Hardening your transformer assets
Maximized resilience with minimized design impact

Malevolent attacks and extreme environments have the potential to damage critical electrical infrastructure such as power transformers.

Failure of a transformer can result in temporary service interruption, considerable revenue loss, and may incur replacement and other collateral costs.

Around the concept of the hardened transformer, ABB has developed different strategies to help utilities enhance physical security and reliability in a cost-effective way.

Background
Severe weather, seismic activity, physical and cyber attacks, sabotage and solar storms all have the potential to damage large power transformers (LPTs). Should units fail, it is very challenging to quickly replace them. Manufacturing lead times are long, involving complex processes of design, procurement, production, testing and deployment. Routinely weighing between 100 and 400 tons, LPTs are difficult to transport and time-consuming to install, requiring specialty equipment and skills.

Transformer hardening
The conventional solution to protect electrical equipment from malevolent attacks or vandalism is to provide fences or ballistic walls around the equipment. This is an expensive solution that can still be breached, rendering the equipment inside vulnerable to attack.

Equipment hardening is a cost-effective way to provide an additional layer of security to all conventional security means or barriers. Equipment hardening mainly focuses on protection of the active part, which is the most valuable part of the transformer.

Our solution
ABB has developed a simple and cost-effective solution to preserve the active part integrity and minimize the recovery time in case of natural or man-made events.

It consists of four critical elements, including:
1) AssetShield™ protective system
2) Dry type bushings
3) Transformer ballistic impact sensor (TRAPS)
4) Automated cooling valves

The solution is provided without having to change the customer’s standard design and with the dimensions of a normal transformer. With full access to the unit for maintenance and any replacement can be done without additional measures.

There is no visual difference between standard transformers and hardened transformers. The look and feel of a normal transformer avoids any additional attraction from possible perpetrators.
**Hardening of transformers** help power utilities protect critical assets and restore power quickly in the event of physical damage to large power transformers.

This solution is an integral part of ABB’s Transformer Resilience initiative which includes five strategic elements – **assessment, hardening, monitoring, rapid repair, and rapid replacement.**

1) **AssetShield protective system**
ABB has designed an optimized combination of special coating and hardened steel designed to protect essential power equipment such as transformers, switchgear, circuit breakers, reclosers, and capacitors from extreme events. AssetShield is able to withstand the highest level of UL 752 stopping a 0.5 Cal bullet fired 15 feet away from the target. It reduces the kinetic energy of bullets and limits spalling (or fragmentation) after impact, which can help reduce collateral damage.

The videos below depict the outcomes:

- **Video 1:** Typical tank wall with 3/8” MS (UL 8)
- **Video 2:** Hardened steel without AssetShield caused significant spalling
- **Video 3:** AssetShield with ½” hardened steel (UL 10)

2) **Dry type bushings**
Bushings are vital transformer components, and when a single porcelain bushing is struck by an object it can explode, sending large porcelain shards flying as far as 40 yards. Porcelain-free ABB dry bushings eliminate the danger of collateral damage to equipment and people, and are also oil and paper free, eliminating the risk of fire. ABB dry bushings are available in many voltage and current ratings, and are high-seismic zone rated. In case of penetration the bushing can be replaced in a matter of days.

3) **Transformer ballistic impact sensor**
ABB has developed an impact detection system which can alert the operations center and be used by the control system to take action following a ballistic impact close to the transformer. The system is simple and robust while providing vital detection of an ongoing event.

4) **Automated cooling valves**
The transformer is protected with automated cooling valves that can open and close based on an ABB developed radiator/cooler leakage detection system. This ensures that the core and coils stay under oil and that the oil leakage is limited to the cooler bank volume even if the radiator/cooler is damaged from an attack. ABB’s solution does not impact air flow, dimensions, weight or maintenance whereas traditional solutions with walls/shielding may cause thermal issues, foundation work and significant maintenance challenges.