

Bullet resistant power transformer retrofit

Mitigate risks and protect assets without compromising performance and reliability

Why bullet resistant?

Power transformers are essential in the effective and reliable transmission and distribution of electricity. Serving as critical nodes, transformers have been engineered over decades to withstand operational risks such as lightning strikes, severe weather events, seismic activity, and power fluctuations. However, up until now transformers have still been vulnerable to human impacts, especially those carried out with high-powered ballistics. Siemens Energy has taken significant steps to develop and test new materials and designs that enable our transformers and reactors to withstand ballistic attacks, ensuring their physical security.

Alarming attacks on U.S. power stations

There have been multiple attacks on U.S. power stations in the past decade. One of the most publicized instances occurred on April 16, 2013, when an electric substation in Metcalf, California was attacked by snipers with at least one high-powered rifle. The assailants surgically knocked out 17 giant transformers within 20 minutes. The attack resulted in an estimated \$16 million in damages and a substation rendered inoperative for 27 days. Although the most well publicized, the Metcalf attack was not an isolated incident.

Most recently, two substations in Moore County, North Carolina were attacked on December 3, 2022, leaving an estimated 40,000 customers without electricity for days. Due to significant capital expenditure requirements and extended lead-times, the best practice to ensure reliable operation of critical transformers and reactors is to preemptively protect them from these types of malicious attacks.

Siemens Energy research and development

In order to increase network safety and reliability, Siemens Energy has investigated ways to produce bullet resistant protection for transformers and reactors. This research has resulted in the first transformer and reactor protection solution of its kind. Mitigating the threat of high-powered ballistics, the comprehensive solution can be retrofitted onto equipment already in operation.

Effective steel alloy

Over the course of several studies, Siemens Energy found that a 3/8" steel sheet, which is a typical material for transformer tanks, can be easily penetrated by a UL 752 Level 8 bullet. Not even concrete, which is used for fire protection purposes in substations, is an adequate material for protection as required by ballistic standard UL 752. Therefore, we developed a material that deflects UL 752 Level 10 which is the highest class of rifle projectile according to UL 752. Steel is still dominant in the design of protective structures and is the preferred material for safeguarding critical transmission equipment due to the high absolute strength and hardness of the material combined with high ductility, formability, and durability. Furthermore, steel often provides a more cost-effective bullet resistant solution than other materials.

One-of-a-kind bullet resistant shielding for new and retrofit solutions

The Siemens Energy solution offers an innovative concept of bullet resistant panels supported on brackets that attach directly to the transformer tank. The system may be installed on new units and retrofitted onto critical transformers already in operation. In contrast to direct hardening of the tank, the bullet resistant panels are able to protect external equipment, which nullifies the need for the transformer to be fitted with additional components such as impact sensors and automated cooling valves. The panels protect the transformer tank, cooling equipment, conservator, turrets, and the bottom of the bushings, while allowing the movement of air for efficient cooling.

Easy access to ancillaries

Sliding doors in front of the control cabinets and pumps allow for ease of access during operation, while removable panels allow for major maintenance.

Space efficient solution

Mounting the bullet resistant panels directly onto the transformer tank is significantly more effective and space efficient than a fixed external masonry wall or ballistic barrier. The advantage is that the system may be used to safeguard equipment in confined areas. This is becoming increasingly important with the trend of locating critical electrical infrastructure in urbanized environments.

Reduction of acoustic emissions

Bullet resistant panels can be adapted to significantly reduce acoustic emissions. This may be particularly beneficial in urban areas. The bullet resistant panels encase the transformer, including cooling fans.

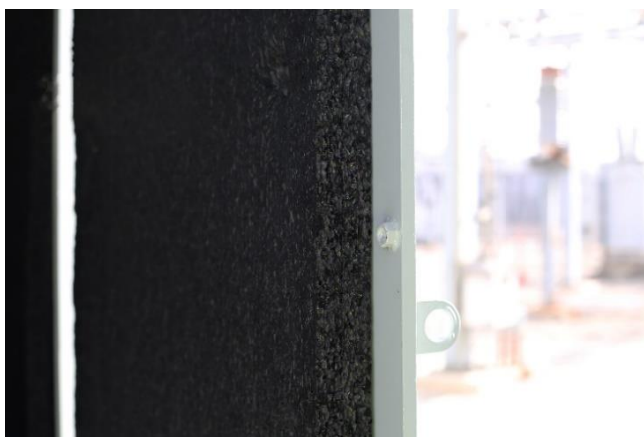


Figure 1 Neoprene insulation can be used to reduce transmission vibrations from the transformer tank, thus reducing noise.

Design and installation

- The design of the bullet resistant system allows for fast and uncomplicated installation.
- The support structure is mounted directly onto the transformer tank or close to the transformer on the transformer's foundation.

- Full installation of the bullet resistant system can be completed within a few days.
- Neoprene strips isolate the panels from the support structure and hence reduce the transmission vibrations from the transformer tank.

Hardening concept for bushings

As with the tank hardening concept, standard porcelain oil-filled bushings may also be replaced with polymer or composite Resin Impregnated Paper (RIP) or Resin Impregnated Synthetic (RIS) type bushings to eliminate the risk of fire. Consult with Siemens Energy for the most suitable technology for your application.



Figure 2 The system allows for easy access to key components during operation of the transformer.

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