

To Avoid Lightning Accidents on Ships

PDCE Lightning Rod

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株式会社 落雷抑制システムズ

Lightning Suppression Systems

History of Lightning on Ships

Wooden Sailing ship



High impedance of mast and hull creates voltage when lightning strikes

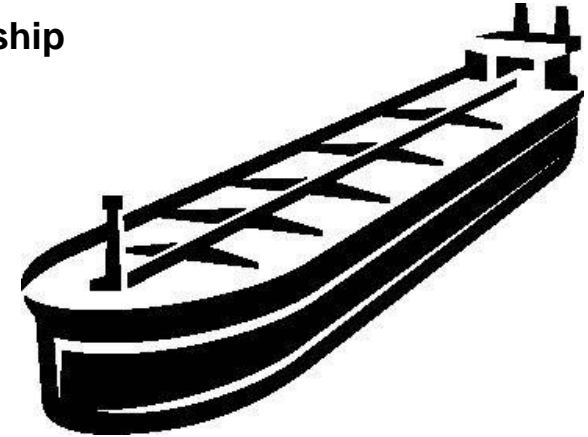
During 1799-1815, 150 ships were hit by lightning
10 were seriously damaged
1 out of 18 set on fire
70 sailors died

by Admiral Harris Great Britain Navy

They used pitch to prevent water coming into the ship, therefore they were flammable

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

Steel ship



Lower impedance makes the current of lightning easy to get through, causing no fatal damage. Control has been mechanically integrated at Bridge therefore reducing the influence of lightning.

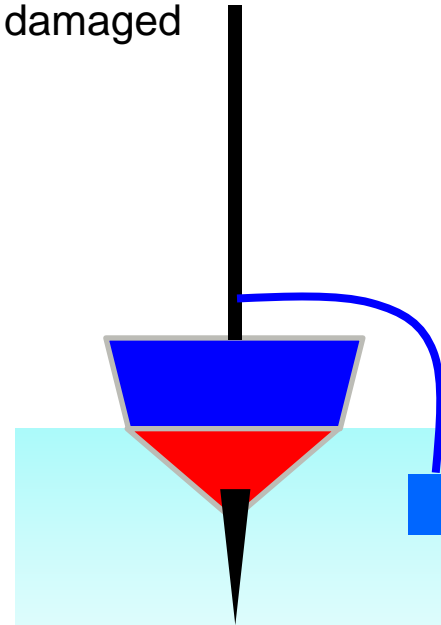
However networking on ships makes the ship susceptible to lightning



Lightning **A**ccidents on **S**ailing **B**oats

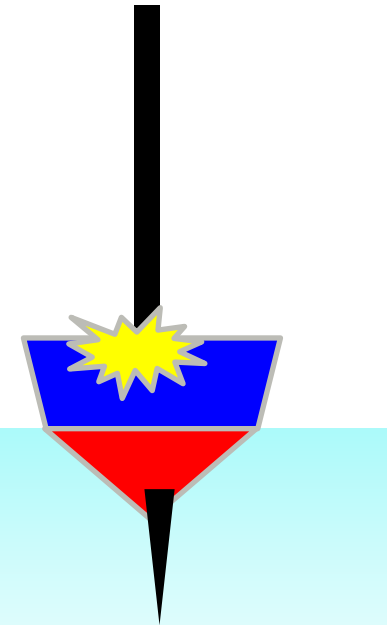


Aluminum mast should have an Earth contact with the sea and in that case the FRP hull will not get damaged



Lower impedance means less damage

Wooden hulls and wooden masts are seriously damaged due to high impedance



High impedance results in serious damage



What Happens if Lightning hits a Ship?

Luck

Good

Bad



No damage

Damage to Electrical system

Damage to hull

Over 95%?

Damage on Radio, Rader

3-5%?

Damage on ship or Cargo

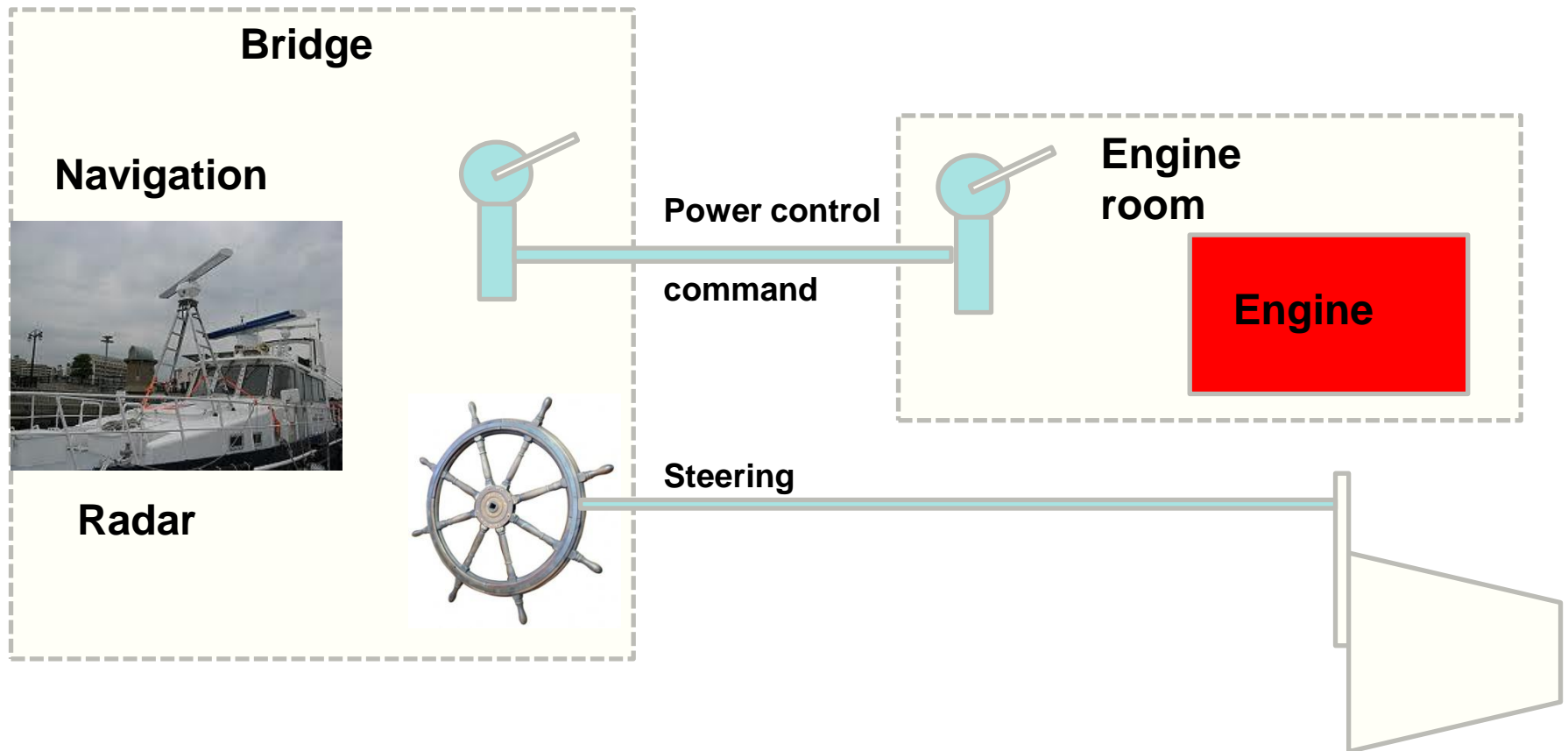
**Less than
1%?**

Good ←

PDCE can ensure luck



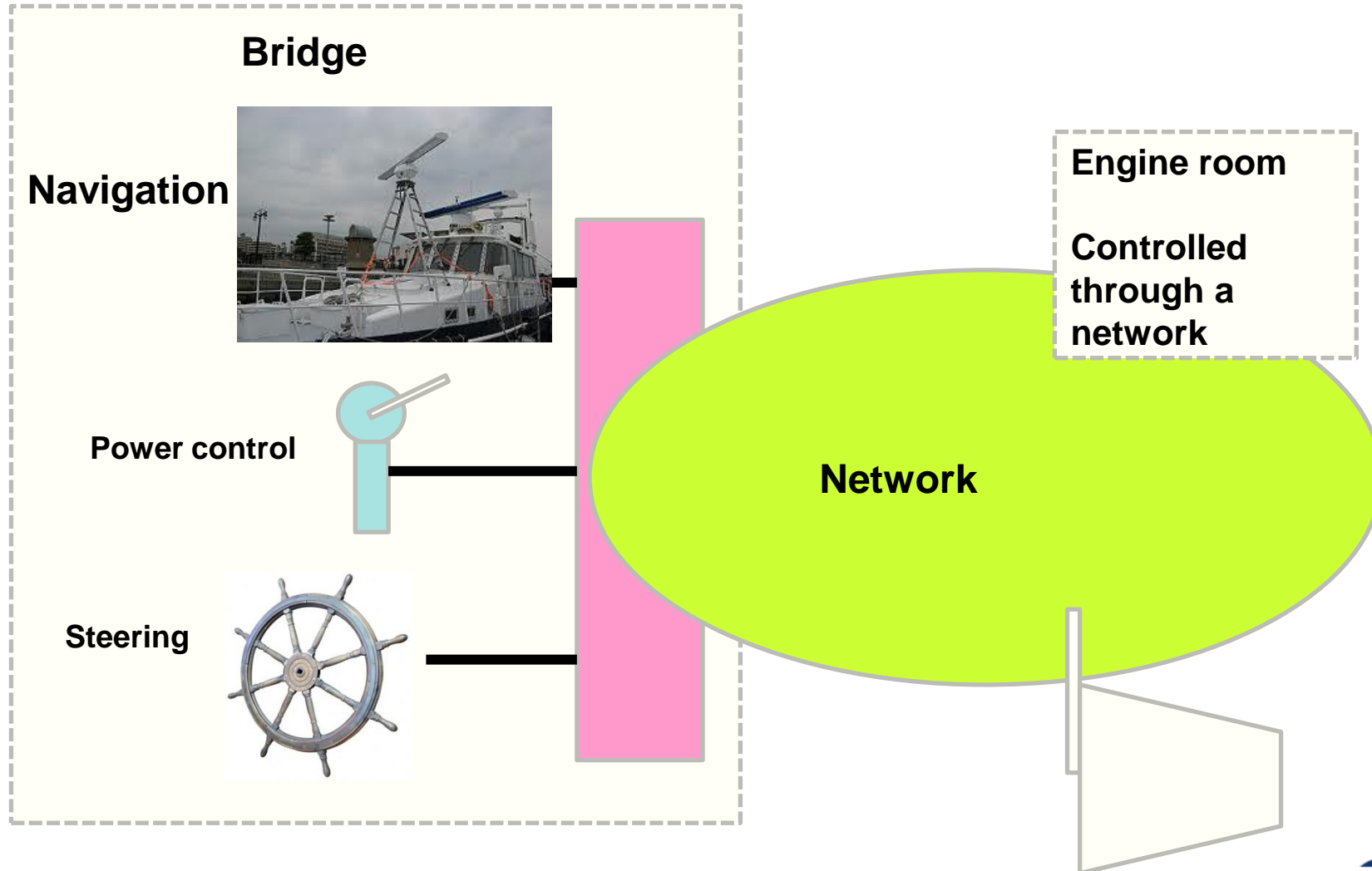
Traditional Control Mechanically Integrated



Sensitive devices are the radar and the radio, resulting in limited damage caused by lightning

In the Near Future

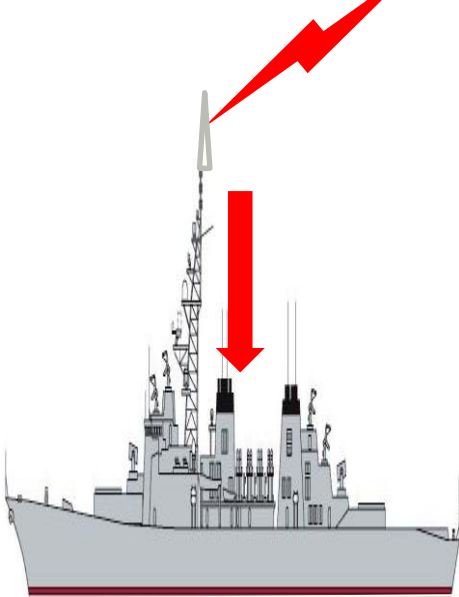
Control through Networks



Networks are highly sensitive to lightning hits

Comparison: Ordinary Lightning Rod vs PDCE

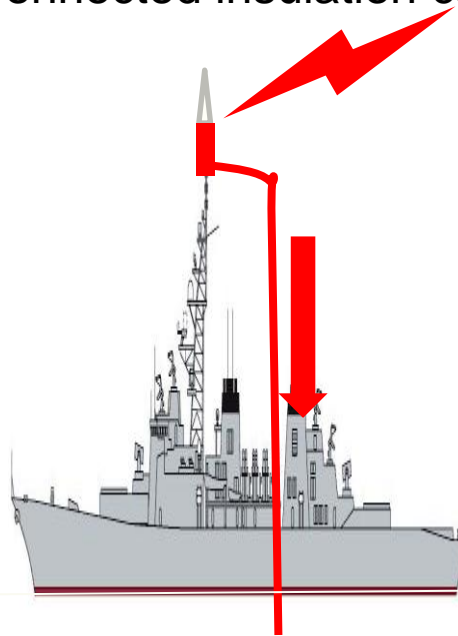
Ordinary rod



Side effects
by electrical magnetics

Lightning current goes through hull resulting in a strong EM field, which cause damage to electronic devices

Ordinary rod on insulator
Connected insulation cable



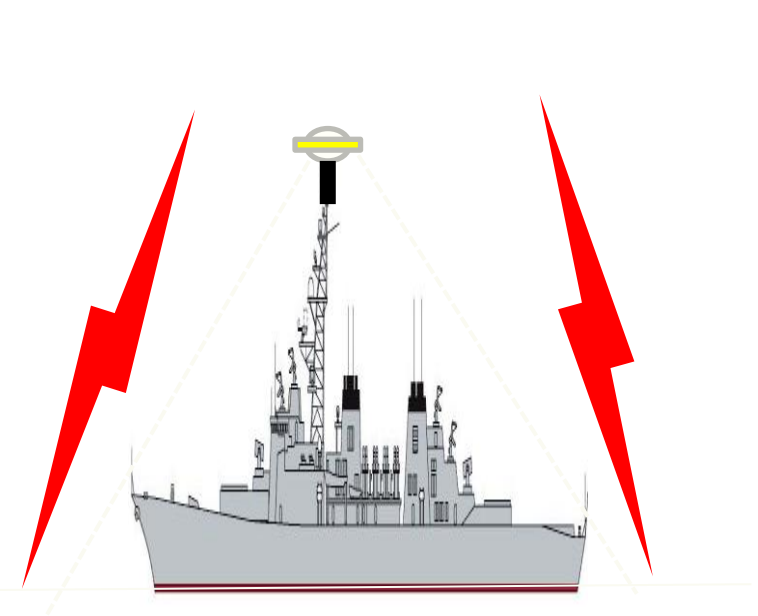
Minimal side effects
by electrical magnetics

Independent insulation conductor for lightning current

Lightning rod on insulator connected to special cable for lightning current

Popular method on land

PDCE



No lightning effect

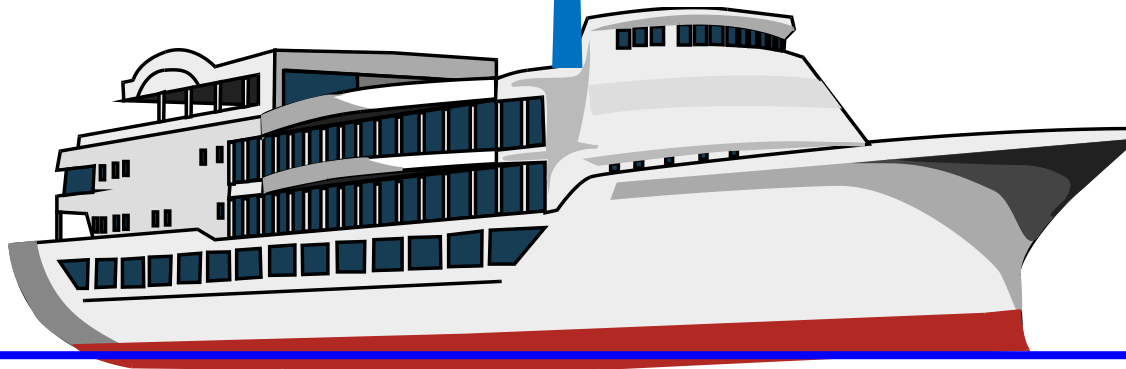
No lightning will hit the hull of the ships

Avoiding a Lightning Hit

Placed on highest
position on ship
PDCE protects the entire ship

It may be elevated higher than GMDSS

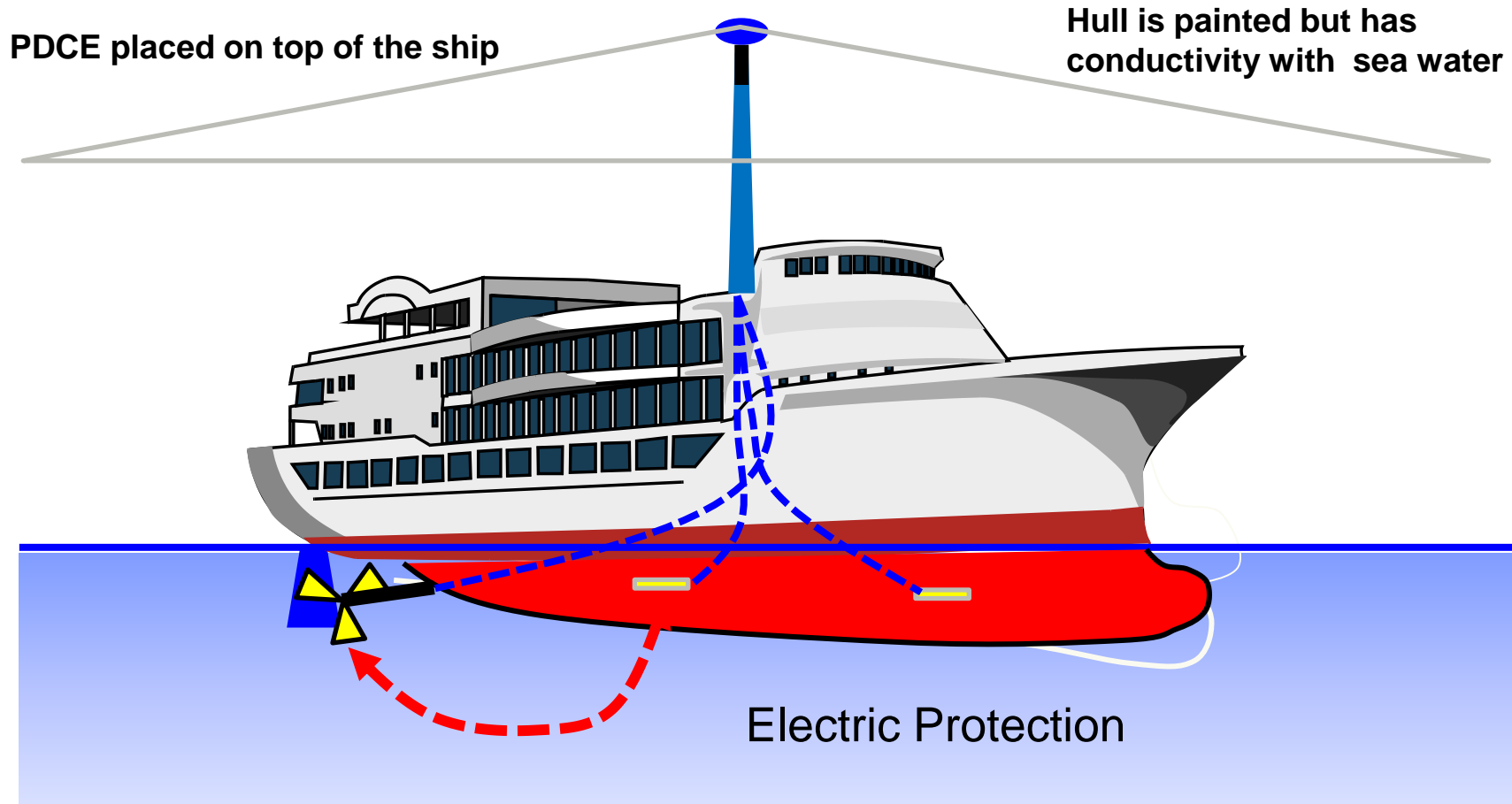
Global Maritime Distress and Safety System



Compared with wooden ships, metal ships are robust against lightning due to lower impedance against lightning currents. However, the networking trend makes ships highly susceptible to lightning

Actual case: Lightning hit ⇒ Damage to RADAR ⇒ Unable to move at night, voyage only during day time
⇒ Arrival delays ⇒ Customer complaints

How to Achieve Grounding on Ships



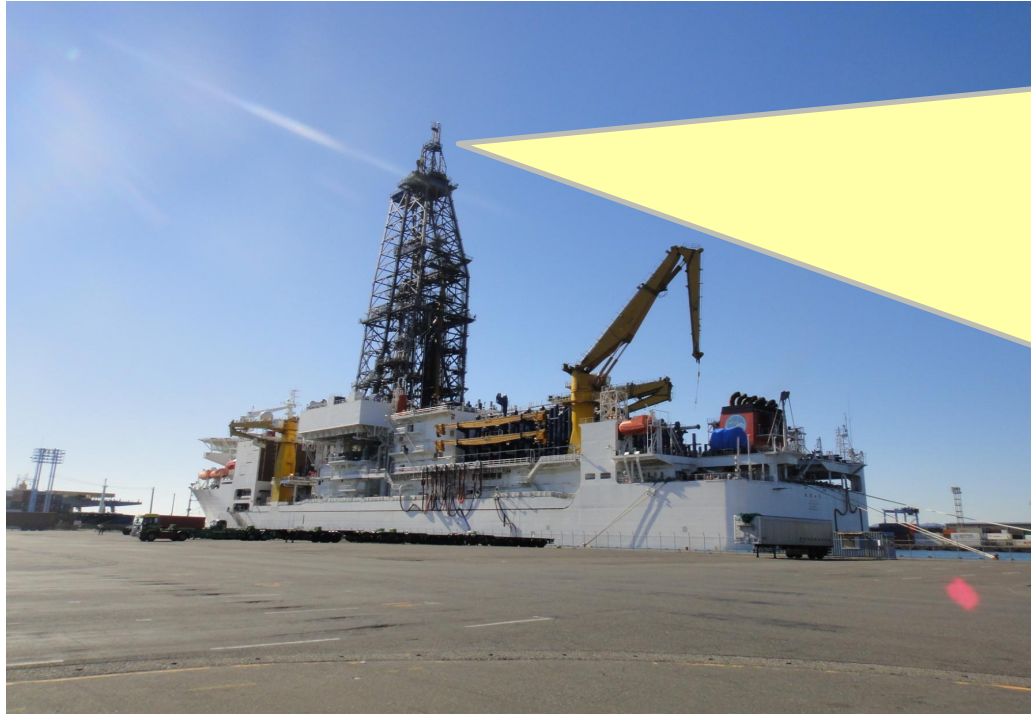
Material of Screw: Copper alloy \Rightarrow sea water [salt water] \Rightarrow Hull [steel] \Rightarrow Voltaic

Thus prevents rust by Zinc block

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

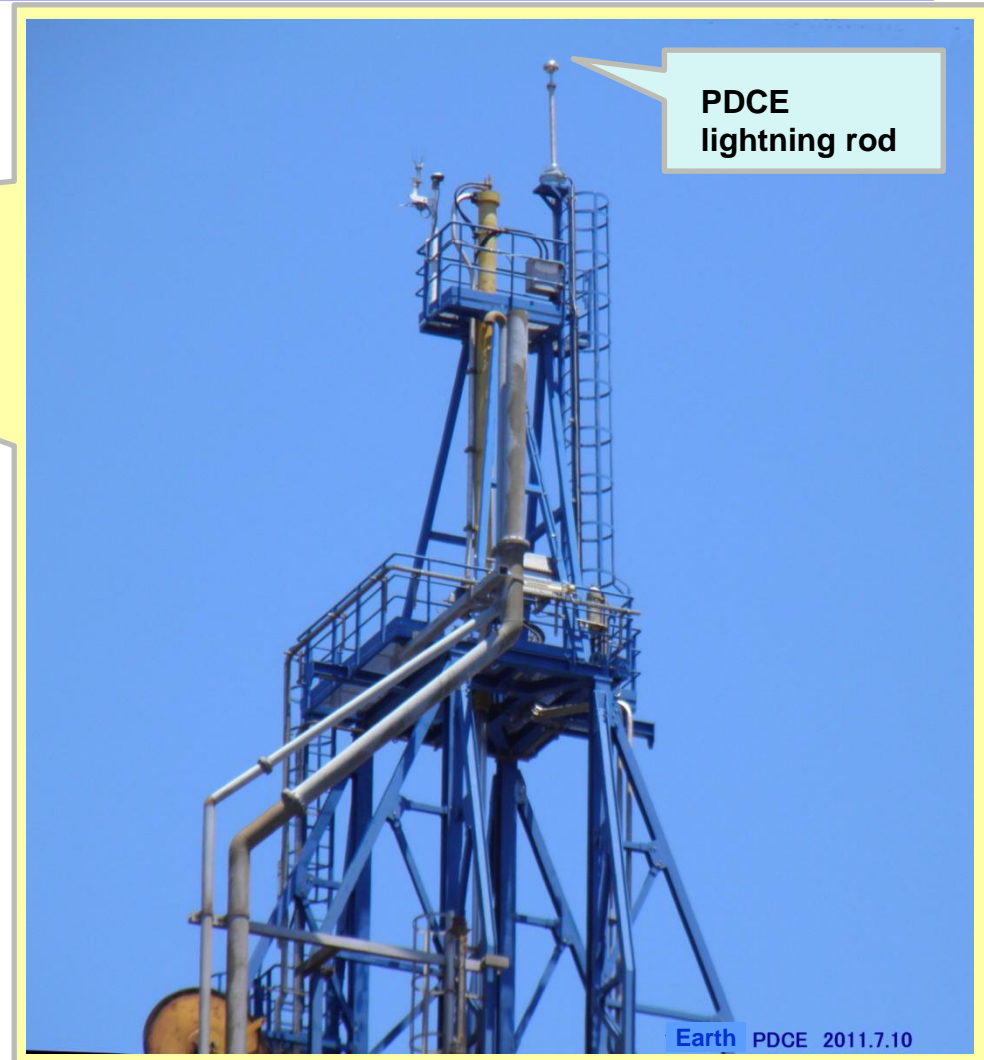
Actual usage Drilling ship “CHIKYUU”

120m Drilling tower above sea level



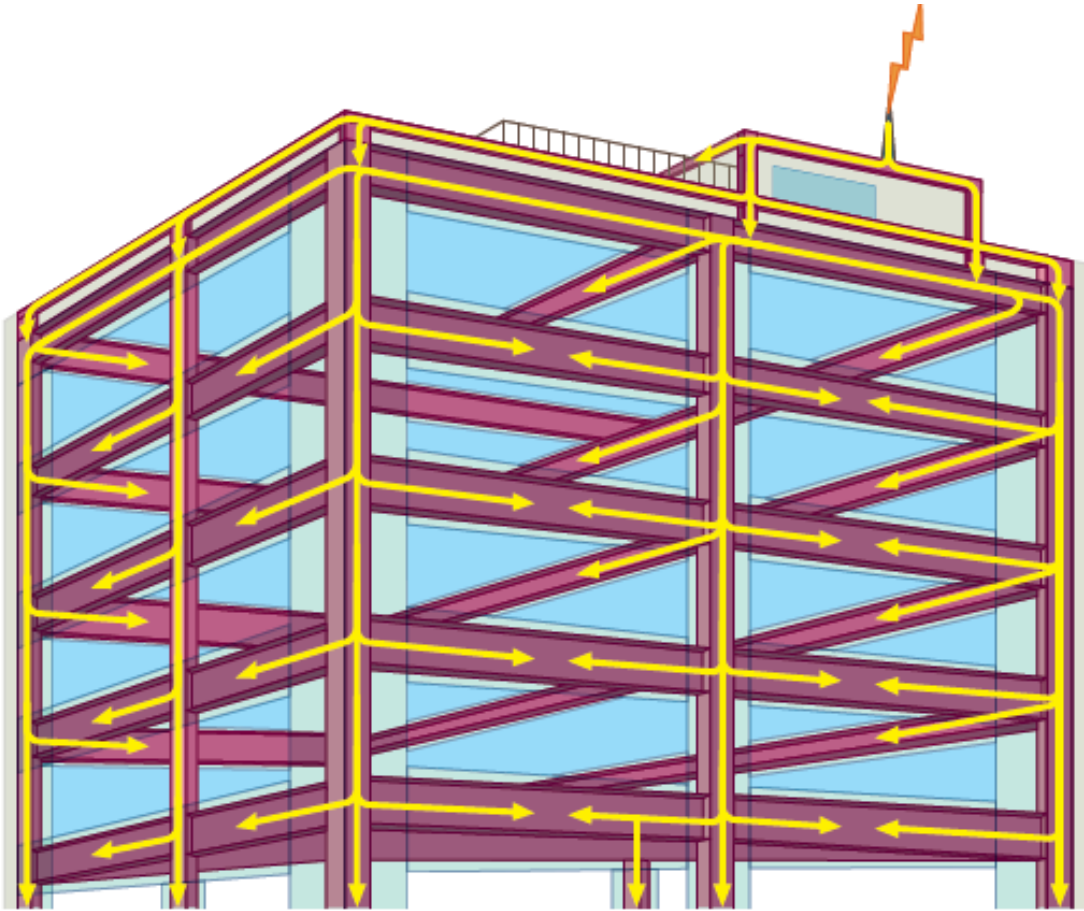
2011/07 till 2012/02
Drilling work at Sri Lanka

“Lightning hit extremely close to our ship at sea level however none actually hit our ship”



No use to Guide Lightning into the Rod

Massive side effects remain on office buildings nowadays



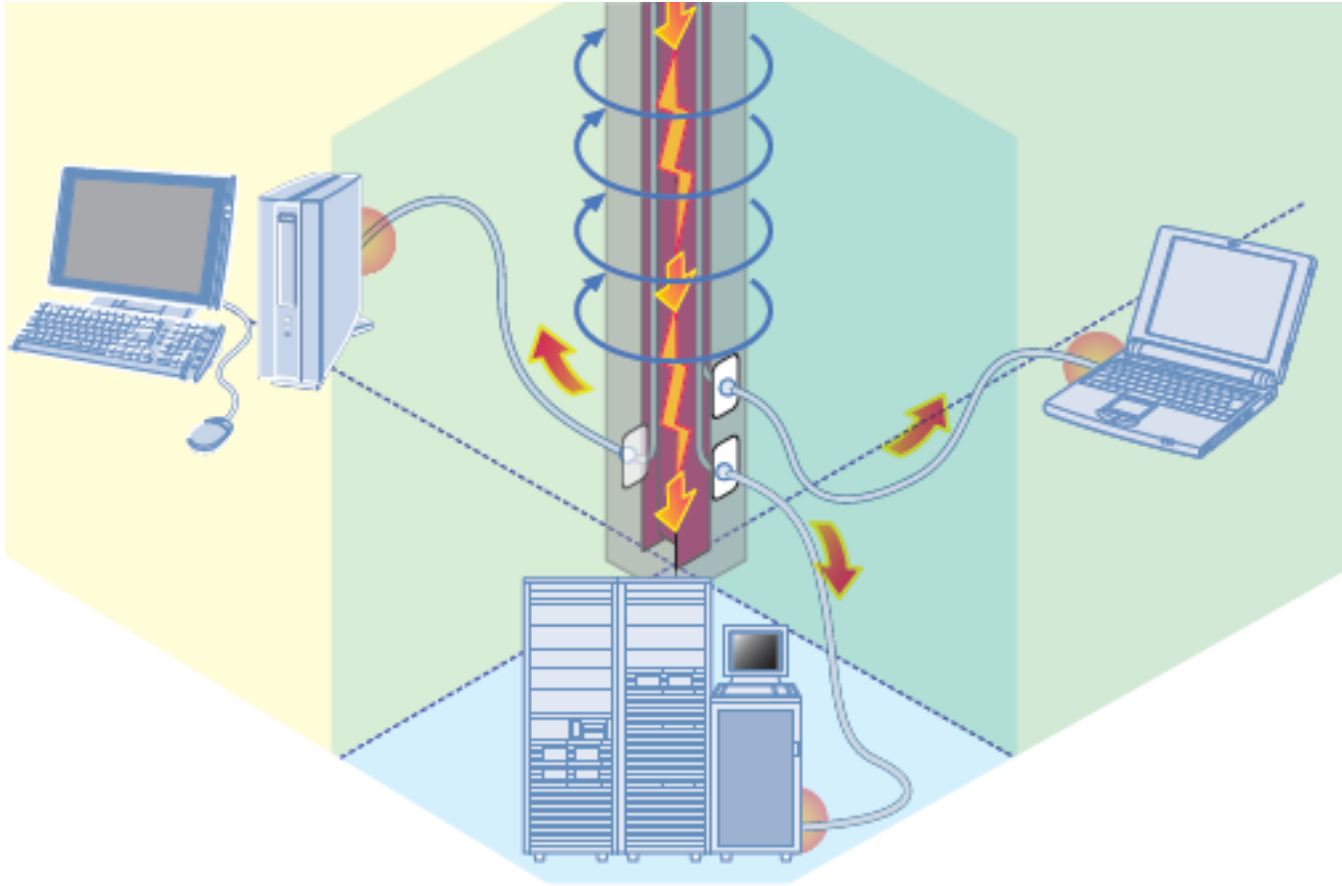
90% of office buildings use structures for lightning conductors

Lightning current flows over the structure, **creating a** strong Electromagnetic field

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

An electro network can not be protected by a lightning rod

Side Effects Caused by Lightning Currents



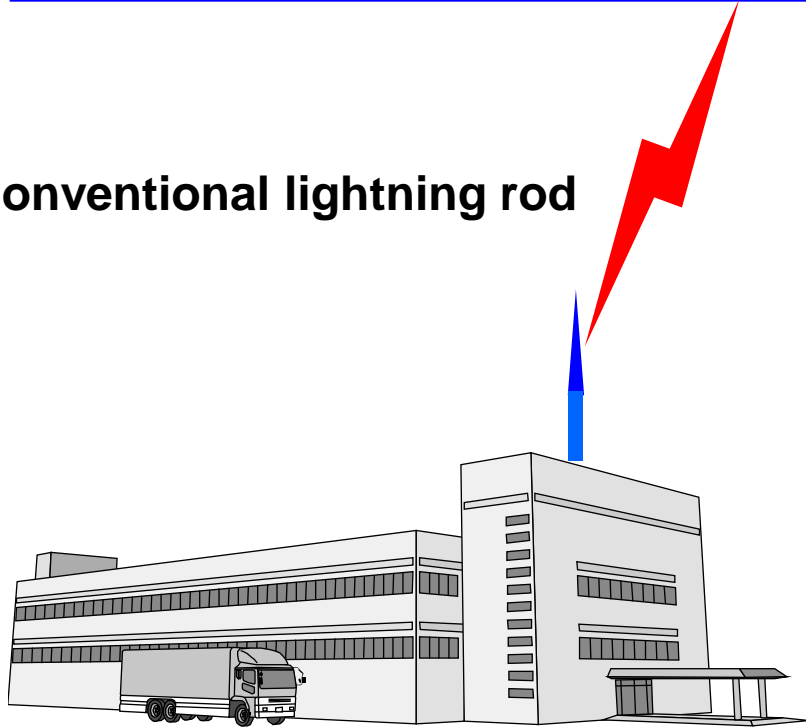
Buildings contain a substantial amount of cabling

**Power
Lighting
Elevators
Information Networks
Security
Building management
Pumping
Etc..**

Strong lightning currents creates currents on the nearby cables

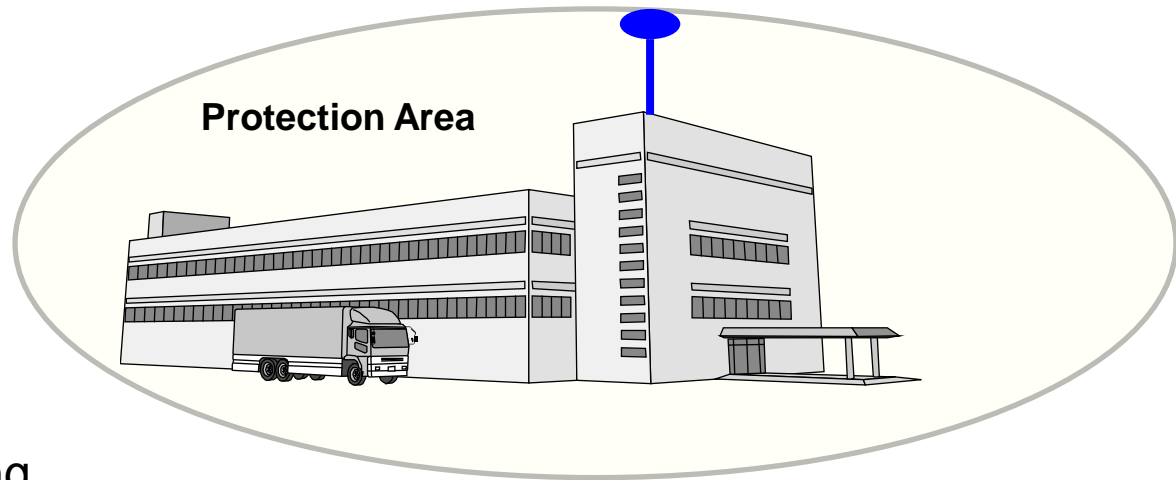
Merit to avoid Lightning hits by PDCE

Conventional lightning rod



Lightning rod ⇒ To protect the building
but not the facilities
↓
Lightning causes damage to the facilities

Building protected by PDCE



Protects the building from lightning hits

Why use Anti-lightning for Ships?

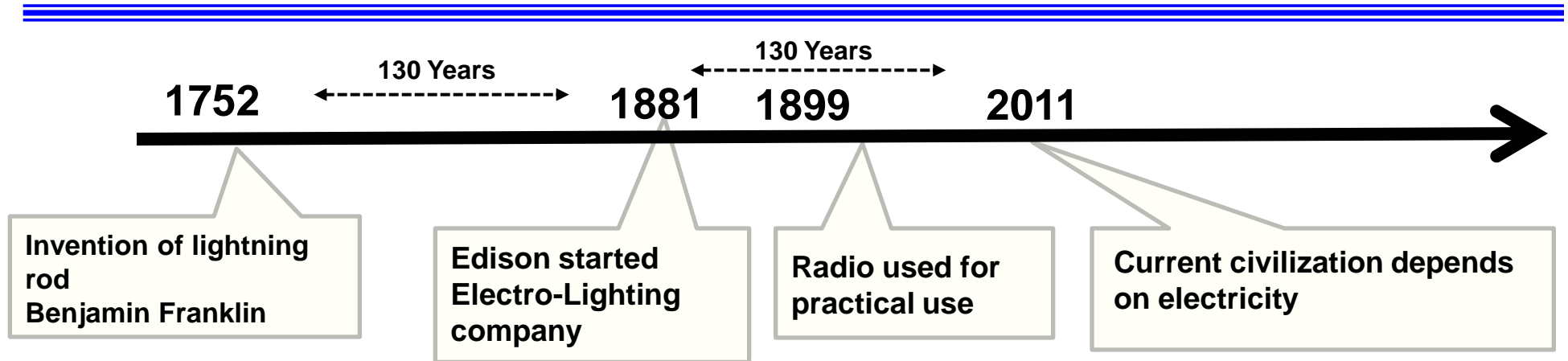
World Leading Trend

- 1) Background 1: Lightning is increasing world wide
- 2) Background 2: Ships use more networks. They are therefore less robust for lightning hits
- 1) The ship will not be stopped by a lightning hit
- 2) Suspension of a voyage can have an impact on business with unsatisfied customers
- 3) Ships move around the world. Some regions must have extreme lightning conditions
- 4) It is the owner's choice, however shipbuilders need to at least provide solutions
- 5) Lightning damage could become a serious environmental problem



History of the Lightning Rod

Problems of side effects



Franklin Rod

Two problems exist

1. Large currents still cause problems on the ground
2. Are not 100% effective



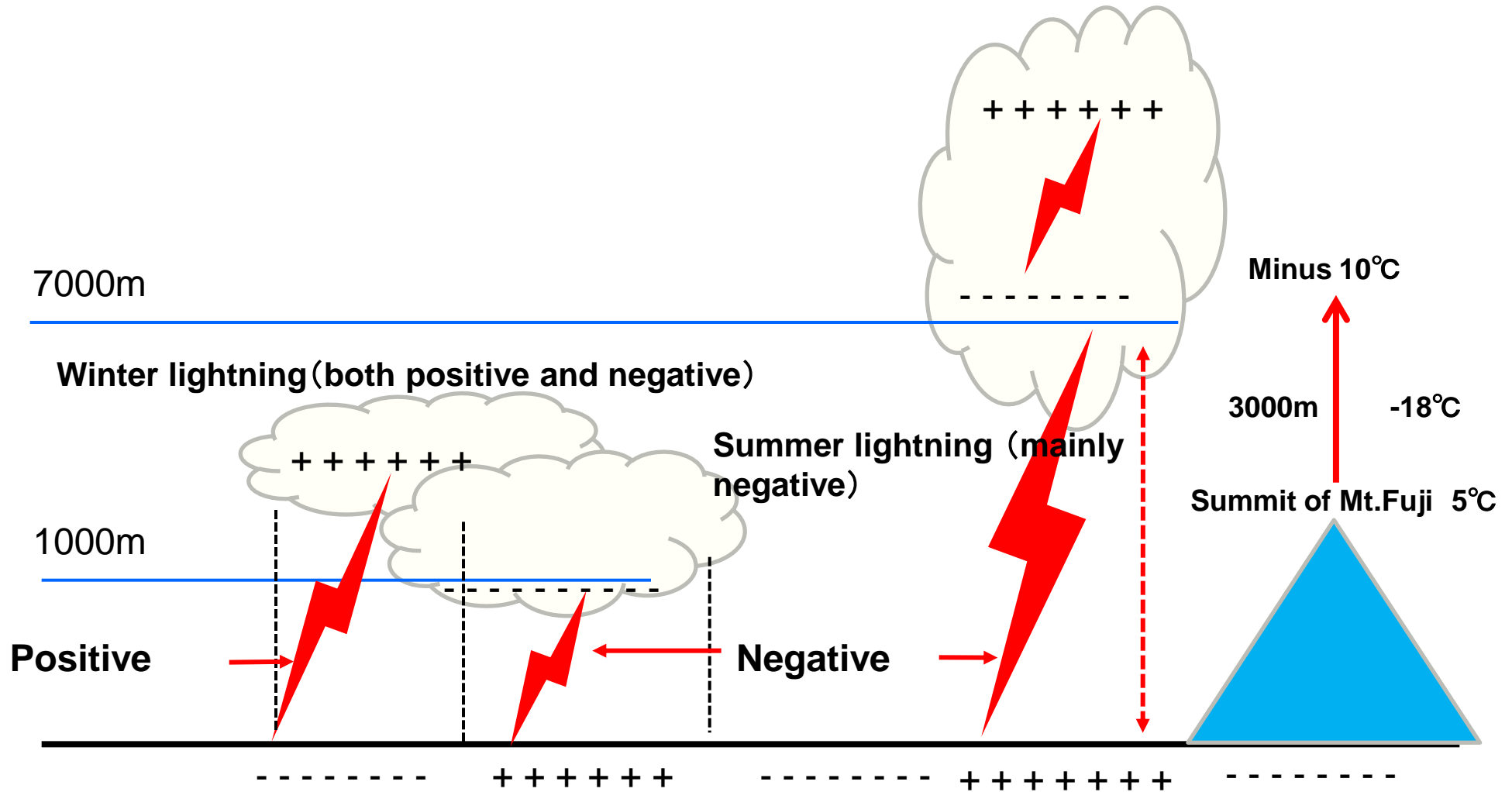
Oil Lamp

In the olden days they had non electrical goods therefore had no side effects

Why do people still rely on 260 year old technology?

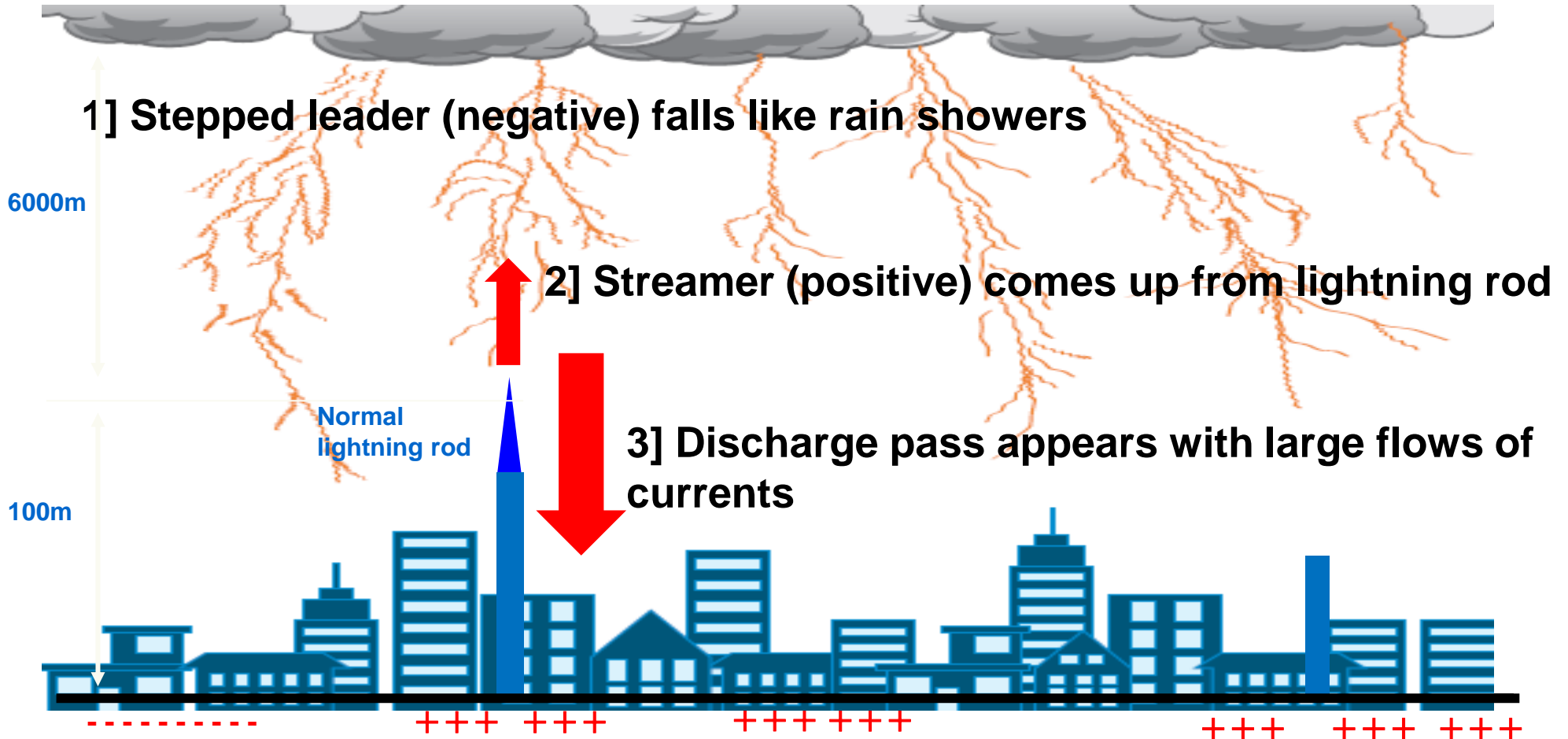


There are many Types of Lightning



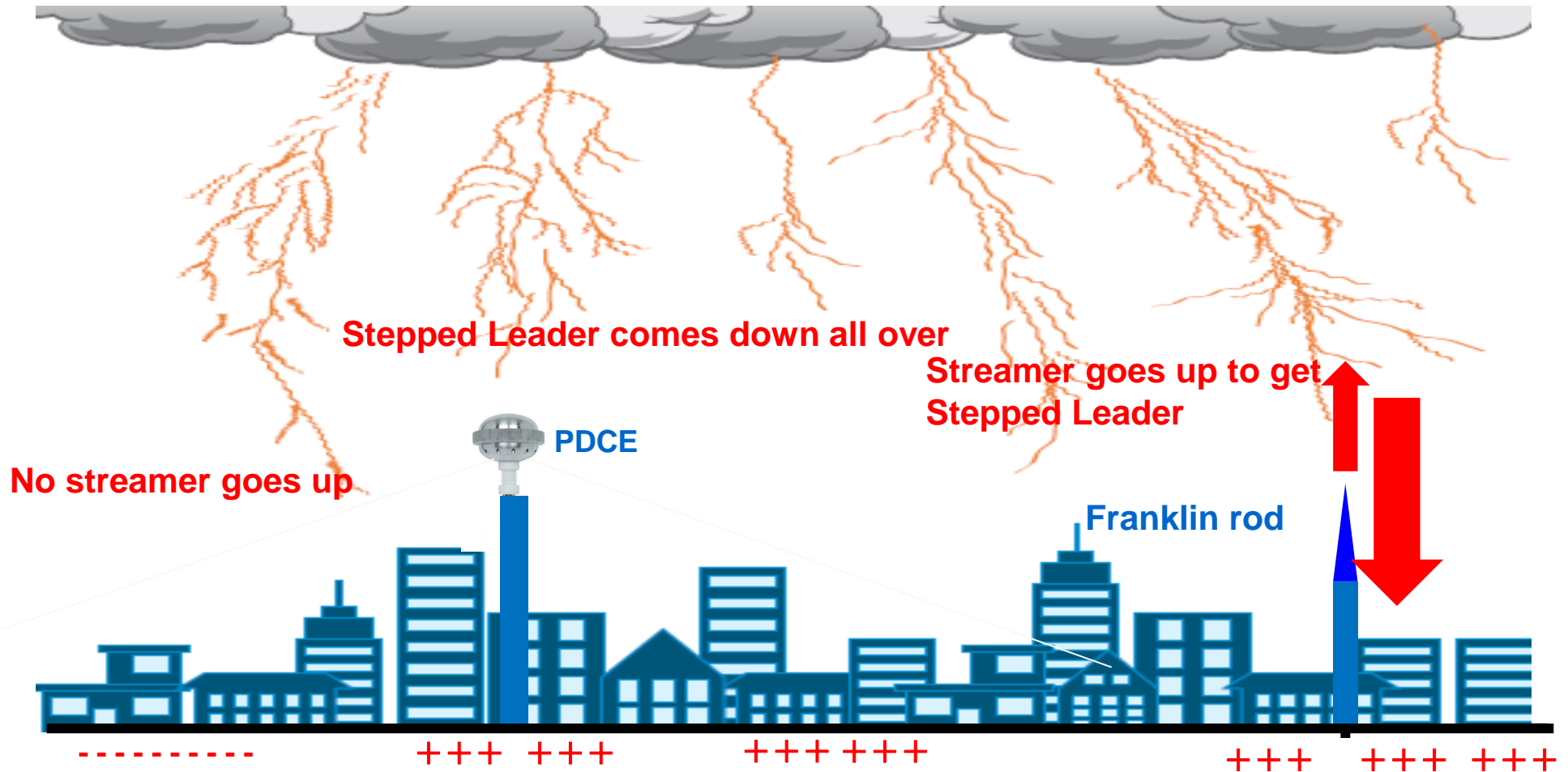
Surface of the ground or ocean has a negative charge but lightning clouds induce positive charges

How Conventional Lightning Rods work?



Principle of PDCE

Difference with Franklin Rod



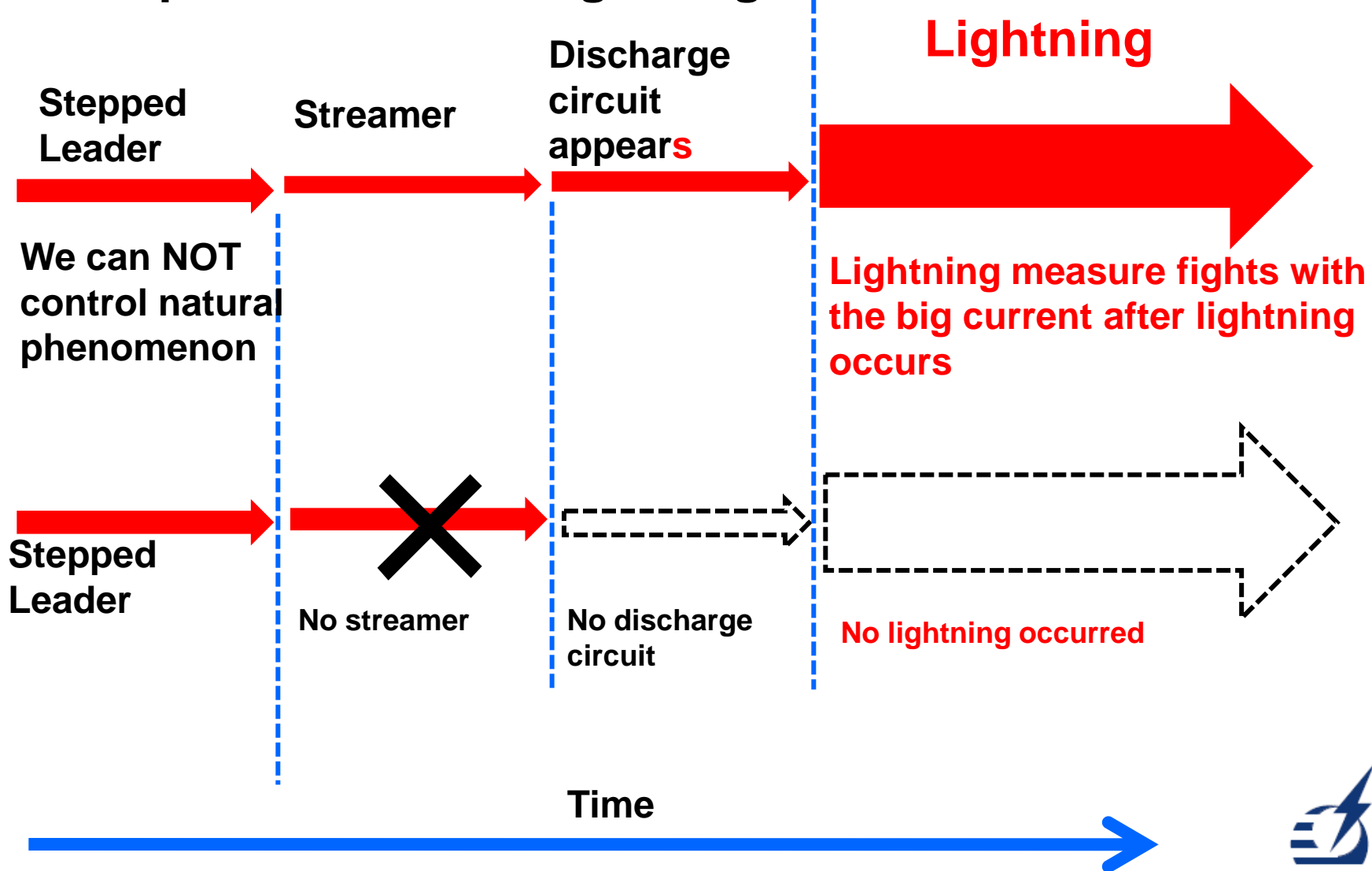
Two reasons why lightning is avoided

- 1) Two electrically separated parts: upper part with negative charge and lower with positive charge
- 2) Round surface produces no Streamer

Principle of PDCE (2)

Time sequence

3 steps occur before lightning hits



Confirmed by 3rd Party Test Lab



Bureau VERITAS examined 200 sites where PDCE's Were installed in France and Spain for 5 years data and confirmed that no lightning hit near a PDCE

Lightning positioning data has 200m of tolerance

But with error analysis the effect is meaningful



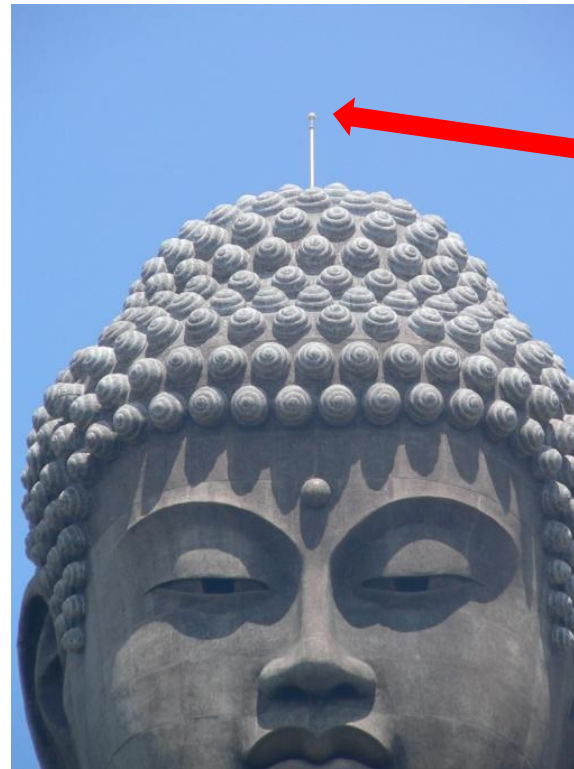
Installation case 1 Tall Buddha Statue 120m



Source: Wikipedia

120m height is the tallest bronze statue in the world

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



PDCE

Keeps people safe even
when lightning occurs



Installation case 2. The Earth Drilling Ship [Chickyu]



During a voyage to Sri Lanka in July 2011 until Feb 2012, The ship observed many lightning hits to the sea surface but none hit the ship with their 120m height tower

There are plenty of scientific devices on board the ship which are highly sensitive to lightning currents



PDCE-Magnum (Marine) for Ships



No Power needed

Grounding is essential

PDCE-Marine

Mechanical strength improved for vibration on ships

Weight 13kg



Where should a PDCE be Positioned



Influence of Lightning

Damage to Radar ⇒ Unable to continue the voyage at night ⇒ Arrival delayed

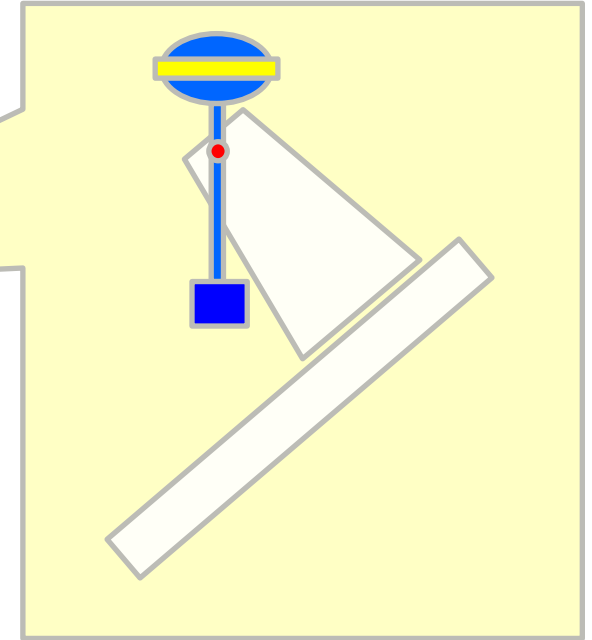
Inflammables cause fires
⇒ Serious accidents

Fishing Boats

For the Safety of Fishermen



Where Should the PDCE be Placed? All points higher than sea level (1)



PDCE always points upwards

Where Should the PDCE be Placed? All points higher than sea level (2)



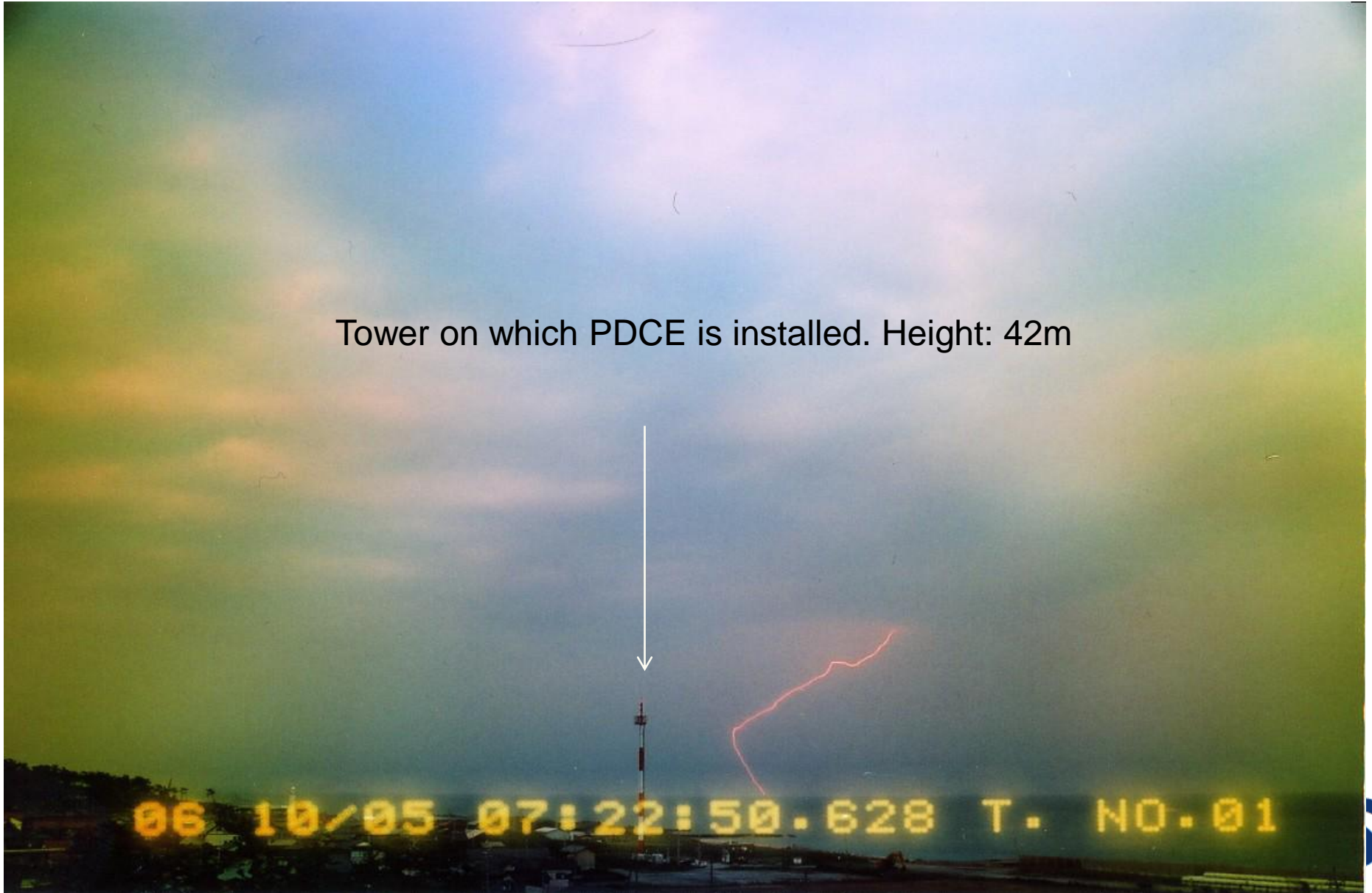
Where Should the PDCE be Placed? All points higher than sea level (3)



Used at Mexican Gulf

A Tower was Protected from Lightning due to PDCE (1)

Tower on which PDCE is installed. Height: 42m



A Tower was Protected from Lightning due to PDCE (2)



A Tower was Protected from Lightning due to PDCE (3)

