

To avoid Lightning accidents on ships

PDCE Lightning rod

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Lightning Suppression Systems

History of lightning on ships

Wooden Sailing ship



High impedance of mast and hull make high voltage when getting lightning

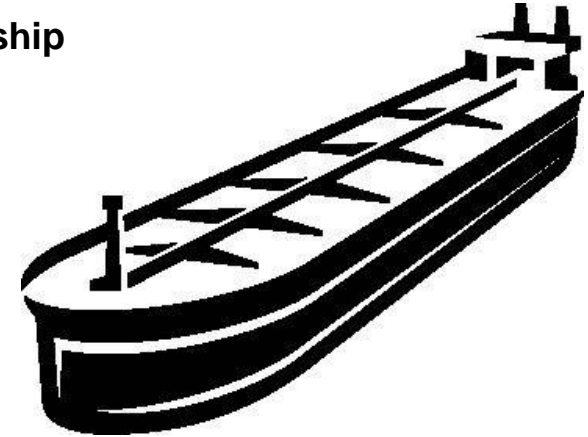
During 1799-1815, 150 ships got lightning
10 got serious damage
1 out of 18 got fire
70 sailors died

by Admiral Harris Great Britain Navy

They used pitch to prevent water comes into the ship, thus they are quite flammable

Breakdown electric field Air 35.5kV/cm
Breakdown resistance Wood 8kV/cm

Steel ship



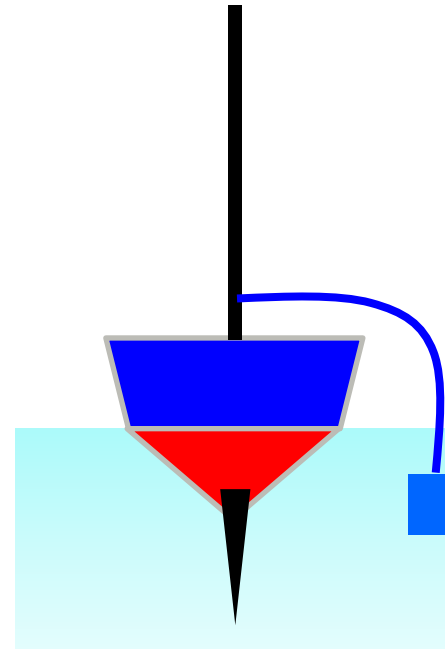
Lower impedance make lightning current easily go through, causing no fatal damage. Control has been mechanically integrated at Bridge and get less influence by lightning.

But Networking on ship make the ship weak against lightning

Lightning accidents on sailing boat

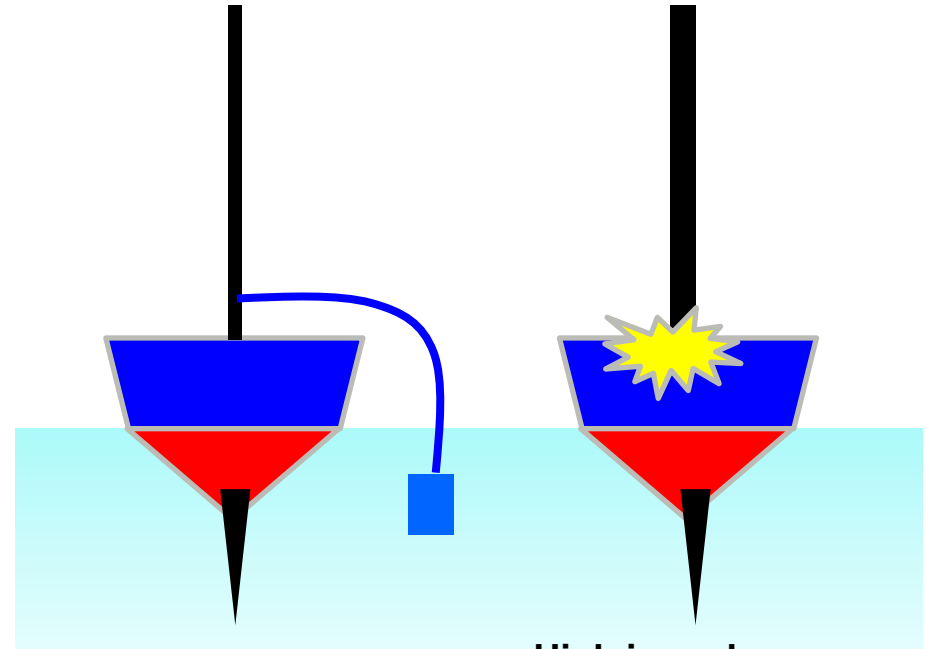


Aluminum mast should have Earth contact with sea then even FRP hull get no damage



Lower impedance get less damage

Wooden hull and wooden mast get serious damage due to high impedance



High impedance result in serious damage

What will happen if the lightning hit the ship?

Luckiness

Good

Bad



No damage

Damage for Electrical system

Damage on hull

Over 95% ?

Damage on Radio, Rader

3-5% ?

Damage on ship or Cargo

Less than 1% ?

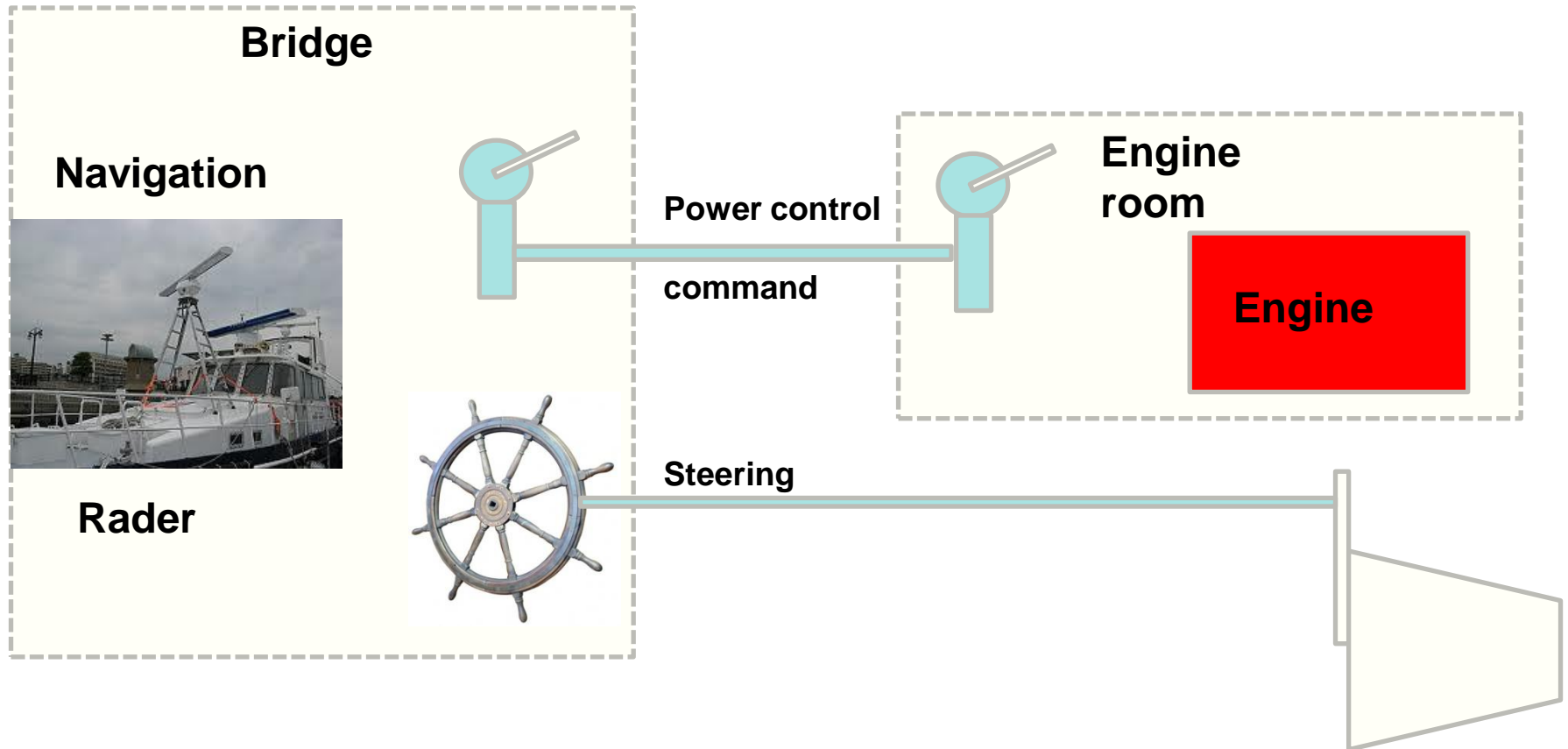
Good ←

PDCE can bring all case Lucky



Traditional control

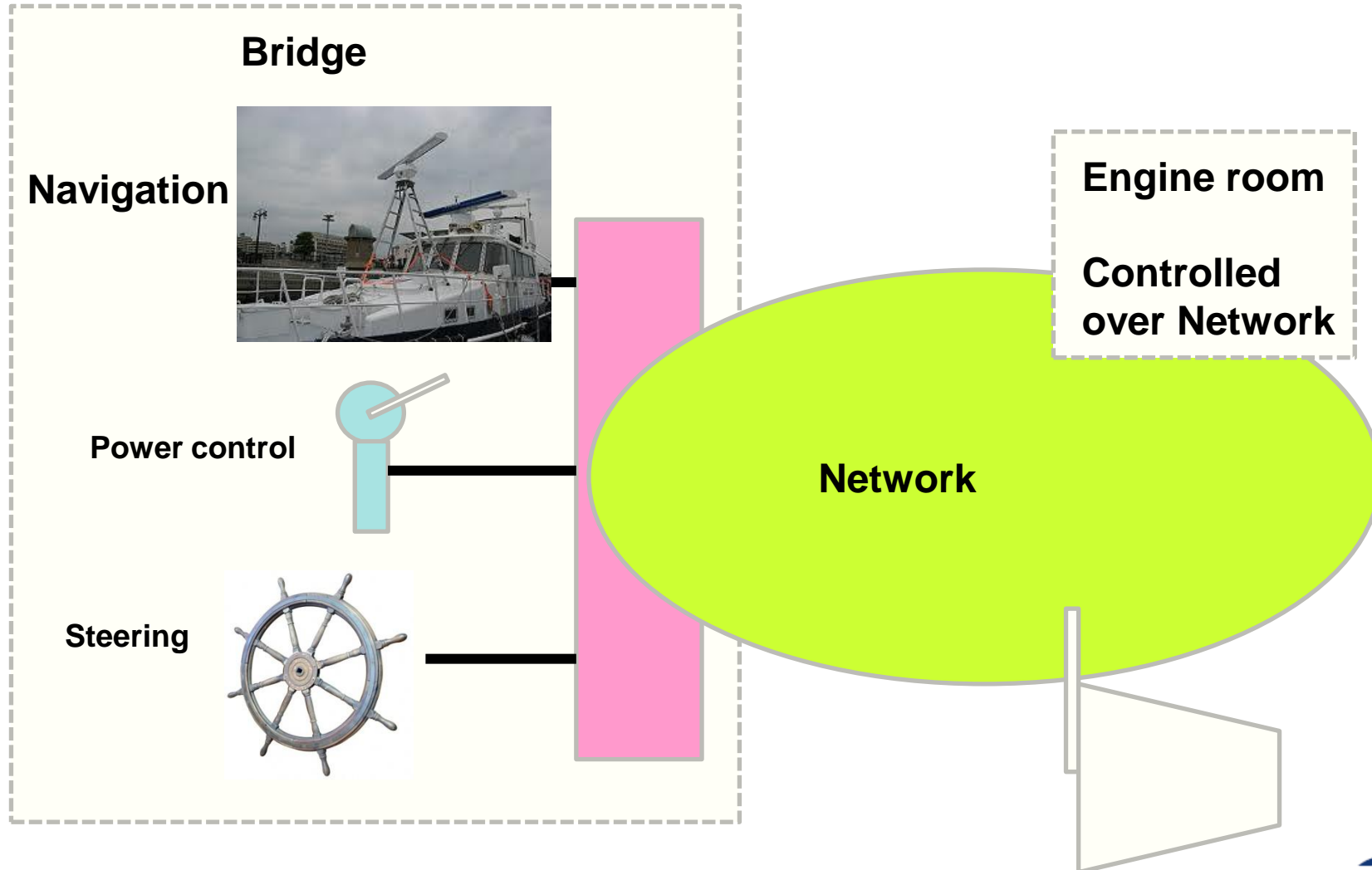
Mechanically integrated



Sensitive devices are Rader and Radio, no big damage by Lightning

In near future

Control by Network



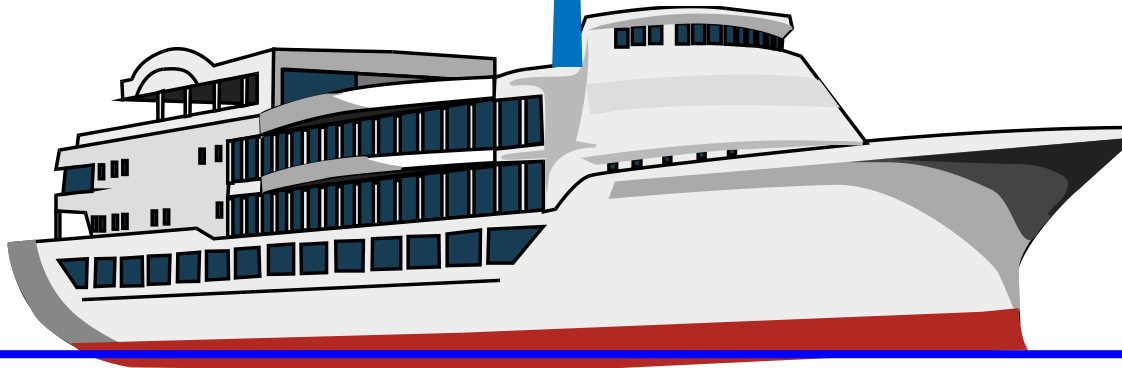
Network is very sensitive by Lightning hit

To avoid lightning hit

Highest position on ship
So as PDCE can cover whole ship

You may put it higher than GMDSS

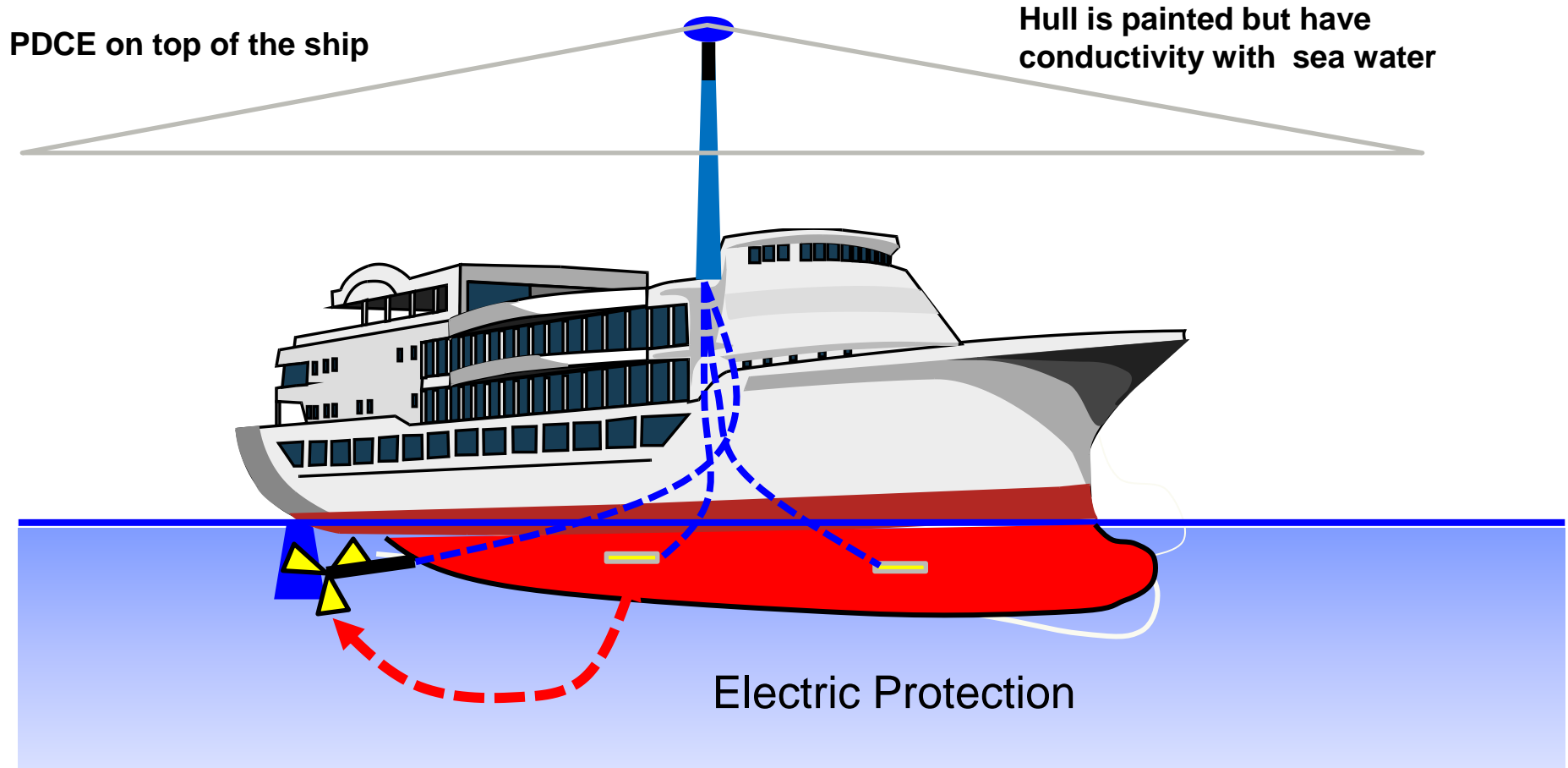
Global Maritime Distress and Safety System



Compared with wooden ships, metal ship is robust against Lightning due to lower impedance against lightning current. However, trend for Networking make ships very sensitive on Lightning

Actual case: Lightning hit ⇒ Damage on RADAR ⇒ No move at night, voyage only day time
⇒ Arrival Delay ⇒ Customer complain

How to get Grounding on ships



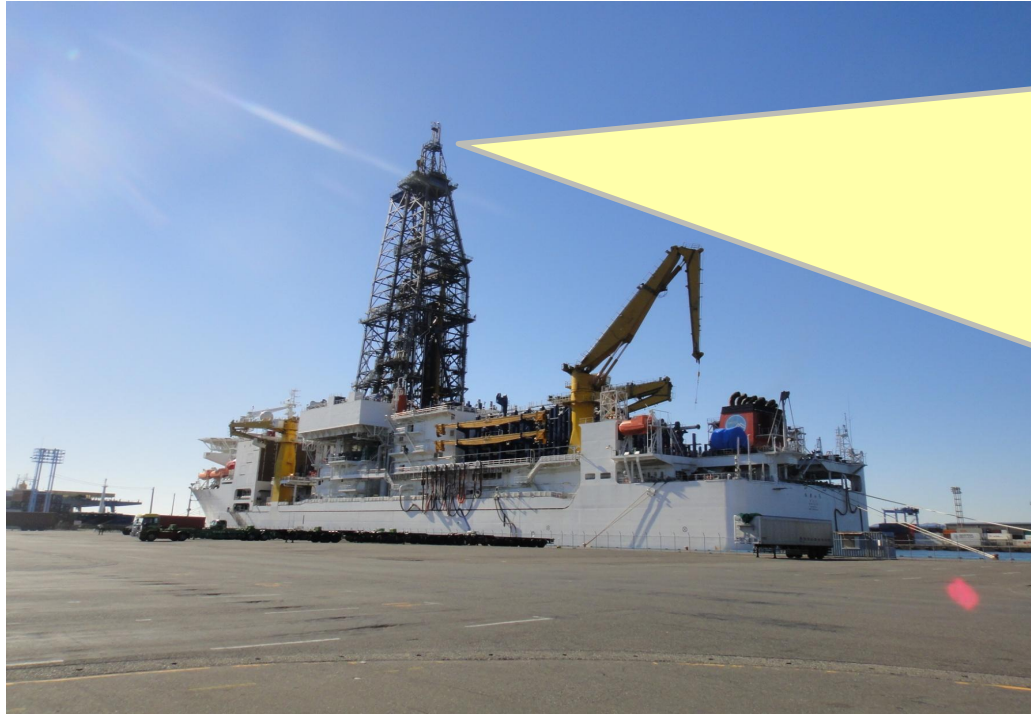
Material of Screw : Copper alloy \Rightarrow sea water [salt water] \Rightarrow Hull [steel] \Rightarrow Voltaic

Thus prevent rust by Zinc block

Around Screw propeller is almost battery \Rightarrow Hull and seawater has conductivity

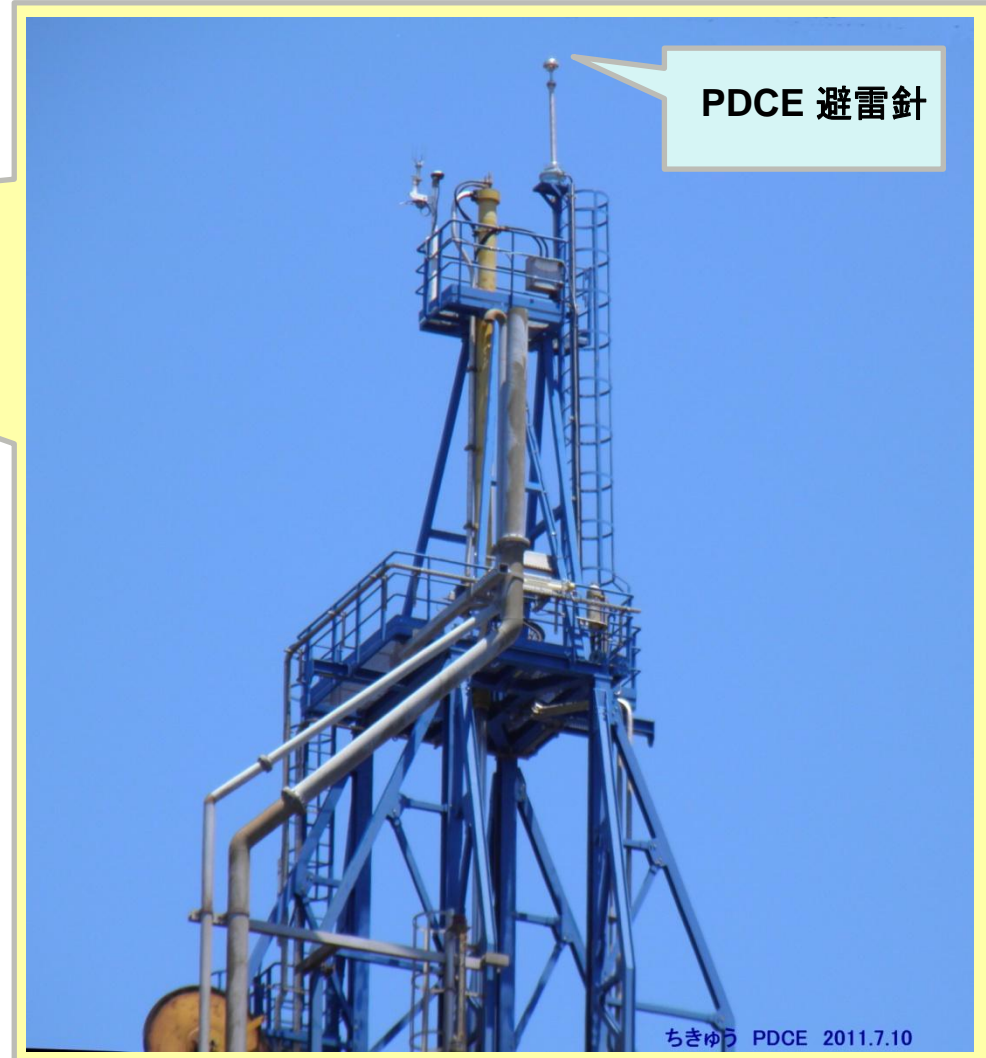
Actual usage Drilling ship 「CHIKYUU」

120m Drilling tower above sea level



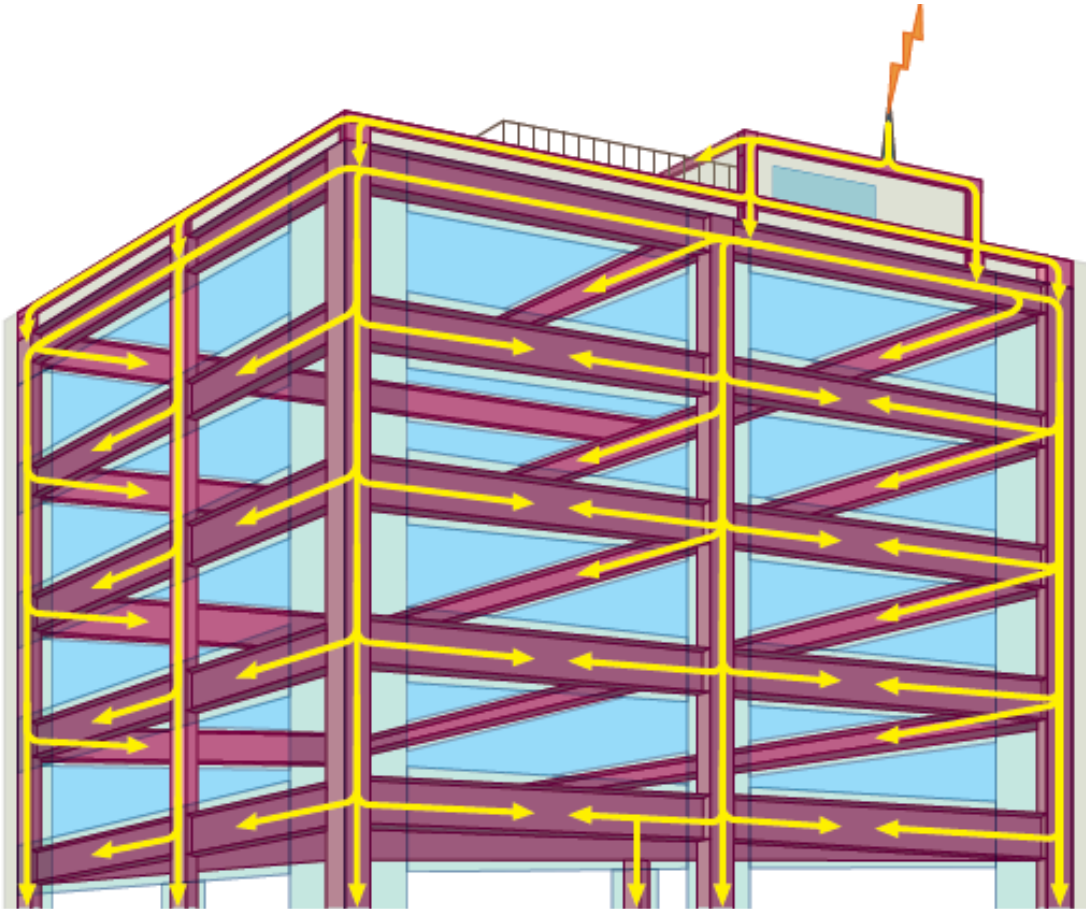
2011/07 till 2012/02
Drilling work at Srilanka

“So may lightning hit on sea level near our ship but none for our ship”



Of no use to guide the lightning into the rod

Big side effect remain on office building nowadays



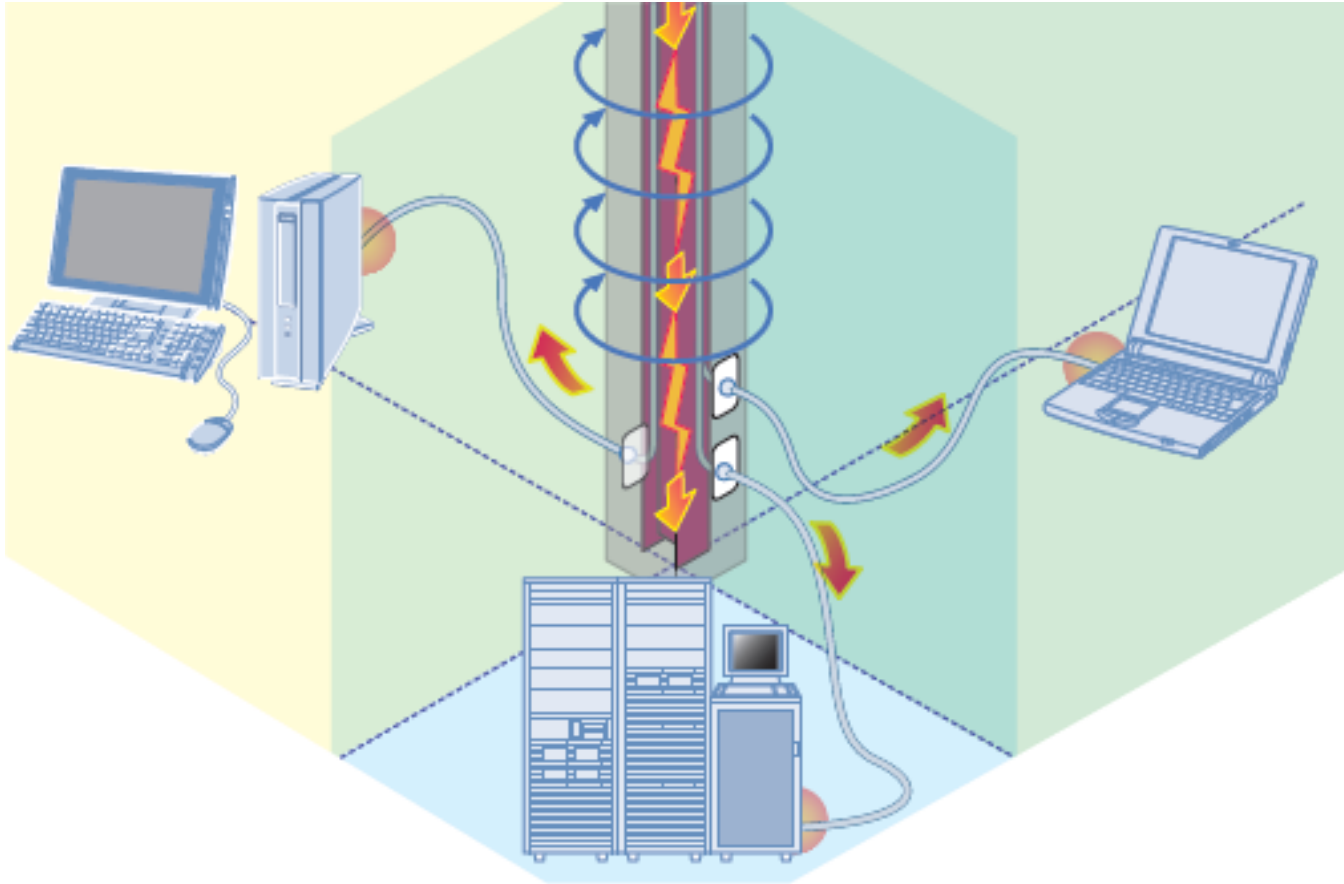
90% of office building use structure for lightning conductor

Lightning current flow over the structure, making strong Electromagnetic field

Main purpose of the lightning rod is to protect the building, not electro facility of the building.

Electro network can not be protected by Lightning rod

Side effect caused by lightning current



So many cabling in a building

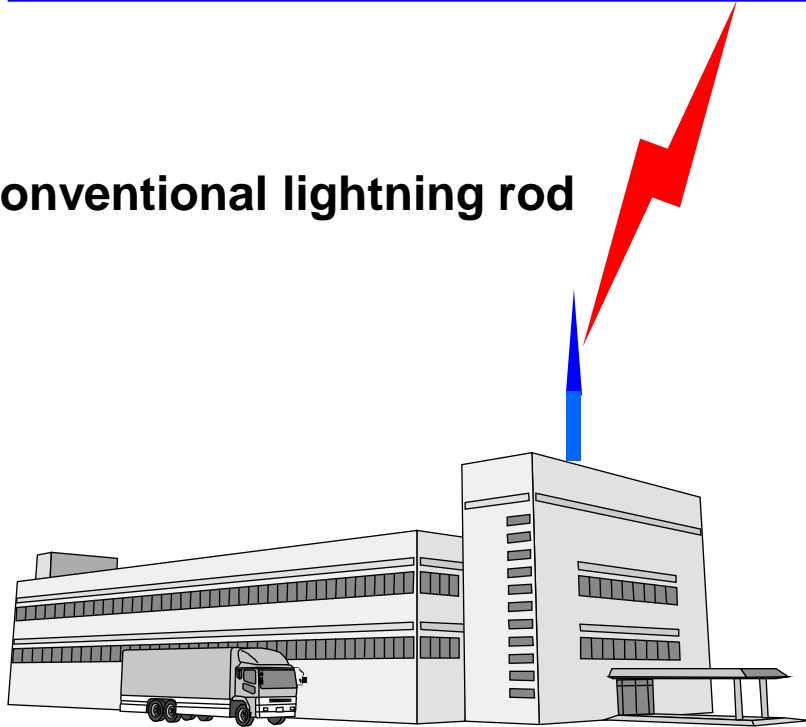
Power
Lighting
Elevator
Information Network
Security
Building management
Pumping
Etc..

Strong current by lightning introduce current on cable near by.



Merit to avoid lightning hit by PDCE

Conventional lightning rod

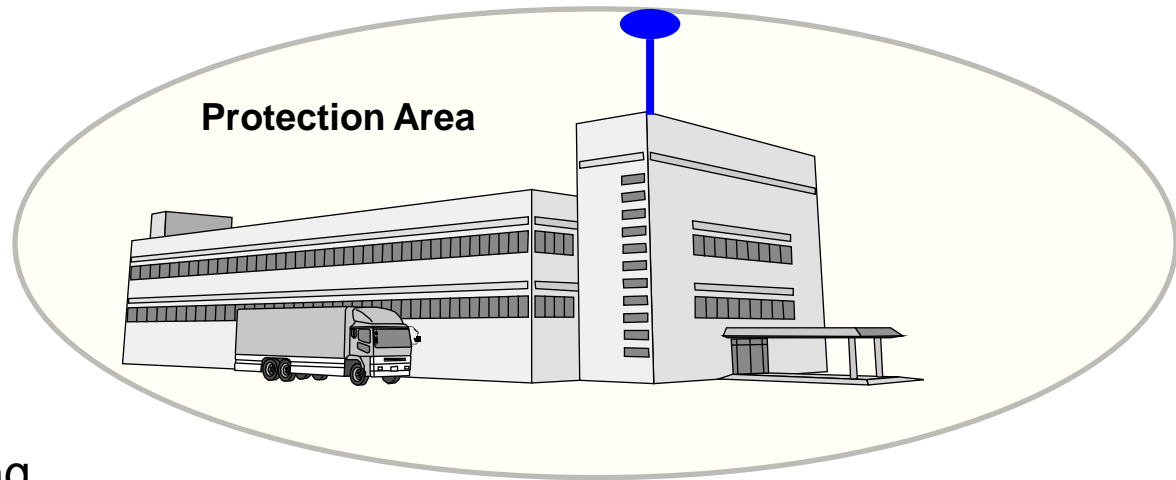


Lightning rod ⇒ To protect the building
but not the facilities



Getting lightning cause damage to the
facilities

Building protected by PDCE



No lightning hit means no trouble

Why anti-lightning hit for ship ?

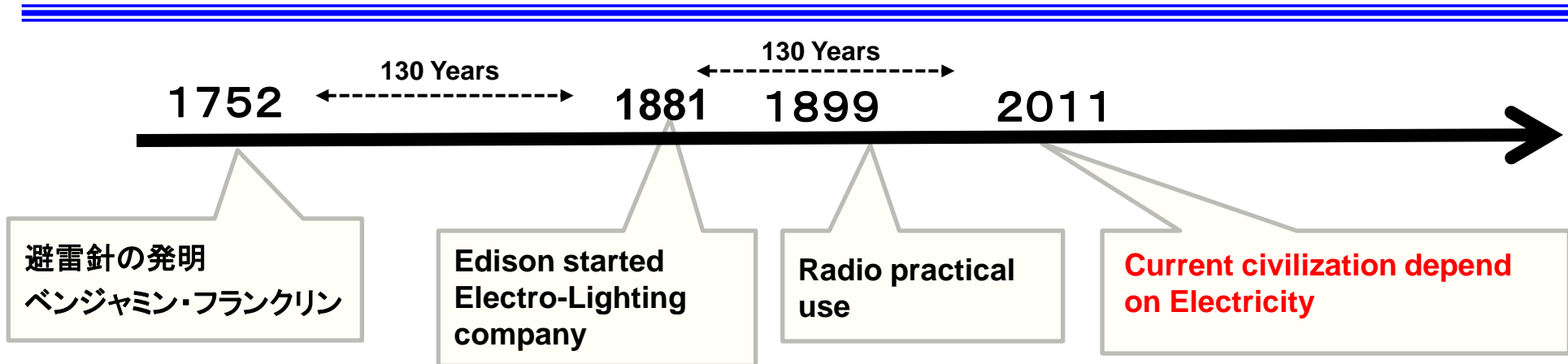
Lead the trend of the world

- ① Background 1 : Number of lightning increase world wide
- ② Background 2 : Ships use more Network on it. It means less robust for the lightning hit

- ① Must not stop by lightning hit
- ② Suspension of voyage make big social effect
- ③ Ship move around the world. Some region must have hard lightning
- ④ It is owner's choice. But shipbuilders must provide solution at least
- ⑤ Damage by lightning may become serious environmental problem

History of Lightning rod

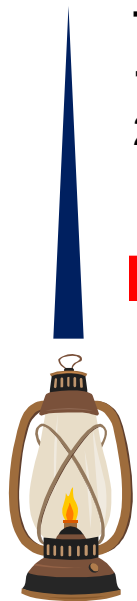
Problem of side effect



Franklin Rod

Two problems

1. Big current still cause problem on the ground
2. Can not catch 100%



Oil Lamp

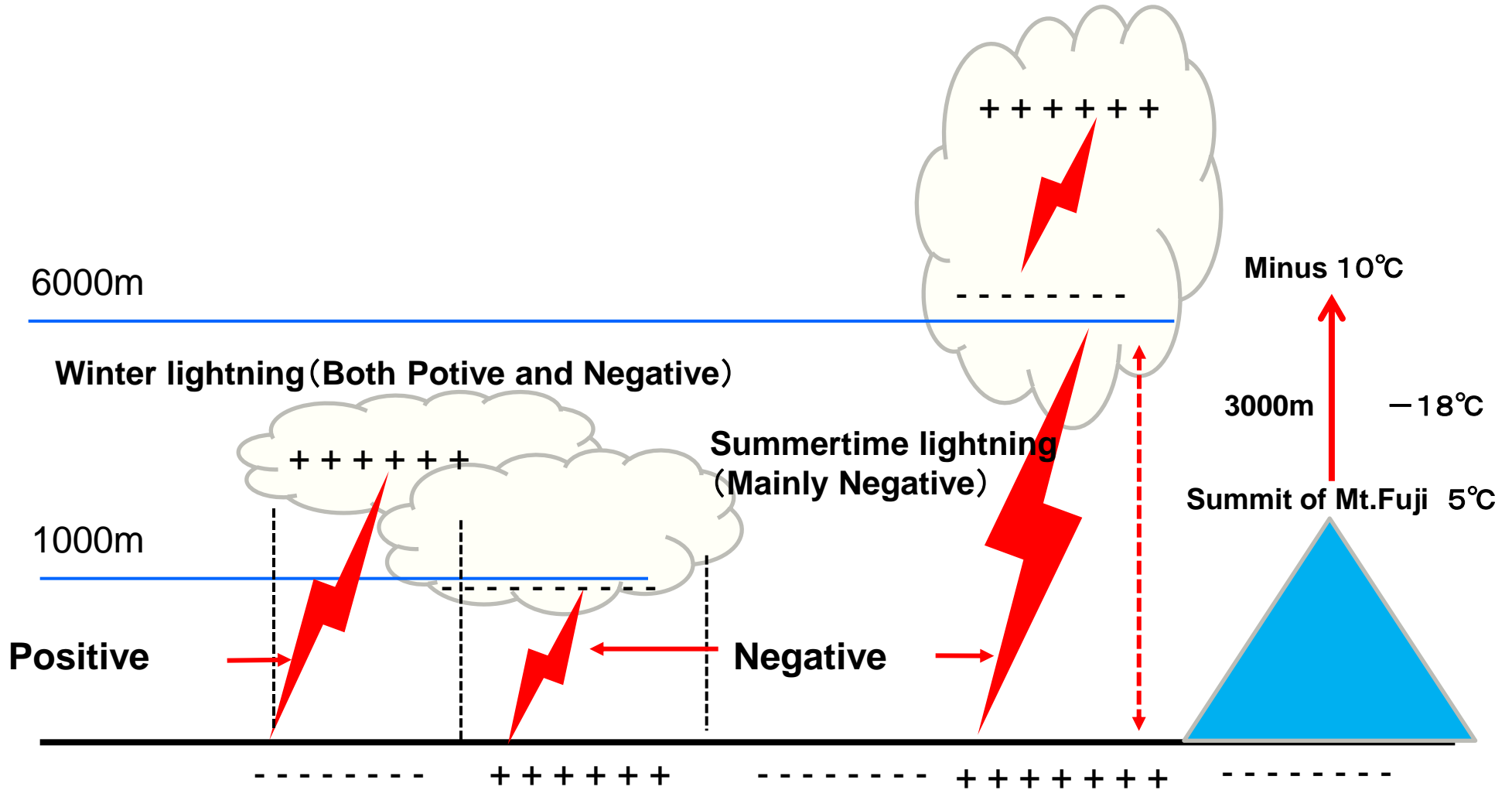
In old days they had non electrical goods thus had no side effect

Why people still rely on 260 years old technology ?



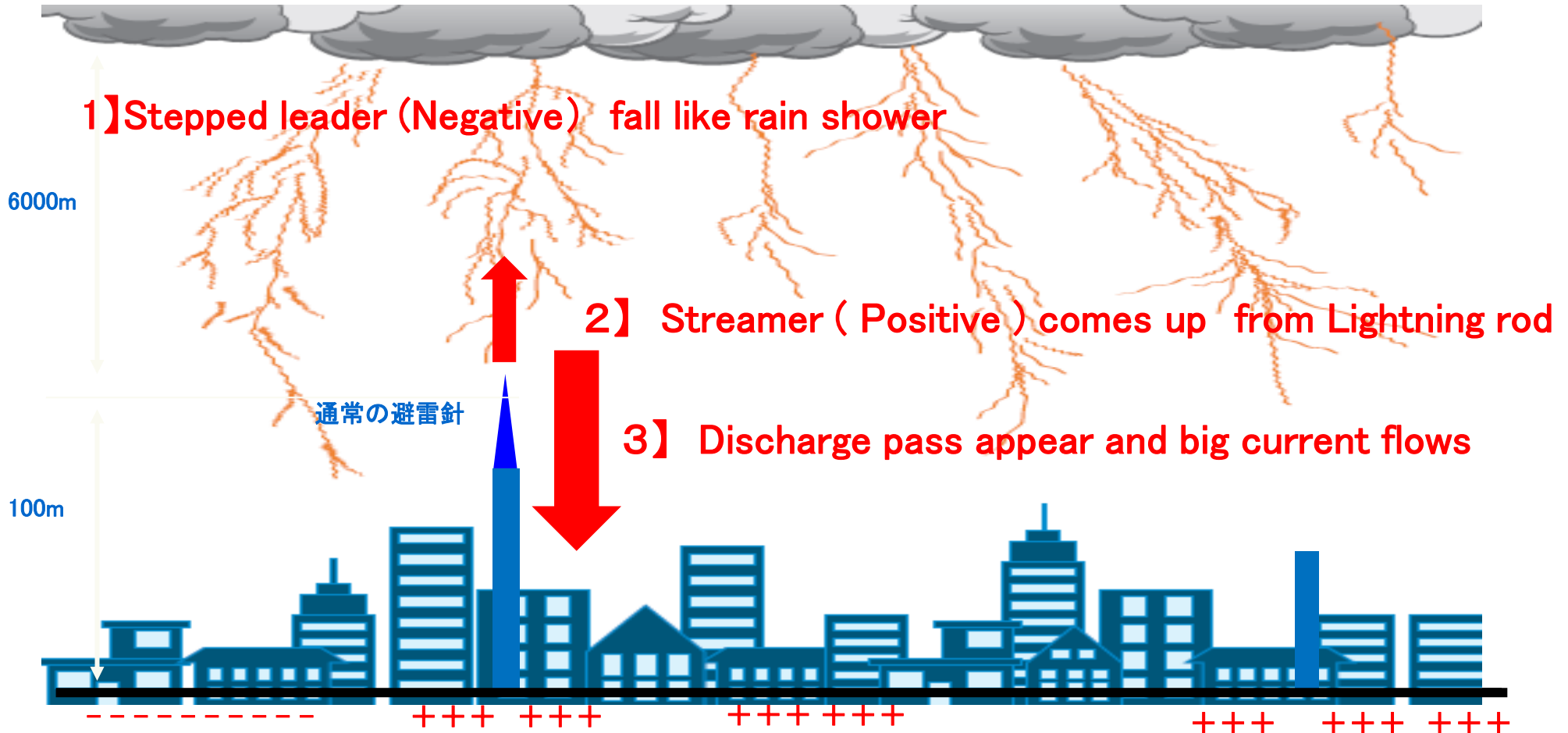
Lightning is not only one kind

There are so many kind



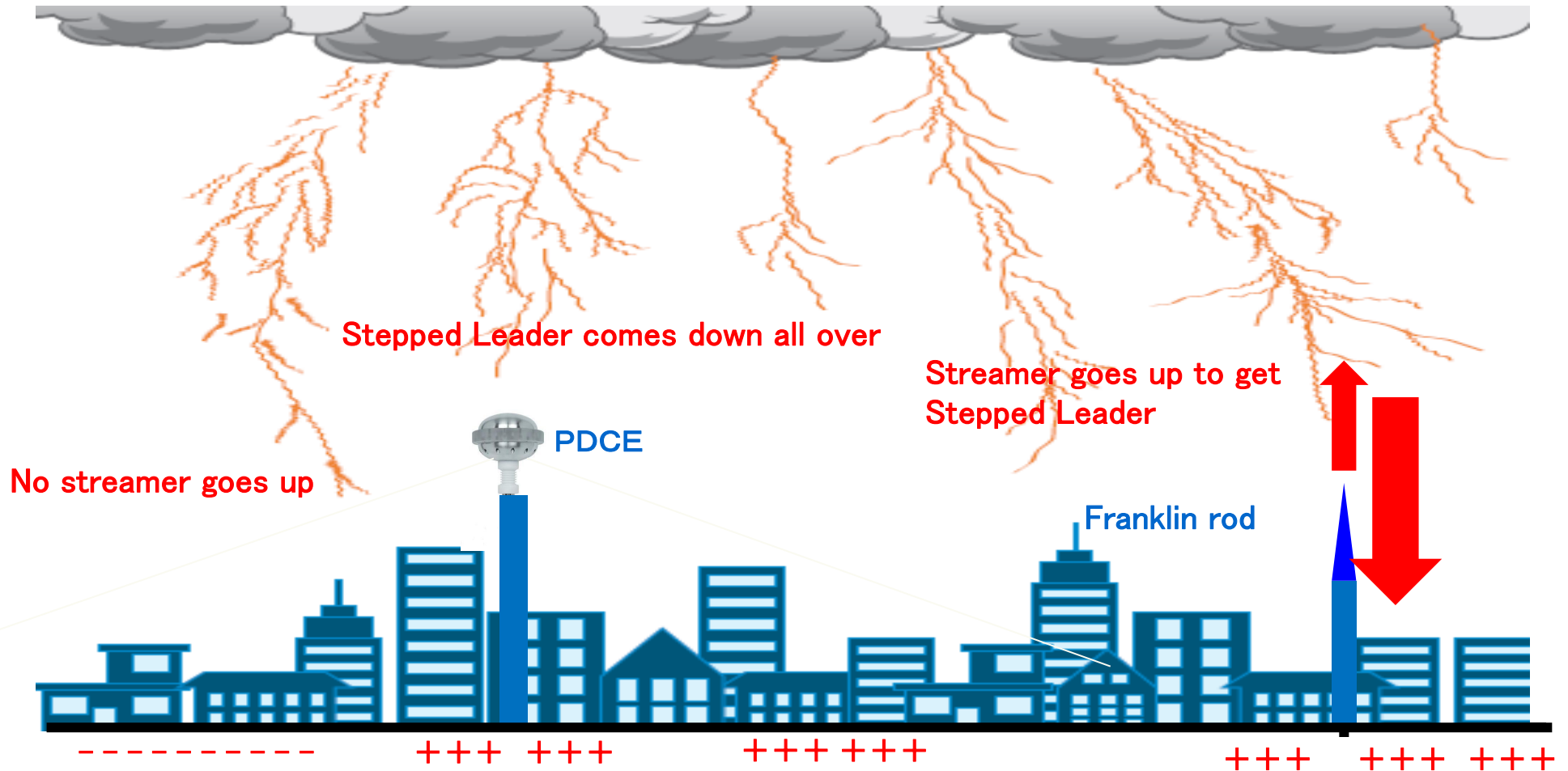
Surface of the ground or ocean has Negative charge but lightning crowd induce positive

How conventional lightning rod works?



Principle of PDCE

Difference with Franklin Rod



Stepped Leader comes down all over

Streamer goes up to get Stepped Leader

No streamer goes up

PDCE

Franklin rod

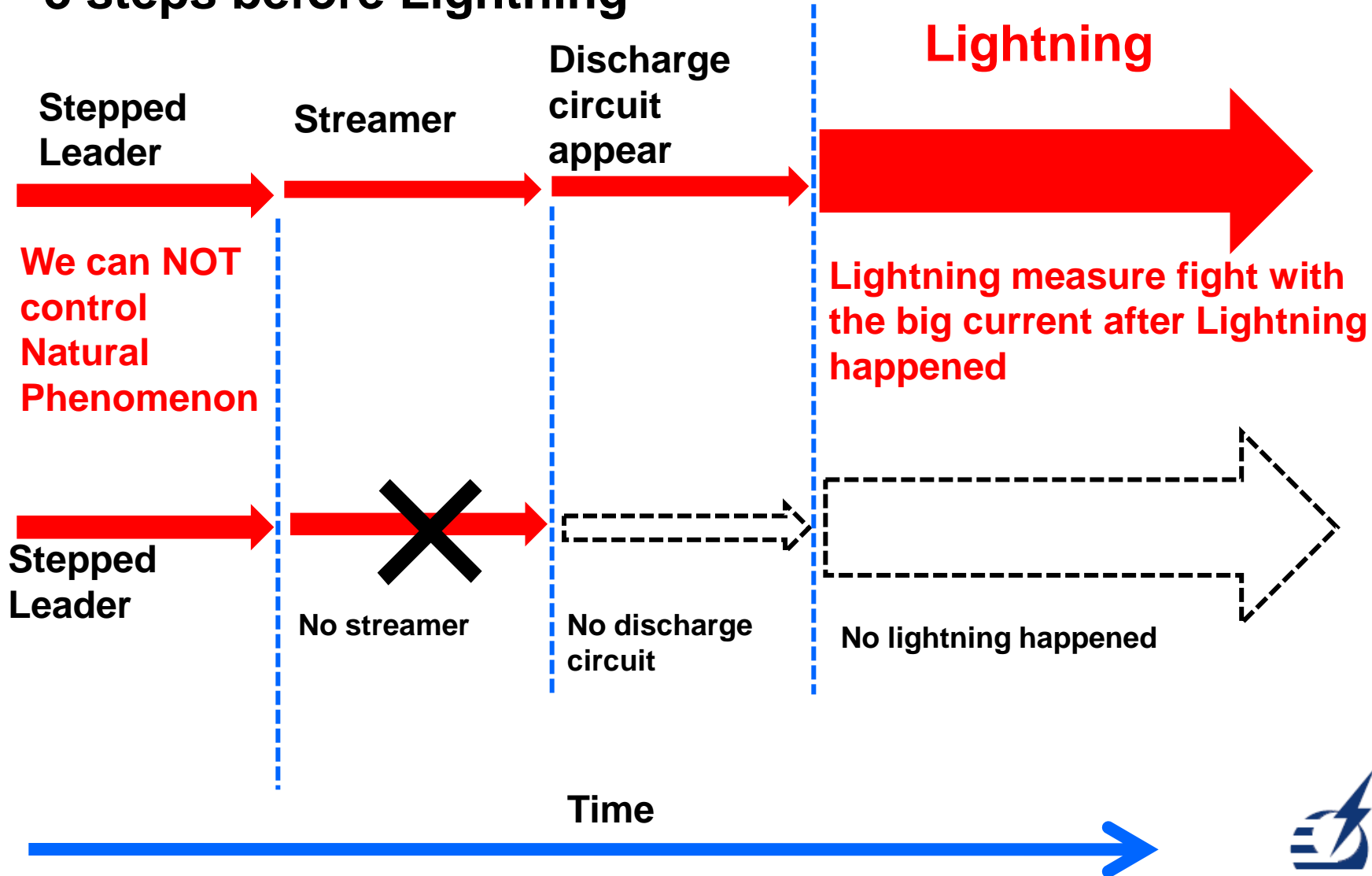
Two reason why not receive Lightning

- 1) Two electrically separated part: Upper with Negative and Lower with Positive
- 2) Round surface make no Streamer

Principle of PDCE (2)

Time sequence

3 steps before Lightning



Confirmed by 3rd party Test Lab.



Bureau VERITAS examined 200 places of PDCE installation in France and Spain for 5 years data and confirmed that no lightning hit near by PDCE

Lightning positioning data has 200m of tolerance

But with error analysis the effect is meaningful

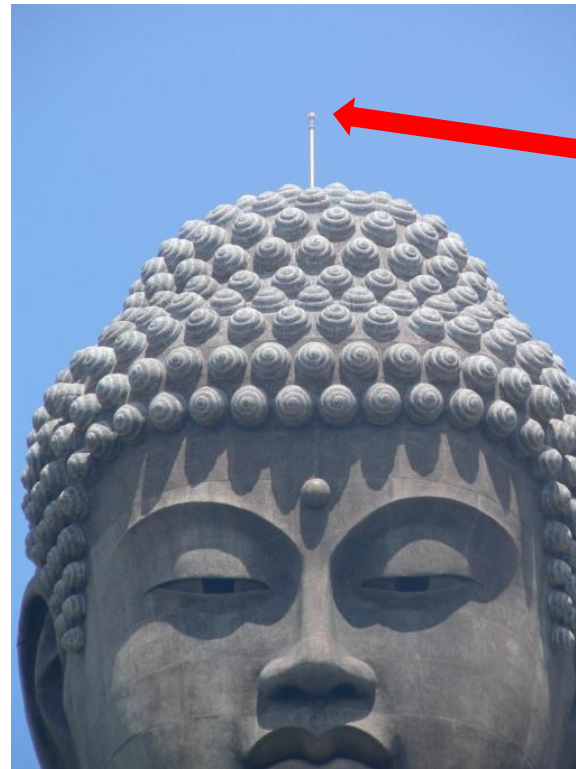


Installation case 1 Tall Buddha stature 120m



120m height is the tallest bronze statue in the world

Elevator goes up to 85m height, which damaged by lightning



PDCE

Keep folks safe even in
Lightning shower.

Installation case 2. The Earth Drilling Ship [Tickyu]



In voyage to Sriranka during July 2011 till Feb 2012, they observed many lightning hit to the sea surface but none to the ship with 120m height tower

Lot of Science devices in the ship are very sensitive with Lightning current



PDCE-Magnum (Marine) for ships



No Power needed

Grounding is must

PDCE-Marine

Mechanical strength improved for vibration on ships

Weight 13kg



Where should we place PDCE



Influence of Lightning

Damage on Rader ⇒ Voyage at night impossible ⇒ Arrival delayed

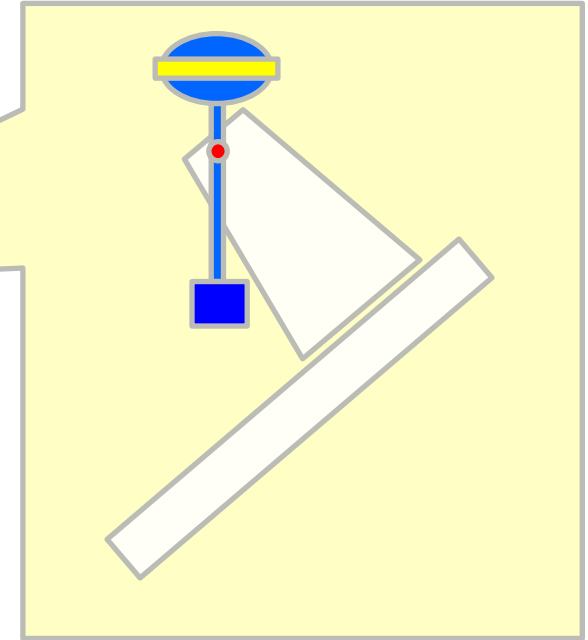
Catch fire on inflammable ⇒ Serious accident

Fishing Boat

For safety of fishing folks



PDCE on where? All points high from sea level (1)



PDCE always point upward

PDCE on where? All points high from sea level (2)



PDCE on where? All points high from sea level (3)



Used at Mexical
Gulf

Lightning which did not hit a tower protected by PDCE (1)

PDCEを取り付けたタワー 高さ42m



Lightning which did not hit a tower protected by PDCE (2)



Lightning which did not hit a tower protected by PDCE (3)

