Canadian Certified Rental Building™ Program
Operations Management Standard – 19
Electrical Maintenance Standard of Practice

Standard of Practice:

Members shall ensure that each building's electrical and associated systems are safe and maintained in accordance with Electrical and Fire Safety Code requirements.

Requirements:

- Members have a regularly updated Electrical Maintenance Plan at the building site that is readily available and accessible to building and property management staff, Licenced Electrical Contractor(s) completing work at the building site, as well as ESA and local authorities

- Members shall have a contract(s) with a Licenced Electrical Contractor to help ensure maintenance and repairs are completed according to Code, and shall obtain the name of the Designated Master Electrician assigned by the LEC who will be responsible for ensuring electrical work is carried out in accordance with the Ontario Electrical Safety Code (OESC)

- Building and property management staff are provided with information on what electrical maintenance can be conducted by whom

- Wherever practicable Owners/Property Managers are required to be members of and utilize the CSS (Continuous Safety Services) program offered by the Electrical Safety Authority as a means for obtaining permits, logging, inspecting and demonstrating organizational commitment to managing electrical safety risks and providing safe workplaces.

- Residents must receive notification that apprises them of their responsibilities in relation to electrical work and steps that should be taken if repairs are required.

- Members are required to maintain logs/or other records that document electrical work conducted and activities undertaken to maintain the electrical systems within the building and to verify completion of the tasks required as part of the building's electrical maintenance plan.

- Electrical logs must identify why and where the task was undertaken, what specific task was completed, by whom and when. These logs must also document and confirm required review of completed work and as appropriate information on the certificate of acceptance.

Audit Verification Requirements:

- An Electrical Maintenance Plan is readily available and accessible for review at each building site

- A contract is available that includes ECRA/ESA Electrical Contractor Licence number, information on insurance coverage of LEC, and clear expectation that ESA Certificates of Acceptance will be provided for all work completed

- The name and contact information for the Designated Master Electrician assigned by the LEC, is provided to each building site

- Completed logs or other documentation (paper/electronic) are available at the building site for all electrical work undertaken throughout the building including in resident's suites

- Documentation/training records are available that document employees have been trained on their roles and responsibilities in relation to electrical maintenance and repairs.

- The resident welcome package contains an information sheet outlining resident responsibilities in relation to electrical and other repairs.

1. Background and Rationale

Within multi-unit residential buildings, electrical control and distribution systems can be complex and expensive assets, and while significant effort is often applied to managing a building's mechanical assets, electrical equipment often receives less focus.

However, the aging and deterioration of electrical equipment is inevitable. As soon as new equipment is installed, a process of normal deterioration begins. Unchecked, the deterioration process can cause malfunction or an electrical failure. Deterioration can be accelerated by factors such as a hostile environment and overload.

Electrical equipment failures can account for millions of dollars in damage and disruptions to residents/tenants who live and work in multi-res apartment buildings. As the electrical infrastructure in multi-res buildings continues to age, this problem will only worsen.

In Toronto, as a result of several major electrical system failures within multi-residential buildings, in 2019, the City of Toronto passed a by-law amendment requiring an owner or operator of a multi-res building with 3 storeys, 10 units or more to create and maintain an electrical maintenance plan in collaboration with a Licensed Electrical Contractor with a valid ECRA/ESA licence. Under this Toronto regulatory by-law, a multi-res building's owner and operator are also required to maintain any information and records necessary to demonstrate compliance with the electrical maintenance plan

An effective electrical maintenance program and plan can help identify and recognize factors leading to deterioration and can inform strategies to reverse these effects and avoid failures. An electrical maintenance program and plan can also identify the systems and processes that manage the conducting of routine inspections and tests and the servicing of electrical equipment so that impending troubles can be detected and reduced or eliminated. A well-administered electrical maintenance program and plan can prevent accidents, save lives, minimize costly breakdowns and reduce unplanned outages. It also may lower insurance premiums that typically are more costly if the facility has an inadequate or marginal maintenance and testing program.

Given the regulatory requirements for having an Electrical Maintenance Plan in Toronto, the many positive benefits and reduced risks that can result from having an electrical maintenance program and the fact that the Certified Rental Building Program promotes best practice approaches to operating and maintaining multi-res buildings, the following electrical maintenance standard is being introduced as part of FRPO's Certified Rental Building Program.

The Certified Rental Building Program's standard of practice will address not only requirements and expectations regarding the development and implementation of an Electrical Maintenance Program and Plan, but also will highlight recommended roles of key players such as building and maintenance staff, a contracted LEC, the ESA, etc. in completing predictive, preventative and reactive maintenance and repairs on major systems, as well as required in-suite electrical work.

This standard of practice will not however, address issues relating to electrical efficiency, electrical intensity and usage, types of appliances used in suites and in common areas, as well as the use of energy efficient fixtures.

While this Standard of Practice focuses on Electrical Maintenance and Safety it is recognized that the electrical systems within a building do not work in isolation of other mechanical and building systems. As such, an organizations/buildings electrical maintenance plan should be part of a broader plan that addresses the all building systems, including electrical, mechanical, HVAC, and plumbing

Members shall have a regularly updated Electrical Maintenance Plan at the building site that is readily available and accessible to building and property management staff, Licenced Electrical Contractor(s) completing work at the building site, as well as ESA and local authorities

2. **Criticality and It's Role in Electrical Maintenance**

Risk priority number calculator

Probability of failure						
	6	12	18	24	30	36
	5	10	15	20	25	30
	4	8	12	16	20	24
	3	6	9	12	15	18
	2	4	6	8	10	12
	1	2	3	4	5	6

Impact of failure

Asset criticality level
- Critical
- High
- Moderate
- Low

Criticality in relation to electrical maintenance is a risk assessment process. It is a measure of how important an asset is to a process and a building. The more critical the asset, the more of an impact it will have if it fails. A criticality rating given to a piece of equipment can be used to determine how often the equipment should be inspected or maintained, and can help determine which testing, inspection or work orders require more immediate attention.

To determine which assets are critical, two questions are important:
- How likely is the asset to fail (probability of failure)?
- What are the consequences/impact if it does (consequence of failure)?

For many organizations a simple risk scoring matrix is utilized with the x axis being the impact of failure and the y axis being probability of failure. To calculate the criticality score for a given asset, multiply its probability of failure rating by its consequence of failure rating. Multiplying probability of failure and consequence of failure ratings together provides the overall criticality score (risk score) for a given asset, with higher scores indicating greater risk. The assets that have the greatest probability of failure and the greatest consequences due to failure will be the assets that are the highest risk and therefore the most critical. The assets that have low likelihood of failure and low consequences if there is a failure will be the least critical assets. (See Appendix 2 for examples of rating scales for both probability of failure and consequence of failure.)

It should be noted that the criticality of assets changes over time. If factors such as community characteristics or service needs change, if financial factors increase (e.g., cost of repair, or replacement) or environmental regulations become more stringent, the probability of failure and/or the consequence of failure for any assets impacted by any of these scenarios can change. It is therefore necessary to periodically review the criticality scores of assets and make adjustments to account for changing circumstances or asset decay.
While each property management organization and building will handle the exact process of criticality analysis a little differently, it's an important part of maintenance planning. When prioritizing preventive maintenance tasks, determining assets to monitor for predictive maintenance, or evaluating schedule compliance, knowing the criticality of an asset will help ensure the most important items are prioritized first.

More advanced property management organizations engaged in formal ESG risk management also utilize assessing electrical safety and maintenance with added step of criticality by consequence. This asset criticality framework only takes the impact of asset failure into account. It measures the impact of failure in three areas—health and safety, environment, and operations. Each area is rated on a scale of one to five. When multiplied, you get the total criticality of your assets. The higher the number, the more critical it is. (See Appendix 2)

3. **Electrical Responsibilities of Property Owner/landlords/property managers** –

When it comes to conducting electrical work at multi-unit residential buildings, owners, operators/property managers have a range of obligations. May it be a high-rise or a low-rise building with 10 or 300 suites, in all cases across Ontario, building owners/property managers have the same range of responsibilities in relation to electrical work and maintaining and servicing electrical equipment. These include the following obligations:

- Complying with the Ontario Electrical Safety Code.

  Complying with the Ontario Electrical Safety Code includes meeting ESA permit, notification, inspection, testing, maintenance and documentation requirements. More specifically, all electrical work must be completed in accordance with Rule 2-004 of the Ontario Electrical Code which includes obtaining inspection applications before or within 48 hours of electrical work starting and arranging for inspections, as required. It also includes arranging for the review of existing notifications.

  It should be noted that even if a property a manager/owner has an electrician on staff, electrical inspection applications and an ESA review of the work is almost always required.

- Demonstrating due diligence and a commitment to managing electrical risks and creating a safe workplace.

Owners/Property Managers are responsible for ensuring the health and safety of employees, residents, visitors and other members of the public when on your premises. In line with this requirement,

In part this means ensuring only qualified individuals (qualified staff and/or licensed electrical contractors) are allowed to complete electrical work

Owners/Property Managers are responsible for ensuring staff receive requisite WHMIS and first aid training, training at heights, as well as other basic training such as Worker health and safety in 4 steps. In addition, it is strongly recommended that building staff receive basic training on electrical hazards for maintenance staff.

- Meeting documentation and recording requirements as identified in the Ontario Electrical Safety Code (OESC) and as stipulated under municipal by-laws such as Toronto By-Law 354.

  The Electrical Code requires that all electrical work performed be recorded and inspected, regardless of the installer's qualifications or the size of the job. The following OESC rules outline some of these requirements.

  OESC Rule 2-003 Record of Electrical Installation Work: The owner shall maintain a record of all electrical installations acceptable to the inspection department in any public building, commercial or industrial establishment, apartment house, or other building in which the public safety may be involved, and shall produce this record to any inspector at any time and from time to time upon requires, as specified by the inspection department.

- City of Toronto bylaw, 354-3.9 which specifically relates to an Electrical maintenance plan, requires that "an owner or operator shall create and maintain an electrical maintenance plan in collaboration with a Licensed Electrical Contractor with a valid ECRA/ESA licence. Under this by-law an owner and operator must maintain any information and records necessary to demonstrate compliance with the electrical maintenance plan.

4. Completing Electrical Maintenance at Multi-Res Buildings

There are a variety of electrical tasks that need to be completed at a multi-residential building. These range from ensuring the development and implementation of a building-specific electrical maintenance program and plan and the completion of predictive and preventative maintenance tasks, to reactive maintenance and addressing major and minor electrical repairs within the building including in resident's suites. Regardless of the type of electrical work, all renovations, repairs and replacement work involving 'electrical', need to be done in compliance with the Ontario Electrical Safety Code (Code).

Under the Ontario Electrical Safety Code, Property Managers/Buildings Owners are required to ensure all electrical work completed at their building is done by qualified staff and/or licensed electrical contractors and that any necessary notifications are obtained to facilitate the review of the electrical work by the Electrical Safety Authority.

Resident's Role

Under Ontario Electrical Safety Code, residents are responsible for following safe practices within their unit, including not tampering with the electrical wiring in their unit, throwing out frayed cords, not overloading the circuit by plugging in too many devices and not using extension cords on a permanent basis. Residents are also responsible for informing the property manager/building staff of potential electrical issues in their unit or common areas within the building.

Under Code, residents themselves can technically complete electrical work within their own unit as long as they provide notification to ESA of work to be completed, pay the respective ESA fees, have the work inspected and obtain a Certificate of Acceptance from ESA following completion. Further, under Code, residents can technically hire a Licensed Electrical Contractor to complete electrical work within their unit. However, as with most electrical work to be completed, the LEC must file all notifications, have all inspections completed and obtain the necessary certificates of acceptance.

In order to maintain the integrity of the electrical systems within a multi-res building, under the Certified Rental Building Program, all residents/tenants must be apprised that they are NOT to complete any electrical work within their unit. Under this CRBP standard, residents must be apprised that if electrical maintenance or work needs to be completed within their unit that they must complete and submit a request to building/property management in the same manner as all maintenance requests are submitted. At minimum, procedures for addressing electrical maintenance issues within a unit should be included within the lease or the New Resident's/ Tenant's Welcome Package.

Residents must receive notification, at minimum within the lease or welcome package, that apprises them of their responsibilities in relation to electrical work and steps that should be taken if repairs are required.

Property Management/ Building Employees Role

According to Ontario Electrical Safety Code, building superintendents, general contractors, freelance electricians, unlicensed electricians, general handymen and other service providers may only do electrical work in your buildings IF they hold an ECRA/ESA licence OR are an employee of the property management company (i.e., on the payroll). General handymen, or freelance electricians not working for a Licensed Electrical Contractor **CANNOT** do electrical work in your building unless their business holds an electrical contractor licence number.

In situations where property managers and building owners are allowed to do their own electrical work, all electrical work must be completed in accordance with Rule 2-004 of the Code. This includes obtaining inspection applications (before or within 48 hours of electrical work starting) and arranging for inspections, as required. Even if your company has an electrician on staff, electrical inspection applications and an ESA review of the work is almost always required.

Building and property management staff are provided with information on what electrical maintenance can be conducted by whom

While in most situations, individual notifications and inspections of work must be completed, the Code does permit periodic inspections for electrical installation work of a routine nature in connection with the maintenance or operation of the building or plant. This compliance option is available only to Continuous Safety Services program members.

Continuous Safety Services Program

The ESA operates a Continuous Safety Services (CSS) program as one strategy to help increase electrical safety and compliance with the Ontario Electrical Safety Code within buildings. The Continuous Safety Services compliance option offers business owners and operators a streamlined permit, inspection, and safety process to help ensure business/ buildings are in compliance and run more efficiently.

With the Continuous Safety Services (CSS) compliance option, rather than taking out a separate permit for each electrical job, under CSS clients log all electrical maintenance work conducted and CSS inspectors review that work on an audited basis.

The following is a general guideline of the scope of work covered by the CSS Program:

1. Electrical Maintenance Work (Excluding LDC Connection Authorizations)
   a. Panels and distribution systems
   b. Service and electrical equipment
   c. Building and general wiring

2. Routine Electrical Work
   a. All electrical installation work of a routine nature in connection with the maintenance or operation of the building or plant therein performed at frequent intervals

3. Repair, Replace, Relocate
   a. Like-for-Like Replacement of electrical devices
   b. Repair existing equipment
   c. Relocations of existing equipment from one area of the building to another using the original electrical devices i.e. moving an assembly area or machine tool.

4. Minor installations
   a. Outlets or switches that do not require a new circuit, etc.

5. Categories of Maintenance Work (with examples)
   a. Wiring Devices – Light Switches, Receptacles, Relays, etc
   b. Branch Circuits – Raceways, Cables, etc
   c. Lighting – 120V
   d. Lighting – Greater than 120V i.e. 208V, 240V, 347V, 600V
   e. Electrical Equipment – Replacement of capacitors, contactors, equipment panels, ups's, etc
   f. Building Management Systems – energy management systems, fire alarms, emergency lighting, ventilation systems, etc
   g. Motors/Motor Controls – 120V Single Phase. i.e., Circulation pumps, exhaust fans (small motors)
   h. Motors/Motor Controls – 3-Phase (Greater than 120V, Less than 750V) i.e. Frequency drives, large supply pumps, assembly conveyors, mcc's, etc
   i. Motors/Motor Controls – High Voltage (Greater than 750V) i.e. Large industrial pumps, mcc's, etc
   j. Electrical Distribution – switch gear, panels, transformers, enclosed switches, etc.

Under Continuous Safety Services (CSS), customers and their contractors log electrical maintenance work using an electronic logbook. With the electronic logbook approach, rather than obtaining a permit each and every time electrical maintenance work is done, customers log all electrical maintenance work and Electrical Safety Authority (ESA) inspectors audit and inspect the work entries during scheduled visits throughout the year.

In addition to the audit and inspection of electrical work, CSS customers receive information and guidance on electrical safety and Code issues from a dedicated inspector. This inspector conducts a visual inspection of your electrical system to identify existing hazards, as well as scheduled reviews of specific electrical maintenance activities based on the logbook entries

While the ESA's CSS is a voluntary program and is based on continued compliance with program rules and requirements, it does represent a best practice on electrical maintenance for multi-res buildings and helps ensure continued compliance with the Electrical Code. As such under this CRBP standard of practice, on-going participation and compliance under the CSS is a CRB requirement.

Wherever practicable, Owners/Property Managers shall utilize the CSS program offered by the Electrical Safety Authority as a means for obtaining permits, logging, inspecting and for demonstrating organizational commitment to managing electrical safety risks and providing safe workplaces.

Licensed Electrical Contractor's Role

A licensed electrical contractor (LEC) is a vital player in helping to ensure electrical safety at our buildings and compliance with the law. A Licensed Electrical Contractor (LEC) is an individual or business that is licensed to operate an electrical contracting business in accordance with the licensing regulation; Ontario Regulation 570/05 made under Part VIII of the Electricity Act. If you're hiring someone to do electrical work, by law, it must be a Licensed Electrical Contractor.

It is the LEC's duty to ensure that all electrical work is carried out in accordance with all applicable laws; and to ensure a Master Electrician is designated at all times to oversee the electrical work carried out on behalf of the electrical contracting business.

In other words, an electrical contractor is required to designate at least one licensed ME (Master Electrician) as the DME (Designated Master Electrician). DME must be actively employed by the designating LEC and cannot act as the DME for more than one LEC at the same time. The DME has the role and has a responsibility to ensure electrical work is carried out in accordance with the OESC, and the laws relating to health and safety and consumer protection.

Members shall have a contract(s) with a Licenced Electrical Contractor to help ensure maintenance and repairs are completed according to Code, and shall obtain the name of the Designated Master Electrician who will be responsible for ensuring electrical work is carried out in accordance with the OESC.

In addition to completing routine electrical repairs and maintenance required at multi-res buildings, LEC's have a vital role to play in the development and implementation of a building specific electrical maintenance program and plan for each multi-res building as required under Toronto By-Law 354, and as highlighted by the ESA and CSA Z463 - Maintenance of Electrical Systems.

However, the fact that a business is a Licensed Electrical Contractor and hires and uses licensed electricians to complete work does not in itself, qualify someone as an Electrical Maintenance Program specialist. The technicians and individuals who can assist organizations in developing and implementing an electrical maintenance program and plan often require specialized training and certification in such areas as infrared thermography, ultrasonic technology and safety. Further, areas such as power quality analysis require specialized engineering training and certification.

Appendix 1 highlights key qualifications Property Managers/Owners may wish to look for and consider when hiring an LEC.

5. **Electrical maintenance in the multi-residential context: Creating an "Electrical Maintenance Program" and an electrical maintenance plan** –

A cornerstone of the CRBP Electrical Maintenance Standard is ensuring the availability of a building specific electrical maintenance program and regularly updated Electrical Maintenance Plan.

Members shall have an Electrical Maintenance Program and associated Plan that is readily available/accessible at the building site

According to Canadian Standards Association -CSA Z463-18 - Maintenance of electrical systems, an electrical maintenance program is defined as a "program of regular inspection and service of equipment used to detect potential problems and to take proper corrective measures through the approved work process controls. Further, it is a system that manages the conducting of routine inspections and tests and the servicing of electrical equipment so that impending troubles can be detected and reduced or eliminated "

An electrical safety program outlines requirements, policies and practices to address hazards associated with working near electricity. The intent of an Electrical Maintenance Program is to identify and address wherever possible, any issues before a failure occurs. When developing an Electrical Maintenance Program, there is no "one size fits all" program. The nature and content of a building specific plan will be dependent upon knowing what electrical systems and equipment exist at the site, the age of the building and equipment, the history and repair status of electrical systems and associated mechanicals, and the criticality of the equipment and systems to overall operational and safety of the building and residents. In other words, every Electrical Maintenance Program should be custom-designed to fit the characteristics and vulnerability of the building/facility.

The following identifies the type of information and factors that should be considered by the Licensed Electrical Contractor and the Property Manager/Owner when developing an electrical maintenance program and the building's Electrical Maintenance Plan.

- **Purpose of the Electrical Maintenance Plan**
  - ❖ The plan should clearly articulate the overall purpose and objectives of the plan. In other words, what is the purpose of the electrical maintenance plan? Is it to ensure the safety, reliability, integrity of electrical system and equipment? Is it to ensure a range of activities to help keep systems and equipment dry, cool, clean and tight? Are there other reasons or factors, such as preventative approach?

- **Required Building Information**
  - ❖ The Electrical Maintenance Plan should include information about the building including address, age of building, number of storeys, general condition of building and mechanicals and equipment rooms, name and contact information of the owner/property manager and building staff. It is also important that the plan clearly identify the name, contact information and license number of the LEC, as well as the

name and contact information for the DME (Designated Master Electrician) appointed by the Licensed Electrical Contractor, for the building.

- **Roles and Responsibilities**
  - ❖ Define the roles and responsibilities of the LEC – Contractor, Equipment Manufacturer, Building/Maintenance Staff within the context of maintaining the building's electrical assets and completing electrical work

- **Employee/Worker/Resident Safety**
  - ❖ What steps are to be taken and training and information provided to ensure employee/worker and resident safety

- **Criticality of Assets and Risks (Impact)**
  This section of the plan should identify
  - ❖ What factors are being used and how is *criticality* being assessed (safety, environment, operational consequences, non-operational consequences) in determining the importance and timing of maintenance related activities

- **Approach and types of maintenance to be used**
  This section of the plan should identify
  - ❖ Is a preventative, predictive, reactive or other approach or a combined maintenance approach being taken? Are visual, mechanical, and/or electrical testing or a combination of strategies to be used for testing and inspection to be used?

- **Systems and equipment covered by the Electrical Maintenance Plan**
  - ❖ Include a full and detailed listing that highlights the purpose/role of the equipment that include Switchgear, Transformers, Service and Circuit Breakers, Buswork, Enclosures, and Insulators, Arrestors, Battery Chargers, Switches and Disconnects, motors, relays

- **Asset Record Registry**
  - ❖ Detailed information on each piece of electrical equipment including nameplate information should be collected and maintained (See Appendix for a possible sample)
  - ❖ This section of the plan should highlight who is responsible for collecting asset registry information, how frequently this information should be updated and where the information will be maintained.

- **Schedule of Required Equipment Maintenance**
  - ❖ A detailed record of check/inspect, test, maintenance and servicing tasks should be developed for each type/piece of electrical equipment. This record should also identify the recommended time frame (daily, weekly, monthly, quarterly, semi-annual, annual, etc.) for each specific check/inspect, test, maintenance and/or servicing tasks as well as identify who should complete the task. This schedule should include both regular and more specialized/periodic tests such as thermographic imaging, etc.
  - ❖ It is important that the people who perform your EPM program be properly trained to work on the specific equipment being maintained or tested. This includes understanding the functionality of the equipment, both electrically and mechanically, and having a thorough knowledge of electrical safety practices and procedures. Special training is required for high-voltage equipment and protective relay devices.

- **Maintenance Logs**
  - ❖ Detailed maintenance logs and documentation on actions taken, when and by whom are a critical piece of the Electrical maintenance plan.

- ❖ Logs should include: tasks completed on what equipment, the outcome, date completed, by whom, and any follow-up actions required. Each log entry should be signed by individual who completed the work and the certificate of acceptance noted (See Appendix for potential sample.)
- ❖ This section of the plan should identify where these logs will be maintained and available for viewing.

- **Follow-up Maintenance Reporting**
  - ❖ An annual report outlining the overall status of the electrical systems and equipment within the building, any issues that require addressing, potentials replacements etc. should be identified.
  - ❖ Inspection and maintenance action plans are to be provided upon completion of all inspection and maintenance activities carried out by the LEC.

When creating an electrical maintenance plan", an effort should be made to avoid producing a maintenance plan around individual or separate component. Instead, planning should focus on a system-wide maintenance perspective as this will enhance overall performance.

Appendices

Appendix 1 - Licenced Electrical Contractor - what are the key qualifications you should look for when hiring an LEC

Appendix 2 - Criticality and ESG Consequences

Appendix 3 – Template for Electrical Maintenance Plan and sample log sheets

Appendix 4 – Creating a Maintenance Plan – Ontario Electrical Safety Authority

Appendix 5 –Excerpts from – CSA - Z463-18 - National Standard of Canada -Maintenance of electrical systems Annex M - Equipment-specific types of maintenance and maintenance priority levels and from ANSI/NETA MTS-2019 Standard for Maintenance Testing Specifications for Electrical Distribution Equipment and Systems

Appendix 1:
Licenced Electrical Contractor –
Key qualifications to look for when hiring an LEC

When selecting a Licenced Electrical Contractor to both help create an Electrical Maintenance Plan, as well as to complete and oversee required maintenance, it is important that a qualified and competent LEC is selected to perform these activities. The following is a list of key questions to help determine the appropriate LEC for your organization

- How many years of experience does the LEC have in performing preventive maintenance on electrical equipment in multi-unit residential buildings?
- What is the LEC's ECRA/ESA licence number? Is the ECRA/ESA licence number on their truck and any estimates of work to be performed? Is the ECRA/ESA licence verifiable by look-up of company name at http://findacontractor.esasafe.com/
- Can the LEC provide the name, contact information and qualifications for the DME (Designated Master Electrician) who is employed by the LEC and who will be responsible for overseeing electrical work at the building site.
- Can the LEC provide a minimum of three references that relate to similar work performed in the past year?
- Can the LEC provide documentation showing they are fully insured?
- Can the LEC offer an ESA Certificate of Acceptance following completion of work?
- Is the LEC familiar with the requirements of existing electrical maintenance standards, such as CSA Z463 or equivalent?
- Does the LEC have the appropriate resources to be able to undertake such a complex task of testing and repairs, including sourcing parts to fit the installed electrical equipment?
- Will any of the work, such as high voltage equipment maintenance, be outsourced to third party service providers?
- If applicable, what geographic area does your service cover, and can you provide turnkey solutions and services for multi-site projects?
- Can the LEC provide 24/7/365 service?
- What is your backup plan for emergency generators, security staff etc. in the event the outage takes longer than planned?
- Can the LEC provide calibration records for all your test equipment by an approved agency in the last 12 months of use.
- Is the LEC eligible for risk-based oversight selective inspections? If yes, please provide documentation.
- Can the LEC provide a sample of an electrical safety plan including electrical safety training records.

- Does the LEC require that personnel wear properly rated Arc flash gear within the Arc Flash Boundary Distance?

- Is the LEC identified in the ESA data Licensed Electrical Contractor data-base available at https://findacontractor.esasafe.com/

- Please provide a proof of insurance (min. $5 million).

In addition to the prequalification questionnaire above, qualified LEC shall have relevant experience with:

- CSA (Canadian Standards Association) Z462-2018 Standard for Electrical Safety in the Workplace
- CSA (Canadian Standards Association) Z463-2018 Maintenance of Electrical Systems
- CSA (Canadian Standards Association) Z1001 Occupational Health and Safety Training
- ANSI (American National Standards Institute)/NETA (International Electrical Testing Association) MTS-2019 Standard for Maintenance Testing Specifications for Electrical Distribution Equipment and Systems
- NFPA (National Fire Protection Association) 70E Standard for Electrical Safety in the Workplace
- NFPA (National Fire Protection Association) 70B Recommended Practice for Electrical Equipment Maintenance
- Approved & Accepted Standards of Equipment Manufacturers
- All applicable laws that fall within the scope of work performed (e.g. www.e-laws.gov.on.ca)

Appendix 2:
Criticality and ESG Consequences

A detailed maintenance plan for electrical equipment and systems should identify all the maintenance activities required to confirm the safety, reliability, and integrity of the electrical system and equipment. This is in part determined by performing a criticality assessment of the electrical system and equipment.

An asset criticality template helps calculate the impact a piece of equipment has on the organization and the consequences of that equipment failing.

Example 1 -Assessing criticality

There are two ways to assess asset criticality. The first is to measure the probability of failure and the impact of failure. Each is scored from one to six. The scores are multiplied to find the risk priority number for the asset and a corresponding asset criticality level.

Risk priority number calculator

Probability of failure						
	6	12	18	24	30	36
	5	10	15	20	25	30
	4	8	12	16	20	24
	3	6	9	12	15	18
	2	4	6	8	10	12
	1	2	3	4	5	6

Impact of failure

Asset criticality level

- Critical
- High
- Moderate
- Low

The other method is criticality by consequence. This asset criticality framework only takes the impact of asset failure into account. It measures the impact of failure in three areas—health and safety, environment, and operations. Each area is rated on a scale of one to five. When multiplied, you get the total criticality of your assets. The higher the number, the more critical it is.

SCORING KEY

0-18 = NO RISK | 19-36 = LOW RISK | 37-87 = MODERATE RISK
88-106 = HIGH RISK | 07-125 = EXTREME RISK

How to fill in this template: Rate the impact of asset failure in each category on a scale of 1-5, with 1 being low impact and 5 being a critical impact. Multiply the numbers together to find the total criticality of your assets

Asset	Impact on health and safety	Impact on environment	Impact on operations	Total impact
Asset #1	3	4	5	60
Asset #2	2	2	4	16
Asset #3	5	2	5	50

Information taken from https://www.fiixsoftware.com/blog/12-maintenance-templates/

Sample 2 – Assessing Criticality and ESG Consequences

Taken From: https://swefc.unm.edu/iamf/criticality-introduction/

Probability of Failure

To calculate the criticality of an asset, the probability of failure of that asset needs to be quantified. Each asset should be assigned a probability of failure (POF) rating based on how likely the asset is to fail. These ratings should be based on a probability of failure rating structure created by system staff. Each failure rating in the structure should have a general description of likelihood of occurrence. Entirely eliminating the possibility of failure is unrealistic and most likely impossible. However, systems can work to minimize failure, especially for critical assets that have high consequences of failure.

There are four modes by which an asset can fail: mortality, financial inefficiency, capacity, and level of service. Each of these four failure modes has a variety of factors that contribute to that potential mode of failure. These factors can range from O&M history to customer expectations to condition of the asset. There is not one factor that is the most common cause of failure, and these factors may impact green and gray assets differently. When thinking about how each individual asset might fail, all four mechanisms need to be considered. It is also worthwhile to consider which failure mode is most likely to affect that particular asset.

Creating Probability of Failure Ratings

To calculate the criticality of an asset, the probability of failure of that asset needs to be quantified. Systems can quantify the probability of failure by creating a probability of failure rating structure that includes a numeric rating as well as a description of each rating. One of the best ways to develop these standardized criteria is to engage a cross-section of system personnel who have different viewpoints and different experiences with the assets. Staff should choose a rating scale, such as 1 to 5 or 1 to 10, and keep the descriptions broad enough so the ratings can apply to any assets (gray and green) in the system. Creating these ratings does not have to be a long, time-intensive activity. A small system should be able to complete the process of developing the rating structure by meeting a few times for a few hours each. A larger system may take longer and may wish to have a more expansive rating system.

Once developed, staff will use the structure to assign a rating to each asset based on how likely the asset is to fail. Three examples of possible rating structures are shown below. Two use a 1 to 5 scale and the third a 1 to 4 scale with the lowest number being the lowest probability and the highest number being the highest probability.

Table 1. Probability of failure ratings with descriptions.

Rating	Description
1	Very Low Probability of Failure
2	Low Probability of Failure
3	Moderate Probability of Failure
4	High Probability of Failure
5	Very High Probability of Failure

Table 2. In-depth probability of failure ratings with descriptions.

Rating	Description
1	Asset is brand new or like new. Failure not anticipated within the foreseeable future.
2	Asset is not brand new but shows no more than cosmetic signs of wear and tear. Asset failure is not anticipated in the near future. The asset receives regular maintenance.
3	Asset shows signs of wear but has not yet entered a potential failure state. Asset has the potential to be maintained at a level 3 for some period of time if the proper maintenance is completed and repairs are made. Asset may show light rust, some light wear and tear, or be nearing, but not at, physical capacity.
4	Asset is in potential failure, but not functional failure mode. Functional failure not expected within the next year (if so, should be PoF of 5). Potential failure means the asset is showing signs of failure, such as cracks, root intrusions, vibration, noise, excessive rust, but is still delivering all or most of the required service. The potential failure issues will need to be addressed to prevent a functional failure. Functional failure occurs when the asset is in one of the four failure modes.
5	Already in functional failure mode (Mortality – already broken, collapsed; Level of Service - not doing what it's supposed to; Capacity – not sufficiently sized; Financial Inefficiency – costing too much to continue to use) or expected to be in functional failure mode within 1 year. A failure of one of the four types is imminent, if the asset is not already in failure mode.

Table 3. Example of a corporate level probability of failure rating.

Rating	Description
Very unlikely	The event could happen but probably never will (less than 10%). Unlikely to occur within a 12-month period.
Unlikely	The event could happen but very rarely (10%-50%). Might occur at some time in a 12-month period.
Likely	The event could happen sometime (50%-90%). Will probably occur at some time within a 12-month period.
Very Likely	The event could happen at any time (more than 90%). A strong probability of multiple occurences within a 12-month period.

Source: WRF report titled Asset Management Framework for Forested and Natural Assets.

Factors Impacting Consequence of Failure

Prior to assigning consequence of failure ratings to each asset, system staff will want to create a consequence rating structure. Once the rating structure is created, system staff will rate the consequence of failure of each asset using the rating structure. The consequence of failure rating is complex because it includes a variety of qualitative and quantitative factors that need to be considered together within the triple bottom line categories of financial, environmental, and social. It can be difficult to blend these types of factors and decide how to value each of them compared to the others. As an example, the system may have to pay direct costs related to an asset failure, such as cost of water loss, repairs, fines or property damage. There are also potentially indirect costs that may occur in the form of social consequences that are not easily quantified, such as business or customer interruptions, traffic delays, public perception or reputation. Often when an asset fails, the consequences of that failure will fall into at least two of the three Triple Bottom Line categories, if not all three.

To assess the qualitative and quantitative consequences from gray and green assets, consider all the information the system may have, such as past experience, known financial costs, past regulatory failures, complaints from customers, and models to help predict the consequences of failure. Impacts of relevant natural hazards (e.g., wildfire, earthquake, tornado, or hurricanes) on assets may be more challenging to estimate because data may not be readily available, and the events are relatively infrequent. Because these events can potentially have high consequences, especially to large natural assets, there are several models available to predict how these natural assets will respond to natural disasters. For example, watershed models can be used to quantify the effect of a fire on erosion and water quality in an affected river that serves as source water. Additional sources of information such as source water assessments, watershed assessments, USFS Forest-to-Faucet maps, or others can serve as reasonable proxies for consequence estimates.

Systems must look at financial, environmental and social consequences when assessing the overall consequences of asset failure in order to make holistic and informed judgements across all types of assets. Below are descriptions of these three consequence categories as well as some examples of the type of consequences that fall into each category. When assessing the overall consequences of asset failure and assigning a rating, systems should consider the factors below.

Financial

Consider all of the potential financial costs associated with an asset failure. The examples below are not an exhaustive list of financial costs but are some of the most common costs to consider. These common costs include repair/replacement, collateral damage caused by the failure, legal costs associated with the failure, loss of revenue, cost of water lost, regulatory fines, and any required payments to businesses affected by the failure (if the business had losses related to the failure but the system did not have to pay anything toward these losses, it is classified as a social consequence rather than a financial one.)

Cost of Repair/Replacement – Depending on the type of asset and the extent of the failure, repair may be simple, moderate or extensive. Some failures may be so severe, or repairs may be so expensive that asset replacement is the best option. If the asset can be repaired easily at a reasonable cost, the consequences are lower. As the costs and complexity of repairs increase, the consequence of failure increases. For example, a small leak in a water distribution pipe can be repaired with a clamp, or a chlorine pump can be replaced with a spare pump or perhaps the parts can be replaced inside the pump. Both of these situations would constitute a lower consequence of failure. The failure of a major wastewater collection pipe or wetlands may be more involved and expensive, may require extensive efforts to repair, and may result in a number of additional consequences beyond financial (environmental, public health, social). These types of failures will result in higher consequences.

Costs or Impacts Related to Collateral Damage Caused by the Failure – In some cases, when an asset fails, damage may extend to other assets within the system or to assets unrelated to the water, stormwater, or wastewater system. One example of this type of damage is a drinking water line failure causing a sinkhole which in turn causes major sections of a road to collapse or damages the foundation of a building, or damage to cars falling in the sinkhole. Another example is several planters becoming clogged over time and the planters experience a large storm event in which water cannot properly infiltrate. The water may go into a store front, potentially causing damage inside the store. Another example is a sewer pipe failure that leaks sewage into a home or yard or onto a schoolyard or playground. In these cases, there may be a significant amount of clean up required to restore property or habitat. The system may be held responsible for this collateral damage, and in these cases, the costs related to this type of failure need to be considered. Collateral damage may also occur within a utility. If a sewer collapses, debris may be delivered to the wastewater treatment plant which may damage motors or other moving parts.

Legal Costs Associated with Asset Failure – In some cases, individuals or businesses may sue for damages related to harm to property, injuries sustained, or lost revenue caused by an asset failure. For example, imagine a driver is driving down the road and his car falls into a sinkhole caused by a water line failure and the driver sustains an injury. The driver may sue the system to cover the costs associated with the injury and loss of work time. If the sinkhole causes damages to businesses, they may sue for damages. Systems can also be sued for causing significant environmental damage. These costs would be in addition to the costs of repairing and replacing damaged property or other assets.

Cost of Shutting Down or Limiting Operations – Shutting down or limiting operations, even for a short period of time, may have significant economic impacts for businesses. A sewer pipe leak near a major roadway may prevent customers from visiting businesses because of road blockages or odor. The reduction in business income due to repair work having blocked or shut down the businesses can financially impact businesses. Lack of service may also impact the system's revenue if the service disruption is lengthy, and water is not passing through the meters of business customers.

Property Values – Property values can be raised when significant green infrastructure is installed in neighborhoods due to the aesthetic appeal and the opportunity for outdoor recreation. However, failure of that green infrastructure leading to unkept, clogged or dilapidated green assets can just as easily decrease livability and property values and negatively impact those living in the community.

Environmental

Some types of asset failure can lead to environmental consequences. Any abrupt or significant change to water quantity and quality can lead to negative environmental impacts. Asset failures that have environmental impacts may not always be easy to assess in monetary terms. However, some attempt should be made to assign some type of quantitative or qualitative value to the environmental consequences. Environmental consequences resulting from asset failures include contamination of waterways or land, loss of habitat, negative impacts to plants or wildlife, violations of any regulatory requirements, or discharge of waste products. An example of an environmental impact related to a failure would be a sewer pipe break that caused sewage to enter a waterway or flow onto public or private land. A value, in either quantitative or qualitative terms, would need to be placed on this type of consequence. If the leakage resulted in a regulatory fine, the cost of the fine would be included in the financial category. The magnitude of environmental consequence can be assessed in relative terms. A failure that resulted in large quantities of raw sewage being discharged into a major waterway should be given a high consequence rating; a failure that resulted in a moderate amount of sewage leaking on land could be given a medium rating; and a failure that would cause small amounts of sewage to be discharged onto impervious surfaces only could be given a low rating.

Contamination – One of the main objectives of green infrastructure is to capture and treat rain and stormwater. Many of these assets are protecting source water or recreational waterways. Any failure would not only increase the treatment load for water or wastewater systems but could also allow untreated or insufficiently treated contamination to enter waterways. There is a close relationship between urbanization and water quality. Stormwater picks up trash, excess nutrients, sediment, and other pollutants that flow into a storm sewer system or directly to a lake, river or wetland. By capturing and treating rainwater where it falls, green infrastructure practices can reduce the pollution in rivers, lakes, and coastal waters. An asset failure for a water system could mean contaminated water reaching the waterways. Wastewater assets are already treating contaminated water and thus inherently any failure of the system poses a contamination risk. For example, a sewer pipe that leaked sewage into a waterway or onto public or private land could cause significant environmental impacts. While drinking water is generally considered safe, the discharge of chlorinated water has the potential to impact aquatic life. This type of discharge can have environmental consequences, even if it would not cause public health consequences.

Violations or Fines – Some type of failures will result in violations of regulations. Violating environmental law and EPA regulations that are in place to protect the public health and the environment can lead to severe consequences. In addition, it is possible that the violation can result in a fine. For example, if a system violates their stormwater discharge permit by having several overflows or exceeding the permit limit for a contaminant like E. Coli in the discharged effluent, they can face fines in the tens of thousands of dollars. While the environmental consequence of the violation is considered in this category, the fine associated with the consequence is considered in the financial category.

Loss of Habitat – Failures of assets can have significant negative impacts on wildlife habitat. Some green assets such as canopy and open space may be habitat for birds, mammals, amphibians, reptiles, and insects. These green assets can act as nature corridors for wildlife to move through a city's urban environment. Failures of these assets can impact their ability to serve these functions. Failure of gray assets can cause erosion problems or contaminate wildlife habitat.

Impact on Wildlife – Some type of asset failures will directly impact wildlife. Polluted water, whether it be stormwater or wastewater, has adverse effects on wildlife and aquatic life. For example, trash can clog waterbodies, excessive nutrients can cause harmful algae blooms and sediment can reduce visibility and destroy habitat. Polluted waterways poison fish and other aquatic life and can reduce oxygen levels in the water dramatically, thus threatening marine life. Chlorinated drinking water that enters waterways can also have an impact on aquatic life.

Social

Social impacts refer to any impact to people, which in the case of a water, wastewater, and stormwater system, can be the general public, elected leaders, and employees. When an asset fails, there may be minor or major impacts or inconveniences to the community, elected leaders, or employees. Social consequences can relate to safety, public health, traffic inconvenience, business disruption, service outages, or the public's ability to use or enjoy an area or facility. In some cases, the impacts may be minor, such as a 1-hour water outage in the middle of the day or a 2-hour blockage of one lane of a minor street, while in others it may be much higher. On the other hand, if the system has very few isolation valves such that a water line repair requires a large portion of the system to be shut down, the inconvenience to the public is much greater. In the first case (a simple repair in a residential area that shuts off a few customers for an hour), the consequence of failure related to the social impact is low. In the second case where the whole system must be shut down to make the repair, the social impact is much higher. These examples have focused on inconvenience, which may appear insignificant, but to members of the community, the inconvenience may be extremely important and may affect how they feel about the system in general. If customers have negative impressions of the system, it can impact the ability to raise revenue. More consequential social costs include impacts related to public health and safety. Water, stormwater, and wastewater infrastructure failures can negatively impact water quality which can threaten public health, public recreation, and safety. Of particular concern are asset failures that may pose a safety concern to employees. One example is a walkway and railing on top of a wastewater equalization tank. The employees use the walkway and railing to make observations or collect samples. This metal walkway and railing were severely corroded and had numerous areas of weakness, including the fact that the railing easily moved back and forth when touched. If the walkway and railing asset failed while an employee was standing on it, the employee would fall into the raw sewage tank and may be seriously injured or lose his or her life.

These consequences, as well as those less severe related to inconvenience, may be hard to quantify monetarily but should be included in a qualitative way. Below are categories of social consequences systems should consider.

Public Health – Some types of asset failures can negatively impact public health. Polluted runoff poses a threat to public health by contaminating the rivers, lakes, and coastal waters where communities swim, boat, fish, and obtain drinking water. Some communities have combined sewers that convey both stormwater and wastewater and if these pipes fail, a combined sewer overflow (or CSO) can occur. This situation is possible during periods of heavy rainfall. If the CSO occurs near waterways, the polluted water can enter lakes, rivers, or oceans potentially creating a public health risk. Failure of green and gray assets can also lead to recreational and drinking water sources being contaminated with bacteria, sewage, or excess nutrients that cause toxic algal blooms. A decrease in local water quality can result in higher health care costs for the community. Increased vegetation with green infrastructure creates co-benefits, such as improved air quality or reduced heat island effect, but failures reduce or negate those additional improvements.

Public Safety – Some types of failures can negatively impact public safety. Asset failures may damage roads and directly impact public safety. For example, if a water line fails and causes a sinkhole people in cars, houses or sidewalks may be hurt. Another asset failure could leave water covering the street. If that water freezes, that could negatively impact traffic and cause accidents. Asset failures may cause streets or sidewalks to be blocked and, if not fixed quickly, could lead to safety concerns. Assets near critical facilities (e.g., schools, parks or hospitals) and those near primary roads should have higher consequence ratings.

Impact on Community Resources – Water, wastewater, and stormwater infrastructure failures may have impacts on community resources. The failure of green assets could temporarily reduce recreation space or recreational opportunities. Trees and parks help transform an urban neighborhood into an inviting, exciting place to live, work and play. Overgrowth and lack of maintenance on these and similar green assets could reduce property values and harm businesses because people may be less likely to spend time in areas with degraded infrastructure. This type of asset failure (which is best defined as a level of service type failure) can also reduce the activities of residents in outdoor spaces. If green assets are not maintained, especially in the first few years, the vegetation is likely to fail. Failure of the vegetation diminishes the urban heat island reduction that occurs when urban areas replace man-made land cover with trees, green roofs and other green infrastructure that cool the areas by shading, deflecting radiation from the sun, and releasing moisture into the atmosphere. Level of service failures such as odor complaints associated with sewers, wastewater treatment plants or pump stations that are not addressed in a timely manner aggravate and frustrate the community. These inconveniences lead to a lack of confidence and ultimately a negative impact on the system's public image.

Public Image & Confidence – Certain types of failures may negatively impact the public's confidence in the water, wastewater or stormwater system and this may have a detrimental effect on the system. The assets must be in working order to deliver the level of service desired by the system and its customers. If the assets fail, the ability to deliver the desired level of service may be compromised. An asset that has a major impact on the ability to meet the level of service would be considered more critical to the system than an asset whose failure would not have a significant impact on level of service. Failure with any social consequences (public health, smell, aesthetics, level of service, safety) can cause widespread loss of community confidence in government and adverse media coverage, possibly resulting in diminished ability to raise revenues necessary to operate the system. Therefore, it is important to weigh these consequences just as heavily as environmental and financial consequences. As an example, the failure to provide safe water to the community of Flint, Michigan not only effected the public image of that system; it effected the public image of the water industry as a whole. It is important to consider how hard a system must work to gain public confidence and how quickly it can be lost. Once lost, it may be extremely difficult to retrieve.

Taken From: https://swefc.unm.edu/iamf/criticality-introduction/

Creating Consequence of Failure Ratings

The consequence of failure of an asset needs to be quantified. Assets should be assigned a consequence of failure rating. Systems can quantify the consequence of failure by creating a rating structure that includes a numeric rating and a degree of impact description for each rating. From an implementation perspective, it may be easiest to use the same scale for both consequence and probability of failure. If a 1 to 5 scale was used for probability of failure, systems may want to use a 1 to 5 scale for the consequence of failure, but it is not necessary to do it this way. If a system wishes to weight one of the factors more heavily than the other, it is possible to have a 1 to 5 rating for probability of failure and 1 to 10 rating for consequence of failure or vice versa. If the scale is 1 to 5 for both probability and consequence, the overall risk will be between 1 and 25. A rating of "0" is never used because it would result in an overall risk of 0 and no asset is completely without any risk of failure or consequence of failure.

One of the best ways to develop standardized criteria is to engage a cross-section of system personnel who have different viewpoints and different experiences with the assets. Staff should choose a rating scale, such as 1 to 5 or 1 to 10, and keep the descriptions broad enough so the ratings can apply to any assets (gray and green) in the system. Creating these ratings does not have to be a long, time-intensive activity. A small system should be able to complete the process of developing the rating structure by meeting a few times for a few hours each. A larger system may take longer and may wish to have a more extensive rating system.

Once developed, staff will use the structure to assign a rating to each asset based on the significance of the consequences. Three examples of possible rating structures are shown below. Two use a 1 to 5 scale and the third a 1 to 4 scale with the lowest number being the lowest probability and the highest number being the highest probability.

Table 4: Consequence of failure ratings with descriptions

Rating	Description
1	Very Low Consequence of Failure
2	Low Consequence of Failure
3	Moderate Consequence of Failure
4	High Consequence of Failure
5	Very High Consequence of Failure

Table 5: In-depth consequence of failure ratings with descriptions

Rating	Description
1	No identifiable consequences. Less than $10,000 in repair costs. (use the appropriate monetary amount for your system. A smaller system will want to set a lower monetary threshold).
2	$10,000 to $49,999 in repair costs. Short term disruption to traffic or business or operations (less than 4 hours). Bypassing (without violating permit) for less than 3 days.
3	$50,000 to $99,999 in repair costs. Disruption to businesses. Disruption to traffic. Disruption to septic haulers. Disruption to staff or regular operations. Bypassing (without violating permit) for more than 3 days.
4	$100,000 or more in costs related to repair. Damage to other assets and/or private property. Potential to negatively harm the environment; potential to cause impacts to endangered species. May make some minor news report.
5	Health and safety of employees and/or public at risk. Exceedance of permit limits. Politically problematic/becomes a major news story.

Table 6: Consequence of failure ratings with descriptions

Rating	Description	Level of Effect
1	Insignificant disruption	Negligible effect on costs; no significant consequences or impact on level of service
2	Minor disruption	Minor effect, some loss of system capacity, but minimal costs or impacts
3	Moderate disruption	Moderate effects, loss of some system capacity, yet important level of service still achieved
4	Major disruption	Major effect, loss of system capacity, major consequences or costs, level of service compromised
5	Catastrophic disruption	Massive system failure, severe economic, environmental, health, and/or social consequences, persistent and extensive damage, unable to meet level of service goals

Source: New Jersey Department of Environmental Protection Asset Management Technical Guide

Appendix 3:
SAMPLE TEMPLATE – ELECTRICAL MAINTENANCE PLAN
Table of Contents

- **Purpose of the Electrical Maintenance Plan**
  - ❖ Is it to ensure the safety, reliability, integrity of electrical system and equipment? Is it to ensure a range of activities to help keep systems and equipment dry, cool, clean and tight? Are there other reasons or factors, such as preventative approach?

- **A Bit about the Building**
  - ❖ Include address, age of building, number of storeys, general condition of building and mechanicals and equipment rooms, name and contact information for of owner/property manager and building staff, name and contact information of LEC

- **Roles and Responsibilities**
  - ❖ Define the roles and responsibilities of the LEC – Contractor, Equipment Manufacturer, Building/Maintenance Staff within the context of maintaining the building's electrical assets and completing electrical work

- **Employee/Worker/Resident Safety**
  - ❖ What steps are to be taken and training and information provided to ensure employee/worker and resident safety

- **Criticality of Assets and Risks**
  - ❖ What factors are being used and how is criticality being assessed (safety, environment, operational consequences, non-operational consequences) in determining the importance and timing of maintenance related activities

- **Approach and types of maintenance to be used**
  - ❖ Is a preventative, predictive, reactive or other approach or a combined maintenance approach being taken? Are visual, mechanical, and/or electrical testing or a combination of strategies to be used for testing and inspection to be used?

- **Systems and equipment covered by the electrical maintenance plan**
  - ❖ Include a full and detailed listing that highlights the purpose/role of the equipment that include Switchgear, Transformers, Service and Circuit Breakers, Buswork, Enclosures, and Insulators, Arrestors, Battery Chargers, Switches and Disconnects, motors, relays

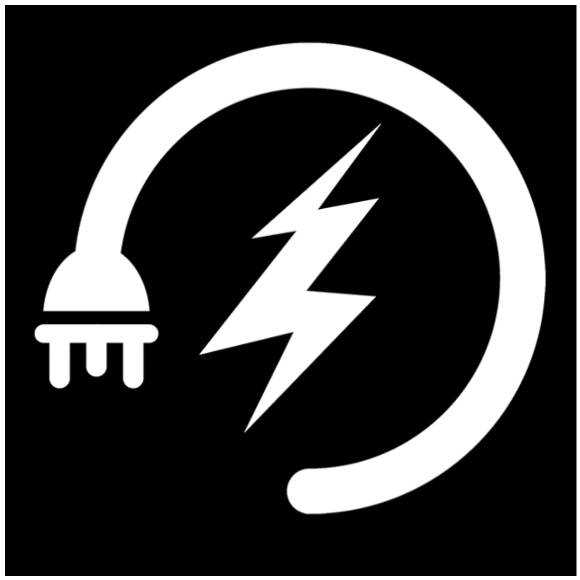
- **Asset Record Registry**
  - ❖ Detailed information on each piece of electrical equipment including nameplate information should be collected and maintained
  - ❖ (Who should collect this information? How frequently should it be updated? Where should this information be kept?)

- **Schedule of Required Equipment Maintenance**
  - ❖ Detailed record of check/inspect, test, maintenance and servicing tasks should be What specific check/inspect, test, maintenance and/or servicing tasks should be carried out on a daily, weekly, monthly, quarterly, semi-annual, annual, etc. basis and by whom.

- **Maintenance Logs**
  - ❖ Detailed maintenance logs and documentation on actions taken, when and by whom are a critical piece of the Electrical maintenance plan.
  - ❖ Logs should include: tasks completed on what equipment, the outcome, date completed, by whom, and any follow-up actions required. Each log entry should be signed by individual who completed the work and the certificate of acceptance noted?
  - ❖ Where should these logs be maintained)

- **Follow-up Maintenance Reporting**
  - ❖ An annual report outlining the overall status of the electrical systems and equipment within the building, any issues that require addressing, potentials replacements etc. should be identified.

ELECTRICAL MAINTENANCE PLAN



BUILDING ADDRESS:

____

NAME OF COMPANY:

____

ELECTRICAL MAINTENANCE PLAN

Building Address: ____

____

Year Built: _______________________________________

Number of Storeys: _______________________________________

Picture of Building	Picture of Building	Picture of Building

ELECTRICAL MAINTENANCE PLAN
Address: ________________________

Contacts

Building Owner: ____

Property Management Company: ____

Contact Number: ____

Property Manager: ____

Contact Number: ____

Primary Building Contact : ____

Contact Number: ____

LEC Responsible for Development of Electrical Maintenance Plan:

____

ECRA Licence: ___________________________ Contact Number: _____________________

Licensed Electrical Contractor (LEC) Responsible for Work at the Building:

____

ECRA Licence: ___________________________ Contact Number: _____________________

ELECTRICAL MAINTENANCE PLAN
Address: ______________________

Version Control

Title				
Description				
Created By				
Date Created				
Maintained By				
Version Number	Modified By	Modifications Made	Date Modified	Status

ELECTRICAL MAINTENANCE PLAN
Address: ______________________

Purpose of the Electrical Maintenance Plan

(Identify the purpose or overall goal of your maintenance plan. Is it to ensure the safety, reliability, integrity of electrical system and equipment? Is it to ensure a range of activities to help keep systems and equipment dry, cool, clean and tight? Are there other reasons or factors, such as preventative approach?)

Identify the statements that reflect the goals and objectives of this building's electrical maintenance plan

This plan is designed to:

- ☐ improve the safety and comfort of building occupants
- ☐ maximize efficiency of the building
- ☐ minimize the need for major repairs and replacements
- ☐ provide for a deliberate approach to funding maintenance and operations
- ☐ preserve the investment in the building;
- ☐ help the building function as it was intended and operate at peak efficiency, including minimizing energy consumption;
- ☐ prevent failures of building systems that would interrupt occupants' activities and the delivery of services;
- ☐ sustain a safe and healthful environment by keeping buildings and their components in good repair and structurally sound;
- ☐ provide maintenance in ways that is cost-effective;
- ☐ Other (Please elaborate);

ELECTRICAL MAINTENANCE PLAN
Address: ______________________

Roles and Responsibilities

(Define the roles and responsibilities of the LEC – Contractor, Equipment Manufacturer, Building/Maintenance Staff within the context of maintaining the building's electrical assets and completing electrical work)

Role of the LEC at the Building

Duties of an LEC at the building site are to:

- Ensure that all electrical work is carried out in accordance with all applicable laws;
- Ensure that at least one Master Electrician is designated at all times to oversee the electrical work carried out on behalf of the business.
- Identify the licensed DME designated to the business
- Work with Building Owner/Property Manager in creating a building specific Electrical Maintenance Plan that is in compliance with regulatory requirements.
- Accept responsibility and liability for all aspects of the electrical work being carried out, including work performed by a sub-contractor, when they hold the electrical permit for the site unless the sub-contractor has taken out their own permit for the portion of electrical work that they are responsible for

Other LEC Roles and Responsibilities at the building site:

Role and Responsibilities of Equipment Manufacturers at the Building Site

Duties and/or responsibilities of equipment manufacturers at the building site include:

- Providing documentation and associated manufacturer's maintenance recommendations for equipment installed at the building site. This information forms an important base of recommended maintenance intervals and tasks for the building.
- When appropriate, and when specialized service is required, provide technicians from the original equipment manufacturer who have been trained by the manufacturer to perform maintenance, service or repair on the equipment.

Other Roles and Responsibilities of Equipment Manufacturer at the building site:

Role and responsibilities of Building/Maintenance Staff in Maintaining the Building's Electrical Assets and Completing Electrical Work

Duties and/or responsibilities of building/maintenance staff (on payroll of Property Manager/Owner) at the building site include:

- Filing notifications with ESA before or within 48 hours of the electrical work starting If completing electrical work either in common areas or resident's suites and arranging for inspections/Certificates of Acceptance following inspection of electrical work.
- Documenting and maintaining records of all electrical work on electrical systems (including maintenance) in on-site record books. (See OESC Rule 2-003, Record of Electrical Installation Work)
- Keeping all operating electrical equipment in safe working condition. If it is defective, it must be fixed or permanently disconnected. (See OESC Rule 2-300 General Requirements for Maintenance and Operation)
- Fixing electrical deficiencies or ensure electrical deficiencies are fixed as soon as possible. Under the CSS program, participants are also required to notify ESA of the corrective action that is taking place within 30 days of the issuance of the defect(s).

Other Roles and Responsibilities of building/maintenance staff in maintaining the building's electrical assets at the building site:

Employee/Worker/Resident Safety

(What steps are to be taken and training and information provided to ensure employee/worker and resident safety)

The Property Manager will ensure all Building employees/maintenance workers who operate at the buildings site receive the following types of training

☐ safety training to recognize and avoid the electrical hazards involved
☐ training on use of appropriate PPE when working with electrical equipment
☐ training on use of relevant electrical equipment
☐ training/ knowledge of maintenance techniques and procedures to safely and effectively maintain electrical equipment.

☐ Other: (Please Specify)

ELECTRICAL MAINTENANCE PLAN
Address: ______________________

Criticality of Assets and Risks

(What factors are being used and how is criticality being assessed (safety, environment, operational consequences, non-operational consequences) in determining the importance and timing of maintenance related activities and the potential need for replacement of electrical asset components and systems. Highlight the criticality matrix being used)

Criticality by failure probability and impact

Risk priority number calculator

Probability of failure						
	6	12	18	24	30	36
	5	10	15	20	25	30
	4	8	12	16	20	24
	3	6	9	12	15	18
	2	4	6	8	10	12
	1	2	3	4	5	6

Impact of failure

Asset criticality level
- Critical
- High
- Moderate
- Low

Asset	Risk Priority Number	Criticality Level

Asset criticality risk assessment using ESG (Using an ESG Mindset)

SCORING KEY

0-18 = NO RISK | 19-36 = LOW RISK | 37-87 = MODERATE RISK
88-106 = HIGH RISK | 07-125 = EXTREME RISK

How to fill in this template: Rate the impact of asset failure in each category on a scale of 1-5, with 1 being low impact and 5 being a critical impact. Multiply the numbers together to find the total criticality of your assets

Asset	Impact on Health & Safety	Impact on Environment	Impact on Operations	Total Impact

ELECTRICAL MAINTENANCE PLAN
Address: ______________________

Approach and types of maintenance to be used

(Identify if a preventative, predictive, reactive or other approach or a combined maintenance approach will be taken? Are visual, mechanical, and/or electrical testing or a combination of strategies to be used for testing and inspection to be used?)

The primary focus and approach to maintenance under this electrical plan is:

☐ Preventive maintenance involves inspecting and performing maintenance on machinery, regardless of whether the equipment is in need of maintenance. This maintenance schedule is based on either a usage or time trigger

☐ Predictive maintenance, also known as condition-based maintenance is maintenance that monitors the performance and condition of equipment, during normal operation to reduce the likelihood of failures. Also known as condition-based maintenance, predictive maintenance is scheduled as needed (based on real -time conditions of asset

☐ Reactive Maintenance essentially operates on the run-to-failure strategy Reactive maintenance describes the strategy of repairing parts or equipment only after the asset has broken down or been run to the point of failure.

☐ Other (Explain)

Systems and equipment covered by the Electrical Maintenance Plan

(Identify a full and detailed listing that highlights the purpose/role of the equipment that include Switchgear, Transformers, Service and Circuit Breakers, Buswork, Enclosures, and Insulators, Arrestors, Battery Chargers, Switches and Disconnects, motors, relays?)

☐ Power distribution switchgear & panel board
☐ Transformers
☐ Reactors
☐ Power cable
☐ Circuit breakers
☐ Disconnect and circuit switchers
☐ Network protectors
☐ Protection, control, and metering devices
☐ Instrument transformers
☐ Ground grid systems
☐ Rotating machines
☐ MCCs
☐ Adjustable speed drives
☐ Charging equipment
☐ Power factor correction (PFC) capacitors and reactors
☐ Engine generators
☐ UPS
☐ Automatic circuit reclosers and line sectionalizers
☐ Regulating equipment
☐ Lighting, signs, and outline lighting

ELECTRICAL ASSET RECORD

Building Address:
Owner:
Property Manager:

ELECTRICAL SYSTEM/ EQUIPMENT	Description	Manufacturer	Model Number	Serial Number	Tag Number
Equipment Location:		**Voltage:**	**Amperage:**	**Frequency (Hz)**	**Power/Watts**
Vendor Name	**Vendor Contact**	**Contact Number**	**Date Installed**	**Anticipated Replacement Date**	**Service Manual at Site (Y/N)**
Warranty Information					

Images of Asset

Maintenance Activities:

Required inspect/test & servicing requirements	Online Task	Offline Task	Recommended Frequency Daily, weekly, monthly, semi-annually, annually, every 3 years, etc.	Work To Be Completed By: LEC/Equipment Manufacturer/ PM Staff	Criticality /risk task interval

Maintenance Activities:					
Required inspect/test & servicing requirements	Online Task	Offline Task	Recommended Frequency	Work To Be Completed By:	Criticality /risk task interval
			Daily, weekly, monthly, semi-annually, annually, every 3 years, etc.	LEC/Equipment Manufacturer/ PM Staff	

NOTE: A separate asset registry record is required for each piece of equipment

MONTHLY
EQUIPMENT MAINTENANCE SCHEDULE

Building Address: ______________________________

Electrical System/ Equipment	Required Maintenance Activity	Equipment Number	Outcome		Check/ Inspect/ Servicing Completed By	Date Completed	Follow-up Action Taken	Completed By
			OK	Action required				

QUARTERLY
EQUIPMENT MAINTENANCE SCHEDULE

Building Address: ______________________________

Electrical System/ Equipment	Required Maintenance Activity	Equipment Number	Outcome		Check/ Inspect/ Servicing Completed By	Date Completed	Follow-up Action Taken	Completed By
			OK	Action required				

ANNUALLY

EQUIPMENT MAINTENANCE SCHEDULE

Building Address ______________________________

Electrical System/ Equipment	Required Maintenance Activity	Equipment Number	Outcome		Check/ Inspect/ Servicing Completed By	Date Completed	Follow-up Action Taken	Completed By
			OK	Action required				

ELECTRICAL MAINTENANCE LOG

Building Address: ______________________________

ESA Notification Number	Issue /Description of Work	Equipment Location	Equipment Tag #	Actions Taken			Person Completed By/ Signature	Certificate of Acceptance (As required)
				Start Date	Maintenance Performed	Date Work Completed		

APPENDIX 4 –
CREATING A MAINTENANCE PLAN –
TAKEN FROM ESA – "Guide to Multi-Residential Electrical Maintenance"

Creating a Maintenance Plan

1 Hire a Qualified Professional

One of the most critical steps you can take in building a maintenance plan is ensuring that you consult with experts to understand the complex integrated systems that keep your building running safely. For the electrical component of the plan, that means working with a Licensed Electrical Contractor (LEC) or engineer with relevant experience in maintenance planning practices. Keep in mind that experience means more than the number of years they've been in the industry. It includes the understanding of practices that are informed by the use of standards such as CSA Z463 Maintenance of Electrical Systems.

2 Develop a Plan that Considers:

a Building Complexity

Specific services may include deployment of diagnostic testing (such as infrared and insulation resistance testing), emergency generators or site security and servicing of large switchgear.

b Building Age

There have been many changes to the Ontario Electrical Safety Code over the years, meaning that the type of wiring and equipment in a 30-year-old building could be different than that of a 50-year-old building. Depending on the maintenance practices that have previously been used, there may be deterioration of the electrical equipment as a result of age.

2 **Develop a Plan that Considers:**

c Equipment Manufacturers' Service Manuals

Each piece of equipment in your building should have an associated service guide that details the recommended frequency and scope of maintenance.

When preparing to develop your plan, gather records of previous maintenance and repairs done on each piece of equipment so that your Licensed Electrical Contractor (LEC) or maintenance planning professional can compare the work against the recommendations in the service manual.

When creating the maintenance plan, it is important to understand the recommended frequency and scope of the work required to ensure that equipment will remain safe and reliable. Ensure there is a clear maintenance schedule for each piece of equipment, as well as plans for more significant repairs over time.

Note: As electrical equipment ages, consideration should be given to replacement upgrading for the following reasons:

- Aged equipment repairs can be very costly
- Replacement components may be difficult or impossible to source
- As with any mechanical system, the equipment may just reach the end of its life cycle
- Maintenance cost of older equipment may be better spent on new equipment
- Upgrading will allow the system to enjoy newer technology, products and safety features such as ground fault and arc fault protection as well as better monitoring

d Applicable Standards

There are also a number of standards that will help you and those assisting you to develop a comprehensive maintenance plan including:

- **CSA Z463-18 Maintenance of electrical systems**
- **ANSI/NETA MTS-2007 Standard for Maintenance Testing Specifications for Electrical Distribution Equipment and Systems**
- **NFPA 70B Recommended Practice for Electrical Equipment Maintenance**

Note: These standards should be used and referenced by individuals familiar with maintenance planning and the use of the standard.

While this guide focuses on the electrical maintenance plan, the breakdown of any single system can impact other systems and cause their eventual failure. It's important to develop a comprehensive maintenance plan that includes all building systems to ensure that your building continues to operate safely and reliably.

Executing Your Maintenance Plan

Once you've created a maintenance plan, it's time to begin conducting regular maintenance and repair. The evolution of your plan will depend on your installation complexity, building condition and previous maintenance and repair. **Below are some key requirements to keep in mind as you execute your maintenance plan:**

1 Hiring a Licensed Electrical Contractor (LEC) to Perform Maintenance

Where a property owner or manager does not directly employ maintenance staff who are competent to undertake the work under a maintenance plan, the owner or manager will be required to hire a LEC. ESA recommends you ask key questions to ensure they are capable of undertaking the required work:

Q. Do you have experience performing electrical maintenance of the critical electrical equipment found in these types of residential buildings?

Q. What is your ECRA/ESA license number and can you provide three references where you performed similar maintenance work?

Q. Are you familiar with and trained on electrical maintenance standards, such as CSA Z463 or equivalent, and what they require?

Q. Can you provide me with options which include cost/benefits of maintenance compared to replacement?

Q. Does your company have the appropriate resources including test equipment to undertake the complex tasks associated with ensuring the safety and reliability of the electrical infrastructure?

Q. Are you prepared for unexpected events including sourcing replacement parts for the existing electrical equipment?

2 Notification of Work

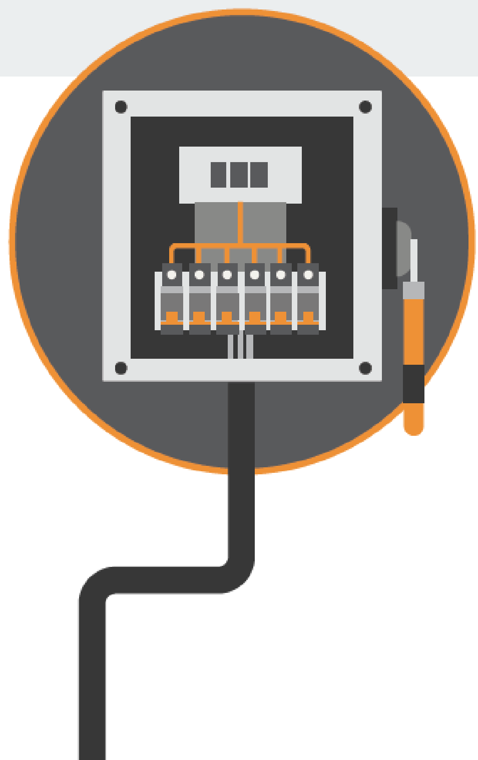
Always file the necessary notifications of work with ESA and request inspection of electrical work. You may also wish to inform municipal officials of any potential outages related to maintenance. Where an inspection is required, be prepared to supply ESA with records, including recent electrical maintenance and repairs, testing results and any identified and/or outstanding electrical deficiencies.

3 Regular Testing

Most maintenance and repair work is inspected visually, which will not detect some potentially dangerous problems. ESA recommends periodically performing insulation resistance and infrared tests, which can identify electrical issues not visible to the naked eye that can be addressed during regular maintenance. Periodic operation of electrical equipment is important to identify where repair or replacement is required (i.e. switches, circuit breakers, etc.).

4 Shutting Down Power

The Ontario Electrical Safety Code requires that no repairs or alterations be carried out on energized (live) equipment, except where complete disconnection of the equipment is not feasible. However, there are instances where testing can only be done energized including non-contact diagnostics such as infrared imaging. Where the main service of a building needs to be disconnected, a planned power outage to all or parts of the building will need to be coordinated by the property owner with the residents, local utility company and the Licensed Electrical Contractor who is doing the assessment. It is also important to contact your municipal government to inform them of the shutdown.



5 Educating Tenants

Improve the overall safety of your building by ensuring tenants know what their electrical safety responsibilities are, including:

- Ensuring they follow safe practices within their home, including not tampering with the electrical wiring in their unit, throwing out frayed cords or overloading the circuit by plugging in too many devices. Extension cords must be rated to carry the current of the appliances they connect.

! **Tenants should not complete any repairs without consulting you.**

6 ESA Programs

ESA's Continuous Safety Services (CSS) program offers services designed to increase electrical safety and compliance in facilities and support the requirements of the Ontario Electrical Safety Code.

The program offers:

✓ Facility Review

An ESA electrical inspector will conduct a visual inspection of your electrical system.

✓ Periodic Inspections

The CSS program offers regular inspections of electrical work in conjunction with maintenance activities. You will receive detailed inspection reports, which identify and prioritize electrical concerns (defects) that require action.

✓ Code Advice & Training

Members of the CSS program receive information and guidance on electrical safety and Code issues from a dedicated electrical inspector backed by a team of technical experts. Members also receive access to a number of general and technical electrical training workshops.

For further information on the CSS program or to apply to become a member of the program,

» please call 1-877-854-0079 or email at CSS.ContactUs@electricalsafety.on.ca

APPENDIX 5 –
EXCERPT FROM – CSA - Z463-18 - National Standard of Canada Maintenance of electrical systems
Annex M - Equipment-specific types of maintenance and maintenance priority levels

NOTE: CSA-Z463-18 Standards document highlights tests and expected results for different types of electrical equipment and systems that may be found in a multi-unit residential rental building. Each building will potentially be different and hence equipment and required tests will be unique to a specific building

Table M.1
Switchgear, metal-enclosed bus, outdoor bus, and overhead lines
(See Clauses 8.2.1, 8.2.6, 8.2.21, and 8.2.29.)

Legend:

x = a test or inspection should be performed
y = factory testing should be performed
— = factory testing is not required
n/s = not specified; testing frequency is at the discretion of the user
n/a = not applicable
a/n = as needed

Maintenance activities	Type of equipment — Tests to be performed: Switchgear and switchboard assemblies	Arc-resistant switchgear	SF6-insulated switchgear	Medium-voltage MCCs	Outdoor bus	Metal-enclosed busways	Low-voltage MCCs	Outdoor bus structures	Maintenance priority level, months: Minimal frequency	Good electrical practice	Optimized program for critical or severe-duty applications	Factory testing
Requiring minimal training, equipment, and safety apparel												
Verify that the environment is clean, dry, and non-corrosive	x	x	x	x	x	x	x	x				
Inspect the physical condition of the equipment	x	x	x	x	x	x	x	x	36	24	12	—
Check annunciation and component status	x	x	x	x			x		1	1	1	—
Ensure that all control and indicating devices are operational and clearly labelled	x	x	x	x	x	x	x	x	12	12	12	—
Clean power component cells	x	x		x			x			12	12	—
Function test interlocks and control devices	x	x	x	x	x		x	x	36	24	12	—

(Continued)

Table M.1 (Continued)

Maintenance activities	Type of equipment — Tests to be performed								Maintenance priority level, months			Factory testing
	Switch-gear and switch-board assem-blies	Arc-resist-ant switc-hgear	SF_6-insulat-ed switch-gear	Medi-um-voltage MCCs	Out-door bus	Metal-en-closed bus-ways	Low-volt-age MCCs	Out-door bus struc-tures	Mini-mal fre-quen-cy	Good elec-trical prac-tice	Optimized program for critical or severe-duty applica-tions	
Function test all switching devices	x	x	x	x	x		x	x	36	24	12	—
Inspect and clean control cabinets	x	x	x	x			x	x	36	36	12	—
Check insulating gas pressure			x						2	2	2	—
Check insulating gas leakage detection			x						36	36	36	—
Check online monitors and gauges for GIS			x						2	2	2	—
Inspect and function test cameras in GIS compartments			x						36	36	36	—
Verify shutter and barrier operation	x	x		x			x		36	24	12	—
Inspect equipment bonding	x	x	x	x	x	x	x	x	60	36	24	—
Inspect vents and filters	x			x			x		12	12	12	—
Ensure that all bolts are in place and properly torqued	x	x	x	x	x	x	x	x	36	24	12	—
Inspect instrument transformers	x	x		x			x	x	36	24	12	—
Verify the operation of space heaters	x	x		x			x		24	12	12	—
Conduct an internal inspection of gas-insulated switching components			x						72	72	72	y
Clean and lubricate raking mechanisms, shutter mechanisms, and drawers	x	x		x		x	x	x	12	12	12	—

(Continued)

Table M.1 (Continued)

Maintenance activities	Type of equipment — Tests to be performed								Maintenance priority level, months			Factory testing
	Switch-gear and switch-board assem-blies	Arc-resist-ant switc-hgear	SF_6-insulat-ed switch-gear	Medi-um-voltage MCCs	Out-door bus	Metal-en-closed bus-ways	Low-volt-age MCCs	Out-door bus struc-tures	Mini-mal fre-quen-cy	Good elec-trical prac-tice	Optimized program for critical or severe-duty applica-tions	
Monitor equipment loading and ensure that it is within equipment ratings	x	x	x	x	x	x	x	x	12	12	12	—
Requiring specialized training, equipment, and safety precautions												
Clean and inspect insulators	x	x		x	x		x	x	36	24	24	—
Insulation resistance test	x	x	x	x					—	—	36	—
Dielectric withstand test	x	x	x	x		x	x	x	36	24	12	—
Perform a ground resistance or bonding check	x	x	x	x	x	x	x	x	60	36	24	—
Verify connection bus torque	x	x	x	x	x	x	x	x	36	24	24	—
Function test plenum air handling systems		x							24	12	12	—
Contact resistance test of main bus assemblies	x	x	x	x	x	x	x	x	36	24	12	—
Contact resistance test of ground bus	x	x	x	x	x	x	x	x	36	24	12	—
Perform thermographic survey	x			x	x	x	x	x	24	12	12	—
Verify instrument transformers	x	x	x	x			x	x	36	24	12	—
Power factor test					x			x	36	24	12	—
Sample and analyze gas			x					x	36	24	12	—
Perform short-circuit analysis and ensure that gear is adequately rated	x	x	x	x	x	x	x	x	60	60	60	—

(Continued)

Table M.1 (Concluded)

Maintenance activities	Type of equipment — Tests to be performed								Maintenance priority level, months			Factory testing
	Switch-gear and switch-board assem-blies	Arc-resist-ant switc-hgear	SF_6-insulat-ed switch-gear	Medi-um-voltage MCCs	Out-door bus	Metal-en-closed bus-ways	Low-volt-age MCCs	Out-door bus struc-tures	Mini-mal fre-quen-cy	Good elec-trical prac-tice	Optimized program for critical or severe-duty applica-tions	
Ensure that arc flash labelling is in place and up to date	x	x	x	x	x	x	x	x	60	60	60	—
Test relays, meters, instrument transformers, breakers, surge arresters, etc., in accordance with the appropriate section of this Standard	x	x	x	x	x	x	x	x	*	*	*	—

* *Refer to the applicable guidance in Clause 8.*

Notes:

1) *Prior to starting testing, contractors should ensure that all client requirements necessary to allow work access to the equipment are met [e.g., permits, JHA].*
2) *For additional information, consult the following standards and reference material: ANSI/NETA MTS.*

Table M.2
Transformers
(See Clause 8.2.2.)

Legend:

x = a test or inspection should be performed
y = factory testing should be performed
— = factory testing is not required
n/s = not specified; testing frequency is at the discretion of the user
n/a = not applicable
a/n = as needed

Maintenance activities	Type of equipment — Tests to be performed							Maintenance priority level, months		
	Dry-type distribu-tion class <500 kV•A	Liquid-filled distribu-tion class <500 kV•A	Liquid-filled distribution class <500 kV•A pole mounted	Dry-type power class >500 kV•A	Liquid-filled power class >500 kV•A	TR sets	Arc fur-na-ces	Mini-mal fre-quency	Good elec-trical prac-tice	Optimized program for critical or severe-duty applications
Requiring minimal training, equipment, and safety apparel										
Read and reset T&P gauges				x	x	x		12	6	6
Visually verify that the paint is in good condition (no corrosion or peeling)				x	x	x		12	12	12
Check for leaks (tank, valves, etc.)					x	x		24	12	12
Exercise radiator cooling fans				x	x			12	12	12
Exercise radiator cooling pumps					x			12	12	12
Visually check the ground connections on the tank				x	x	x		24	24	24
Check that the nameplate remains legible				x	x	x		36	36	36
Make sure that the enclosure prevents the entry of vermin				x				12	12	12
Requiring specialized training, equipment, and safety precautions										

(Continued)

APPENDIX 5 –
EXCERPT FROM – ANSI/NETA MTS-2019 Standard for Maintenance Testing Specifications for Electrical Distribution Equipment and Systems

Sample of Inspection and Test Procedures and expected results of tests

7. INSPECTION AND TEST PROCEDURES

7.1 Switchgear, Switchboard, and Panelboard Assemblies

A. Visual and Mechanical Inspection

1. Inspect physical, electrical, and mechanical condition.
2. Inspect anchorage, alignment, grounding, and required area clearances.
3. Prior to cleaning the unit, perform as-found tests, if required.
4. Clean the unit.
5. Verify that fuse and/or circuit breaker sizes and types correspond to drawings and coordination study as well as to the circuit breaker address for microprocessor-communication packages.
6. Verify that current and voltage transformer ratios correspond to drawings.
7. Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
8. Inspect bolted electrical connections for high resistance using one or more of the following methods:
    1. Use of a low-resistance ohmmeter in accordance with Section 7.1.B.1.
    2. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or Table 100.12.
    3. Perform a thermographic survey in accordance with Section 9.
9. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
    1. Attempt closure on locked-open devices. Attempt to open locked-closed devices.
    2. Make key exchange with all devices included in the interlock scheme as applicable.
10. Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
11. Inspect insulators for evidence of physical damage or contaminated surfaces.
12. Verify correct barrier and shutter installation and operation.
13. Exercise all active components.
14. Inspect mechanical indicating devices for correct operation.
15. Verify that filters are in place and/or vents are clear.

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7. INSPECTION AND TEST PROCEDURES

7.1 Switchgear, Switchboard, and Panelboard Assemblies *(continued)*

16. Perform visual and mechanical inspection of instrument transformers in accordance with Section 7.10.

17. Perform visual and mechanical inspection of surge arresters in accordance with Section 7.19.

18. Inspect control power transformers.

    1. Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

    2. Verify that primary and secondary fuse ratings or circuit breakers match drawings.

    3. Verify correct functioning of drawout disconnecting and grounding contacts and interlocks.

19. Perform as-left tests.

B. Electrical Tests

1. Perform resistance measurements through bolted electrical connections with a low-resistance ohmmeter in accordance with Section 7.1.A.7.1.

2. Perform insulation-resistance tests for one minute on each bus section, phase-to-phase and phase-to-ground. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1.

*3. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data. within the absence of manufacturer's published data, use Table 100.2. The test voltage shall be applied for one minute. Refer to Section 7.1.3 before performing test.

*4. Perform insulation-resistance tests on control wiring with respect to ground. The applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.

5. Perform electrical tests on instrument transformers in accordance with Section 7.10.

6. Perform ground-resistance tests in accordance with Section 7.13.

7. Test metering devices in accordance with Section 7.11.

8. Control Power Transformers.

    1. Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1.

    2. Verify correct function of control transfer relays located in switchgear with multiple power sources.

9. Verify operation of switchgear/switchboard heaters and their controller.

10. Perform electrical tests of surge arresters in accordance with Section 7.19.

*11. Perform online partial-discharge survey in accordance with Section 11.

12. Perform system function tests in accordance with Section 8.

C. Test Values – Visual and Mechanical

1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value. (7.1.A.8.1)

2. Bolt-torque levels should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.12. (7.1.A.8.2)

3. Results of the thermographic survey shall be in accordance with Section 9. (7.1.A.3)

D. Test Values – Electrical

1. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2. Insulation-resistance values of bus insulation should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated. Dielectric withstand voltage tests should not proceed until insulation-resistance levels are raised above minimum values.

3. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the test, the test dielectric withstand voltage specimen is considered to have passed the test.

7. INSPECTION AND TEST PROCEDURES

7.1 Switchgear, Switchboard, and Panelboard Assemblies *(continued)*

4. Minimum insulation-resistance values of control wiring should be comparable to previously obtained results but not less than two megohms.

5. Results of electrical tests on instrument transformers should be in accordance with Section 7.10.

6. Results of ground resistance tests should be in accordance with Section 7.13.

7. Accuracy of metering devices should be in accordance with Section 7.11.

8. Control Power Transformers

   1. Insulation-resistance values of control power transformers should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.

   2. Control transfer relays should perform as designed.

9. Heaters should be operational.

10. Results of electrical tests on surge arresters shall be in accordance with Section 7.19.

11. Results of online partial-discharge survey should be in accordance with manufacturer's published data. In the absence of manufacturer's published data, refer to Table 100.23.

12. Results of system function tests shall be in accordance with Section 8.

NOTE: The ANSI/NETA Standards document highlights tests and expected results for different types of electrical equipment and systems that may be found in a multi-unit residential rental building. Each building will potentially be different and hence equipment and required tests will be unique to a specific building

APPENDIX B

Frequency of Maintenance Tests

NETA recognizes that the ideal maintenance program is reliability-based, unique to each plant and to each piece of equipment. NETA's Standards Review Council presents the following time-based maintenance schedule and matrix.

One should contact a NETA Accredited Company for a reliability-based evaluation.

The following matrix is to be used in conjunction with Appendix B, Inspections and Tests. Application of the matrix is recognized as a guide only.

Specific condition, criticality, and desired reliability must be determined to correctly apply the matrix. Application of the matrix, along with the culmination of historical testing data and trending, should provide a quality electrical preventive maintenance program.

MAINTENANCE FREQUENCY MATRIX				
		Equipment Condition		
		Poor	Average	Good
Equipment Reliability Requirement	Low	1.0	2.0	2.5
	Medium	0.50	1.0	1.5
	High	0.25	0.50	0.75

March, 2023

APPENDIX B
Frequency of Maintenance Tests

Inspections and Tests
Frequency in Months
(Multiply These Values by the Factor in the Maintenance Frequency Matrix)

Section	Description	Visual	Visual & Mechanical	Visual & Mechanical & Electrical
7.1	Switchgear & Switchboard Assemblies	12	12	24
7.2	Transformers			
7.2.1.1	Small Dry-Type Transformers	2	12	36
7.2.1.2	Large Dry-Type Transformers	1	12	24
7.2.2	Liquid-Filled Transformers	1	12	24
	Sampling	–	–	12
7.3	Cables			
7.3.1	Low-Voltage, Low-Energy	–	–	–
7.3.2	Low-Voltage, 600-Volt Maximum	2	12	36
7.3.3	Medium- and High-Voltage	2	12	36
7.4	Metal-Enclosed Busways	2	12	24
	Infrared Only	–	–	12
7.5	Switches			
7.5.1.1	Air, Low-Voltage	2	12	36
7.5.1.2	Air, Medium-Voltage, Metal-Enclosed	–	12	24
7.5.1.3	Air, Medium- and High-Voltage Open	1	12	24
7.5.2	Oil, Medium-Voltage	1	12	24
7.5.3	Vacuum, Medium-Voltage	1	12	24
7.5.4	Medium-Voltage, SF_6	1	12	24
7.5.5	Cutouts	12	24	24
7.6	Circuit Breakers			
7.6.1.1	Air, Insulated-Case/Molded-Case	1	12	36
7.6.1.2	Air, Low-Voltage Power	1	12	36
7.6.1.3	Air, Medium-Voltage	1	12	36
7.6.2	Oil, Medium-Voltage	1	12	36
	Sampling	–	–	12
7.6.2	Oil, High-Voltage	1	12	12
	Sampling	–	–	12
7.6.3	Vacuum, Medium-Voltage	1	12	24
7.6.4	SF_6	1	12	12
7.7	Circuit Switchers	1	12	12
7.8	Network Protectors	12	12	24

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APPENDIX B Frequency of Maintenance Tests (*continued*)				
Inspections and Tests Frequency in Months (Multiply These Values by the Factor in the Maintenance Frequency Matrix)				
Section	**Description**	**Visual**	**Visual & Mechanical**	**Visual & Mechanical & Electrical**
7.9	Protective Relays			
7.9.1	Electromechanical and Solid State	1	12	12
7.9.2	Microprocessor-Based	1	12	12
7.10	Instrument Transformers			
7.10.1	Current Transformers	12	12	36
7.10.2	Voltage Transformers	12	12	36
7.10.3	Coupling-Capacitor Transformers	12	12	36
7.11	Metering Devices			
7.11.1	Electromechanical and Solid-State	12	12	36
7.11.2	Microprocessor-Based	12	12	36
7.12	Regulating Apparatus			
7.12.1.1	Step-Voltage Regulators	1	12	24
	Sample Liquid	–	–	12
7.12.1.2	Induction Regulators	12	12	24
7.12.2	Current Regulators	1	12	24
7.12.3	Load Tap-changers	1	12	24
	Sample Liquid	–	–	12
7.13	Grounding Systems	2	12	24
7.14	Ground-Fault Protection Systems	2	12	12
7.15	Rotating Machinery			
7.15.1	AC Induction Motors and Generators	1	12	24
7.15.2	Synchronous Motors and Generators	1	12	24
7.15.3	DC Motors and Generators	1	12	24
7.16	Motor Control			
7.16.1.1	Motor Starters, Low-Voltage	2	12	24
7.16.1.2	Motor Starters, Medium-Voltage	2	12	24
7.16.2.1	Motor Control Centers, Low-Voltage	2	12	24
7.16.2.2	Motor Control Centers, Medium-Voltage	2	12	24
7.17	Adjustable-Speed Drive Systems	1	12	24
7.18	Direct-Current Systems			
7.18.1	Batteries			
7.18.1.1	Flooded Lead-Acid	1	12	12
7.18.1.2	Vented Nickel-Cadmium	1	12	12
7.18.1.3	Valve-Regulated Lead-Acid	1	12	12
7.18.2	Battery Chargers	1	12	12

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APPENDIX B
Frequency of Maintenance Tests (*continued*)

Inspections and Tests
Frequency in Months
(Multiply These Values by the Factor in the Maintenance Frequency Matrix)

Section	Description	Visual	Visual & Mechanical	Visual & Mechanical & Electrical
7.18.3	Rectifiers	1	12	24
7.19	Surge Arresters			
7.19.1	Low-Voltage Surge Protection Devices	2	12	24
7.19.2	Medium- and High-Voltage Surge Protection Devices	2	12	24
7.20	Capacitors and Reactors			
7.20.1	Capacitors	1	12	12
7.20.2	Capacitor Control Devices	1	12	12
7.20.3.1	Reactors, (Shunt and Current-Limiting) Dry-Type	2	12	24
7.20.3.2	Reactors, (Shunt and Current-Limiting) Liquid-Filled	1	12	24
	Sampling	–	–	12
7.21	Outdoor Bus Structures	1	12	36
7.22	Emergency Systems			
7.22.1	Engine Generator	1	2	12
	Functional Testing	–	–	2
7.22.2	Uninterruptible Power Systems	1	12	12
	Functional Testing	–	–	2
7.22.3	Automatic Transfer Switches	1	12	12
	Functional Testing	–	–	2
7.23	Communications - Reserved			
7.24	Automatic Circuit Reclosers and Line Sectionalizers			
7.24.1	Automatic Circuit Reclosers, Oil/Vacuum	1	12	24
	Sample	–	–	12
7.24.2	Automatic Line Sectionalizers, Oil	1	12	24
	Sample	–	–	12
9.	Thermographic Survey	–	12	–
10.	Electromagnetic Field Survey – As Needed	–	–	–
11.	Online Partial Discharge Survey for Switchgear	–	–	12