\* LIGHTNING TERMINAL

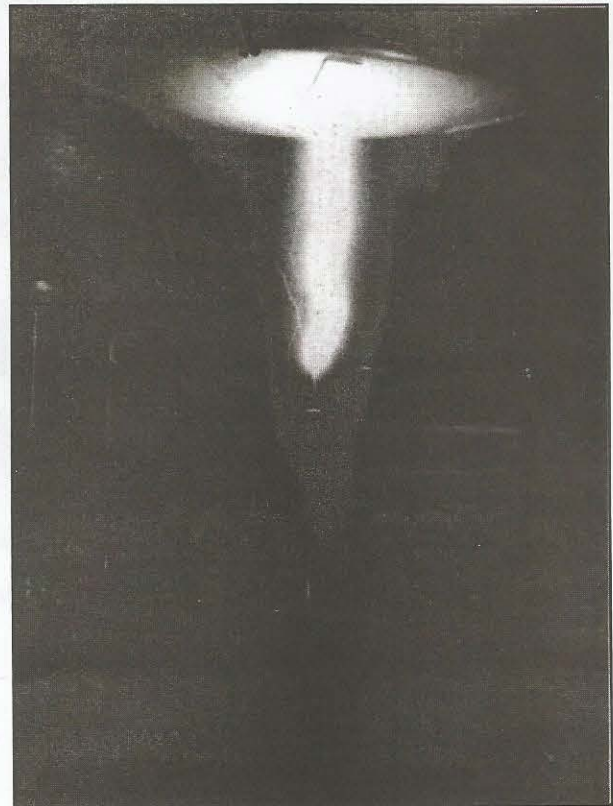
In 1928, on Monte Generoso (Switzerland), A. Brash, F. Lange and C. Urban tried to pick up the atmospheric electricity in order to obtain current.

\*E.F.\* International resumed this research in 1980 and discovered the principle of the self-controlled lightning protection.

The \*E.F.\* Lightning Terminal develops a free primary electron current with intensity being automatically regulated by the magnitude of a lightning stroke coming close to the area to be protected.



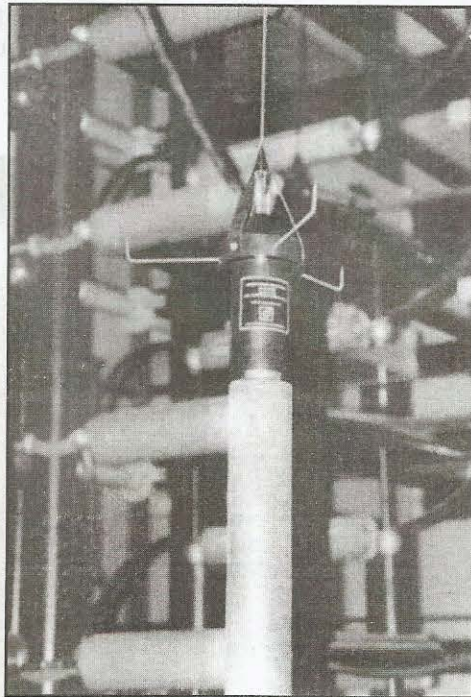
The \*E.F.\* Lightning Terminal starts working in the High Voltage Laboratory...



...until the lightning breakdown.

## Tests

### Lightning waves withstand tests



Tested object

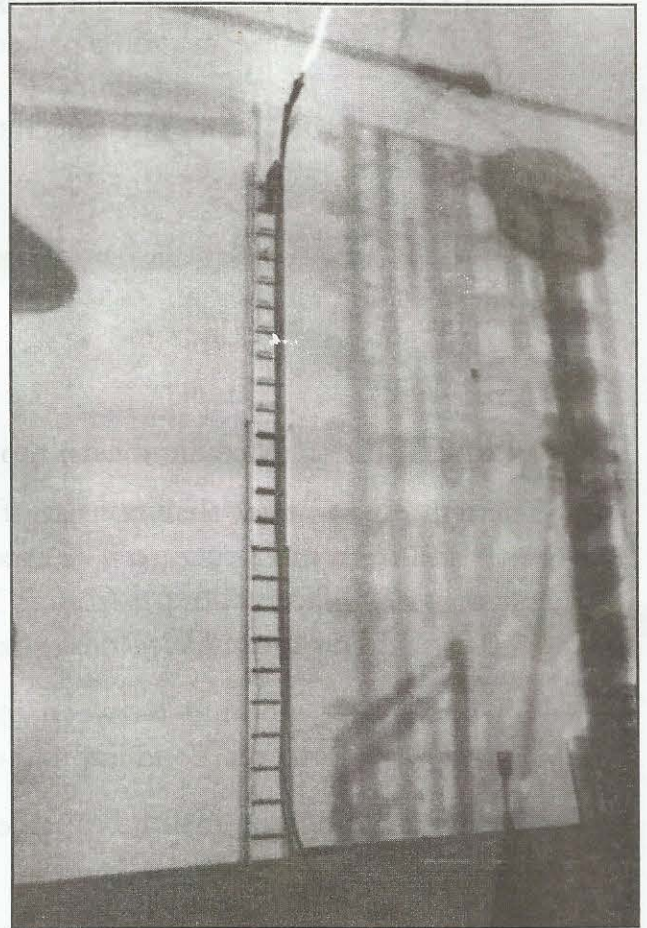
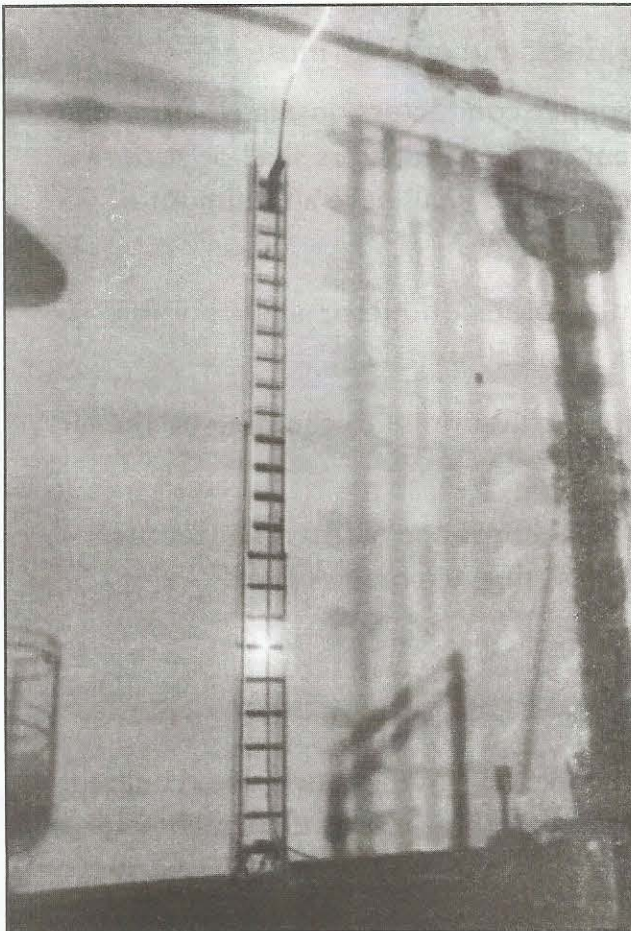
### Conclusion

The \*E.F.\* Terminal successfully passed the requirements. it can therefore be used with the \*E.F.\* Lightning Carrier.



## **\*E.F.\* LIGHTNING CARRIER**

Lightning stroke on the \*E.F.\* Carrier System safely conveyed to earthing through the \*E.F.\* Lightning Carrier - without electrification of the structure.



Same test as above but conveyance with a bare or insulated conventional cable - giving rise to side-flashing.



# Specifications

## AIR TERMINAL

WEIGHT: 2 kg

INSTALLATION: The terminal is to be installed 2 or 3 m above the highest point of the area to be protected, on a fibreglass mast with a minimal length of 2 m, minimal thickness of 4 mm, and an internal diameter of 60 mm into which the base of the terminal is inserted.

## LIGHTNING CARRIER

WEIGHT: 1.5 kg / m

DIAMETER: 31 mill

INSTALLATION: Metallic masts, mounting rings, and guyings must not be used.

- The lightning Carrier shall consist of two copper conductors, insulated from one another and from the Structure. The arrangement of the conductors shall be such that one is coaxially placed about the other. Each conductor shall have a minimum of 35 mm cross sectional area of electrical grade copper.
- The insulating medium between inner and outer conductor shall be able to withstand a 1/ 50 microsecond impulse not less than 250 kV
- The inner conductor shall be capable of direct crimp press to the base of the air terminal.
- The downconductor shall be installed in accordance with manufacturer's instructions and shall not be subject to bends of less than 0.6 m in radius.

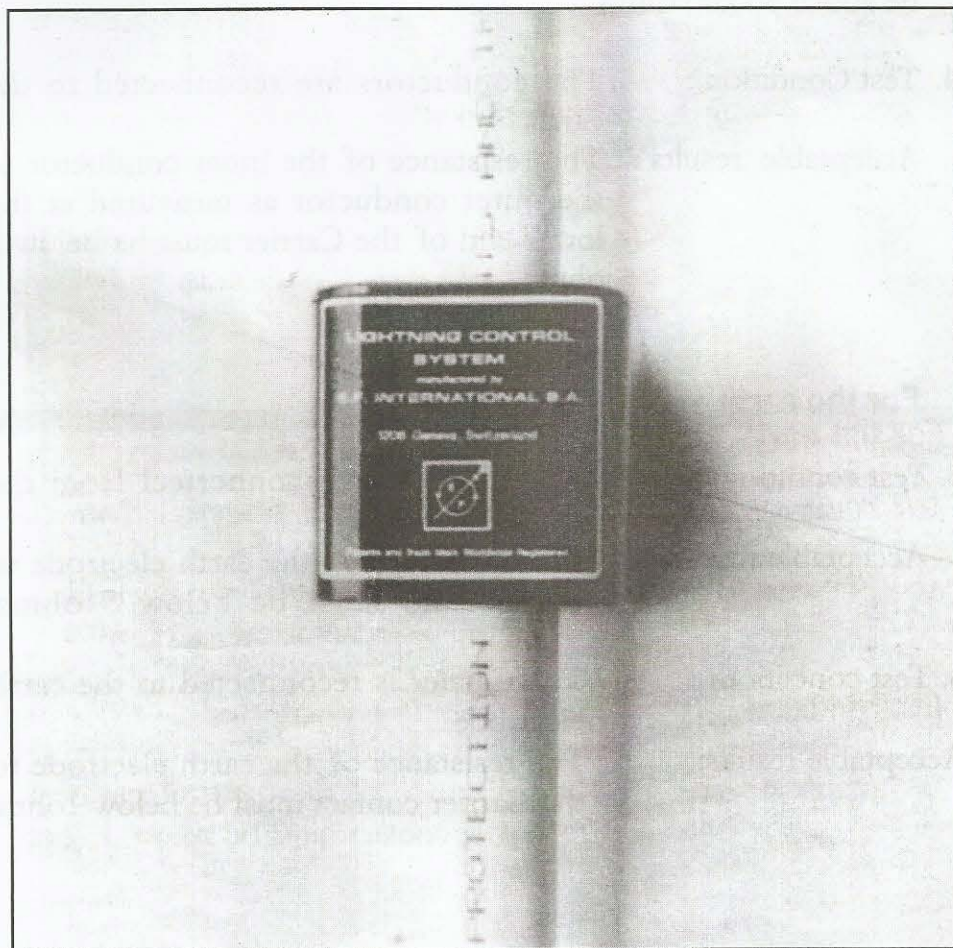
## EARTHING

There are numerous methods of providing a suitable earth. Whatever method utilized, we recommend the use of high quality non-corrosive copper material and we recommend that the earth resistance be below 5 ohms.



## LIGHTNING COUNTER

WEIGHT:	0.8 kg
MINIMUM OPERATING CURRENT:	1500 amperes on a 1.50 microsecond impulse.
RECORDING:	Registers up to 999,999 strokes and is non resetable.
POWER SUPPLY:	Self-powered.
CONSTRUCTION:	Fully encapsulated torroidal coil. Internal diameter: 20 mm External diameter of coil: 120 mm Counter is built into the coil housing and viewed through the polycarbonate window.
INSTALLATION:	The Counter is slipped over the Lightning Carrier before connection with the earthing.



# Certificate of Compliance

After the installation of the Lightning Protection System has been completed, a certificate of compliance shall be issued provided that the system satisfies six electrical conditions.

## For the Lightning Carrier :

\*\*The readings for items 1-3 are taken after the inner and outer conductor lugs are disconnected at the earth electrode.

1. The resistance of the outer conductor to the earth must be above 50 kilo ohms.
2. The resistance of the inner conductor to the earth must be above 50 kilo ohms.
3. The resistance of the inner conductor to the outer conductor must be above 50 kilo ohms.

4. Test Condition : The conductors are reconnected to the earth.  
Acceptable results : The resistance of the inner conductor to the outer conductor as measured at the lower end of the Carrier must be below 1 ohm.

## For the earth :

5. Test condition: The Carrier is disconnected from the earth electrode.  
Acceptable results: The resistance of the earth electrode to the ground must be below 5 ohms.
6. Test condition : The Carrier is reconnected to the earth electrode.  
Acceptable results: The resistance of the earth electrode to the Carrier contact must be below 1ohm.



# Maintenance

It is essential that the \*E.F.\* Carrier System of Lightning Protection be regularly maintained.

Maintenance should be provided after each known strike on the Lightning Terminal or after any strikes recorded by the Lightning Counter. In any events, the entire system should be evaluated at least once a year.

**All lightning protections present a permanent potential danger if they cannot guarantee the hermetic conveyance to earth**

# **The ★ E.F. ★ CARRIER SYSTEM OF LIGHTNING PROTECTION**

The achievement of the \*E.F.\* Lightning Carrier and the \*E.F.\* Lightning Terminal as such leads to the **THIRD LIGHTNING PROTECTION PRINCIPLE: ITS INTEGRATION**, which is fully achieved only by the hermetic conveyance of lightning discharges and the use of a high voltage unipolar termination.

The references of thousands of \*E.F.\* Carrier System of Lightning Protection installations in the most lightning-prone countries of the world are available on request. These installations protect historic places, major industrial complexes, oil and gas storage, mining areas, military installations, airports, microwave networks, ground satellites stations, as well as high-rise buildings, golf courses, and private houses.

Because of its unique characteristics, the \*E.F.\* Carrier System of Lightning Protection makes the installation easy and safe and in accordance with the standards and know-how supplied to the \*E.F.\* Licensees. Its manufacturing meets the highest quality requirements of ISO 9001 International Quality Standard. It is tropicalized.

**PATENTS AND TRADE MARK WORLDWIDE REGISTERED**



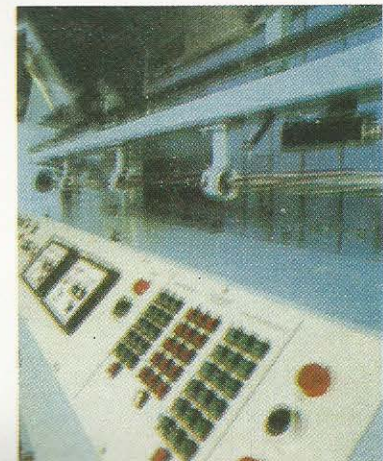
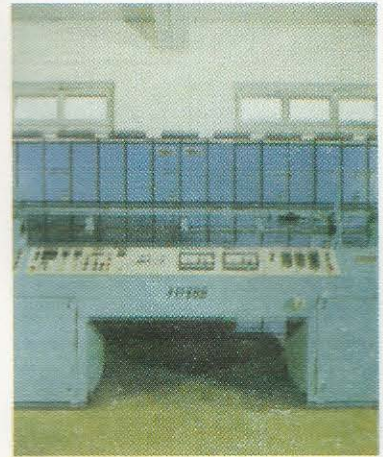
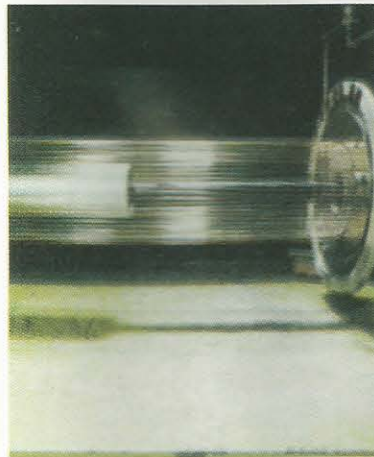
"E.F." LIGHTNING CARRIER - PATENTS AND TRADE MARK WORLDWIDE

# Manufacturing Line

## Developed

### for the

#### ★ E.F. ★ Carrier



Scale 1:1

For the latest and detailed information, including installations, contact  
your local \*E.F.\* Licensee.

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