FRANCE PARATONNERRES®

LA RÉFÉRENCE

IONIFLASH *MACH*® NG

Early Streamer Emission Air Terminal

International patent, French technology and production

Qualifoudre INERIS N° 05116B729019

ISO 9001 BUREAU VERITAS Certification

FRANCE PARATONNERRES®
LA RÉFÉRENCE

EARLY STREAMER EMISSION

40 years of experience for advising you

in your projects of prevention and protection against lightning and electrical damages

THE QUALITY OF THE CONTACT AND THE REACTIVITY OF A TEAM LISTENING TO YOU

- A technical support dedicated to our customers
- Reliable and reactive answers given within 24 to 48 hours
- Shipment of the material within 24 to 48 hours

AN ECO-RESPONSIBLE COMPANY

- Carbon impact results

PERIMETER	Results IONIFLASH MACH (T eq CO_2)	Results IONIFLASH MACH + accessories (T eq CO_2)
Restricted	99.2	115.2
Life cycle	93.6	109.6
Global	151.2	167.2

- Results per ESE air terminal

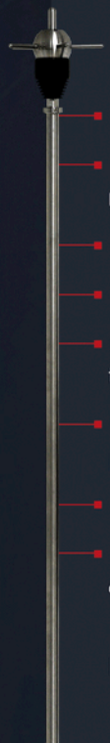
PERIMETER	Results IONIFLASH MACH (kg eq CO_2/unit)	Results IONIFLASH MACH + accessories (kg eq CO_2/unit)
Restricted	33	38
Life cycle	31	37
Global	50	58

Data collected within the framework of the Carbon Assessment 2008/2009 of France Paratonnerres

MACH **NG15** MACH **NG25**

RELIABILITY OF THE IONIFLASH *MACH*® NG

Five solutions adapted to all your projects



- Higher efficiency demonstrated (High Voltage Laboratories results on request)
- Double security thanks to the two spark gaps dimensioned to have an operating range adapted to the frequential spectrum of the lightning (0 to 10 MHz)
- Electrical and physical continuity from the IONIFLASH tip to the earth
- Reliable and autonomous device even in extreme climatic conditions
- Support tools for study and installation (software IONEXPERT 4000®, operational tests devices IONICHECK®, IONICOUNT® impulse counter)
- **10 years guarantee. Lifetime of 35 years: all material in stainless steel 316L, protective fairing**
- Lowest carbon impact 33 kg eq. Co2 / unit
- Tested in accordance to the Standards NFC 17-102 Edition 2011, EN 50164-1, IEC 60060-1, UNE 21186, production conformed to NF EN ISO 9001 : 2015 Standard

For working steps of the IONIFLASH MACH®, see technical data sheet

AIR TERMINAL IONIFLASH *MACH*® NG

CERTIFIED

MACH **NG30** MACH **NG45** MACH **NG60**

France Paratonnerres is a world-wide company recognized for its expertise,

and the quality of its products since more than 40 years. Inventor and producer of a technology of the latest generation, the Early Streamer Emission Air Terminal IONIFLASH MACH® NG.

POLE of RESEARCH
- Applied research
- In situ tests
- Incident expertise

RESEARCH DEPARTMENT
- Lightning Risk Analysis
- Lightning Technical Studies
- Checkings of lightning installations
- Training sessions (governmental authorization)

POLE of DEVELOPMENT
- Member of the Standard Committees (AFNOR-UTE/CENELEC/CEI)
- Actor in the scientific research world
- International conferences, workshops, scientific reviews
- Partnerships with Laboratories

PRODUCTION and TECHNICAL DEPARTMENT
- Studies and production of specific solutions adapted to complex problems
- Removal, dismantling, storage of radioactive early streamer emission air terminals, ASN autorisation

COMMERCIAL DEPARTMENT
- Trilingual team
- Rigour, reliability of service
- Reactivity

QUALITY
- ISO 9001
- Qualifoudre

INTERNATIONAL REPRESENTATION
- in more than **70** countries

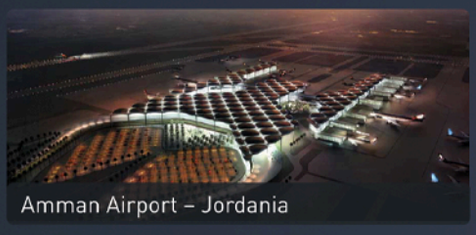
OUR REFERENCES

40 YEARS OF EXPERIENCE WITH PRESTIGIOUS REFERENCES

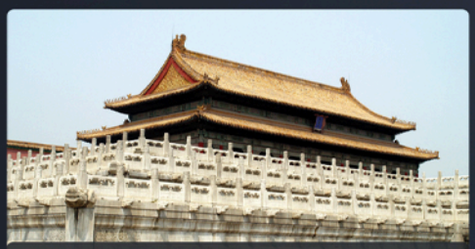
More than **20 000 protected sites**


Cathedral Notre Dame de Paris – France


Photovoltaic Central – France


Amman Airport – Jordania


Ariane 5 space rocket launch pad – Kourou - Guyana


Beijing Forbidden City – China


Cable ship - Atlantic

FRANCE PARATONNERRES, A WORLD-WIDE COMPANY

GEOGRAPHIC LOCATION


France Paratonnerres is located in Limoges (87) at
1 hour from Paris by plane and 3 hours from Paris by train

France Paratonnerres has its own Research and Development Department and devotes a significant budget to the innovation through strong partnerships with Scientific Laboratories and Research Centers.

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DISTRIBUTOR

THE TECHNOLOGY IONIFLASH *MACH*® NG

LIGHTNING : A NATURAL PHENOMENON

Lightning is a natural phenomenon which occurs in a violent and unpredictable way with a recurrence increased in certain areas of the globe. It contributes to the electric stability of the earth.

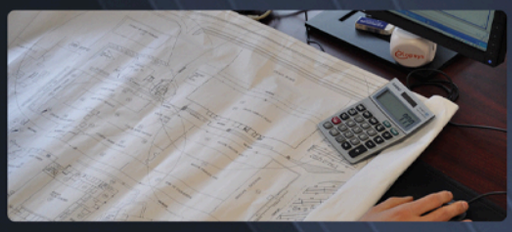
CONSEQUENCES

Besides the fact that lightning causes many deaths, it represents billion euros of losses for the economy of the countries.

SOLUTION

The IONIFLASH® : the efforts of the R&D Department made it possible to develop and to improve the performances of its technology with the achievement of the IONIFLASH MACH® (registered patent).

THE FIRST WORLD TECHNOLOGY WITH PATENTED SPHERICAL OPTIMIZATION



The IONIFLASH MACH® is the first Early Streamer Emission Air Terminal in the history of the lightning protection which transposes the last research results and tests in real conditions of lightning. Long research studies [1] have highlighted the superiority of the performance of a rounded tip compared to a sharp rod, both positioned in the same conditions, in laboratory [2] and in real conditions of lightning [3,4].

The rounded tip shows a much higher efficiency.

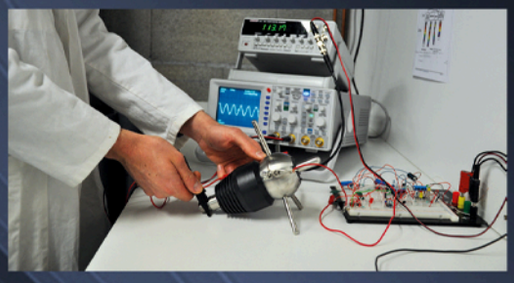
Thanks to the design of the IONIFLASH MACH®, the concentration and the electric field lines control at the top of the air terminal amplify and regulate [2] considerably the ionization, starting factor of the propagation of the upward leader.

The connection process of the upward leader with the downward leader becomes intensified, synchronically supplied by the principal spark gap and the auxiliary spark gap.

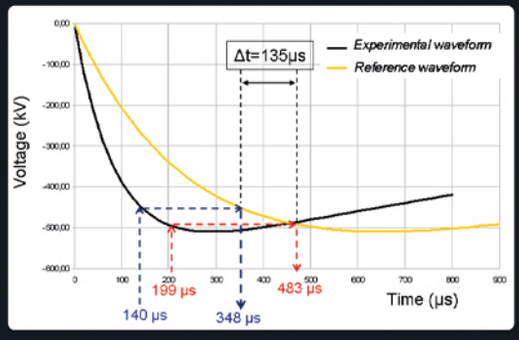
The IONIFLASH MACH® tip in ellipsoid of revolution and the conception of the spark gaps working in extreme climatic conditions demonstrate [4,5] the precursory and regular character of the propagation of the IONIFLASH MACH® upward leader, connecting and ensuring the capture of the downward leader to the earth.

Indeed, for a level of electric field given, the sharp rods produce too many charges compared to the rounded tips.

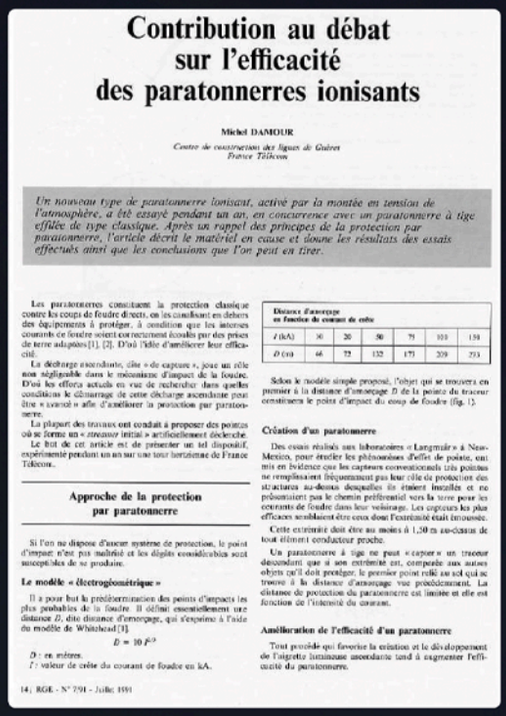
This surplus bound in a plasma then will contribute to mask the sharp rod from the downward leader effects and will reduce strongly the connection process and the capture of the downward leader. Thus, the superiority of the spherical tip of the IONIFLASH MACH® is shown.



[1] International Patents France Paratonnerres (1987, 2009)
[2] National Center of Research Laboratory – Tests under new standard NFC 17-102 2011 (M. Troubat)
[3] Institute of Mining and Technology New Mexico C.B. Moore, William Rison, James Mathis and Graydon Aulich "Lightning rod Improvement studies"
[4] France TELECOM – Tests in real conditions on hertzian pylon of 70 meters – Alt. 819 m.
"Contribution au débat sur l'efficacité des paratonnerres ionisants" (Eng. M. Damour)
[5] SAS France Paratonnerres – In situ tests of IONIFLASH at SUPERBESSE (A. Mottin)



Results of Laboratory tests NFC 17-102



Contribution au débat sur l'efficacité des paratonnerres ionisants

Michel DAMOUR

Centre de constructions des lignes de Guéret
France Télécom

Un nouveau type de paratonnerre ionisant, activé par la montée en tension de l'atmosphère, a été essayé pendant un an, en concurrence avec un paratonnerre à tige effilée de type classique. Après un rappel des principes de la protection par paratonnerre, l'article décrit le matériel en cause et donne les résultats des essais effectués ainsi que les conclusions que l'on peut en tirer.

Les paratonnerres constituent la protection classique contre les coups de foudre directs, en les canalisant en dehors des équipements à protéger, à condition que les intenses courants de foudre soient correctement écoulés par des prises de terre adaptées [1], [2]. D'où l'idée d'améliorer leur efficacité.

La décharge ascendante, dite « de capture », joue un rôle non négligeable dans le mécanisme d'impact de la foudre. D'où les efforts actuels en vue de rechercher dans quelles conditions le démarrage de cette décharge ascendante peut être « contrôlé » afin d'améliorer la protection par paratonnerre.

La plupart des travaux ont conduit à proposer des pointes où se forme un « streamer initial » artificiellement déclenché.

Le but de cet article est de présenter un tel dispositif, expérimenté pendant un an sur une tour hertzienne de France Télécom.

Distance d'amorçage en fonction du courant de crête

I (kA)	30	20	50	75	100	150
D (m)	66	77	132	171	209	255

Approche de la protection par paratonnerre

Si l'on ne dispose d'aucun système de protection, le point d'impact n'est pas maîtrisé et les dégâts considérables sont susceptibles de se produire.

Le modèle « électrogéométrique »

Il a pour but la prédétermination des points d'impacts les plus probables de la foudre. Il définit essentiellement une distance D, dite distance d'amorçage, qui s'exprime à l'aide du modèle de Whitehead [1].

$$D = 10\,I^{0,65}$$

D : en mètres.
I : valeur de crête du courant de foudre en kA.

Selon le modèle simple proposé, l'objet qui se trouvera en premier à la distance d'amorçage D de la pointe du traceur constituera le point d'impact du coup de foudre (fig. 1).

Création d'un paratonnerre

Des essais réalisés aux laboratoires « Langmuir » à Nouveau-Mexico, pour étudier les phénomènes d'effet de pointe, ont mis en évidence que les capteurs conventionnels très pointus ne remplissaient fréquemment pas leur rôle de protection des structures au-dessus desquelles ils étaient installés et ne présentaient pas le chemin préférentiel vers la terre pour les courants de foudre dans leur voisinage. Les capteurs les plus efficaces semblaient être ceux dont l'extrémité était émoussée.

Cette extrémité doit être au moins à 1,50 m au-dessus de tout élément conducteur proche.

Un paratonnerre à tige ne peut « capter » un traceur descendant que si son extrémité est, comparée aux autres objets qu'il doit protéger, le premier point relié au sol qui se trouve à la distance d'amorçage vue précédemment. La distance de protection du paratonnerre est limitée et elle est fonction de l'intensité du courant.

Amélioration de l'efficacité d'un paratonnerre

Tout procédé qui favorise la création et le développement de l'aigrette ionisante ascendante tend à augmenter l'efficacité du paratonnerre.

14 | RGE - N° 7/91 - Juillet 1991

Results published in IEEE

Qualifoudre INERIS N° 05116B729019

ISO 9001 BUREAU VERITAS Certification

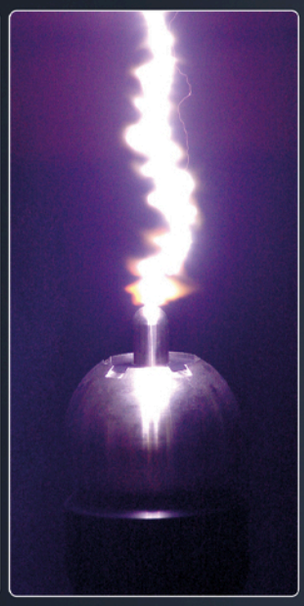
LABORATORIES TESTS

MAIN TESTS

The first ESE air terminal which presents the double performance of conformity to all the tests of the NFC 17-102 Edition 2011 Standard and IEC tests.

- The NFC 17-102 Edition 2011 is the European Standard used as the reference for the prescription and installation of the ESE air terminals.
- The appendix C of the NFC 17-102 Standard requires a complete sequence of consecutive tests carried out with the same ESE air terminal, in conformity in particular with the Standards EN 50164, EN 62305.
- The electrical Standard IEC 60060-1 prescribes the test of insulation in rain conditions, applied to high voltage equipments.

These tests were defined out of France Paratonnerres company, in independent, governmental or accredited COFRAC Laboratories.

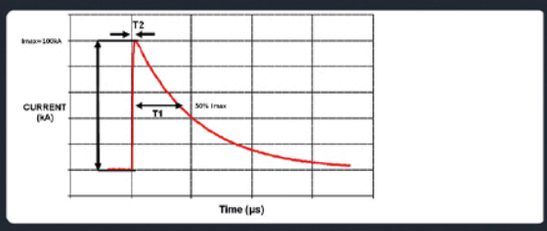


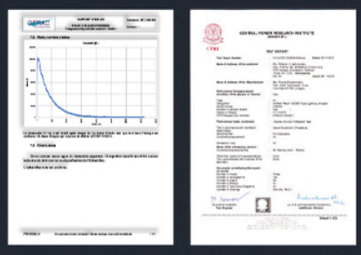
TESTS SEQUENCE

According to NFC 17-102 Edition 2011 (Appendix C)

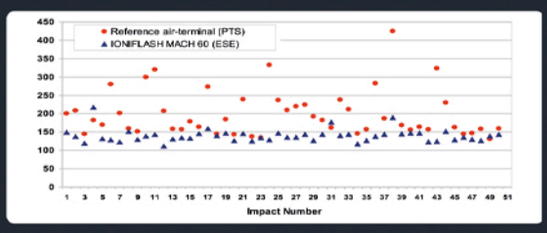
RESULTS AND TEST REPORTS

Test according to EN 50164-1, prescribed by NFC 17-102 ed.2011 High current test 100 kA (waveform 10/350)

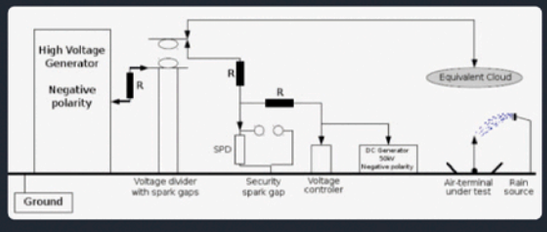




Early streamer emission test according to EN 61180-1, prescribed by NFC 17-102 ed. 2011

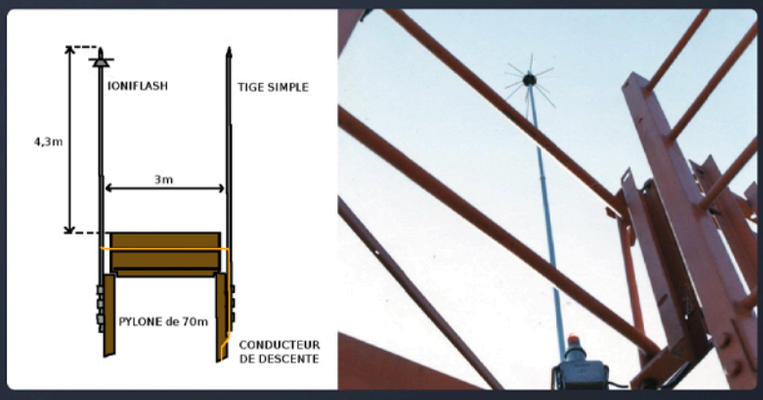


Insulation test according to IEC 60060-1



IN SITU TESTS – Tests in real conditions of lightning

Several test campaigns were carried out between 1988 and 2011 in France and abroad. Two of them still continue. The results of the first tests (below) on the IONIFLASH were published and are available at the IEEE.



ESE air terminal compared with simple rod

IN SITU TEST - FRANCE TELECOM

PUYBEAUBIER SITE (FRANCE) – ALT. 879 METERS – JUNE 1988

Hertzian pylon of 70 meters – very struck by lightning. Installation of the IONIFLASH® ESE air terminal and a simple rod at 3 meters away from one another, common height of 4.30 meters at the top of the pylon.

Results recorded by France Telecom : **several impacts on the IONIFLASH® – 0 impact on the simple rod**

ESE air terminal in extreme climatic conditions

IN SITU TEST - HIGH MOUNTAIN RESORT

SUPERBESSE SITE (FRANCE) – ALT. 1804 METERS – APRIL 2009

The target : to validate the performance of the materials used, as well as the behaviour of the IONIFLASH MACH® in extreme climatic conditions :

- Winds > 150 km/h
- Temperatures : - 35°C / + 40°C
- Installation on pylon of radiotelecommunication – height of 15 meters

The mechanical resistance and in temperature of materials of the IONIFLASH MACH® in extreme climatic conditions is perfect.

The lightning strike counter IONICOUNT® records the events.

ESE air terminal compared with simple rod

IN SITU TEST

SATU MARE CHURCH (ROMANIA) – JUNE 2011

The target : to observe the early streamer emission of the IONIFLASH MACH® facing a simple rod both installed in the same conditions.

The church has two spires : the IONIFLASH MACH® is installed with equidistance of the simple rod (dimensioned such as defined in the NFC 17-102 Standard).

The lightning strike counter IONICOUNT® records the events.

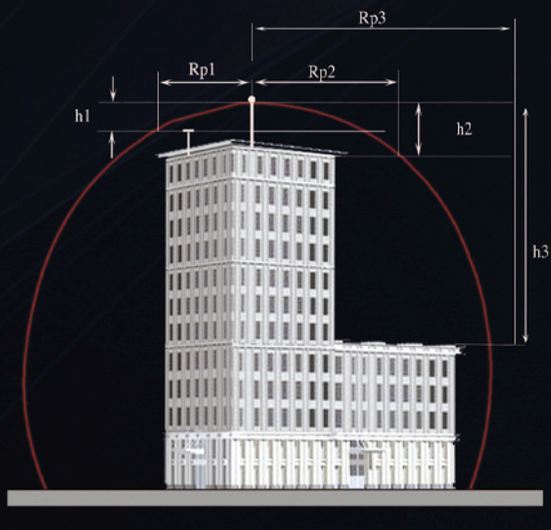
INSTALLATION STANDARDS

PROTECTION RADIUS

The protection radius (Rp) of a ESE air terminal depends of the height of its installation in relation to the surface to be protected, its early streamer emission (Δt) and the level of protection chosen.

	Height in meters	2	3	4	5	6	10	15	20	30	45	60
Level I	**MODELS**											
	IONIFLASH MACH **NG15**	13	19	25	32	32	34	35	35	34	24	
	IONIFLASH MACH **NG25**	17	25	34	42	43	44	45	45	44	37	21
	IONIFLASH MACH **NG30**	19	29	38	48	48	49	50	50	49	43	30
	IONIFLASH MACH **NG45**	25	38	51	63	63	64	65	65	64	60	51
	IONIFLASH MACH **NG60**	31	47	63	79	79	79	80	80	79	76	69
Level II	**MODELS**											
	IONIFLASH MACH **NG15**	15	22	30	37	38	40	42	44	45	42	34
	IONIFLASH MACH **NG25**	20	29	39	49	49	51	53	54	55	53	46
	IONIFLASH MACH **NG30**	22	33	44	55	55	57	58	59	60	58	52
	IONIFLASH MACH **NG45**	28	42	57	71	71	72	73	74	75	73	69
	IONIFLASH MACH **NG60**	35	52	69	86	87	88	89	89	90	89	85
Level III	**MODELS**											
	IONIFLASH MACH **NG15**	18	27	36	45	46	49	52	55	58	60	58
	IONIFLASH MACH **NG25**	23	34	46	57	58	61	63	65	68	70	68
	IONIFLASH MACH **NG30**	25	38	51	63	64	66	69	71	73	75	73
	IONIFLASH MACH **NG45**	32	48	64	81	81	83	85	86	89	90	89
	IONIFLASH MACH **NG60**	39	58	78	97	97	99	101	102	104	105	104
Level IV	**MODELS**											
	IONIFLASH MACH **NG15**	20	31	41	51	52	56	60	63	69	73	75
	IONIFLASH MACH **NG25**	26	39	52	65	66	69	72	75	80	84	85
	IONIFLASH MACH **NG30**	28	43	57	71	72	75	78	81	85	89	90
	IONIFLASH MACH **NG45**	36	54	72	89	90	92	95	97	101	104	105
	IONIFLASH MACH **NG60**	43	64	85	107	107	109	111	113	116	119	120

The level of protection is given using the NFC 17-102 Edition 2011, EN 62305-2 or UTE 17-108 guide. If the site presents a risk for the environment, the protection radius must be reduced of 40%.



For 2m ≤ h ≤ 5m

$$Rp(h) = h \times \frac{Rp(5)}{5}$$

For h ≥ 5m

$$Rp(h) = \sqrt{h(2r - h) + \Delta(2r + \Delta)}$$

where :

Rp (h) (m) corresponds to the protection radius for a stated height (h). h (m) corresponds to the height of the tip of the ESE air terminal in relation to the horizontal point passing through the top of the element to be protected.

r (m) = 20m for protection level I
30m for protection level II
45m for protection level III
60m for protection level IV

The experience shows that Δ is equal to the efficiency obtained during the evaluation tests of the ESE air terminal.

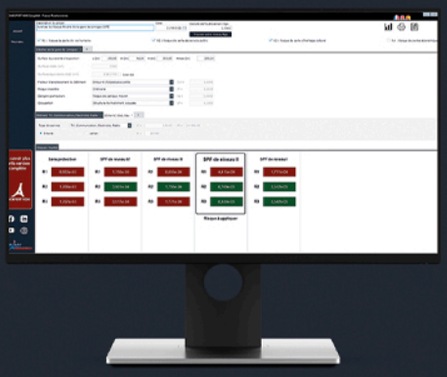
$\Delta (m) = \Delta T(\mu s) \times 10^6$

ΔT = Early streamer emission time of the ESE air terminal obtained with laboratories tests.

FRANCE PARATONNERRES

IONEXPERT4000

The IONEXPERT 4000® software developed by France Paratonnerres enables you to carry out the lightning risk analysis.



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