New life for old switchgear

Medium voltage switchgear modernization – an alternate choice for customers

Stephen Pearce

The pace of technology makes today's cutting edge seem old hat tomorrow, but age need not equate to obsolescence. Modernization can protect the customer's investment by extending the equipment lifespan while raising safety, reliability and performance standards.

In ABB's refurbishment and retrofitting options for medium voltage switchgear, equipment is returned to as-new condition. The integration of advanced sensors, protection and control gear improves reliability and safety. The shorter downtime as compared to total replacement ensures a better protection of productivity.

Whether the switchgear customer opts for modernization or replacement is often a question of economics, with modernization offering advantages in many cases. Questions the customer must consider include: Is it meaningful to install state of the art switchgear in a plant with reduced life expectancy? How much downtime can be justified? Does the overall budget allow for major investment?

In today's competitive business environment, companies constantly focus on asset optimisation through cost reduction, and increasing safety, reliability and utilisation. In utilities and industrial plants, operators of electrical distribution networks face the challenge of achieving optimised utilization of their facilities: They must balance investment in new equipment against maintenance costs, safety and down time. Performance of medium voltage switchgear within the network is a main factor influencing overall reliability of the system, and consequently it is a key element for optimization.

A traditional equipment management strategy followed by plant operators, was to replace switchgear when it had reached the end of its economic lifecycle. This choice provided maximum equipment lifespan and the latest technology and safety features on replacement, but usually implied high economic investment. Such a replacement strategy does not necessarily fit with the overall needs of a plant:

- The life expectancy of the plant as a whole may not match that of the new switchgear.
- The downtime of the plant to enable replacement of the switchgear may not fit with operational and production commitments.
- The timing of the switchgear replacement may not match the capital expenditure plans of the business.
- Such a strategy does not necessarily represent the optimal life cycle costs.

Accordingly, medium voltage switchgear manufacturers have developed a number of alternative solutions to help customers find the best safety and life cycle management option for their equipment. Having more choices, each with different advantages and costs, enables customers to select the specific solution that best fits the overall business strategy of the plant. Alternative choices for customers include:

- Refurbishment: The existing switchgear is fully overhauled and restored to an as new condition.
- Retrofit: One or more main elements of the switchgear are replaced with modern equivalents. Elements with the highest maintenance cost and failure risk can be targeted specifically.
- A combination of the above.

1 Circuit breaker refurbishment at the ABB Product Support Center in Florence, USA.

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Refurbishment

Refurbishment of medium voltage switchgear offers customers a life extension for their equipment at low cost. This option is attractive for customers with no imminent need to modernize, but wishing to maintain acceptable performance over a short to medium term life extension.

Refurbishment of switchgear can take place in a number of ways:

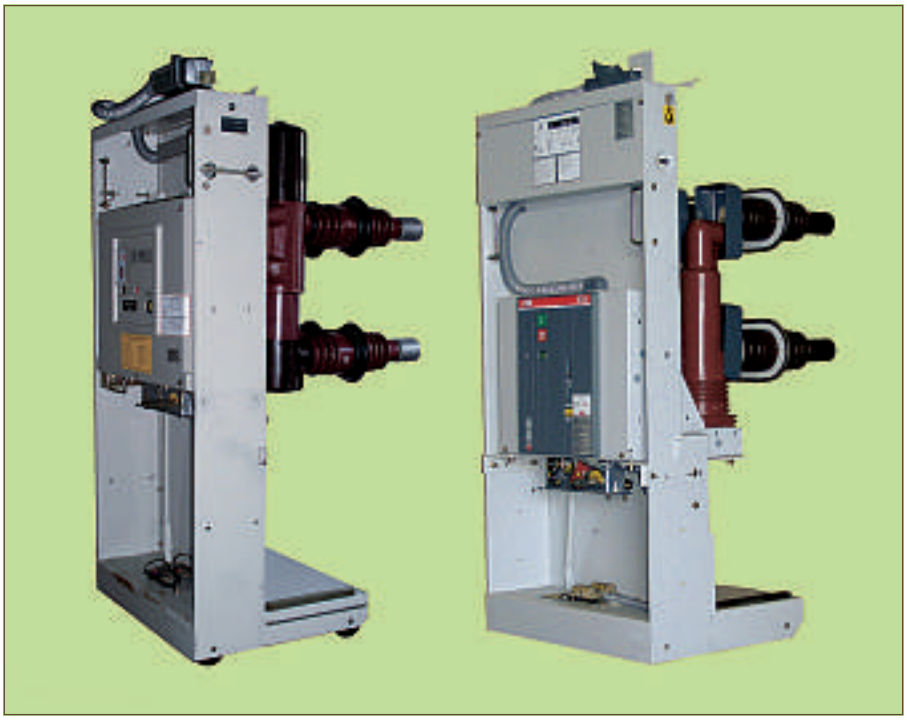
- Refurbishment of the switching devices.
- Refurbishment of the complete panel.

Refurbishment of switching devices

Switching devices such as circuit breakers, contactors and switches are typically candidates for refurbishment. The devices are removed from the switchgear, sometimes on a rotational basis in order to maintain continuity of supply, and returned to the manufacturer.

For refurbishment, each breaker is completely disassembled to the smallest components 1. In general, bearings, cotter pins and other selected components are totally replaced. All other parts are thoroughly checked for wear and damage and are replaced as needed. Each component is cleaned and re-plated if required. Product enhancements that have developed since the original manufacture are implemented to bring the breaker up to the latest production standards. When such a refurbished breaker leaves the factory it has a new lease of life and a full new warranty.

2	Calor Emag OD3 breaker (left) and retrofit using ABB VD4 vacuum breaker (right).



A large utility recently recognised the value of extending the life of their aging ABB/ITE breakers by awarding ABB a 6-year blanket contract for refurbishing nuclear safety-related and commercial breakers in their power plants. This customer will enjoy the advantages of as-new breakers with the latest enhancements, without the costly prolonged down time associated with complete switchgear replacement.

Panel refurbishment

This option normally applies to customers who intend to decommission an existing switchboard and re-use it at a different sub-station. Such a life extension choice is typically made where the switchgear application must provide short-term power supply, for example in the construction and mining industries.

Refurbishment of the switchboard can be performed at the customer's site. The board is stripped and key components are replaced as necessary. Where more extensive refurbishment is required, the board is normally decommissioned and removed from site and shipped to the manufacturer. Here the switchboard is completely stripped, and components cleaned and repainted. Insulation is inspected, tested and replaced if necessary. Switching components are refurbished as described in the previous section.

Customers are increasingly using retrofit of MV switchgear as a means of economically increasing the operational life of their equipment and improving safety.

Optionally, refurbishment can also include some form of retrofit, such as an upgrade of protection and control equipment.

Retrofit

Customers are increasingly using retrofit of MV switchgear as a means of economically increasing the operational life of their equipment and improving safety. Retrofit of the switchgear can take many forms, based on the needs of the customer:

- Retrofit of switching devices, where the existing device is replaced by a more modern equivalent.
- Retrofit of the switchgear panel, where components of the panel are replaced to enhance the safety of the equipment.
- Retrofit of protection and control, where protection and control devices are replaced - providing increased functionality, data communication and safety.

The advantage of retrofit over replacement are especially strong when:

- Special shut down of the plant to replace the switchgear cannot take place due to operational commitments.
- Physical constraints of the existing site limit replacement.
- Existing cable systems are old and it is preferred not to disturb and re-terminate cables on new switchgear.

Where a retrofit design is developed, type testing to verify ratings and ensure safe operation is a key requirement. This should be performed by the manufacturer.

Circuit-breaker retrofit

Retrofit of a circuit breaker involves complete replacement of the original circuit breaker truck with a roll in replacement, incorporating a modern vacuum or SF_6 interrupter. The retrofit includes all interlocking facilities supplied with the original panel design, as well as racking mechanisms for inserting and withdrawing the breaker from service. The interface for secondary control is also maintained to enable simple swapping of the old breaker with the new retrofit. 2 shows a typical example of a retrofit design, where an old Calor Emag OD3 breaker is replaced with a modern vacuum design.

This retrofit option provides customers with a fast upgrade of their switchgear.

The down time is minimised, as the only on-site activities are those of racking out and removing the old breakers and inserting the new retrofits. This can be performed during a normal shutdown of the switchboard.

One specific benefit of circuit-breaker retrofit exists where the original breakers are of an oil-insulated type and there is a need to reduce fire risk in the sub-station for safety or insurance purposes. The breaker can easily be replaced with a non-oil design, enabling the switchboard to reach its full lifespan.

ABB has a long history of supplying different circuit breaker types to customers around the world. Table 1 lists major breaker manufacturers for which ABB already offers retrofit designs.

Panel retrofit

Development of medium voltage switchgear panel technology has led to more compact designs and more safety features. Even so, rare and generally unpredictable events can take place – such as failure of switchgear due to an internal flashover. An internal arc has two phases:

- First, there is an extremely rapid build up of pressure within the panel. The time frame is within the first 10ms of the arc being established, which is beyond operation of conventional protection systems.
- Then, burning occurs as the arc consumes insulation, copper and steel components of the panel.

Panel designs capable of safely containing an internal arc are relatively new; the majority of switchgear installed around the world does not have this feature.

3 Example of an arc vent retrofit fitted to a Reyrolle type LMT panel.

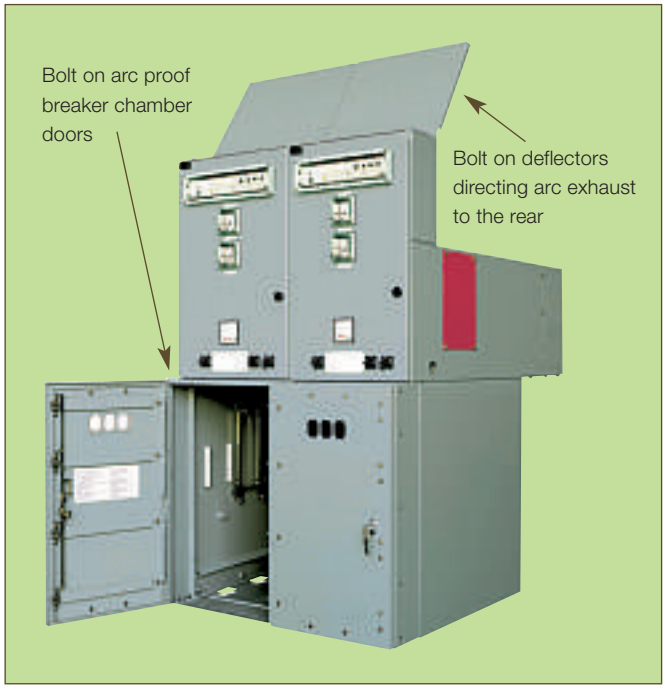


Table 1

Existing retrofit designs available from ABB

ASEA	Magrini
ASEA Brown Boveri (ABB)	Merlin Gerin
Brown Boveri (BBC)	NGEF
Calor Emag	Panel Gardy
Cutler-Hammer	Radaconsher
EJF Brno	Reyrolle
Energo-Invest	Sace
Gardy SA	ABB Secheron SA
General Electric	VOLTAS
Gould, Gould-BBC	ZWAR Warszawa
ITE, ITE Imperial	

Plant operators must also comply with health and safety legislation, which increasingly requires electrical equipment to meet higher standards.

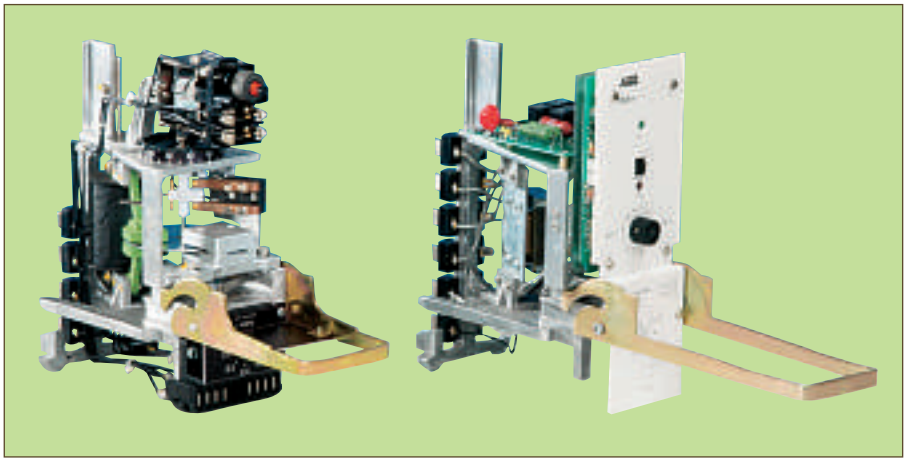
Another consequence of a panel failure is the resultant damage to the substation, and the ensuing downtime of the switchboard. In plants running continuous processes, such downtime and the consequent loss of production can be of significant cost.

Accordingly, upgrade solutions must be provided which both improve safety for operators and also minimise downtime following an internal arc.

A number of options exist for retrofitting solutions to improve internal arc performance of panels. To cater for the first phase of the fault and the resultant pressure build-up, the following retrofit solutions can be applied:

- Retrofit of remote switching – this is a simple and low cost measure improving operator safety. Analysis of switchgear failures, indicates that failure typically occurs during a switching operation. If operation is external to the substation, operator safety is automatically improved. This solution, however, does not cover all possibilities of failure, as some failures take place independently of switching operations (eg, lightning strike), and personnel within the substation may be exposed.
- Retrofit of arc proof covers and doors. This measure involves replacement of the panel doors and covers to provide arc protection and fitting of pressure relief flaps. During the rapid pressure rise following fault inception, the doors and covers withstand the pressure rise. Pressure relief flaps then release the build up in a controlled way. 3 shows an example of this design.
- Retrofit of the circuit breaker compartment: This involves complete replacement of the original circuit breaker compartment by a modern cassette design. With this approach, a standard breaker can be used: Operator safety is assured by arc proof doors, pressure relief of the breaker compartment, and proven interlock systems. A connection to the original busbar and cable system must be provided.

4	Electronic over/under voltage relay. The electronic relay (right) can replace the electromagnetic relay (left).



To limit the duration of arcing, a relevant protection system may be retrofitted:

- Retrofit of internal arc detection: This solution uses light emitted from the arc and current detection to establish the faulted section of the switchgear. The breaker feeding the fault is then switched off. Fault detection is extremely rapid and arcing times can be limited to 50 ms, significantly minimising damage to the switchgear.
- Retrofit of modern protection systems: Using electronic relays, tripping times of 60 – 100 ms can be achieved. Replacement of older relay designs allows fault times to be reduced minimising panel damage.

To achieve the dual objectives of better safety and reduced down time, retrofit of both panel and protection system should be considered.

Protection and control retrofit

Technology of protection and control devices is rapidly advancing: Modern devices have better communication and control capability and can provide more diagnostic information. Equally, plants increasingly incorporate process automation software systems, which require higher levels of electrical plant integration for operation. Adoption of this technology optimises utilisation and permits increased plant performance.

> Modifications to protection and control systems can be accompanied by replacement of conventional current and voltage transformers by equivalent sensors. Such devices are compact and provide linear output without saturation.

Historically, protection devices were of an electromechanical design. This technology has provided reliable performance for many years and is still accepted today. Usually devices were specific to their function – with protection relays for protection functions, whilst separate devices provided control and indication functions. With the development of microprocessor based relays, many of these functions are now combined into single sophisticated devices providing a range of protection, control and indication functions.

Retrofit of protection and control systems can be adapted to customer need. Some electronic relays have been developed with the same draw-out features and case dimensions as their electromechanical predecessors 4.

An alternative approach is the replacement of the protection scheme: Normally a number of discrete protection and control devices are replaced by a single multifunction microprocessor relay.

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Conclusion

Advances in refurbishment and retrofit techniques have provided customers with a range of options for economically improving safety and extending the life of their switchgear. Analytical comparison of these options allows plant operators to identify the most suitable way of improving the performance of their electrical assets and so maintaining a sustainable competitive advantage in the market place.

Stephen Pearce
ABB Medium Voltage Switchgear
South Africa
stephen.pearce@za.abb.com