Maintain, Replace or Modernize: Optimize Your Switchgear Investment

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Electrical Reliability and Aging Equipment

Keeping aging switchgear performing at optimum performance levels can be challenging. When it comes to the reliability of an electrical distribution system, it's not a question of if a system component will malfunction, but when. Electrical equipment ultimately degrades and reaches the end of its useful life, no matter how much maintenance is performed. And, with the advancements in the design of the new circuit breakers, those with older technology are no longer considered sustainable solutions.

Plant managers and engineers must ensure continuity of operations and develop a plan to replace or upgrade aging switchgear. Facilities without a properly-implemented strategy put operations at risk that could lead to safety issues, equipment damage and/or downtime.

Maintain or Replace?

Facility engineers and maintenance managers must continuously evaluate the condition of the electrical system to optimize its performance. At some point in time, the "maintain or replace" decision arises relative to how to address aging or outdated equipment.

Maintenance Requirements

To ensure proper operation and maintain equipment warranties, major electrical equipment manufacturers generally require annual maintenance for power circuit breakers. A thorough onsite maintenance work scope for power circuit breakers includes:

- Inspection
- Cleaning and lubrication
- Adjustments
- Overcurrent protective device testing
- Insulation testing
- Charge/close/trip circuit testing
- Dielectric testing
- Time and speed testing

New or refurbished parts or subassemblies may be required to return a circuit breaker to its designed operating condition.

In-shop reconditioning is a more intensive maintenance option. Circuit breakers are initially tested to relevant ANSI standards and then completely disassembled, cleaned and inspected. Damaged parts are refurbished or replaced, and pivot points are cleaned and lubricated before the circuit breaker is reassembled. The reconditioned breaker is retested to relevant ANSI standards, including primary injection and timing testing.

Even with annual maintenance, however, power circuit breakers may need additional upkeep or upgrades. Factors to consider include:

- Age of Equipment
- Operating Environment
- Availability of Spare Parts
- Reliability of System Components
- Cost of Ongoing Maintenance
- Emerging Technology

Financial Considerations When Replacing Switchgear

In addition to the initial cost of new switchgear, it is important to consider the potential disruption to the facility's processes and workflow during the course of changing out the equipment. Unless process loads can be rerouted temporarily during the demolition of old equipment and installation of the new switchgear, the cost of lost production can be substantial.

Another consideration that is often overlooked is conduit placement. Installing new switchgear (which is usually smaller than the older/obsolete equipment it is designed to replace) requires that existing conduit above and below the equipment be moved. Cabling may need to be replaced or spliced, as well. This is an expensive and time-consuming process, often costing more in labor and material than the cost of the new equipment.

Switchgear Modernization Solutions: A Viable Solution

Electrical switchgear is composed of passive and active components. The switchgear's frame, enclosure and horizontal and vertical bus sections make up the passive elements of the equipment. Circuit breakers and fusible switching devices have an active role in the equipment's operation which includes protecting the electrical assets downstream, disconnecting the circuit, and reducing or eliminating the arc flash hazards associated with switching high magnitude currents.

Switchgear modernization solutions keep the existing structure and footprint intact, which minimize demolition costs and downtime. Once complete, the electrical power system has been upgraded to current technology to support a facility's operations.

Switchgear Modernization Project Example:
Before (above, left) image and after (above, right) image of existing components with LV direct replacement breakers and monitoring system installed.

Two Modernization Solutions, the Same End Result

NEMA Rated

Upgrading existing switchgear with state-of-the-art circuit breakers does not compromise the reliability of the equipment. NEMA rated enclosures meet the National Electrical Manufacturers Association standards for performance and protection of the electrical equipment installed within them.

In general terms, any process that modernizes and extends the life of electrical equipment is referred to as a retrofit. Listed below are two specific retrofit strategies for low-voltage and medium-voltage switchgear that save time and money. Both direct replacement and retrofill solutions adapt modern circuit breakers into existing equipment while leaving the structure, conduits, cabling and footprint intact.

- Direct Replacement: A new circuit breaker fits into the existing cubicle with little-to-no modification to the switchgear cell. This option reduces downtime since there is minimal (if any) outage on the equipment bus.
- Retrofill: The existing switchgear cell and bus are modified to accept the new circuit breaker. This process usually requires a longer bus outage, during which time the internal circuit breaker cell is modified to accept the new circuit breaker.

Though different processes, direct replacement and retrofill solutions:

- Modernize switchgear to current technology
- Improve power system reliability and lower lifecycle costs
- Are available for any manufacturer's existing equipment

The remainder of this paper will primarily focus on medium-voltage applications. Medium-voltage switchgear can consist of one of four types of circuit breakers based on the arc quenching medium; air, vacuum, oil, or SF6 gas. These circuit breakers are typically draw-out type, a design which facilitates removal from the power source and simplifies maintenance. Air, vacuum, oil, and SF6 gas circuit breakers require similar maintenance; however, each has unique characteristics and testing procedures.

Why Update / Modernize?

Modern power circuit breakers are designed using arc extinguishing technology. Since power circuit breakers provide such a vital function in protecting the electrical system, as well as reducing or eliminating of arcing fault hazards, this design improvement represents are a quantum leap forward in equipment and operating personnel protection. In addition, they have lower maintenance requirements than the older design circuit breakers.

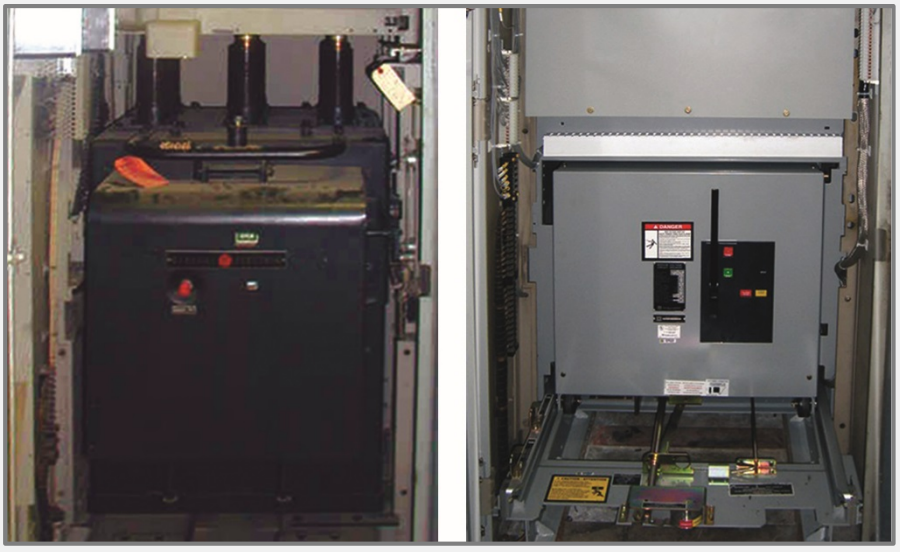
With this in mind, following are eight reasons to extend and optimize the life of your electrical switchgear equipment and improve its reliability[1]:

1) **Performance and Safety Upgrades:** Circuit breaker and switchgear upgrades offer enhancements for performance and improved safety. Integrating arc resistant technology into the retrofit can increase protection for both personnel and equipment. As an added benefit, because of the short circuit interruption and opening time is generally faster, the upgraded circuit breaker is better suited for load transfer applications.

   Upgrading can also increase the capabilities of circuit breakers and switchgear:

   - Arc fault current interruption
     - New circuit breakers are available with higher ratings
     - In most cases, the interruption capacity of the entire switchgear can be increased with an engineering study and a circuit breaker upgrade or replacement
   - Arc flash limiting circuit breaker availability
   - Trip unit accuracy and repeatability with new circuit breakers
   - Power metering, monitoring and communication

2) **Improved Reliability:** Aging materials reduce equipment reliability due to the dielectric breakdown of insulating components and the degradation of aging mechanical parts. Electromechanical trip interrupting devices on existing circuit breakers may not trip at all. Those that do trip are not repeatable and may be well outside the time-current coordination parameters.



Above: Before/After Retrofill Solution
Medium-voltage retrofill solutions are often used for larger devices such as main breakers or tie breakers.

3) Reduced Maintenance Costs: By using upgraded vacuum circuit breakers as retrofits, the circuit breaker maintenance cycle can be extended to five years or more. Modern circuit breaker designs utilize a virtually maintenance free operating system. Compare this with these facts:
    - Older circuit breakers require extensive periodic maintenance and overhaul (expensive and time consuming)
    - Spare parts for existing and older circuit breakers may no longer available

4) Rating Upgrades: As the need for more and more power at many industrial facilities increases so does the need for improved and increased protection of the electrical system. In most cases the switchgear bus, bracing, frame or enclosure are usually higher rated than the circuit breakers, but if not they typically can be upgraded. The circuit breaker used in the switchgear also can be upgraded at least one class; for example, from 25kA short circuit interrupting capability to 40kA, and in some cases, even up to 50kA. The continuous current carrying capability also can be increased by reviewing the existing switchgear buss design and updating it. Modern vacuum circuit breakers are also faster, most having short circuit current interrupting ratings of 3 cycles or less, compared to the older circuit breakers with interrupting time of 5 cycles, 8 cycles or even more.

5) Upgrades to Meet the Latest ANSI Standards: A major improvement in circuit breaker design is that vacuum circuit breakers are operating with the voltage factor K=1, which means that the interrupting capability is not affected by the system voltage. A vacuum circuit breaker with an assigned short circuit current interrupting capability will function at any voltage level without reducing the assigned short circuit interrupting rating. This allows the user to be more flexible concerning interchangeability of the new circuit breakers.

6) Environmental Upgrades: Many older design air magnetic circuit breakers used asbestos based arc chutes, oil used in the oil circuit breakers may contain hazardous chemicals, and SF6 gas was recently classified as a greenhouse gas. By replacing these designs with the new technology of vacuum interrupters, environmental concerns can be resolved.

7) Upgrades Reduce Size and Weight of the Circuit Breaker: Utilizing new vacuum technology typically results in a 30% to 60% weight reduction, which can improve access for maintenance and transportability.

8) Upgrade/Retrofit Cost Considerations: Factors influencing the cost when considering upgrades, repairs, or retrofit solutions, compared to acquiring new equipment:
    - Cost of new equipment compared with cost to retrofit/upgraded equipment
    - Plant maintenance cost analysis
    - Additional space requirements
    - Construction and installation costs
    - Removal and disposal of existing equipment
    - Labor cost of training maintenance personnel
    - Downtime cost (loss of production)

Conclusion

Power equipment and electrical distribution systems have never been designed or intended to be placed into continuous operation without regularly-scheduled maintenance. If not properly performed, a shortened useful life of the system's components may be the result.

Switchgear modernization solutions present facility managers with a viable, cost-effective option to the 'maintain or replace' decision. New design capabilities exist to modernize and extend the life of the active components, i.e., circuit breakers, while leaving the existing passive switchgear structure intact, saving time and money. All things considered, extending the life of existing switchgear in this way is most often a real advantage.

Sources

[1] White Paper: Modernization Solutions for MV Switchgear by Miklos J Orosz, Sr. Staff Engineer - Schneider Electric

About the author

Doug Robling has more than 25 years' experience in the industry. In his role as Business Development Manager for Schneider Electric Services, Doug is focused on modernization solutions to optimize equipment life and reliability that return real business value.

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