High voltage assembly

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The liberalization of electricity markets has quickly changed the environment in which utilities operate. Customers are demanding improved reliability, transmission plant availability and system management.

Rising demand for electricity and an increasing number of generation plants connected to the network have only added to the urgency. Utilities must be able to guarantee high quality power delivery and reduce the number and duration of outages.

Against this backdrop, ABB has developed a new family of switching device: a circuit breaker combining one or more disconnectors and control gears. This combination works for both indoor and outdoor installations.

An IEC working group is preparing a new standard (the future IEC 62271-205) to classify the switching device combinations as "assemblies" of high voltage devices. The aim is to have an International Standard (IS) ready by 2007. The Cigre working group, B3-02/03, is also working to provide basic guidance for the assembly of high voltage devices in an already existing substation design.

The assemblies can be based on traditional air insulated switchgear (AIS), on advanced SF_6 gas insulated switchgear technology (GIS) or on a hybrid of both technologies featuring the benefits of both AIS and GIS techniques. The most important advantages of hybrid modules are:

- Compact design due to GIS technology.
- Complete assembly and test within the factory.
- Easy transportation to and on the site.
- Short installation time (already tested in the factory).
- Low maintenance because all high voltage contacts are enclosed in SF_6.
- Low maintenance outages because of high reliability.
- Low lifecycle costs due to low equipment cost.
- Low energy losses and low spare redundancy costs.
- Easy replacement in case of failure.
- Environmentally friendly due to smaller dimensions.

PASS hybrids from ABB

In the 1990s, ABB developed the hybrid switchgear called PASS (Plug And Switch System) for voltages between 72.5 and 170 kilovolts, and breaking currents of 31.5 to 40 kiloamps.

PASS is a multifunctional module , which integrates and combines several functions. For example, the disconnector/earthing switch can be combined with a breaking chamber for better reliability. The breaking chamber guarantees the earth connection of a line in conditions where a short circuit is likely. Outdoor transformers mounted on SF_6 bushings will measure the current.

Modular substation design

PASS modules are pre-engineered bays whose introduction has markedly enhanced the module-based approach to substation design. The substation is divided into modules in which design engineers can test both structure and design with great precision.

Price and technical feasibility of a substation can be determined at the start of a project. Alternatives can be generated and evaluated quickly, and

the value of a potential investment estimated without exhaustive design studies. Results come in days, even hours, compared with months often required for conventional systems.

ABB's PASS M0 and M00 modules are briefly discussed below.

The PASS M0 modular bay

PASS M0 is a very modular and flexible switching bay. The circuit breaker is equipped with a disconnector/earthing switch and current transformers suitable for most standard designs of high voltage substations. The following layout configurations are available: PASS M0 SBB for single busbar systems; PASS M0 SBB with the additional combined disconnector/earthing switch line side 1; PASS M0 with GIS voltage transformers already mounted in the factory 2; PASS M0 DBB for double busbar systems 3; PASS M0 IOS for incoming and outgoing busbar systems; and PASS M0 DCB for H scheme substations 4.

PASS M0 DCB brings a very compact solution to the H scheme substation. For all the above-mentioned modules, the time taken to unpack, construct, fill with SF_6 gas and commission has been sharply reduced.

Other significant technological improvements include simpler design – the only moving part is the motor rotor – and an electrolytic capacitor bank stores the energy needed for the 0-0.3"-CO cycle. The digitally controlled travel characteristic allows the interruption of current at lower frequencies, eg, the 16⅔ Hz used in railway applications, without having to modify the breaking chamber.

The innovative electronic CB drive, Motordrive 5 is precise and accurate, and exhibits high repeatability of opening and closing times for better current-interrupting capability compared with conventional drives.

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The new PASS M00 design

PASS M00 is the ABB plug and switch module in the 72.5 to 100 kV range, and breaking current up to 31.5 kA. Standard functions of the PASS M00 include current measurement, disconnecting, current interruption and earthing.

The number of functions can be increased depending on the requirements of the substation. PASS M00's unique feature is its five-position disconnector, whose mobile contacts are integrated within the chamber itself 6.

Precise rotation of the mobile contacts enables line disconnection, busbar disconnection, and earthing of the line and busbar through the closure of the circuit breaker – all with a single drive.

PASS M00 retains the modularity of the PASS M0. The double busbar version, for example, is obtained by adding the module containing an additional disconnecting switch 7.

On-site work includes the installation of the supporting structure 8 and active components on the structure 9.

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Lifecycle cost (LCC) analysis

The most useful way to compare the cost of the hybrid-module approach with the traditional AIS-equipment is Lifecycle cost (LCC) analysis. LCC is focused not only on the investment cost but also on fixed and variable costs arising during the whole life of the substation.

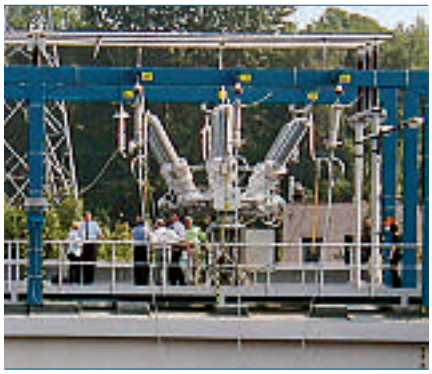
1 PASS M0 SBB.

2 PASS M0 SBB with VTs.

3 PASS M0 DBB.

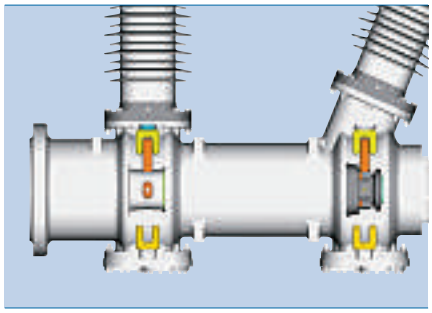
The investments costs (CI) cover primary equipment, control and protection system, civil works, operation, land acquisition etc. Fixed costs (CF) comprise maintenance of the site, buildings, and equipment, as well as spare parts, manpower and any planned outages for maintenance purposes. Variable costs (CV) accrue from unplanned events such as faults, replacement time and penalties due to energy/power not dispatched to users.

4 PASS M0 DCB.

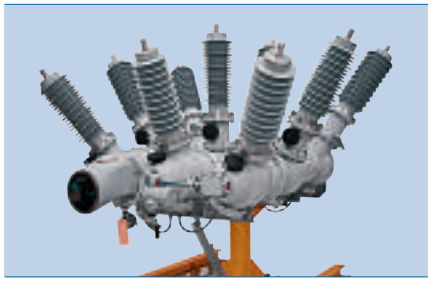


5 PASS M0 with Motordrive.

6 DS mobile contacts integrated in the CB.



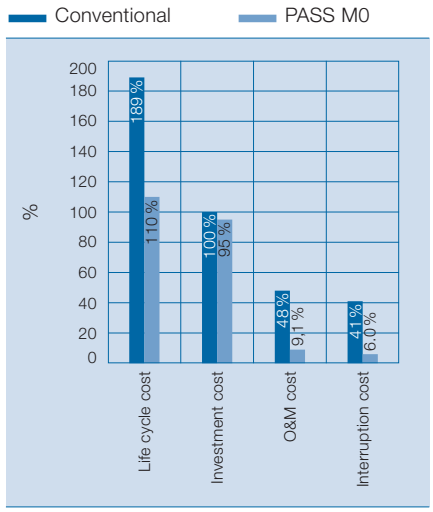
7 PASS M00 DBB.



8 Installation of the supporting structure.

9 Active components on the structure.

10 Lifecycle cost comparison of a 123 kV double busbar substation with 10 feeders.



The three categories add up to the LCC of the substation according to the formula:

$$LCC = CI + \left[(CF+CV)\left(\frac{(1+i)^n - 1}{i(1+i)^n}\right)\right]$$

where "i" is the interest rate and "n" is the expected life of the substation.

Substation reliability can be calculated by means of appropriate software. 10 shows the values in percentage of the three cost categories and the total LCC calculated for a case study of a 123 kV double busbar substation with 10 feeders using conventional AIS equipment and PASS M0 modules.

The most useful way to compare the cost of the hybrid-module approach with traditional AIS-equipment is Lifecycle cost analysis.

The compact PASS M0 and PASS M00 allow a 50 to 70 percent reduction in the occupied area compared to the AIS bay, depending on the substation layout.

Conclusion

Key advantages of the PASS modular system include the flexibility to adapt to the most common substation layouts.

The use of hybrid switchgears has enabled the development of new and simpler substations with very compact design, fast installation, easy replacement in case of failure, lower maintenance and lifecycle costs and higher reliability than comparable AIS-configurations.

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