

FIGURE 1:
*Aged Switchgear –
5 kV oil breaker*

LIFE EXTENSIONS AND SAFETY UPGRADES FOR AGING DISTRIBUTION EQUIPMENT

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HELP!

We just had an arc-flash incident. What can we do to protect our operators?
The cost of keeping this gear on line is adding up. Is there a more cost effective approach than replacing the equipment?

With much of our electrical distribution equipment approaching or beyond the end of its originally intended life and new safety requirements in place, many of us that have vintage equipment are faced with a similar dilemma.

In many cases, with equipment that has reached the end of its expected life, one will have some or perhaps all of the following concerns:

- Switchgear and breakers are now causing reliability issues.
- Existing breaker technology is obsolete and maintenance is challenging.
- Replacement parts are difficult or impossible to locate.

- Counterfeit or used parts do not meet specifications and tend to only compound the problem.
- Arc chutes may contain asbestos, causing environmental and health concerns.
- Mechanisms are complicated and difficult to lubricate effectively without a comprehensive overhaul.
- Operator safety is a concern – arc flash hazards, training gaps, improper tools to do required maintenance, PPE requirements, etc., all raise serious safety issues.
- Forced outages due to poor equipment reliability can have huge financial impacts.
- Workforce attrition has made maintenance support more difficult. The technicians that knew this equipment have retired and left a new challenge.

We are all asking the same questions:

What are the most cost effective options for improving reliability while extending the life of installed distribution equipment?

How can we improve safety and reduce the PPE requirements?

Do we have any exposure to financial or legal liability if we do not make any improvements?

If you have distribution equipment that is over thirty years old you have probably been asking yourself some of these same questions. What are the right answers to address the issues of an aging distribution system?

Low- and medium-voltage distribution systems are complex and involve a wide variety of electrical and mechanical components. Therefore, life extension of these systems can be a complex decision. All of the elements of the switchgear must be considered as well as overall system design. When comparing the expense to upgrade the aging equipment to a wholesale system or equipment change out, complex decision parameters that require a structured evaluation are required. For example, what is the impact of the outage time needed for each alternative?

The issues associated with extending the life of existing switchgear can be grouped into three categories. These categories and some of the variables that need to be considered will help to determine cost effective solutions which meet your performance improvement expectations.

MAINTENANCE

Maintenance of aging equipment can become both more intensive and expensive. Aging alone may result in degradation of mechanical and electrical performance. Depending on the availability of life cycle support, some system components may no longer be maintainable. Options are to repair, to refurbish/overhaul, or to replace.

- Maintenance cost – have O&M costs for this equipment gotten out of control?
- In house talent for maintenance – In many cases all the talent exited the building at the last retirement party; therefore, your options are limited to the following:
 - Outsourcing
 - Training new people
 - Improving the reliability through upgrades.
- Parts – if purchasing new equipment or upgrading the existing gear, there is an opportunity to reduce and standardize on equipment that requires less maintenance and fewer, more readily available replacement parts.

SUITABILITY

The equipment met the requirements when it was purchased decades ago, but several questions should be answered in the evaluation of a life extension decision:

- Is the gear rated for current fault levels?
- Has the feeder to the switchgear been reconfigured since it was installed?
- Have technological developments resulted in new capabilities that would improve the safety, reliability, or capability of your system?
- Can the existing equipment be enhanced or upgraded to meet your current requirements?
- Are the current PPE requirements so high the maintenance employees are complaining the conditions are making it difficult to perform their jobs?

When addressing these questions, areas for improvement with respect to reliability, safety, and reducing cost can also be reviewed.

- **Training** – documents and repeatable training for present and future generations that may have to operate or maintain the updated equipment.
- **Safety upgrade requirements** – there are several after-market options to improve the safety of your older gear and in many cases offer a more cost effective approach than new gear. Examples include arc-mitigation relays, remote racking, IR ports, replacement breakers, and relay upgrades.
- **Arc-flash concerns** – old gear cannot be converted to arc-resistant gear, so what are the expectations and what can the organization live with? There are several options to reduce clearing times or to remove operators from harm's way.
- **Engineering impacts** – in all cases there will be engineering cost to incorporate the upgrades or to redesign replacement equipment into the system.
- **Down time** – upgrading or replacing requires a window of time and typically the upgrades will take less time to complete and be less disruptive across all departments.

RISK MANAGEMENT

The risk management decision-making approach provides the ability to prioritize action, forecast expenditures over the projected life of the switchgear, and create visibility of the alternatives to everyone throughout the organization.

- **Life extension goal** – Is it short term or long term?
- **Long term cost of the decisions** – the cumulative cost over the targeted life extension period.
- **Litigation exposure** – The arc-flash studies are done. The incident energy levels and PPE requirement are known. Can one afford to do nothing?
- **Budgets** – Cost will drive the decision as much as the other needs.
- **Unplanned outages** – What has the financial impact been due to unplanned outages, around the clock maintenance, expediting charges, and lost production.

There are many things to take into consideration. A set of tools to help create a decision model can be employed.

EQUIPMENT ASSESSMENT

The first step is to perform a system and equipment assessment. The objectives of an assessment are to develop a risk profile of the asset base and provide a risk mitigation plan with priorities for action. This will identify the critical issues of the system and provide the basis for establishing cost parameters and evaluating the impact of varying levels of expenditure.

The assessment tool establishes:

- The condition of each individual asset and types of assets
- The importance of the asset in the system
- Risk profile for assets and the system as a whole
- Prioritization of recommended actions based on the condition and importance evaluations

Switchgear lineups are often feeding critical loads, and the financial consequences of their failure can easily exceed their actual asset value. Equipment assessment has a modular structure, allowing the level of investigation and solutions implemented to be adapted to specific needs and budget.

Assessments are an intelligence-based service, allowing the most cost-effective course of action for asset management that prioritizes the right actions at the right time and budget to be determined. They provide insight that can improve the performance, availability, predictability, and safety of switchgear and motor control centers.

The output of a comprehensive equipment assessment study is a report that identifies and prioritizes the critical risks in a system. Generally the reports will spell out specific data and give a health rating for each breaker, MCC bucket, transformer, etc. The assessment will also indicate which parts of the system need to be addressed immediately. In many cases, while the assessment is being performed, the technicians can easily perform some basic maintenance and in turn raise the health of the equipment to an improved as-left condition.

Recommended actions can take the form of repair, replacement, upgrade, maintain or monitor based on condition, importance, and cost.

- Maintenance spending can be prioritized to more effectively focus limited maintenance budgets.
- “What if” analysis can be applied to determine the impact on varying levels of expenditure on the overall risk profile.
- An action plan can be developed for the proposed extended life of the equipment which meets the specified objectives.

Not only is there now a solid basis for comparing the cost of extending the life of existing equipment to alternatives, if life extension is the way to go you there is now a game plan.

COST/BENEFIT ANALYSES

Now that the condition of the equipment is known there is a list of specific upgrades needed to reach the established life extension and safety and performance goals, the next step is to run a return on investment analysis.

There are tools available that allow owners/operators to evaluate the options they desire as safety and life extension upgrades and compare that to the cost of a complete change out of existing gear with new equipment. These tools take into consideration the key variables as they apply to each unique situation. These can be any combination of influences such as environmental, maintenance cycle times, labor rates, talent levels of technicians, budget constraints, safety expectations, or life extension goals.

The typical analysis will allow the evaluator to play out some “what if scenarios.” The evaluations will begin with inputting several key variables. The primary drivers will be labor burden rates, PM cycles, refurbishment cycles, age of equipment, equipment upgrades, and life extension expectations. Additional selections include safety upgrades like arc-mitigation relays, remote racking, and IR ports.

EXAMPLE

This example is of a (10) frame line up of medium-voltage gear that is 35 years old. The expectation is to extend the life another thirty years. After including all the engineering, maintenance and refurbishment cycles along with selected safety upgrades that are typical across all options, the following results can be expected:

Cost Comparison

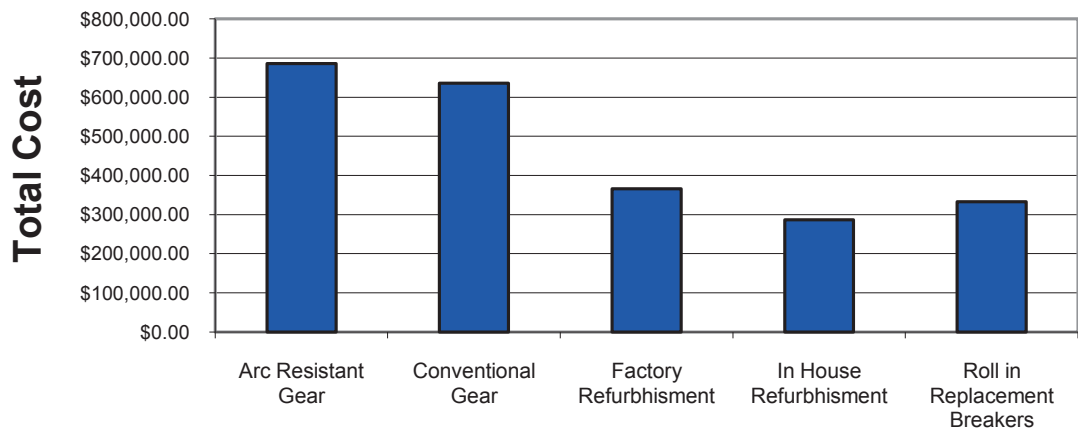


FIGURE 2:
*Capital cost expense
for decision purposes*

- Typical evaluations have shown that the most cost effective approach is utilizing replacement breaker technology with added safety upgrades. This approach results in a cost which is less than 45 percent of the cost of replacement with arc-resistant gear.

Keep in mind, as stated previously, vintage gear cannot be converted to arc-resistant gear. With that said, we are not comparing apples to apples – we are making a cost and cycle time decision. What can be accomplished at the end of the day is to upgrade the equipment to effectively have another thirty plus years of life while improving safety to very highly desired levels. The improved clearing times utilizing arc-mitigation relays and increasing operator distance from the gear with remote racking systems will improve the safety of the operator. The breaker refurbishment approach was considered but the lower cost was so minor it did not justify the offset of the other benefits of new technology, training materials, reduced parts and improved reliability that were associated with the replacement breaker option.



Figure 3: *Retrofitted unit with new cell and breaker*



Figure 4: *Front view of updated gear after replacement breaker project*

CONCLUSION

While situations and results will vary, many of us will be facing the same issues and dilemmas in our decisions regarding aging distribution equipment. While there are lots of variables to consider in the distribution equipment life extension decision, fortunately, there are tools and help available to guide the decisions and justify the best approach for the situation. The process can be structured to become a valuable exercise in determining your needs over the future extended life. By categorizing the factors and considerations while employing risk assessment and cost benefit analysis tools, the life extension decision process can provide a clear roadmap for optimizing maintenance and upgrade expenditures over the desired extended life and greatly improve the ability to meet performance objectives.



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