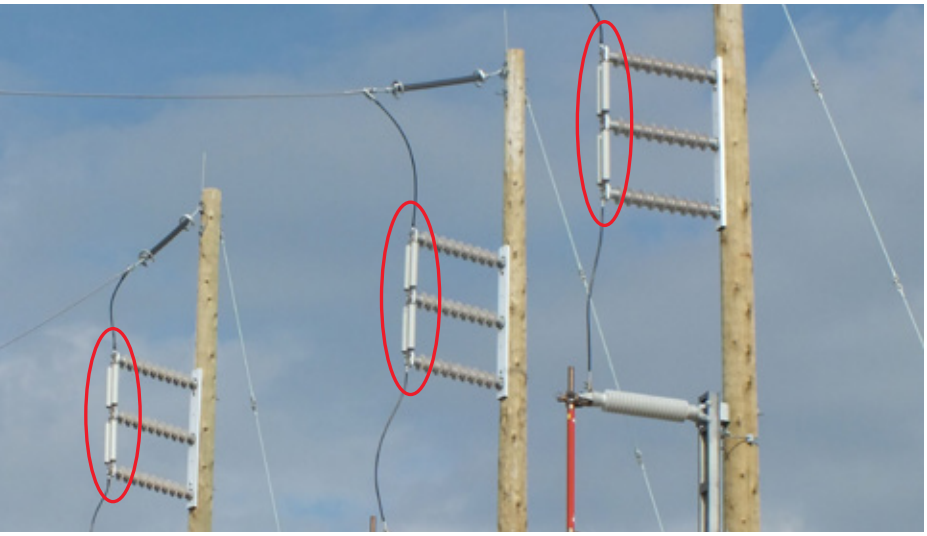
CASE STUDY

Hi-Tech® 46–138kV current-limiting backup fuses



Abstract:
Substations are a critical investment in any utility system that require extensive planning, infrastructure and protection due to the high available fault currents. Historically, expulsion fuses and/or circuit breakers have been used as protection to clear and isolate fault conditions. However, these noncurrent-limiting devices allow the equipment and system to be subjected to tremendous amounts of energy during a fault due to the clearing time of such devices. These high energy levels can result in costly damage that affects restoration time, repair costs and safety around the substation and surrounding area.

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115/138 kV installation using two 100K modules in series to maximize protection against high fault currents.

Hi-Tech's optimal solution
An external current-limiting backup fuse (EXT) paired with an expulsion fuse offers state-of-the-art protection that drastically reduces energy let-through by clearing in less than one half cycle. The two-fuse approach has been applied for decades on distribution systems and has proven to improve safety, reduce energy, isolate faults and minimize the potential for catastrophic failures.

Systems ranging between 46 kV and 138 kV can now benefit from these same advantages by pairing a Hi-Tech EXT fuse with a suitable expulsion fuse, such as S&C SMD® expulsion fuses. Using match-melt coordination techniques, L-N rated EXT fuses are installed in series with L-L rated expulsion fuses so that the expulsion fuse will melt and drop open, making it easy to pinpoint where the fault occurred while allowing an L-N rated EXT fuse to be used.

For 46 kV systems, Hi-Tech's current-limiting protection up to 50 kA coordinates with common SMD fuse types up to the 50E standard speed. For protection schemes using the SMD slow speed style, the two-fuse protection can be achieved using the 40E and smaller.

A single 100K module is suitable for 69 kV systems when paired with 100E standard speed fuse or smaller. Additionally, two 100K modules can be used in series for optimized protection at 115/138 kV up to 20 kA.

The combination of a Hi-Tech EXT with an SMD expulsion fuse provides industry-leading protection by increasing the overall maximum interrupting current well above an expulsion fuse while normally achieving more than a 90 percent reduction in energy (I^2t) due to the current-limiting fuse performance. Tables 1 and 2 illustrate the difference in I^2t values between an expulsion fuse and the two-fuse approach now available.

Table 1: Energy comparison at 69 kV

Expulsion fuse	Fault current (kA)	100E standard speed expulsion fuse Maximum I^2t let-through (A^2sec)[1]	100E standard speed expulsion fuse with Hi-Tech 100K EXT Maximum I^2t let-through (A^2sec)[1]	Reduction %
SMD-2B @ 69 kV	5	2,190,000	830,000	62.1
	10	6,800,000		87.8
	12	9,800,000		91.5
	16	17,400,000		95.2

[1]Maximum I^2t values based on an X/R of 15 and total clearing time corresponding to the available fault current per SMD-2B standard speed TCC at 69 kV.

Table 2: Energy comparison at 138 kV

Expulsion fuse	Fault current (kA)	100E standard speed expulsion fuse Maximum I^2t let-through (A^2sec)[1]	100E standard speed expulsion fuse with Hi-Tech 100K EXT Maximum I^2t let-through (A^2sec)[1]	Reduction %
SMD-2B @ 138 kV	5	2,670,000	830,000	68.9
	10[2]	8,800,000		90.6
	12[2]	12,700,000		93.5
	16[2]	22,000,000		96.2

[1]Maximum I^2t values based on an X/R of 15 and total clearing time corresponding to the available fault current per SMD-2B standard speed TCC at 69 kV.
[2] Fault current exceeds the maximum interrupting current (8,750A) of an SMD-2B at 138 kV.
Faults that exceed max IC must be cleared by another protection device, such as a circuit breaker or Hi-Tech 100K EXT rated up to 20 kA.

Hi-Tech's solutions for 46 kV systems offer benefits to the system protection, such as the drastic energy reduction shown above for 69–138 kV, but also for fault levels up to 50 kA. The 46 kV offering has several hardware configurations for flexibility during installation. The concept applies to new or existing applications using SMD expulsion fuses, which also includes station service and instrumentation transformers.

Application

Many of today's substations use external current-limiting backup fuses on 34.5kV circuits. However, a large Canadian utility has taken the next step and completed multiple installations ranging between 66 kV and 138 kV to protect an innovative substation concept known as high voltage padmount transformer (HVPT) station.

HVPT stations are 10 MVA or smaller and protected by both expulsion and current-limiting fuses when the available fault current exceeds 4 kA. Even though most expulsion fuses will operate and clear a 4 kA fault, the additional current-limiting fuse offers increased safety to minimize the effects of such a fault.

The HVPT station requires minimal land in most cases (less than half an acre) when compared to several acres that are required for traditional stations. The compact footprint houses deadfront equipment in tamper-resistant enclosures for underground cable designs and can often eliminate the need for large station structures and fencing. This can also reduce the size of station yards and associated ground grids.

Additional information on HVPT stations can be found at hvptstation.com.

Please contact your ABB representative for additional details regarding EXT current-limiting fuses for applications up to 138 kV.

New HVPT station

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