BRASIL TEST FACILITY

- Cachoeira Paulista -

'Testing under real lightning conditions'

Overview of the test facility

The Cachoeira Paulista test facility is located within the INPE (Brazilian Institute of Space Research) compound half-way between Sao Paulo and Rio de Janeiro. This geographical location offers ideal tropical storm conditions.

Two experiments began in 1998:

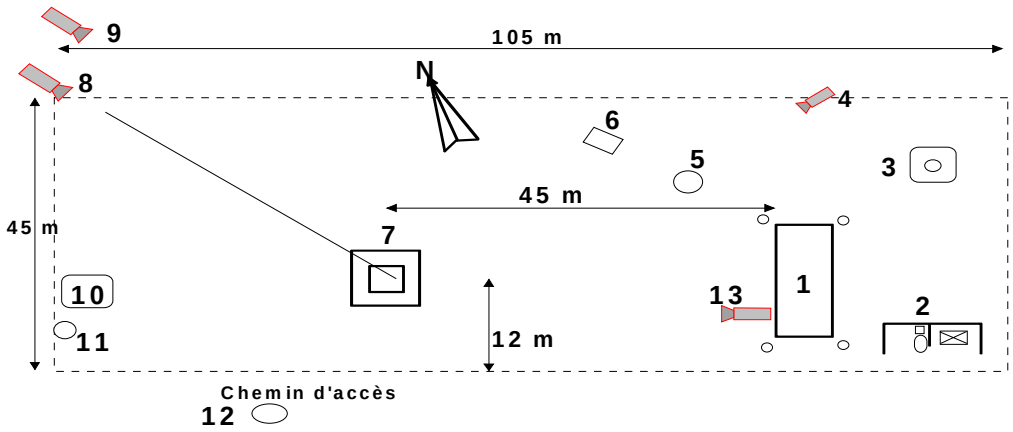
- construction of an instrumented test facility designed to conduct tests under natural lightning on both a simple tapered rod, a simple flared rod and two ESELCs;
- a lightning triggering platform fitted out with different types of instrumented air terminals. The discharges are triggered using rockets which trail a length of copper conductor with a Kevlar insulated end section.

Location of the test facility


Launch platform & conductor masts


Rocket launch tubes


Triggering rocket



1 Control station,
2 Genset, air compressor, fuel tank,
3 Electric field sensor (launch sensor),
4 Automatic video camera (natural & triggered lightning flashes) 75 meters away
5 Vertical component of the radiated electric field,
6 Electromagnetic induction in a meshed cage,
7 Lightning conductor test & measurement launch platform,
8 Video camera operated from the control station (1) 50 meters away
9 Automatic camera (natural & triggered lightning flashes) 800 meters away,
10 GPS station,
11 Geodesic mark,
12 Isolated tree,
13 High speed video camera (8000 fps).

When launched in the right electrical fields, the rockets will fly up into the base of the electrically charged storm cloud and cause a “short circuit” with the ground.
A downward leader then moves down the conducting wire, ending its journey to the ground freely and independently.
In addition to the rocket launch tubes, the test platform comprises three lightning conductor tips and is fully instrumented to allow both the low-level currents of the upward leaders and the high-level currents of the actual lightning strikes to be precisely measured.
An electrical field sensor is also attached to one of the masts at the same height as the tips.
To prevent any electromagnetic disturbances, all data is sent over fiber optic cable.
Several cameras are also present to help monitor and record both naturally occurring and triggered lightning events.
Several automatic cameras were installed which were triggered optically (lightning flash) or electromagnetically (induction loop).
The fastest camera is capable of recording 8000 frames per second.


Control station


Inside the control station

LSR-G triggered launch rocket

LRS-A triggered launch rocket

Results 1998 – 2003

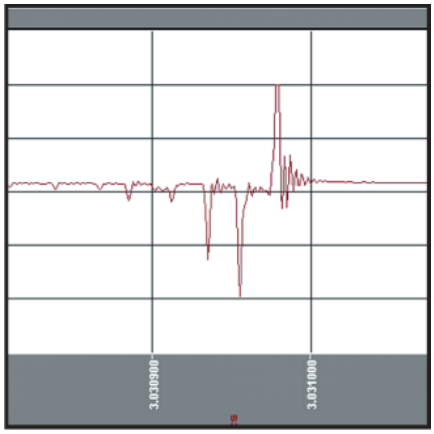
For the first time, video footage allowed scientists to see how the upward leader develops from the ESELC while, in identical field conditions and at the same instant, the simple rod exhibited no discernable activity.

The two images above were captured during naturally occurring, non-triggered lightning conditions and clearly highlight the truth behind the theory that the ESELC ionization system provides for the emission of an early streamer.

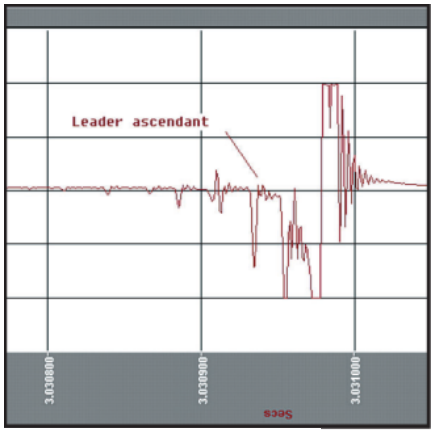
The data collected also allowed the precursor currents at the top of the ESELC to be measured and compared with the activity around the simple rod. The graphs above show the shape and amplitude of the current signals for both types of tip. The initial pulses (low-level corona effects with no propagation) appear simultaneously on the ESELC and the simple rod.

However, the shape of the current around the ESELC then shows the triggering of an upward leader, which then propagates until the first return stroke appears (induction saturation).

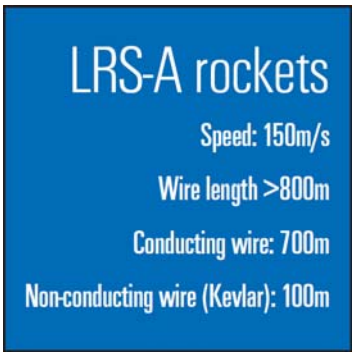
During this time, the similarly sized corona around the simple rod represent its vain attempts to trigger a leader.



Simple rod



ESELC 60µs



In addition to these previously unseen images, the testing carried out under real lightning conditions provided the following results:

Two concurrent downward stepped leaders (courtesy HQ)

Branched downward stepped leaders (courtesy HQ)

A

The ESELC's basic operating principle was verified and shown to comply with the positive results obtained previously at Camp Blanding in Florida and Saint Privat d'Allier in France: the ESELC's ionization system reacts automatically as soon as any sudden build-up in the electrical field - synonymous with a downward leader is detected.

B

The data collected during the triggered launches highlights the robust construction of the ESELC, capable of withstanding repeated high-intensity lightning strikes: the average current measured in a lightning strike triggered at Cachoeira Paulista is 27kA, with an average of 6 return strokes (greater than 3kA).

C

The scientists were able to collect invaluable tropical storm data over the course of each test campaign, while pursuing research projects, involving - among others - the study of electromagnetic interference on overhead telecommunications lines. Video footage taken using high-speed cameras has enabled researchers to collate an unprecedented series of images and other information on the build-up of a lightning strike (see photos of downward stepped leaders taken from video footage).

Conclusion

The Cachoeira Paulista facility in Brazil means it has been able to pursue testing of ESELCs under real lightning conditions that began in Florida in 1993.

These test campaigns provide a host of invaluable information in terms of both fundamental and applied research:

- even today, the uncertainty that shrouds the phenomenon of lightning continues to fascinate the scientific community. New information collected over the course of each test campaign is regularly provided, thereby contributing to a better understanding of the lightning phenomenon.
- the campaigns also form an essential part of the ESELC product development strategy. Testing allows the ESE range of lightning conductors and other lightning protection components to be fully evaluated and developed under real storm conditions.