Topics

• The Lightning Strike Completion Mechanism and Secondary Effect

• Components of lightning current and Methods for grounding floating roofs

• Review of API 545 recommendation for Bypass Conductors

• Lightning Master MAGS Bypass Conductor

• Lightning Protection system installation case-study
Industry Development
Lightning Master is the world leader on reducing lightning and static related ignitions in tanks through principal membership on national code-writing committees, and a commitment to design the best-technology protection systems. Protego India represents Lightning Master and is a trusted Installer of all Lightning Master components.

Engineering Consulting
Assist customers in lightning protection principles and system design, even for existing lightning protection systems

In-House Manufacturing
Complete quality and reliability control of products

Service
Post-Incident Analysis, Site Survey and Evaluation, Education, Installation Supervision, and Installation Q/C
Secondary Effect Ignition
Among the 480 identified fire incidents, lightning is declared to be the cause of ignition for about 150 fires. This confirms the conclusions from both the LASTFIRE [3] and Technica [4] studies stating that lightning is the most common source of ignition.

- Reviewed 242 accidents of storage tanks that occurred in industrial facilities.
- 80 accidents (33%) caused by lightning and 72 (30%) caused by human errors including poor operations and maintenance.
API calls for shunts that bond the shell and roof of the tank in 3m intervals.
A shunt is **not a low resistance electrical** connection

- Shunts are not permanently fixed connections, they ride up and down the tank wall, therefore product deposits, (or paint) can line the inner wall of the shell, interfering with electrical connection

- API 545 testing showed that shunts will arc under many conditions, even in new clean tanks
Design conditions vs. real conditions

API 650 calls for ± 4in annular space

Tanks aren’t perfectly round, and as they age, and the roof can drift slightly off center, disconnecting some of the shunts

Example with 8” nominal annular space

- Perfectly Round (Design)
- Oval (Settling)
- Oval + Movement
Signature Components of Lightning Current

25,000 - 45,000 amperes
Average in the United States

1/4 - 1 second
200 - 300 Amps

Not to Scale
# 2 Signature Components:
## 2 Types of Conductors

### API 545 Recommendations

<table>
<thead>
<tr>
<th>4.2.1.1 Shunts for Conduction</th>
<th>4.2.1.2 Bypass Conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>For fast and intermediate duration components of lightning stroke current</td>
<td>For intermediate and long duration components of lightning stroke current</td>
</tr>
</tbody>
</table>

![Current-Time Graph]

- **Current:** $25,000 - 45,000$ amperes (average in the United States)
- **Time:** $1/4 - 1$ second
- **Amperage:** $200 - 300$ amperes

Not to Scale
To reduce conditions which cause arcing in the rim space

4.2.1.1 Shunts for Conduction

For fast and intermediate duration components of lightning stroke current
Spaced no more than 10 ft apart
Stainless steel, min 2 in wide, min 20mm² cross-sectional area
Min service life of 30 years

4.2.1.2 Bypass Conductors

For intermediate and long duration components of lightning stroke current
Max end-to-end electrical resistance of 0.03 Ω
Spaced no more than 100 ft apart, min two
Min service life of 30 years
Early Methods of Bypass Conductor

Simple Cable

Reel System
MAGS: Bypass Conductor

- Bend radius to exceed conductor manufacturer minimum bend radius, N.F.P.A., 780 minimum bend radius, and local lightning protection code minimum bend radius.
- Electrically bond conductor to tank shell wall and to tank top (typ).
- Unit to lay on top of tank when roof is at its highest point, orient radially to clear tank top apparatuses.
- Stop @ 80° to avoid contact with the side of the tank.
- Floating roof at its lowest point.
- Floating roof at its highest point.
- Finished grade.
MAGS Components

- **Rim Bracket** - Clamps on to tank rim. Flanged to guide cable. Stainless Steel.

- **Base Plate** - Fits to floating roof. Can be welded, bolted, or chemically bonded if tank is in service.

- **Conductor** – Insulated and UV resistant.

- **Mast** – Standard or All-Weather. Assembled to fit any tank height.

- **Articulating Conduit** – Maintains minimum bend radius. Polyester cord structure.
Steel Components: Base Plate and Rim Bracket

- **Stainless Steel Rim Bracket** – natural curve protects cable from excessive wear, maintains low impedance geometry and low maintenance on cable.

- **Stainless Steel Base Plate** – maintains single plane movement of arm. Can be welded or fitted without hot work for new or existing tanks.

- All-weather design keeps hinge elevated above ice level, suitable for use where freeze-thaw cycle occurs
All-Weather Options

**Elevated Base Plate**  
Keeps hinge mechanism above ice layers

**High Performance Reinforced Mast**  
Highly resistant to wind loading
Fiberglass Components: Mast and Articulating Conduit

- **Mast** – assembled to accommodate any tank height. Consists of UV resistant fiberglass.

- **Articulating Conduit** – maintains minimum bend radius of elbow joint (durability of cable, and lower electrical impedance).
MAGS: Simple Movement
External Floating Roof Tanks
- Suitable for new builds and retrofits
- No hot work permit needed for installation
- API 545, IEC 62305, and EN 14015 call for a bypass conductor or permanent grounding/anti-static cable
- Placement is based on 1 unit every 30 meters around the circumference of the tank (API 545)

Internal Floating Roof Tanks
- Must be installed during tank construction or retrofitted during tank maintenance
- API 650
- Placement is based on minimum 2 devices
MAGS installed at 30M intervals
Lightning Master Corporation and Protego will be installing our MAGS system at Reliance Mumbai by end of January 2014.
Rim Bracket and Base Plate
Installation Supervision/Inspection
View of Streamer Delaying Air Terminals on Tank Rim – Direct Lightning Strike Protection
Close-up view of Streamer Delaying Air Terminals on Tank Rim
Application of Streamer Delaying Air Terminals on Tank Rim

- Lightning Master streamer-delaying air terminals are designed to reduce the accumulation of charge on the protected structure (tank). This reduces the likelihood of ignition from direct lightning strikes.

- Designed on the principle of point discharge

- Creates a corona discharge, which retards the formation lightning-completing streamers

- Specified every 15-20 feet around the perimeter of the tank as per IEC 62305 Rolling Sphere Model recommendation.
Lightning Master Streamer Delaying Air Terminals

- Small radius dissipating electrodes are fitted into the tip of each air terminal
- Dissipation wires are Stainless Steel
- Elevation conductor material varies based on application
- Stainless Steel Beam Clamp attachment to tank rim
Dome Roof Considerations

- Top View of HMT Dome with Lightning Master Streamer-Delaying Air Terminals
- Side View of HMT Tank and Dome with Lightning Master Streamer-Delaying Air Terminals
- API and NFPA Compliant Lightning Protection
- Close-up View of HMT Dome Top with Lightning Master Streamer-Delaying Air Terminals
“Colonial protects its tanks with systems designed to deflect electrical charges into the ground. Security cameras reveal that late in the brief storm a tremendous lightning strike came down in the area of the tank battery, (Douglas said). There seems little doubt that the lightning hit the tank, with the electrical grounding system failing to prevent a fire.”

Source: Fireworld Article Archive
Annual Flash Rate

Units: Flashes/sq km/year – Global distribution of lightning over an 8 year study from the combined observations of the NASA OTD (4/95-3/00) and LIS (1/98-2/03) instruments