Ballistic fire barriers - Part II

Critical Infrastructure Protection for substations and transformers

ABSTRACT

With new threats endangering the safety of substations, critical infrastructure protection in substations has come to include sniper fire, ballistics and blast protection. Safe by Design approach allows that all types of design safety and performance criteria – fire, blast, impact, wind – cross over from safety to security. In this article Critical Infrastructure Protection innovations and strategy options are discussed, with a focus on ballistic fire barriers that provide both safety and security at critical facilities.

KEYWORDS

ballistic fire barriers, blast barriers, critical infrastructure protection, Safe by Design, UL 752, NFPA 851

Line of Sight is the straight line of vision or visibility to a target from single or multiple locations

Table 2. Size and separation requirements for transformers

Transformer oil capacity		Minimum (Line of Sight) separation without firewall	
gal	L	ft	m
500-5,000	1,890-18,925	25	7.6
>5,000	>18,925	50	15

Line of Sight and Safe by Design

On April 16th 2013 an attack was staged at a major U.S. substation in San Jose California, owned by a large utility company. A group of snipers opened fire and continued shooting for 19 minutes, destroying a large amount of equipment including 17 large transformers and six circuit breakers, putting the nation's power grid at peril. It took 27 days to repair the substation and amounted to an estimated USD 15.4 million in damages.

Figure 4. Line of Sight compliance and staggered opening for wind load

NFPA 850 [3] and 851 [1] outline specific size and location requirements for impact protection and Line of Sight using barriers. Adoption of this standard into the CIP Strategy is a good first step and will allow the engineers to plan work accordingly and properly size fire and ballistic barriers for protection.

With these types of incidents threatening the U.S power grid, substations are responding to new CIP requirements and Homeland Security objectives with standards and new budgets for upcoming projects to provide a more sophisticated approach to ballistics, fire and other protection. Large and small utilities all recognize the value of having a standard approach to safety, security, liability and loss control which the Safe by Design strategy can provide.

The most vulnerable substations include critical equipment exposed to an open hillside or elevated area that allows for a secured "perch" and Line of Sight to the critical equipment

Some level of physical threat assessment is now part of the planning of all major projects for all utilities across the US. In addition to identifying critical substations and facilities, projects and initiatives to protect the highest risk facilities are already being implemented or built into the next upgrade. Some of the most common areas and trends that see the most need for assessment and protection include:

1. Transformers
2. Switches and controls
3. Buildings and towers
4. Tanks and lines

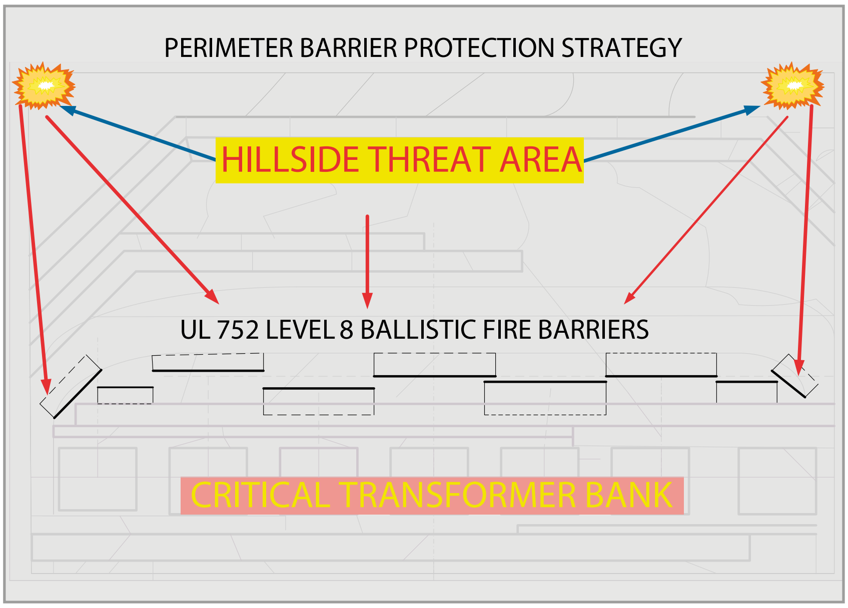

Figure 5. Hillside threat location

Figure 6. Major US substation protected from hillside by UL 752 Level 8 [2] ballistic fire barriers installed to NFPA 851 [1]

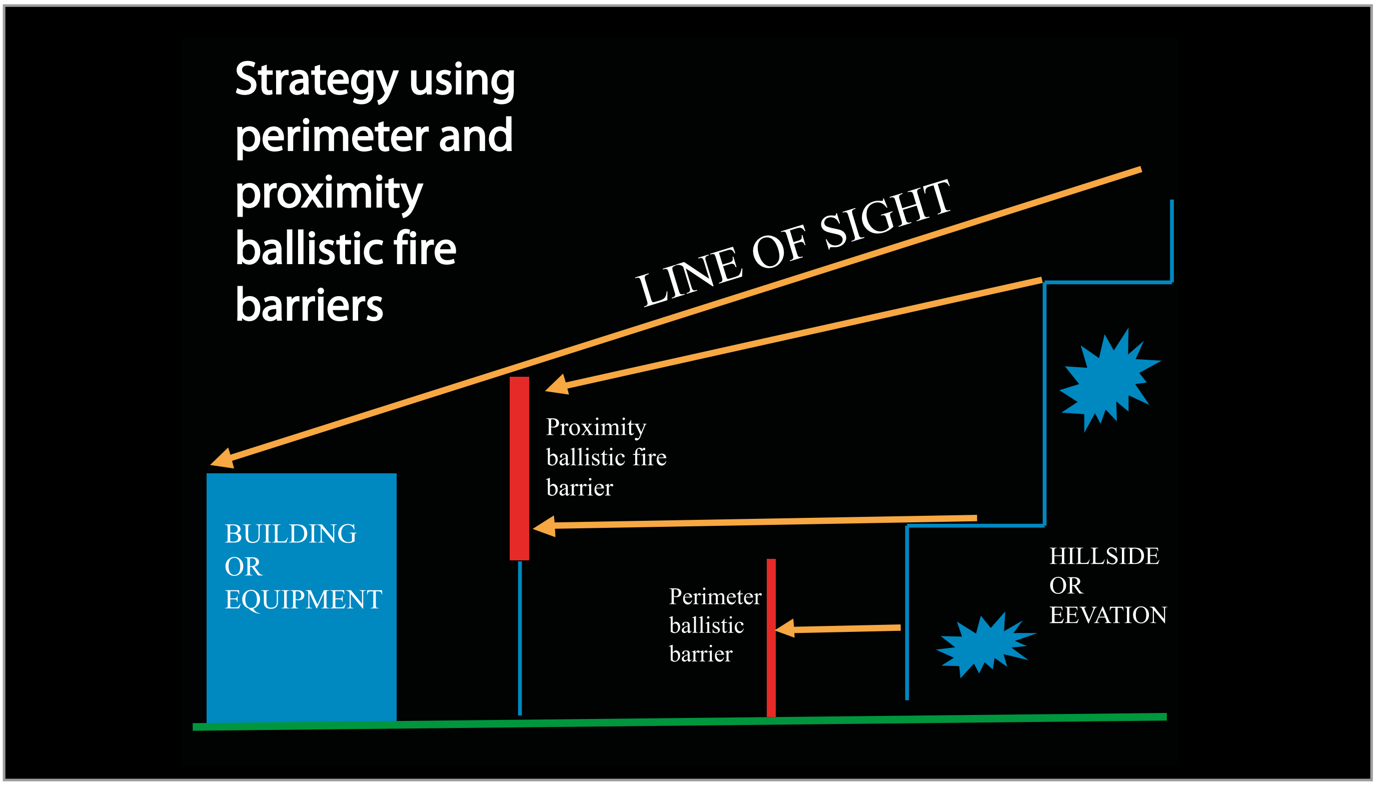

Figure 7. Using proximity/perimeter barriers for Line of Sight compliance

Critical equipment separations can also provide security and safety by isolating and containing incidents both from the environment and from sister equipment such as switches and controls

The combination of proximity and perimeter barriers is typically part of the strategy when protecting these types of assets. With substations vulnerable to sniper and ballistic attack, it is important to recognize that a Line of Sight approach may be the best method to providing standardized ballistic protection across your stations.

Line of Sight is the straight line of vision or visibility to a target from single or multiple locations.

The new innovations in design and performance now enhance the level of protection available to critical infrastructure and the power grid. These sophisticated barriers employ rated materials and designs, and are constructed specifically for our site's topography to protect both personnel and equipment.

World class facilities and projects now have an innovative solution for safety and security to an industry that demands world class protection. The new specifications for ballistics and fire protection developed for these projects now influence all new substation barrier projects and upgrades.

Substations exposed to hillsides

The most vulnerable substations include critical equipment exposed to an open hillside or elevated area that allows for a secured "perch" and Line of Sight to the critical equipment. It is important to perform the physical site assessment with the understanding of the geography and threat involved. In some cases, fire rating may be just as important as ballistics. Protection from outside fires or events, or protection between equipment such as banked transformers has to be a part of the program to be cost effective. Organizations that can marry both safety and security needs using barriers have the most effective physical security CIP programs at the least possible costs.

Switches and controls

Proximity hardening can benefit both safety and security when protecting critical equipment switches or controls. Line of Sight standards can be applied here as well to help guide size decisions when installing proximity barriers. Heat is another consideration when protecting in close quarters such as banked transformer separation walls, switches, and existing sites where control boxes are exposed and planning did not include ballistic or fire barriers for protection.

Safe by Design Strategy

It is recommended to use a combination of **perimeter and proximity** ballistic fire barriers and the Line of Sight provision to provide maximum protection at minimum costs.

Figure 8. Critical equipment separation wall

Substations next to transportation facilities have long been identified as critical infrastructure that could be vulnerable, and may require special attention and protection for combination incidents

Fire rated ballistics are important features to consider when dealing with heat generating equipment such as transformers where fires burn longer and hotter. Fiberglass and other materials used for ballistics protection can add fuel to a fire. Design considerations for ballistics barriers must incorporate fire rated assemblies. Ballistic walls and shields need to perform both before and after exposed to extensive fire conditions and need to be tested to assure that they meet both UL 752 [2] and ASTM E-119 Fire Test Standards for fire, ballistics, wind load, heat transmission, grounding and other factors as part of the Safety by Design process.

Special conditions

Rail yard, chemical and high hazard substations and Safe by Design practices

Ballistics, fire and blast protection can be deployed in different ways to different specifications. One can never protect everything, but the Safe by Design philosophy provides the opportunity to present projects to management with total protection goals. Safe by Design understands the real hazards to critical operations; it defines them. Once the threat is identified, the engineer can use tested assemblies and UL Tested Systems to eliminate that threat.

As an example, substations next to rail or transportation facilities have long been identified as important installations and critical infrastructure that could be vulnerable. These facilities may require special attention and protection for combination incidents involving ballistics, blast, chemical, and fire. Many UL Tested materials can offer tested assemblies and designs for these types of hazards in combination. Many incidents involve two or more hazards – i.e. a fire can be attached to a chemical spill, or a ballistics or projectile incident could have an explosion component. These are all important factors to consider in the Safe by Design process and to design and deploy meaningful protection for critical infrastructure in order to eliminate and mitigate threat and hazard.

The value of UL tested ballistics

Many products claim to have ballistics capability. As an engineer, I understand the value of UL 752 ballistics tested assemblies and when it comes to ballistics, tested works!

The UL 752 test requires five consecutive shots at a set distance and the same location. To pass the test the barrier must not allow a through penetration or fragmentation. If it did not pass the UL 752 ballistics test, it is NOT ballistic rated and NOT a proven assembly to protect against sniper attack [2].

Recommended specifications for CIP barriers

A standard is the best way to control costs and deliver goals and objectives

Figure 9. Local CIP using proximity ballistic fire barriers

for barrier protection. There are many types of untested and in-house designed barriers and walls available. World class facilities demand world class protection. Standards and considerations for barriers protecting substations should include the following highlights:

1. UL 752 Level 8 Ballistic tested at a minimum

2. Physically installed to meet NFPA 851 Line of Sight provisions [1]

3. Wind load tested at 249 kilometers per hour (155 miles per hour or equivalent of a category five hurricane)

4. Transformer fire rated at 1200 degrees

Figure 10. Modular steel fire and impact rated transformer barrier

The diagram in Figure 11. shows a typical schematic image of a rail yard and substation. The barrier placement and size is determined by NFPA 851 Line of Sight [1]. The protection characteristics of fire, blast and ballistics are all UL Tested and if installed correctly, eliminate the threat and are under writable.

Celsius for a minimum of 2 and up to 6 hours

5. Modular designs with panels that can easily be removed or opened. Tested designs now include barriers with columns that are 4.9 meters (16 feet) on centre to make it easy for substation maintenance and transformer access for trucks, service equipment and change-outs.

6. Pier foundations should be a standard at any substation and used for barriers to allow for easy underground access and seismic design capabilities.

Note: Barrier wall foundations can be pier or continuous types. Pier foundations are easier to install and allow access under the barrier. They also allow minimum excavation and can be strategically placed to match your physical plans and requirements for safety and security.

UL 725 Ballistics Test Levels

As indicated in Table 3, UL 752 lists 10 levels of ballistics protection.

UL Level 3 provides protection equivalent to a single impact of a transformer explosion projectile.

UL Level 8 is recommended minimum level of protection for sniper, terrorist, and high powered ammunition protection.

Bibliography

[1] NFPA 851, Guidelines for Transformer Separations

[2] Underwriters Laboratories 752, Standard for Bullet Resistant Equipment

[3] NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations, 2010 Edition

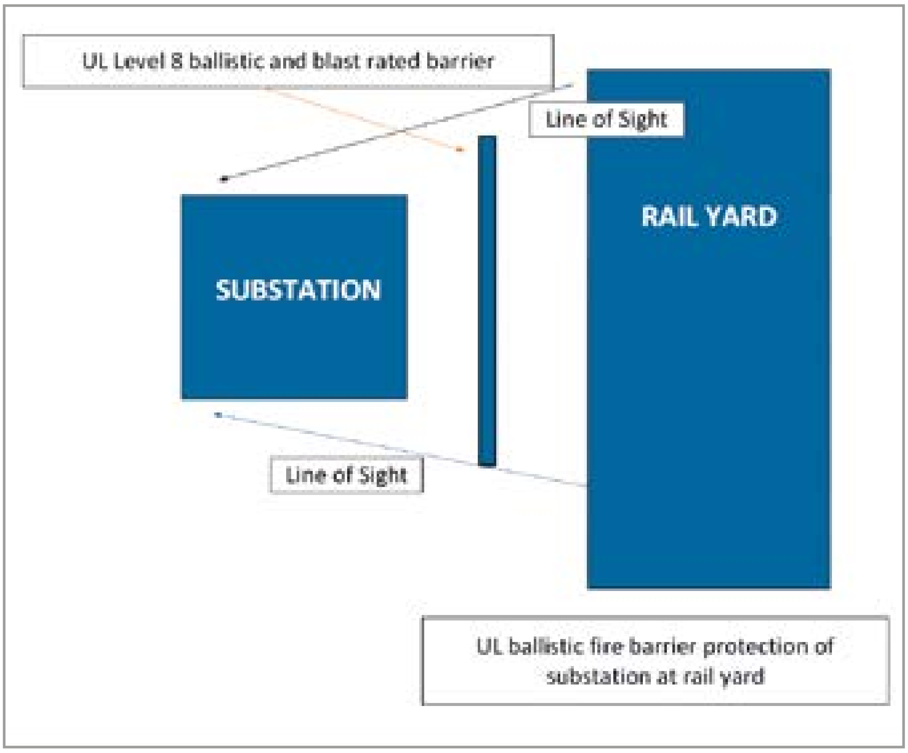

Figure 11. Rail yard Line of Sight protection

Table 3. Underwriters ballistic standards

UNDERWRITERS LABORATORIES 752 LEVELS OF BALLISTIC PROTECTION	
Level 1	9 mm full metal copper jacket with lead core
Level 2	.357 magnum jacketed lead soft point
Level 3	.44 magnum at 15 feet
Level 4	.30 caliber rifle lead core soft point
Level 5	7.62 mm rifle lead core full metal copper jacket military ball
Level 6	9 mm full metal copper jacket with lead core
Level 7	5.56 mm rifle full metal copper jacket with lead core
Level 8	7.62 mm rifle lead core full metal copper jacket military ball
Level 9	.30-06 caliber rifle, steel core, lead point
Level 10	.50 caliber rifle, lead core

Author

John P. Sinisi, Industrial Engineer with BallisticFireBarrier.com, has over 30 years of experience in safety, security and inspection. His expertise in containment, fire barriers and fire stopping brings a Safe by Design approach to threat assessment and mitigation for critical infrastructure. In addition to numerous publications and serving 6 years as Education Chair for the International Fire Stop Council, John holds a US Patent and has work experience in Corporate Safety at United Technologies, BASF, Anheuser-Busch and AGIP Italia before starting his firm in 1999. Recent projects include education programs at NERC and IEEE, threat assessment for major utilities and the design, deployment and installation of the largest UL 752 Level 8 tested ballistic fire barrier ever installed in the US, protecting a major US substation.