E.F. International S.A. benefited from a unique experience in the atmospheric electricity field since the beginning of the 1970s. In 1982, E.F. patented the **E.F. Carrier System of Lightning Protection** which ensures the lightning protection required by the modern world since this system integrates the **E.F. Lightning Carrier** that conveys lightning in an electrically hermetic way. The **E.F. Lightning Terminal** uses the ESE technology.

The **E.F. Lightning Protection system** is the only lightning protection system manufactured with a **Quality Assurance System** which meets the **Swiss Standards SN 029 100 Category A**, and is **ISO 9001 rated**, a standard which includes design/development, production, installation and servicing.

The structure of the **E.F. Lightning Carrier** down conductor ensures the safe conveyance of lightning current from the terminal to the ground without "**sideflashing**" and "**skin effect**" which are hazardous to the structure and equipment inside the structure to be protected. It is the only lightning conductor that has incorporated the **Transient Absorption Technology (TAT)**, screening the electromagnetic field due to lightning discharges.

Capacitance of the **E.F. Lightning Carrier** to withstand the high voltage of lightning of 250 kV is certified by the manufacturer, **NEXANS**. The **E.F. Lightning Carrier** is **flame-retardant** allowing internal installation.

E.F.'s track record of local **installations** is a proof of the system's superiority over other brands. E.F. has become a byword in the lightning protection industry, protecting high-rise structures, plants, telecommunication towers, golf courses, etc.

In the most lightning-prone countries of the world, its comprehensive network of **Licensees** is supported by fully qualified professionals with extensive hands-on experience and expertise, a well-trained staff and an efficient sales network.

**Exclusive Licensee in the Philippines**
LEAH CONST. & DEV’T. CORP.
Rm. 207, Jovan Condo., #600 Shaw Blvd., Mandaluyong City
Tel. No. 533-3433 * 533-3431 * 533-1656
Fax. No. 533-0328
Website: www.ef-international.ch
E-mail Address: ldc@pacific.net.ph
**E.F. Terminal**

The **WORLDWIDE PATENTED** *E.F.* Lightning Terminal is the top part of the *E.F.* Carrier System of Lightning Protection. The *E.F.* Lightning terminal is made of materials resistant to high voltage and is the place where upward streamers are emitted.

**How it works**

When a thunder cloud is formed, a strong electric field is induced directly below it. The field will polarize and then ionized air molecules but the air resistance is still high enough to prevent electrical discharge from cloud to ground. A downward leader will develop at the bottom of the cloud towards the ground below as the space field becomes stronger and more air molecules are ionized.

Fig. 1 is a simplified structure of E.F. terminal. (1) is the collection arm with stamp point and (2) is the discharge arm linked with (1), and (3) is the finial, which is always at ground potential. By means of sharp point discharge phenomena, some ionized air molecules transfer their charges to (1) and charged up (2) as well. (1) and (3) are so narrow that the electric field strength of the gap becomes much higher than that of the space. Such high field intensity causes the air in the gap break down and arcing takes place between (2) & (3).

Arcing eventually produces more ionized particles, which then accelerated along the field direction to a high speed and cause collision with other air molecules and knocking out some electrons of the air molecules. This eventually ionizes the air in the field direction. If the space field is strong enough say 500 KV/M, this process is self perpetuated along the field direction. Finally, an up streamer is formed from the gap between (2) and (3) to intercept the downleader from the cloud within the predetermined zone. A conductive ionized channel is then completed and the main discharge takes place from the cloud to the E.F. Terminal.

The mechanism plays a very important role in the design of lightning terminals. Let us go through a gas-filled discharge tube experiment as in Fig. 2 shall be the best example to illustrate this ESE phenomena. (1) and (2) are the main discharge electrodes and (3) is the auxiliary electrode. First, we set V1 to zero and apply V2 - Vb (the discharge voltage of the tube). A discharge occurs between (1) and (2) after a delay. This is called the “time delay” of the discharge tube.

We may try this experiment again, by applying a voltage V1 to let discharge take place between (2) and (3) and then apply V2. We find that the “time delay” for the discharge between (1) and (2) is much shorter than the time delay in the first experiment.

Repeating the second experiment by increasing voltage V2 gradually from 0, we will find that the voltage required for discharge between (1) and (2) is lower than voltage required in the first experiment.

From the above experiment, we confirm that a discharge of the auxiliary electrode can shorten the main electrode discharge time and lower the required discharge voltage. The E.F. terminal system uses the same principle which can launch up streamer earlier than nearby objects of the ground. This feature makes the E.F. terminal the most preferred lightning discharge point during the thunderstorm at a relatively large area compared with conventional terminals. The "Early Streamer Emission Terminal" **ESE Terminal"** can best describe the function of the E.F. Terminal.
**E.F. Downconductor**

The worldwide patented *E.F. Lightning Carrier* is the central portion of the self-enclosed E.F. Carrier System of Lightning Protection.

The Function of the E.F. Lightning Carrier is to safely conduct the high voltage lightning energy from the lightning terminal down to the ground. No side flashing occurs.

**How it Works**

**The E.F. Carrier** is a coaxial structural cable specially designed for the conveying of lightning current from the E.F. terminal to ground without any side flashing problem.

Lightning current through the bare tape is a fast transient current; its di/dt has a huge magnitude. Any conductor has its own self-inductance $L$, and $V = L \frac{di}{dt}$ is the induced voltage. The inductance becomes larger if a bent exist along the tape, and the corresponding induced voltage also becomes higher. Such a high voltage will generate a high field around the tape and ionize the nearby air. Lightning current jumps off from the conductor to release energy. The phenomenon is called side flashing.

This **SECOND LIGHTNING** not only can cause fire but also can cause electric shock to people. For those buildings of concrete and steel bar structures, side flashing does little damage to the building itself, but the lightning current will penetrate into the steel bar, or whatever the metal part of the structure. If sensitive electronic equipment is placed near a steel bar carrying the lightning current, the strongly varying magnetic flux will definitely penetrate into such equipments coupling with printed circuit boards and internal wiring wires. Surge voltage is then induced and causes substantial interference and even permanent damage and this type of surge cannot be removed by a conventional surge suppressor equipment.

The advantage of the E.F. cable - let us see the structure of the cable as in Fig. 3. We mentioned before, lightning current is a rapid transient impulse, containing high order harmonics or high frequency energy. Skin effect and self-inductance cause problems in conveying the high frequency energy to ground especially for conventional bare tape system. An ideal down conductor has no self-inductance and skin effect resistance, which means that high voltage does not develop on the conductor. The E.F. cable is the only method to reduce the above mentioned problems at a reasonable cost. One thing cannot be seen in Fig. 3 that all conductor wires of the cable are arranged parallel to the cable center axis to further reduce their self-inductance.

![Figure 3](image-url)
The termination method of the whole system plays an important role to couple with the side flashing. At Fig. 4 we can see that the upper end of the outer conductor is floating while its lower end is connected to earth with the inner conductor. The outer conductor is, hence, always at the same ground potential as the nearby objects. This design screens out the electric field produced by inner conductor.

The equivalent of the E.F. cable for further study in Fig. 5 shows that the cable section forms a low pass circuit. The capacitance of the cable stores the lightning energy temporarily and release the same after the current peak value, in a steadier and smoother manner (Fig. 6). This reservoir function reduces the voltage stress between the inner and the outer conductors. Thus voltage breakdown of the cable is nearly impossible. The capacitance of the cable also provides another contribution. When 1=0, the capacitor is equivalent to a short circuit stage, the outer conductor will share the lighting current with the inner conductor. Because both inner and outer conductors are 35mm sq. of conduction cross sectional areas, the combined conduction are is 70 mm sq. at that very critical moment.

All the above efforts are aimed to reduce the developed voltage on the overall system and stress between inner and outer conductors. The outcome is to completely remove the side flashing problem, which cannot be avoided if conventional copper tape is used as down conductor. Since there is no side flashing, the protected object will not be passed through the lightning current and any problem caused by lightning currents are removed. As the E.F. cable can be installed inside the building, precaution has been taken that all materials to make the E.F. cable are FLAME-RETARDANT to prevent fire spreading when fire does happen at any part of he building and the E.F. CABLE IS THE ONLY LIGHTNING CURRENT CARRYING CABLE IN THE WORLD THAT IS HALOGEN FREE AND FLAME RETARDANT.

The E.F. Carrier is the only worldwide patented TOTAL LIGHTNING PROTECTION SYSTEM that is ELECTRICALLY-SEALED SUPPRESSING THE PRIMARY OVERVOLTAGE; AND ABLE TO EXTEND ITS TWO FUNCTIONS AWAY FROM STRUCTURES BEFORE EARTHING.
E.F. Lightning Counter

The E.F. Lightning Counter keeps track of the number of lightning strikes the E.F. Carrier System of Lightning Protection intercepts.

How it works

The E.F. Lightning Counter is small, light weight and waterproof. It can operate normally in extreme climatic conditions. It does not need a battery source to operate nor does it need to be regularly maintained.

Each time a lightning pulse travels down the E.F. Lightning Carrier, the local electromagnetic field rises sharply and causes the E.F. Lightning Counter to advance by one count. It can record up to 999,999 lightning strikes. The counter is triggered whenever it encounters a 1.5 KA impulse current in 1.5 microsecond duration. The counter cannot be reset. The E.F. Lightning Counter provides data, which can be used to analyze the performance of the entire lightning protection system.

Earthing System

How it works

Generally conventional lightning protection system uses copper tape or structure steel as downconductor. Therefore lightning current will flow through the structure from the top to the bottom. But, since, lightning current is a fast transient impulse wave, so even when all metals or earth of electrical appliances are connected together, it is still difficult to get an equip-potential due to the traveling wave of lightning current and induced voltage caused by magnetic field.

The lightning carrying concept of the E.F. Carrier System of lightning protection is very unique and completely different from ordinary lightning protection systems. The E.F. System is electrically isolated from any structure being protected. Therefore, there will be no lightning current flowing through the structure. An independent earth far away from the structure or any other earthing system, will minimize the impulse interruption. If site condition does not allow a separate earth to be built, then, a good bonding to other earth is necessary to obtain an equip-potential, but of course surge protection must be added to the electrical equipment. However, we do not mean surge protection is unnecessary for separate earth than common earth due to less transient impact. This is illustrated in Fig. 1 and Fig. 2

![Figure 1](image1.png)  
**Conventional System**  
E1 ≠ E2'  
E3 ≠ E4'  
So transient damage may caused

![Figure 2](image2.png)  
**E.F. System**  
E1 ≠ E2'  
E3 ≠ E4' < E3 - E4  
Therefore transient impact is minimized
1) Select an appropriate level of lightning protection.
   (a) Standard level of protection – suitable for most commercial buildings and other structures
   (b) High level of protection – suitable for structures containing vital communications
       and computers, or for hospitals, key airport facilities, and military installations.

2) On a plan view of the structure to be protected, select the location for erecting the lightning terminal
   supporting mast.

3) Using an appropriate radius of protection, draw a circle centered on a lightning terminal location.

4) If the circle completely encloses the plan view of the structure, the structure is protected to the
   nominated risk level. Any part of the structure lying outside the circle is unprotected. The remedy is to
   reposition the lightning terminal location or to use two or more terminals.

5) Under all circumstances, the lightning terminal ought to be at least 10 meters higher than the ground
   level.

### The protective radii of the *E.F. Lightning Terminal for Buildings and Structures

<table>
<thead>
<tr>
<th>Building Height (m)</th>
<th>Protective Radii (m)</th>
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<td>(for 5m tall lightning terminal supporting mast mounted above the highest point of the building)</td>
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<td>above 150</td>
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</tbody>
</table>

The protective radii increase with the magnitude of lightning discharge because the effectiveness of the *E.F.
Lightning Terminal is dependent on local electric field strength, which is a function of leader charge and lightning
intensity.

Notes:
1. The lightning terminal should be 2 meters higher than the highest point of the building, which includes
   antenna, rail fence, communication equipments, machine room, water tower, air conditioners, and other
   objects that protrude from the roof of the building. The protective radius of the lightning terminal increases
   with the height of the supporting rod.
2. The *E.F. Lightning Terminal shall be installed on top of the accompanying lightning terminal supporting
   fiberglass mast.
3. The table of protective radii is statistically calculated based on empirical data. The field situation is also
   affected by the proximity of other pointed objects.
A. PRINCIPLE
There are three principles, related to an extensive experimentation in the field, permitting to achieve security in modern lightning protection. The first principle is the ELECTRICALLY SEALED CONVEYANCE OF LIGHTNING by means of an air terminal and a downconductor, the insulation of which has suitably been calculated. The second principle is the production of FREE ELECTRONS to ensure an Early Streamer Emission at the tip of the air terminal. The third principle is THE INTEGRATION OF THESE COMPONENTS INTO A COORDINATED SYSTEM.

B. LIGHTNING TERMINAL
1) When the electric field in the atmosphere is large enough to initiate a lightning event, enhanced emission shall be produced through arcing in the air gap between the finial and the discharge arms of the lightning terminal.
2) Arcing shall not continuous, and shall occur only during an electrical storm.
3) The lightning terminal shall not be made of radioactive material.
4) The protective radius provided shall comply with Collection Volume Design and shall be calculated depending on the level of protection required.
5) The Lightning terminal shall not have any moving parts and shall be completely isolated from the structure to be protected. It shall be made of a material resistant to high voltage.
6) The Lightning Terminal shall be made of material that will not be corroded in normal atmosphere.
7) The Lightning Terminal shall not have to rely on batteries to be effective.
8) The Lightning Terminal shall be made in accordance with ESE codes.

C. AIR TERMINAL SUPPORT
1) The support shall consist of a minimum of 2.4 meters of air termination insulating fiberglass mast pole.
2) The support shall be at least 2 meters above the top of building structure and shall withstand maximum locally recorded wind velocities.

D. DOWNCONDUCTOR
1) The downconductor shall be made of coaxial cable and must convey the discharge to the ground without danger of side-flashing or structure electrification.
2) The downconductor shall consists of two (2) copper conductor coaxially structured and placed one over the other. Each conductor shall be insulated from one another and both insulated from the structure.
3) The insulation electrical stress shall be distributed on the whole length of the downconductor independently of outside conditions, so, it can be placed near to the points or edges without any risk of discharges.
4) The insulation segregating the inner and outer conductors shall be able to withstand a 1/50 microsecond waveshape of impulse of not less than 250kV transients. As per IEC 230 specification.
5) This special downconductor is solely designed for lightning protection with high voltage techniques and as such, the copper wires should be parallel to the core and joined, and should not include wires wound in a helical way.
6) The inner conductor shall be capable of direct crimp press to the base of the air terminal. On the other end of the lightning carrier, both the inner and outer conductors are connected and grounded.
7) The downconductor shall be installed in accordance with manufacturer’s instructions and shall not be subject to bends of not less than 0.6 meters in radius.
8) The downconductor shall be made entirely of materials which do not propagate fire and consequently, is FLAME RETARDANT and HALOGEN FREE.
9) Manufacturing shall comply with ISO 9001/EN29000.

E. LIGHTNING COUNTER
1) The Lightning Counter shall record the number of times lightning energy passes through the internal aperture of the Lightning Counter. The counter advances by 1 count for each lightning pulse that exceeds 1.5kA and 1.5 microseconds.
2) The Lightning Counter shall be designed to function 24 hours a day every day.
3) The internal aperture of the Lightning Counter shall be 32mm.
4) The Lightning Counter shall be located such that the counter is clearly visible and accessible.

F. EARTHING
1) The ground resistance is recommended to be below 5 ohms. Under no circumstances should be ground resistance exceed 10 ohms.
2) The earth resistance shall be measured by the three-pin electrode resistance testing method.
Diagram of E.F. Carrier System of Lightning Protection

See Enlargement A
*E.F.* Lightning Terminal
Weight 2Kg

63mm. Ø Fiberglass Mast

12mm. Ø Bolt & Knot with Washer

6mm THK x 50mm. Flat Bar (Steel Clamp)

See Enlargement B
*E.F.* Lightning Carrier
O.D. 31mm
Weight 1.5Kg/m

Cable Clamps
Spaced at every 1.50m. O.C.

*E.F.* Cable Down to Grounding System in 50mm. Ø PVC Pipe (Roughing-In)

*E.F.* Lightning Counter
Weight 0.8Kg
Internal Aperture 32mm
Dimensions 69x105x70mm

300x300x12mm. THK Base Plate

Grounding System

Enlargement A
*E.F.* Lightning Terminal
Weight 2Kg

3.00m. 3" G.I. Mast

Enlargement B
*E.F.* Lightning Carrier
Weight 1.5Kg/m

Centre core
35mm² cross sectional diameter inner copper conductor
Inner insulating layer
35mm² cross sectional diameter outer copper conductor
O.D. 31mm outer insulating layer

Measurement Unit: mm
Our Track Record Speaks For Itself