Lightning Protection for Nuclear Power Facilities: Browns Ferry

Like all power generation plants, the Browns Ferry Nuclear (BFN) Plant, in northern Alabama, faces many challenges to meet the power demands of a growing and urbanizing population. With Alabama's frequent and intense storms, the challenges posed by lightning had proven to be especially trying due to repeated strikes to the off-gas stack.

Today, BFN prides itself on safe, efficient, and affordable electric power generation for its customers. As the first nuclear power plant of the Tennessee Valley Authority (TVA), the nation's largest public

power company, BFN was the first nuclear plant in the world to generate more than 1 billion watts of power and was the world's largest when it began operation in 1974. In 2006 BFN helped TVA achieve 99.999 percent operational reliability for the fifth year in a row. But a decade ago, lightning strikes to BFN's off-gas stack were hampering reliability.

"The off-gas stack was originally protected by Franklin rods, but equipment on the stack and around its base [was] routinely damaged during lightning storms," says Rick Brehm, a TVA manager with oversight of electromagnetic interference and instrumentation, and control systems. "Lightning strikes to the stack were observed."

The damage from strikes required considerable equipment replacement and repair. While the automated monitoring equipment was offline, extended periods of human monitoring were necessary, which increased the workload and expense.

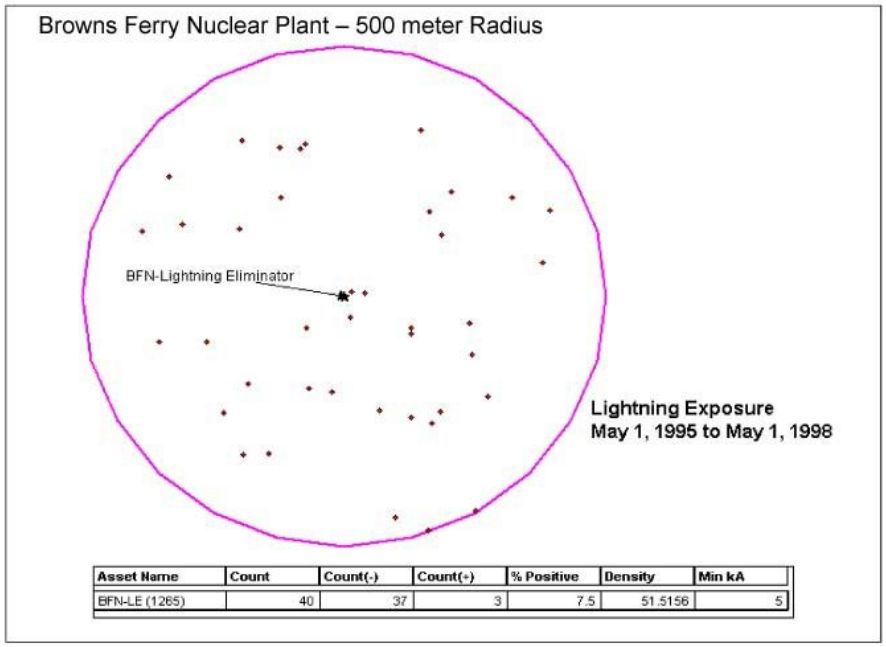
To improve reliability and reduce downtime, BFN turned to Lightning Eliminators & Consultants, Inc. (LEC), which specializes in lightning prevention technology, a relatively new innovation in the lightning protection industry. BFN's move is not uncommon; a growing number of respected power generating utilities have successfully reduced costs by choosing engineered lightning prevention systems to avoid storm- related damage.

Unlike antiquated lightning rods, which collect and direct lightning at a site, charge transfer technology prevents direct strikes by reducing the local electrical field to below lightning- collection potential. LEC's charge transfer device, the Dissipation Array® System or DAS®, has been installed at industrial facilities around the world and is custom-engineered to interface with almost any structure.

To design a comprehensive protection scheme, LEC took into account factors such as the off-gas stack's location, size, shape, equipment, geography, and exposure to lightning activity. They then engineered, and deployed an integrated lightning prevention system for BFN which included DAS strike prevention. Spline Ball Terminals (SBTs), a form of hybrid preventer/collector, were used to augment the protection for the sensitive equipment around the off-gas stack's landings.

"The result has been no known lightning strikes to the off-gas stack in almost ten years," says Brehm. "Instead of using our resources to repair broken equipment and pay emergency overtime, we're preventing the problem in the first place."

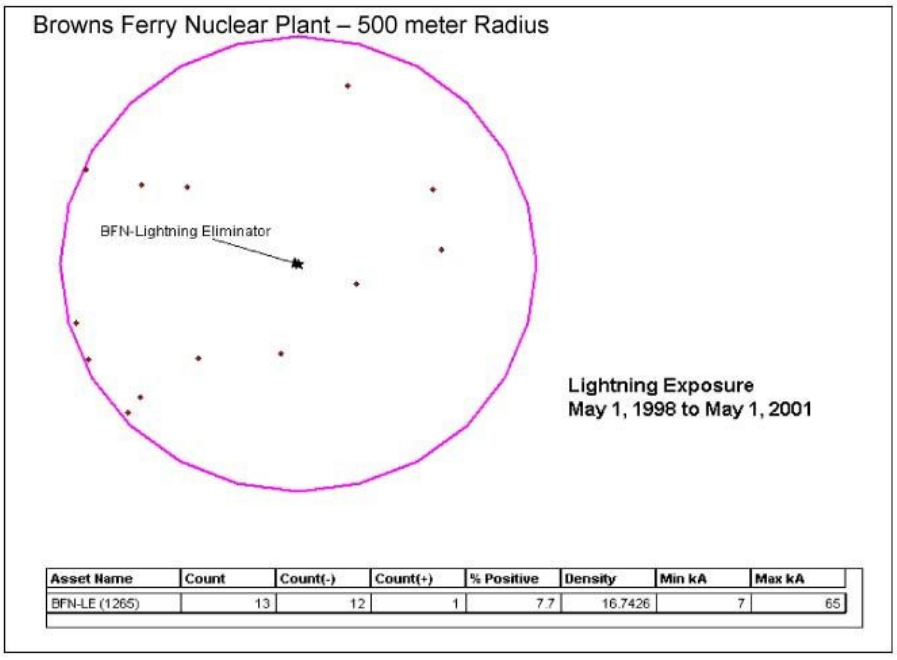
As part of an internal review process, BFN consulted a database of lightning activity to determine the number and location of lightning strikes around the off-gas stack in the three years before and after DAS implementation. They compared the number and location of lightning strikes within 500-meter, 3, 6, and 10-mile radius circles of the off- gas stack for these periods. (See Figures 1 and 2)



Asset Name	Count	Count(-)	Count(+)	% Positive	Density	Min kA
BFN-LE (1265)	40	37	3	7.5	51.5156	5

(Figure 1 is BFN - 500 meter radius lightning exposure May 1, 1995 to May 1, 1998)

"Following DAS implementation, we found an 80% reduction in lightning strikes within 500-meters of the off-gas stack," explains Brehm. "The weighted data for strikes in the wider areas showed no change of statistical significance, though lightning frequency increased by almost 63% in a 10-mile radius around the stack in the three years after DAS implementation. The data shows us the DAS system works. It's undoubtedly saved us from tens of potential lightning strikes since it's been implemented."



Asset Name	Count	Count(-)	Count(+)	% Positive	Density	Min kA	Max kA
BFN-LE (1265)	13	12	1	7.7	16.7426	7	65

(Figure 2 is BFN - 500 meter radius lightning exposure May 1, 1998 to May 1, 2001)

In another test of DAS's effectiveness, BFN recently monitored the voltage drop on a ground cable downcomer from the DAS array on the off-gas stack down to the ground via a voltage sensor. The monitoring lasted about six months, during which time they detected no lightning strikes and current flow remained in the milli-amp range.

"We saw milli-amps of current flowing up and down the downcomer," says Brehm. "This indicated that DAS was making the stack a less attractive strike target. The data showed DAS functioning as intended."

"It's preventing strikes to the protected area and proving to be an effective long-term solution." Because of the DAS prevention system's success in protecting the off-gas stack from lightning strikes, BFN is looking into extending the area of protection to a nearby intake pumping station, which recently sustained motor damage due to lightning.

LEC has used Dissipation Array protection systems to provide engineered areas of protection in a variety of public utilities and facilities. DAS systems provide complete lightning protection to an extensive list of customers and facility types, including the TVA, DOE, Calpine, Florida Power & Light, Michigan Public Power Agency, Grand Bahama Power Company, and Korean Electric Power, as well as many Fortune 500 firms such as ExxonMobil, ChevronTexaco, PPG Chemical, International Paper, and FedEx.

Since 1971, DAS protection has accumulated over 60,000 system-years of history with 99.87% no-strike performance. It has been installed at over 3000 locations in 69 countries worldwide, including facilities as large as three square kilometers and structures.