Gas Discharge Tube

NexTek Coaxial Protector

NexTek produces many coaxial protectors that use the gas-discharge tube (GDT) as the primary protection element connected from the center pin to the shield. The PTC and PTR series coaxial protectors, as well as the bias T devices, use gas discharge tubes because they are compatible with low frequency or dc on the center conductor. The GDT's that NexTek uses are popular industry standard format 8mm diameter devices, and they are chosen to provide high transient current capability, good protection levels, and long life multi-strike capability. These are simple well-proven devices that are constructed similar to a fuse with two conductive end caps and a glass or ceramic cylindrical body between these two end caps. Instead of a fuses' wire conducting current and melting when the current is exceeded, the GDT has a gas inside, somewhat like a neon sign, which arcs brilliantly in the small gap when a high voltage exists between the two end caps. While these gas discharge tubes are rugged components, they can be damaged by *extreme* exposure to lightning. The typical failure mode is an increase in voltage at which the GDT conducts (or protects), or complete catastrophic failure for *severe* exposures. The vast majority of GDTs in service provide satisfactory protection for many years without replacement. Therefore, for extremely exposed conditions, the need for maintenance can arise.

In order to determine maintenance appropriate for a GDT based protector, it is useful to start by considering the energy in the lightning source. While there is considerable variation of actual events, it is not unreasonable see the following typical parameters:

Lightning Parameters

Parameter	Direct Effects	Indirect Effects
Peak Current	10 to 100 kA	5 kA to 50 kA
Pulse Width	10 to 1000 µs	5 to 200 µS
Rise-time (Current)	1 to 10 µs	0.1 to 10 µs
Number of Pulses	1 to 5 per strike	1 to 5 or more per strike

The actual energy coupled to the center conductor of a cable is usually much lower than 100% of the lightning potential. This is due to current sharing and diversion prior to current entry into the cable interior. Also, the pulse on the center conductor is usually slowed down, compared to the original wave.

Now if we consider the capability of the Gas-Discharge Tube used in NexTek products we can see that the tubes can take a substantial pulse currents:

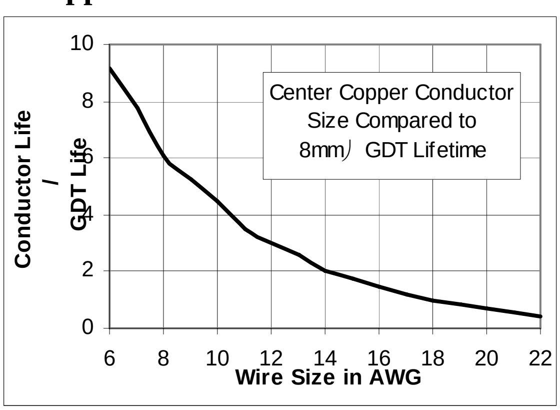
NexTek Gas Discharge Tube Capability

Parameter	Number of Pulses	Amperes	Waveform (Rise time and pulse width)
Single Pulse Protection	1	50 kA	8μs & 20μs
Multiple Pulse Protection	10	20 kA	8μs & 20μs
Pulse Lifetime	1000	1.0 kA	10μs & 1000μs

We can relate other devices on the exposed path (between the antenna and the protector) on their ability to withstand lightning damage. The items typically in this path will be rated in terms of GDT pulse lifetime (the GDT pulse lifetime is 1.0).

The coaxial cable and shield usually have a greater current capability and pulse lifetime than the center conductor, and has to be grounded adequately to reduce damage risk of the cable. The pulse lifetime of the center conductor is mostly a function of the size and material of the center conductor. Below is the center conductor rated in multiples of GDT life.

Approximate Conductor Pulse Life



This would indicate that replacing cable when the GDT fails is sometimes necessary if the center conductor is smaller, particularly less than 14 AWG, and almost always necessary if the size is 18 to 20 AWG or smaller.

Coaxial connectors also have a limited ability to withstand pulses. An estimate of the pulse lifetime for connectors related to GDT pulse lifetime could be:

Connector Pulse Lifetime

(as a multiple of typical 8mmϕ GDT life)

Connector	*Typical Lifetime*
7-16 Connector	3.0 to 10
N Connector	0.8 to 2.0
TNC Connector	0.5 to 1.0
SMA Connector	0.3 to 0.5

Smaller format connectors are less rugged than a typical GDT. Connectors have a wide range of quality in pin material and finish which affect transient capability.

Smaller exposed connectors usually fail before the GDT. Therefore smaller connectors exposed to lightning risk do not benefit from a replaceable ϕ8mm GDT feature.

Antennas have a wide range of tolerance to GDT lifetimes, and this can span the range from 50% to much greater than 200%, especially if the antenna sections are copper and are thick. Since the antenna is physically outside of the coaxial path, in many cases the lightning can arc from the antenna to the shield or nearby ground. This diverts current away from the transmission line center conductor. In some sites where the antenna is not the highest object, or even is fully under grounded objects, the chance for direct strike to the antenna can be dramatically reduced.

This guideline may work well for most sites with significant risk, and less than full lightning energy coupling into the transmission line. However, please remember that in some cases the lightning threat can be much greater and can easily destroy an antenna upon direct exposure. Also, if the grounding is poor, or coupling direct to the transmission line occurs, lightning can destroy larger format connectors, larger cables, and certainly a GDT in a single event.

Gas Discharge Tube Maintenance Guidelines

1. Grounding the shield and the protector to operate correctly and maximize lifetime.
2. Use ground capable of draining lightning current, to electrical/lighting code.
3. Mounting the antenna or exposed wiring under or shielded by other grounded devices or structure if possible, to minimize direct lightning exposure.
4. If direct lightning exposure is more likely due to either transmission component placement or inadequate ground and shielding at the antenna end, use larger format and higher quality connectors, heavier coaxial cable, and antennas rated to survive direct lightning exposure.
5. For cases of antenna, connectors and cables which may exceed the GDT life, maintenance of the Gas Discharge Tube can be accomplished in two ways:
    a. Periodic or Preventative Maintenance based on:
        i. history (at a time interval less than the average time to damage)
        ii. site activity and exposure (for example lightning activity & antenna exposure)
        iii. site configuration and quality (for example grounding & cable type)
        iv. uptime requirements of the system
        v. a “standard” replacement interval (for example every 3 years)
    b. Replacement upon failure of the protected device. (This is frequently the most economical maintenance strategy, especially when combined with the use of redundant protectors or in lower risk settings.)
6. If the antenna and connectors and cable have a substantially less lifetime than a GDT, when the GDT is at its end of life, the other components are probably damaged, and it may be time replace these in addition to the protector and/or GDT.
7. If the antenna has to be replaced, examine the connector pins at the antenna. If black soot, evidence of plating burn-off, or end melting is observed, it may be necessary to replace all elements on the exposed side of the protector.
8. Consult a lightning protection expert since protection of property or danger to personnel is usually involved with lightning.