Harwood Engineering Consultants

WHITE PAPER

Electrical Building Assessment

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Introduction

Building assessments are done for many reasons. For example, an Owner may want an assessment done to anticipate and budget for future maintenance work, or a prospective Owner may want to better evaluate the true cost of a building.

Because electrical equipment is generally quiet and stationary, it is sometimes overlooked when considering the overall condition of a building. However, electrical equipment should not be expected to function safely, effectively, and sustainably over several decades so it must be considered. This paper will help the reader recognize some signs that belie hidden dangers and costs and will show how to recognize some opportunities for energy (cost) savings when assessing electrical components.

This paper is offered as a guide to perform a general assessment of a building's major electrical systems. For a more thorough review, a design professional or qualified electrician should be engaged.

Figure 1 – Building assessment walk-through.

1 Power Distribution

The power distribution system is typically the most expensive and important of all the electrical systems. This system starts with the electrical service to the building at the main service disconnect and distributes out to transformers, panel boards, and large equipment, including the wiring to these devices. A well-maintained system is essential to a building's operation. Recognizing that the useful life expectancy of these components can range between 20 to 30 years is an important start to evaluating the power distribution system.

Therefore, finding the approximate age of these components is the first item to investigate. This can be accomplished by looking at dates on record drawings and by performing a visual inspection of the system. Visual inspections include looking for equipment damage such as rust, dents, water damage, devices falling off their mounting system, or broken equipment such as conduits and junction boxes protecting wiring (Figure 2). A good visual inspection can be followed up by verifying whether the existing equipment is obsolete and if parts are still available from the original equipment manufacturer. To do this, provide nameplate data or a photo to a manufacturer. The manufacturer should be able to help you determine equipment or part availability. Generally though, you can assume that components are not easily available for equipment older than 30 years.

Figure 2 - Exterior PVC conduit pulled apart due to expansion and contraction due to heat.

The electrical equipment layout is also a good clue to use during an assessment. Older buildings tend to have disconnects and other equipment that was “tacked on” to the original service gear as the building use changed. Proper labeling was often not provided, making equipment difficult and dangerous to operate, to troubleshoot, and to use (Figure 3). In contrast, a good layout would include a main service panel with feeder breakers or fuses serving panels and equipment throughout the building, with spaces or spares for future expansion. Also, all components and circuits would be clearly identified and labeled.

Figure 3 – Electrical Service located in a Boiler Room showing equipment added for various building expansions.

Figure 4 – Medium volt switch in crawl space with significant corrosion after being exposed to a water leak for about 30 years.

Environmental conditions should also be considered. Expected life is significantly reduced if the equipment is out in the open and subjected to damage from vehicles, water (flooding), dust, heat and weather (Figure 4).

Electrical systems that have been protected from these environments, such as being installed in dedicated rooms (Figure 5) with proper ventilation, or in clean environments such as office spaces, will have a greater chance to meet or exceed their useful life expectancy.

Check for signs that indicate how well the equipment has been maintained.

It is important to exercise the equipment and perform yearly maintenance per the manufacturer's recommendations. "Exercising" means switching components off and on to prevent dust and corrosion build-up on contacts and moving parts. Look for information on the equipment such as an Electrical Contractor's name and number, Test procedures with dates, or even Arc Flash Warning signs. Many times an electrical contractor is hired to perform maintenance or exercise a building's electrical system. The Contractor should be contacted to discuss any insight they may have about the equipment.

Current codes require Arc Flash Warning Signs on the equipment. If the signs are not present, this is an indication that the panels have not been evaluated recently. When this information is not attainable or present, there may be a high probability that problems may arise, such as overprotection devices not opening during an overload (which could cause personnel injury) or overprotection devices not closing once they are opened.

Figure 5 – Main switchboard with spare breakers and spaces and located in a dedicated electrical room.

2 Generators

Generators are normally used to provide electricity during a power outage to prevent disruption of essential daily tasks. Typically, they provide power for emergency/exit lighting and possibly other critical functions like I.T. and Security. Their function can also be expanded to provide back-up power for critical processes or even entire buildings. Therefore, these machines require special attention when assessing building's electrical systems. When performing a visual assessment on the emergency power system, the following should be observed:

- Equipment age and usage (hours)
- Damaged equipment (rust, cracks, etc.)
- Emergency equipment location and condition
- Fluid Levels and leaks
- Wet Stacking (condition where diesel engines do not fully burn the fuel that passes through the exhaust system)
- Components altered from original design
- Potential issues with today's codes
- Clearances
- Red Flag obsolete equipment
- For generators located inside the building, the mechanical engineer performing the building assessment should review the exhaust and room conditions.

Just like your car engine requires routine maintenance, a generator needs to be regularly maintained so that it performs when needed. The better the maintenance and service, the longer the generator will function without expensive repairs which can lead to unwanted down time; "find the smaller problems before they lead to the big ones." Preventive maintenance and services are vital to ensure proper operation and to extend the useful life of a generator. Check the generator's testing records to see if the following procedures have been done on a regular basis:

- Checking of fluid levels (oil, coolant, etc.)
- Inspection of starting system (battery and chargers)
- Season or every 200 hours
- Lubrication
- Replacement of worn out parts
- Verification of control panel display information
- Testing any mechanical interlocks
- Use of quality fuel stabilizers
- Performing a visual inspection for cleanliness inside and out
- Operating the generator at least once a month (except for health care facilities) and under load once a year.

3 Lighting

While lighting is a major component of a building's electrical systems, it usually provides the easiest and most effective opportunity for energy savings. This section will provide general assessment information along with some easily implemented energy efficiency ideas.

Between lamp replacement, fixture maintenance and small renovations, the lighting fixtures and lamps in a building are often a mixed bag. Because of this, it can be difficult to fully catalog all lighting types without a thorough assessment. After assessing the lights in the building, one should consider upgrades using LED sources for improved energy efficiency.

The first and most important item to record during the lighting assessment is the fixture's condition. Fixtures should be examined for corrosion and wear. Examine the painted areas for chips and scratches, the metallic portion of the fixture for discoloration, and the lenses for water stains. If corrosion is obvious on the exterior of the fixture, it's a safe assumption that the fixture internals are also corroded. In addition to corrosion, check for cracked lenses and crooked fixture mounts, as both pose a failing risk. Finally, if possible, spot check the wiring connections on randomly selected fixtures to make sure they are securely wired.

Even though lighting is slowly transitioning to LED, there are still many buildings with dated lamps. Some older types of lamps that can be found in buildings are:

- T-12
- T-8
- HID (Metal Halide, High Pressure Sodium)
- CFL
- U-Lamps
- Circline Lamps

Each of these lamp types has a unique selection of LED retrofit options. These LED retrofits can be classified into two broad categories: bypass lamps and direct lamps. With a bypass lamp, the fixture's ballast is removed and the fixture is rewired to deliver full line voltage to the LED lamp. A direct lamp is simply "plug and play."

"Plug and play" lamps may seem like the easiest option. Bypass lamps have the benefit of removing the ballast from the fixture, thus removing a significant point of failure. Either way, lamp replacement costs (including labor and material) can be paid back in under two (2) years.
The second item to record while performing a lighting assessment is the lighting levels in the building. When visiting a building, you can use a light meter to help measure the different light levels in a space in the building. The lighting levels can vary depending on the time of the day and direct sunlight exposure.

If a building has tall windows, the lighting levels should be measured at various times of the day. The exposure to sunlight should be considered for lighting calculations during the day and during the night.

Another item to take into consideration is the egress lighting. There are some egress rules that need to be followed and should be verified during the lighting assessment. For example, all exit routes must have some type of emergency lighting. These routes may include stairs, aisles, corridors, ramps, passageways, or any path of egress. In case of an emergency and the building loses power, the emergency lighting should emit at least 1 footcandle in the building and 0.1 footcandle in the path of egress. These conditions should be met for at least 90 minutes after losing power. After 90 minutes, the lighting levels may drop to 0.6 footcandle in the building, and 0.06 footcandle in the path of egress. There should also be a 40:1 maximum to minimum ratio for illumination uniformity.

Lastly, look at the emergency battery units. The emergency battery units have the same requirements as typical emergency lighting. The battery in the units needs to be tested for 30 seconds on a monthly basis and 90 minutes annually. During these tests the battery should be able to bring the fixture back to life after the simulated loss of power. During the annual test, the emergency battery unit must be able to illuminate for all 90 minutes. If the fixture fails during this testing period, the battery needs to be replaced. The typical life for a battery is 5-7 years. To observe proper battery operation and illumination, a power outage should be simulated by turning off breakers that provide normal lighting power. If emergency power is provided by a generator, a qualified person should be employed to simulate the outage.

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Figure 7 – Some fixtures prove difficult to find LED replacement lamps.

4 Fire Alarm

Three areas should be looked at during a general fire alarm system assessment: devices, the control panel and overall system considerations. The devices are the pull stations, horns, strobes, speakers, smoke detectors and other components that are usually readily seen during a walk-through of the building. As devices are surveyed, the following questions should be addressed:

1. Are the pull stations located so they are accessible? Older systems (pre-1990) may have pull stations installed above 60". In most cases, this is in violation of current accessibility codes. All pull stations should be lowered to a compliant height.
2. Do the device placements still make sense? As buildings are renovated, sometimes fire alarm devices are overlooked. For example, a large room could get divided into smaller rooms, potentially leaving some spaces without visual or audible alarms.
3. Are the strobes ADA compliant? Newer ADA compliant strobes use clear plastic lenses which accommodate high light levels during alarm conditions. Older strobes used white translucent plastic lenses that did not cast much light. These older strobes are not ADA compliant.
4. Is the cabling adequately protected? Look above accessible ceilings to see if the fire alarm cabling is neatly strapped or (better) in conduit. Cabling should not be exposed below ceilings in most areas of the building.

Figure 8 – Fire Alarm System

After walking through the building, the control panel location should be evaluated. This is the heart of the system, so careful attention should be paid here:

01 Are there any signs of alarms being indefinitely silenced? There should be indication of this via LED's or an LCD read-out.

02 Has the control panel been tampered with? Look for buttons being taped, signs of bypassing (wire nuts in odd locations, wires not connected) and other suspect field modifications.

03 Look for notes written in and on the panel that may reveal ongoing issues.

04 Is the system turned on? Make sure there is power indication.

05 Code requires a smoke detector to be installed above or near the control panel.

Finally, there are some general issues that should be investigated. This investigation will probably start at the control panel, but could be helped by someone familiar with the system. Determine who maintains and/or tests the system. There may be a sticker on the control panel with a company name, or the current owner may know who this is. If you are not able to find someone familiar with this particular panel, perform an internet search for the manufacturer and model number of the panel and find someone local who can provide general information:

1. How old is the system? Modern fire alarm systems are made of electronics and are highly code driven. Therefore they have a definite expected life cycle. Systems over 20 years old should be replaced or upgraded, if possible.
2. Ask the vendor or manufacturer about availability and cost of parts and devices. Sometimes parts and devices are no longer stocked by the manufacturer and must be creatively searched for via the internet or other sources. This can be difficult and expensive.
3. If building expansion is a possibility, the vendor/manufacturer should be asked about the expandability of the system.
4. Look around for testing documentation to see if the system has been regularly tested.
5. If a thorough assessment of an existing fire alarm system is needed for code compliance or costing, an engineer or fire alarm professional should be consulted.

5 Conclusion

Electrical systems can become outdated, inefficient, and even dangerous without proper maintenance and care. Although these systems are normally silent and motionless, this doesn't mean they will always operate properly when needed.

An electrical systems assessment can reveal expensive and potentially dangerous issues. It can also provide an Owner (or prospective Owner) with opportunities for long term cost savings. The information presented in this paper provides a means for a general understanding of a building's major electrical systems. As mentioned, an industry professional should be contacted if a detailed assessment is needed. Some information an industry professional could provide:

- Return on investment for energy efficiency upgrades
- Cost estimates for upgrades and replacements
- Recommendations along with a timeline that can be used for budgeting
- Review of other systems like CCTV, Access Control, Information Technology cabling, Public Address, and Emergency Communications

Whether done by an electrical professional or by some other interested party, an electrical assessment should be included as part of any overall building assessment.

For more information on **Electrical Building Assessment and Electrical** topics, please contact:

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About Harwood

Harwood Engineering Consultants, Ltd. has a dedicated team of engineers who have mastered their crafts. We are a full service engineering consulting firm that provides civil, electrical, fire protection, HVAC, lighting, plumbing, structural, and technology/security design services. We also offer LEED and commissioning services.

If a project involves a partnership with a contractor for a design assist, a traditional architecturally run project, or a direct system design with a building owner, our strategy has always been, and will continue to be, to provide client satisfaction. We believe a custom approach should be taken with every aspect of a project we are involved with. This allows for innovative functional designs and making sure the client's goals are understood, and met, within budget.

In 2013, Harwood Engineering Consultants, Ltd. celebrated its 30th anniversary and is very proud to be a part of the Milwaukee community. We look around the city, throughout the state of Wisconsin, and other parts of the country and reminisce over all the building projects we have been involved with. We take great pride in knowing that our designs have provided comfortable hospitals, secure detention facilities, safe police and fire stations, schools and universities for our children to learn, places to worship, and fun places for families to vacation.

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